NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 09/08/2014.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

/hachristian/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101
POWER OF ATTORNEY TO PROSECUTE APPLICATIONS BEFORE THE USPTO

I hereby revoke all previous powers of attorney given in the application identified in the attached statement under 37 CFR 3.73(b).

I hereby appoint:

- Practitioners associated with the Customer Number:
  - 02292

  OR
  Practitioner(s) named below (if more than ten patent practitioners are to be named, then a customer number must be used):

<table>
<thead>
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<th>Registration Number</th>
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</table>

as attorney(s) or agent(s) to represent the undersigned before the United States Patent and Trademark Office (USPTO) in connection with any and all patent applications assigned only to the undersigned according to the USPTO assignment records or assignment documents attached to this form in accordance with 37 CFR 3.73(b).

Please change the correspondence address for the application identified in the attached statement under 37 CFR 3.73(b) to:

- The address associated with Customer Number:
  - 02292

  OR
  Firm or Individual Name:
  Address:
  City
  Country
  Telephone
  Email

Assignee Name and Address:
HUMANAX HOLDINGS CO., LTD.
(Yu-bang-dong) 2, Yeongmun-ro, Cheoin-gu
Yongin-si, Gyeonggido 449-934, Republic of Korea

A copy of this form, together with a statement under 37 CFR 3.73(b) (Form PTO/SB/96 or equivalent) is required to be filed in each application in which this form is used. The statement under 37 CFR 3.73(b) may be completed by one of the practitioners appointed in this form if the appointed practitioner is authorized to act on behalf of the assignee, and must identify the application in which this Power of Attorney is to be filed.

SIGNATURE of Assignee of Record
The individual whose signature and title is supplied below is authorized to act on behalf of the assignee:

Signature:
Date: 29, May 2014
Name: Yong-Han, LEE
Title: Assistant Manager
Telephone: +82 31 776 6243

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.
Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-578) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.
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**Payment information:**

Submitted with Payment: no

**File Listing:**

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**Warnings:**

**Information:**

| Total Files Size (in bytes) | 285981 |

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

**New Applications Under 35 U.S.C. 111**

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

**National Stage of an International Application under 35 U.S.C. 371**

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

**New International Application Filed with the USPTO as a Receiving Office**

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.
TRANSMITTAL FORM

Application Number 11/256,189
Filing Date October 24, 2005
First Named Inventor Euee-S JANG et al.
Art Unit 2624
Examiner Name D.P. ZARKA
Total Number of Pages in This Submission 4
Attorney Docket Number 5200-0123PUS1

ENCLOSURES (Check all that apply)

☐ Fee Transmittal Form
☐ Fee Attached
☐ Amendment/Reply
☐ After Final
☐ Affidavits/declaration(s)
☐ Extension of Time Request
☐ Express Abandonment Request
☐ Information Disclosure Statement
☐ Certified Copy of Priority Document(s)
☐ Reply to Missing Parts/Incomplete Application
☐ under 37 CFR 1.52 or 1.53

☐ Drawing(s)
☐ Licensing-related Papers
☐ Petition
☐ Petition to Convert to a Provisional Application
☐ Power of Attorney, Revocation, Change of Correspondence Address
☐ Terminal Disclaimer
☐ Request for Refund
☐ CD, Number of CD(s)
☐ Landscape Table on CD

Remarks

CERTIFICATE OF TRANSMISSION/MAILING

I hereby certify that this correspondence is being facsimile transmitted to the USPTO or deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on the date shown below:

Signature

Typed or printed name

Date

This collection of information is required by 37 CFR 1.5. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.
STATEMENT UNDER 37 CFR 3.73(b)

Applicant/Patient Owner: HUMAX HOLDINGS CO., LTD.

Application No./Patent No.: 7,912,131 Filed/Issue Date: March 22, 2011

Titled: SELECTIVE PREDICTION ENCODING AND DECODING METHODS AND DEVICES WITH AC/DC AND ADVANCED VIDEO CODING PREDICTION

HUMAX HOLDINGS CO., LTD., a Corporation (Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that it is:

1. [ ] the assignee of the entire right, title, and interest in;

2. [ ] an assignee of less than the entire right, title, and interest in  (The extent (by percentage) of its ownership interest is __________ %); or

3. [ ] the assignee of an undivided interest in the entirety of (a complete assignment from one of the joint inventors was made) the patent application/patent identified above, by virtue of either:

A. [ ] An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel ____________, Frame ____________, or for which a copy therefore is attached.

OR

B. [ ] A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: Euhee-S JANG ET AL. To: HUMAX CO., LTD.

   The document was recorded in the United States Patent and Trademark Office at
   Reel 024666, Frame 0670, or for which a copy thereof is attached.

2. From: HUMAX CO., LTD. To: HUMAX HOLDINGS CO., LTD.

   The document was recorded in the United States Patent and Trademark Office at
   Reel 033555, Frame 0343, or for which a copy thereof is attached.

3. From: ____________________________ To: ____________________________

   The document was recorded in the United States Patent and Trademark Office at
   Reel ____________, Frame ____________, or for which a copy thereof is attached.

[ ] Additional documents in the chain of title are listed on a supplemental sheet(s).

[ ] As required by 37 CFR 3.73(b)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (i.e., a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

Signature: [Signature]

Date: SEP 8, 2014

Esther H. Chong, Reg. No. 40953

Printed or Typed Name: Attorney of Record

This collection of information is required by 37 CFR 3.73(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.15 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.
The projected patent number and issue date are specified above.

**Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)**

(application filed on or after May 29, 2000)

The Patent Term Adjustment is 1549 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

Eunee-S Jang, Seoul, KOREA, REPUBLIC OF;
Yung-Lyul Lee, Seoul, KOREA, REPUBLIC OF;
Sun-Young Lee, Seoul, KOREA, REPUBLIC OF;
Sung-Won Park, Seoul, KOREA, REPUBLIC OF;
Jong-Woo Won, Seoul, KOREA, REPUBLIC OF;
Yong-Ho Cho, Seoul, KOREA, REPUBLIC OF;
Chung-Ku Lee, Incheon, KOREA, REPUBLIC OF;

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax
(571) 273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

24735 7590 11/16/2010

BAKER BOTTS LLP
C/O INTELLECTUAL PROPERTY DEPARTMENT
THE WARNER, SUITE 1300
1299 PENNSYLVANIA AVE, NW
WASHINGTON, DC 20004-2400

APPLICATION NO. 11/256,188 FILING DATE 10/24/2005 FIRST NAMED INVENTOR Eunee-S Jang ATTORNEY DOCKET NO. 076960.0101 CONFIRMATION NO. 5518

TITLE OF INVENTION: SELECTIVE PREDICTION ENCODING AND DECODING METHODS AND DEVICES WITH AC/DC AND ADVANCED VIDEO CODING PREDICTION

APPLN. TYPE SMALL ENTITY ISSUE FEE DUE PUBLICATION FEE DUE PREV. PAID ISSUE FEE TOTAL FEE(S) DUE DATE DUE

nonprovisional NO $1510 $300 $0 $1810 02/16/2011

EXAMINER ART UNIT CLASS-SUBCLASS

RASHID, DAVID 2624 375-240180

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
   1) Change of correspondence address (or Change of Correspondence Address form PTOS/B122) attached.
   2) "Fee Address" indication (or Fee Address Indication form PTOS/B47; Rev 03-02 or more recent) attached. Use of a Customer Number is required.

2. For printing on the patent front page, list
   (1) the names of up to 3 registered patent attorneys or agents OR, alternatively,
   (2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

   Baker Botts L.L.P.

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

   PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

   (A) NAME OF ASSIGNEE
   HUMAX Co., Ltd.

   (B) RESIDENCE: (CITY AND STATE OR COUNTRY)
   Gyeonggi-do, Republic of Korea

   Please check the appropriate assignee category or categories (will not be printed on the patent):   [ ] Individual   [ ] Corporation or other private group entity   [ ] Government

4a. The following fee(s) are submitted:
   [ ] Issue Fee
   [ ] Publication Fee (No small entity discount permitted)
   [ ] Advance Order - # of Copies TWO (2)

4b. Payment of Fee(s): (Please first reapply any previously paid issue fee shown above)
   [ ] A check is enclosed.
   [ ] Payment by credit card, Form PTO-2038 is attached.
   [ ] The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment, to Deposit Account Number 02-0375. (enclose an extra copy of this form).

5. Change in Entity Status (from status indicated above)
   [ ] a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27. [ ] b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature / James B. Arpin/ Date February 15, 2011

Typed or printed name James B. Arpin
Registration No. 33, 470

This collection of information is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

FTOL-85 (Rev. 08/07) Approved for use through 08/31/2010. OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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<td>Euee-S Jang</td>
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<td>JAMES B ARPIN</td>
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This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

**New Applications Under 35 U.S.C. 111**
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

**National Stage of an International Application under 35 U.S.C. 371**
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

**New International Application Filed with the USPTO as a Receiving Office**
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.
In re Patent Application of:  
Euee-S JANG et al.  
Application No.: 11/256,188  
Filed: October 24, 2005  
For: SELECTIVE PREDICTION  
ENCODING AND DECODING  
METHODS AND DEVICES  
WITH AC/DC AND ADVANCED  
VIDEO CODING PREDICTION  

Examiner: David RASHID  
Group Art Unit: 2624  
Confirmation No.: 5518

PAYMENT OF ISSUE AND PUBLICATION FEES

MAIL STOP ISSUE FEE  
Commissioner for Patents  
U.S. Patent and Trademark Office  
Customer Service Window  
Randolph Building  
401 Dulany Street  
Alexandria, VA 22314

Sir:

In accordance with the Notice of Allowance and Fee(s) Due mailed November 16, 2010, Applicants are enclosing the Part B - Fee(s) Transmittal including an order for two (2) advance patent copies. Applicants respectfully request that the U.S. Patent and Trademark Office ("PTO") charge the undersigned’s Deposit Account No. 02-0375 for the amount of $1,816.00 for the Issue Fee ($1,510.00), the Publication Fee ($300.00), and the charge for the Advance Order of two (2) copies ($6.00). In the event of any variance between the
amount determined by Applicants and the fees determined by the PTO, please charge or credit such variance to the undersigned’s Deposit Account No. 02-0375.

Respectfully submitted,

BAKER BOTTS L.L.P.

Dated: February 15, 2011

By:

James B. Arpin
Registration No. 33,470

BAKER BOTTS L.L.P.
The Warner; Suite 1300
1299 Pennsylvania Avenue, N.W.
Washington, D.C. 20004-2400
(202) 639-7700 (telephone)
(202) 639-7890 (facsimile)

JBA/djw
Enclosure
NOTICE OF ALLOWANCE AND FEE(S) DUE

BAKER BOTTS LLP
C/O INTELLECTUAL PROPERTY DEPARTMENT
THE WARNER, SUITE 1300
1299 PENNSYLVANIA AVE, NW
WASHINGTON, DC 20004-2400

EXAMINER
RASHID, DAVID

ART UNIT 2524
PAPER NUMBER

APPLICATION NO. 11/256,188
FILING DATE 10/24/2005
FIRST NAMED INVENTOR Ewee-S Jang
ATTORNEY DOCKET NO. 076980.0101
CONFIRMATION NO. 5518

TITLE OF INVENTION: SELECTIVE PREDICTION ENCODING AND DECODING METHODS AND DEVICES WITH AC/DC AND ADVANCED VIDEO CODING PREDICTION

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the SMALL ENTITY status shown above.

If the SMALL ENTITY is shown as YES, verify your current SMALL ENTITY status:

A. If the status is the same, pay the TOTAL FEE(S) DUE shown above.

B. If the status above is to be removed, check box 5b on Part B - Fee(s) Transmittal and pay the PUBLICATION FEE (if required) and twice the amount of the ISSUE FEE shown above, or

If the SMALL ENTITY is shown as NO:

A. Pay TOTAL FEE(S) DUE shown above, or

B. If applicant claimed SMALL ENTITY status before, or is now claiming SMALL ENTITY status, check box 5a on Part B - Fee(s) Transmittal and pay the PUBLICATION FEE (if required) and 1/2 the ISSUE FEE shown above.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

Page 1 of 3

PTOL-85 (Rev. 08/07) Approved for use through 08/31/2010.
PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail

Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

or Fax

(571)273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate “FEE ADDRESS” for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

24735
7590
11/16/2010

BAKER BOTTS LLP
C/O INTELLECTUAL PROPERTY DEPARTMENT
THE WARNER, SUITE 1300
1299 PENNSYLVANIA AVE, NW
WASHINGTON, DC 20004-2400

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Date)

Depositor’s name

(Signature)

APPLICATION NO. 11/256,188
FILING DATE 10/24/2005
FIRST NAMED INVENTOR Eun-S Jang
ATTORNEY DOCKET NO. 076980.0101
CONFIRMATION NO. 5518

TITLE OF INVENTION: SELECTIVE PREDICTION ENCODING AND DECODING METHODS AND DEVICES WITH AC/DC AND ADVANCED VIDEO CODING PREDICTION

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EXAMINER RASHID, DAVID
ART UNIT 2624
CLASS-SUBCLASS 375-240180

1. Change of correspondence address or indication of “Fee Address” (37 CFR 1.363). (a) Change of correspondence address (or Change of Correspondence Address Form PTO/SB/122) attached. (b) “Fee Address” indication (or “Fee Address” Indication Form PTO/SB/47, Rev 03-02 or more recent) attached. Use of a Customer Number is required.

2. For printing on the patent front page, list

1. the names of up to 3 registered patent attorneys or agents OR, alternatively, 2. the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recording as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent):

☐ Individual ☐ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:

☐ Issue Fee

☐ Publication Fee (No small entity discount permitted)

☐ Advance Order - # of Copies ______

4b. Payment of Fee(s): (Please first reapply any previously paid issue fee shown above)

☐ A check is enclosed.

☐ Payment by credit card. Form PTO-2038 is attached.

☐ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment, to Deposit Account Number ______ (enclose an extra copy of this form).

5. Change in Entity Status (from status indicated above)

☐ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27.

☐ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature ___________________________ Date __________

Typed or printed name ___________________________ Registration No. ___________________________

This collection of information is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PTOL-85 (Rev. 08/07) Approved for use through 08/31/2010.

OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment to date is 1285 day(s). If the issue fee is paid on the date that is three months after the mailing date of this notice and the patent issues on the Tuesday before the date that is 28 weeks (six and a half months) after the mailing date of this notice, the Patent Term Adjustment will be 1285 day(s).

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.
Notice of Allowability

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<td>Art Unit</td>
</tr>
<tr>
<td>DAVID P. RASHID</td>
<td>2624</td>
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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS. This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☑ This communication is responsive to the amendment filed 10/1/2010 and examiner-initiated interview 11/5/2010.

2. ☑ The allowed claim(s) is/are 1-4, 13-14.

3. ☑ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
   a) ☑ All   b) ☑ Some*  c) ☑ None  of the:
      1. ☑ Certified copies of the priority documents have been received.
      2. ☑ Certified copies of the priority documents have been received in Application No. ______.
      3. ☑ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: ______.

   Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.

   THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

4. ☑ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER’S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.

5. ☑ CORRECTED DRAWINGS (as “replacement sheets”) must be submitted.
   (a) ☑ including changes required by the Notice of Draftsman’s Patent Drawing Review (PTO-948) attached
       1) ☑ hereto or 2) ☑ to Paper No./Mail Date ______.
   (b) ☑ including changes required by the attached Examiner’s Amendment / Comment or in the Office action of Paper No./Mail Date ______.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☑ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner’s comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

---

Attachment(s)

1. ☑ Notice of References Cited (PTO-892)
3. ☑ Information Disclosure Statements (PTO/SD/08), Paper No./Mail Date ______
4. ☑ Examiner’s Comment Regarding Requirement for Deposit of Biological Material
6. ☑ Interview Summary (PTO-413), Paper No./Mail Date ______
7. ☑ Examiner’s Amendment/Comment
8. ☑ Examiner’s Statement of Reasons for Allowance
9. ☑ Other ______.

/David P Rashid/
Examiner, Art Unit 2624
Examiner-Initiated Interview Summary

Application No. 11/256,188
Applicant(s) JANG ET AL.

Examiner DAVID P. RASHID
Art Unit 2624

All Participants:

1. DAVID P. RASHID.

2. JAMES ARPIN (Reg. No. 33,470).

Date of Interview: 5 November 2010

Status of Application: ____

Time: ____

Type of Interview:

☒ Telephonic
☐ Video Conference
☐ Personal (Copy given to: ☐ Applicant ☐ Applicant’s representative)

Exhibit Shown or Demonstrated: ☐ Yes ☐ No

If Yes, provide a brief description: .

Part I.

Rejection(s) discussed:

Claims discussed:
13

Prior art documents discussed:

Part II.

SUBSTANCE OF INTERVIEW DESCRIBING THE GENERAL NATURE OF WHAT WAS DISCUSSED:

Examiner discussed with Applicant's representative the lack of antecedent basis for "the AVC intra prediction". Claim 13, line 11. Examiner suggested to change Claim 13, line 8 to "an Advanced Video Coding (AVC) intra prediction decoding process", as consistent with Claim 1. Applicant's representative authorized Examiner by Examiner's amendment.

Furthermore, Examiner received via email from Applicant's representative a copy of the publication Intra Prediction (T9/T10) and DC/AC Prediction Results.

Part III.

☒ It is not necessary for applicant to provide a separate record of the substance of the interview, since the interview directly resulted in the allowance of the application. The examiner will provide a written summary of the substance of the interview in the Notice of Allowability.
☐ It is not necessary for applicant to provide a separate record of the substance of the interview, since the interview did not result in resolution of all issues. A brief summary by the examiner appears in Part II above.

/David P Rashid/
Examiner, Art Unit 2624

(Applicant/Applicant’s Representative Signature – if appropriate)
EXAMINER’S AMENDMENT & STATEMENT OF REASONS FOR ALLOWANCE

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Amendments & Claim Status 2
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Formal Examiner’s Amendment 3
Amendment to the Claims 3
Allowable Subject Matter 3
Reasons for Allowance 3
Conclusion 4
Citation of Pertinent Prior Art 4

Amendments & Claim Status


In response to Amendment and the telephone interview, the previous specification objection; objected Claims 1-4, 12, and 14 under 37 C.F.R. § 1.75(a); rejected Claims 25-28 under 35 U.S.C. § 112, second paragraph as being indefinite; rejected Claims 1-20 under § 101 as not falling within one of the four statutory categories of invention are withdrawn.

The replacement drawings were received on Oct. 1, 2010 and are acceptable. In response, the previous drawing objections are withdrawn.

Requirement for Information

[1] The Examiner asked whether Applicant has either (i) a provided full copy of publication; or (ii) information that would be relevant to the patentability determination (e.g., a link to access the publication) to the relevant prior art publication, "Intra Prediction (T9/T10) and DC/Ac Prediction Results", International Organisation for Standardisation Coding of Moving Pictures and Associated Audio Information ISO/IEC JTC1/SC29/WG11 MPEG96/0939 Jul. 1996 ("Tan"), found in the Examiner’s search. See Detailed Action at 3 and 4, Jul. 1, 2010.
The Amendment includes that as of Sep. 30, 2010, “Tan is not readily available to Applicants”, “Applicants are attempting to obtain a copy of Tan”, and that Applicant’s understand this is an acceptable response after a telephone conversation with the Examiner. Amendment at 7.

Amendment at 7 appears both (i) a statement that the information required to be submitted is either unknown and/or not readily available; and (ii) a good faith attempt to obtain the information consistent. See MPEP § 704.12(b).

The request for information is withdrawn.

In addition, Applicant’s representative subsequently contacted Examiner on Nov. 2, 2010 to disclose a copy of Tan. Applicant's representative submitted Tan view view email.

Formal Examiner’s Amendment

[2] This formal Examiner’s Amendment is responsive to the telephone interview dated Nov. 5, 2010. See attached Examiner-Initiated Interview Summary.


This formal Examiner’s amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 C.F.R. § 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

Amendment to the Claims
Claim 13, line 8:

“an Advanced Video Coding (AVC) intra prediction”.

Allowable Subject Matter


Reasons for Allowance
[5] The following is an examiner’s statement of reasons for allowance:

Regarding Claim 1, the prior art of record does not teach wherein the AC/DC code amount is generated by entropy encoding a particular value obtained through the AC/DC prediction, and the AVC code amount is generated by entropy encoding a further value obtained through the AVC intra prediction. Claim 13 allowed by analogy. Claims 2-4 and 14 allowed by dependency.

[6] Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled “Comments on Statement of Reasons for Allowance.”

Conclusion

Citation of Pertinent Prior Art

[7] The prior art made of record and not relied upon is considered pertinent to applicant's disclosure: Tan et al., Intra Prediction (T9/T10) and DC/Ac Prediction Results, International Organisation for Standardisation Coding of Moving Pictures and Associated Audio Information ISO/IEC JTC1/SC29/WG11 MPEG96/0939, Jul. 1996.

[8] Any inquiry concerning this communication or earlier communications from the examiner should be directed to DAVID P. RASHID whose telephone number is (571)270-1578 and fax number (571)270-2578. The examiner can normally be reached Monday - Friday 7:30 - 17:00 ET.

If attempts to reach the examiner by telephone are unsuccessful, the examiner’s supervisor, Bhavesh Mehta can be reached on (571) 272-7453. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR
system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/David P. Rashid/
Examiner, Art Unit 2624

David P Rashid
Examiner
Art Unit 26244
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*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)*

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**Total Claims Allowed:**

- 6

(Primary Examiner) /DAVID P RASHID/
Examiner Art Unit 2624

(Date) 11/02/2010

O.G. Print Claim(s) 1
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(Secondary Examiner)
| CLAIM | DATE | | |
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| Final | Original | 06/23/2010 | 11/02/2010 | | |
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CONFIRMATION NO. 5518

SERIAL NUMBER 11/256,188
FILING or 371(c) RULE 10/24/2005
CLASS 375
GROUP ART UNIT 2624
ATTORNEY DOCKET NO. 076980.0101

APPLICANTS
Euee-S Jang, Seoul, KOREA, REPUBLIC OF;
Yung-Lyul Lee, Seoul, KOREA, REPUBLIC OF;
Sun-Young Lee, Seoul, KOREA, REPUBLIC OF;
Sung-Won Park, Seoul, KOREA, REPUBLIC OF;
Jong-Woo Won, Seoul, KOREA, REPUBLIC OF;
Yong-Ho Cho, Seoul, KOREA, REPUBLIC OF;
Chung-Ku Lee, Inchon, KOREA, REPUBLIC OF;

** CONTINUING DATA ***********************

** FOREIGN APPLICATIONS **********************
REPUBLIC OF KOREA 10-2004-0084918 10/22/2004 DPR

** IF REQUIRED, FOREIGN FILING LICENSE GRANTED **
11/17/2005

FOREIGN Priority claimed ☑ Yes ☐ No
35 USC 119(a-d) conditions met ☑ Yes ☐ No
Met after Allowance ☐ Met after
DPR ☑ Imma

STATE OR COUNTRY KOREA, REPUBLIC OF
SHEETS DRAWINGS 8
TOTAL CLAIMS 20
INDEPENDENT CLAIMS 4

ADDRESS
BAKER BOTTs LLP
C/O INTELLECTUAL PROPERTY DEPARTMENT
THE WARNER, SUITE 1300
1299 PENNSYLVANIA AVE, NW
WASHINGTON, DC 20004-2400
UNITED STATES

TITLE
Selective prediction encoding and decoding methods and devices with ac/dc and advanced video coding prediction

FILING FEE RECEIVED 1330

FEES: Authority has been given in Paper No. _________ to charge/credit DEPOSIT ACCOUNT No. ___________ for following:

☑ All Fees
☐ 1.16 Fees (Filing)
☐ 1.17 Fees (Processing Ext. of time)
☐ 1.18 Fees (Issue)
☐ Other ____________________
☐ Credit
Rashid, David

From: james.arpin@bakerbotts.com
Sent: Tuesday, November 02, 2010 10:01 AM
To: Rashid, David
Cc: DLDCIPDocketing@bakerbotts.com
Attachments: tanref.PDF

Dear Examiner Rashid:

In accordance with our telephone conversation this morning, we are attaching a copy of the Tan reference, for your review. Please confirm receipt of this e-mail transmission by return e-mail. As always, if you have any questions or comments concerning this reference, please do not hesitate to contact us.

Respectfully submitted,

/James B. Arpin/

James B. Arpin
Reg. No. 33470
Baker Botts L.L.P.
The Warner, Suite 1300
1299 Pennsylvania Avenue, N.W.
Washington DC 20004-2400
Tel: 202-639-7735
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE


For: SELECTIVE PREDICTION ENCODING AND DECODING METHODS AND SELECTIVE PREDICTION ENCODING AND DECODING DEVICES

RESPONSIVE AMENDMENT UNDER 37 C.F.R. § 1.111

MAIL STOP AMENDMENT
Commissioner of Patents
U.S. Patent and Trademark Office
Customer Service Window
Randolph Building
401 Dulany Street
Alexandria, VA 22314

Sir:

In response to the Office Action, of which Applicants were notified by the U.S. Patent and Trademark Office (“PTO”) on July 1, 2010, Applicants respectfully request that the Examiner reconsider this application in view of the following:

Amendments to the Specification begin on page 2 of this paper.

Amendments to the Claims are reflected in a listing of claims which begins on page 3 of this paper.

Amendments to the Drawings begin on page 5 of this paper and include both attached replacement sheets and annotated sheets showing changes.

Request for Reconsideration begins on page 6 of this paper.

Remarks begin on page 7 of this paper.

Conclusion begins on page 11 of this paper.
Amendments to the Specification:

Please replace the Title of the Invention with the following, amended Title of the Invention:

Selective Prediction Encoding and Decoding Methods and Selective Prediction Encoding and Decoding Devices with AC/DC and Advanced Video Coding Prediction
Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in this application.

Listing of Claims:

Claim 1. (Currently Amended) A non-transitory, computer-readable medium containing computer readable instructions that cause a computer to perform a selective prediction encoding method for identifying an encoding method for a macro block, comprising the steps of:

performing AC/DC prediction and Advanced Video Coding (AVC) intra prediction for said macro block;

generating an AC/DC code amount from the AC/DC prediction and an AVC code amount from the AVC intra prediction for said macro block;

selecting, between an AC/DC prediction encoding method and an AVC intra prediction encoding method for said macro block, the method which corresponds to the smaller of said AC/DC code amount and said AVC code amount;

performing the selected prediction encoding method to said macro block; and,

recording an AC/DC flag indicating the AC/DC prediction encoding method in a flag field when the AC/DC prediction encoding method is selected and an AVC flag indicating the AVC intra prediction encoding method in the flag field when the AVC intra prediction encoding method is selected,

wherein the AC/DC code amount is generated by entropy encoding a particular value obtained through the AC/DC prediction, and the AVC code amount is generated by entropy encoding a further value obtained through the AVC intra prediction.

Claim 2. (Currently Amended) The computer-readable medium selective prediction encoding method according to claim 1, further comprising the step of checking whether said macro block is a predetermined unit of process and performing the steps of claim 1, only when said macro block is one of said predetermined units of process.

Claim 3. (Currently Amended) The computer-readable medium selective prediction encoding method according to claim 1, wherein the step of selecting further comprises selecting one of the AC/DC prediction encoding method and the AVC intra prediction encoding method in
accordance with a predetermined criterion, when said AC/DC code amount and said AVC code amount are equal to each other.

Claim 4. (Currently Amended) The computer-readable medium selective-prediction encoding method according to claim 1, wherein the flag field is included in [[an]] a macro-block-layer (MB-layer) header of a bit stream.

Claims 5-12. (Canceled).

Claim 13. (Currently Amended) A non-transitory, computer-readable medium containing computer readable instructions that cause a computer to perform a selective prediction decoding method for identifying a decoding method for a macro block, comprising the steps of:

recognizing a prediction flag value identifying either an AC/DC coded macro block or an intra coded macro block, which flag value is included in a header of a received bit stream; and

decoding said received bit stream by one of an AC/DC prediction decoding process and an intra prediction decoding process in accordance with the recognized prediction flag value; and

generating an AC/DC code amount by entropy encoding a particular value obtained through the AC/DC prediction, and generating an AVC code amount by entropy encoding a further value obtained through the AVC intra prediction.

Claim 14. (Currently Amended) The computer-readable medium selective-prediction decoding method according to claim 13, wherein the prediction flag value is recorded in a prediction flag field of [[an]] a macro-block-layer (MB-layer) header of the bit stream.

Claims 15-20. (Canceled).
Amendments to the Drawings:
The attached sheets of drawings include changes to Figs. 1-8. These sheets, which include Figs. 1-8, replace the original sheets including Figs. 1-8. In Figs. 1-8, the view numbers have been enlarged.

Attachment:  Replacement Sheets
             Annotated Sheets Showing Changes
Request for Reconsideration:

Claims 1-4, 13, and 14 are pending in this application. Applicants are amending independent claims 1 and 13 to further describe subject matter of the claimed embodiments of the invention. Applicants also are amending claims 2-4 and 14 for consistency with the claims from which they depend. Applicants also are canceling claims 5-12 and 15-20, without prejudice or disclaimer. No new matter is added by the foregoing amendments, and these amendments are supported fully by the specification, as filed. E.g., Appl’n, Page 12, Line 3, through Page 13, Line 16; Fig. 3. Applicants respectfully request that the Examiner enter the foregoing amendments and reconsider the above-captioned patent application in view of the foregoing amendments and the following remarks.
Remarks:

1. Objections and Rejections.

Claims 1-20 are pending in this application. Initially, the Office Action requests that Applicants provide a complete copy of T.K. Tan et al., “Intra Prediction (T9/T10) and DC/AC Prediction Results,” International Organization for Standardization Coding of Moving Pictures and Associated Audio Information ISO/IEC JTC1/SC29/WG11 MPEG96/0939, July 1996 (“Tan”), under 37 C.F.R. § 1.105. In addition, the Office Action objects to the drawings under 37 C.F.R. § 1.84(u)(2), as allegedly failing to include view numbers larger than the numbers used as reference numbers and to the Title of the Invention as allegedly non-descriptive. Further, the Office Action objects to claims 1, 4, 12, and 14, as allegedly containing certain informalities.


2. Requirement for Information.

As noted above, the Office Action requires Applicants to provide a complete copy of Tan. As Applicants’ representative discussed with the Examiner in a telephone conversation on September 30, 2010, at the present time, Tan is not readily available to Applicants. MPEP 704.10. Nevertheless, Applicants are attempting to obtain a copy of Tan to provide to the PTO. In the telephone conversation, the Examiner acknowledged that this is an acceptable response to the requirement for information.
3. **Objections to the Specification.**

   As noted above, the Office Action objects to the Title of the Invention, as allegedly non-descriptive. Applicants are amending the Title of the Invention to be more descriptive. Therefore, Applicants respectfully request that the Examiner withdraw the objection to the Title of the Invention, at least for this reason.

4. **Objections to the Drawings.**

   As noted above, the Office Action objects to the drawings, as allegedly failing to include view numbers larger than the numbers used as reference numbers. Applicants are amending the drawings to enlarge the view numbers. Therefore, Applicants respectfully request that the Examiner withdraw the objection to the drawings, at least for this reason.

5. **Non-Statutory Subject Matter Rejections.**

   As noted above, claims 1-20 stand rejected as allegedly directed to non-statutory subject matter. Office Action, Page 6, Line 1, to Page 8, Line 2. Applicants are canceling claims 5-12 and 15-20, without prejudice or disclaimer, thereby rendering the rejection of those claims moot. Applicants are amending claims 1-4, 13, and 14 to describe, in part, “[a] computer program product stored on a non-transitory, computer-readable medium comprising instructions for causing a processor to perform a selective prediction encoding [or decoding] method.” Applicants respectfully maintain that claims 1-4, 13, and 14, as amended, are directed to statutory subject matter. MPEP 2106.01. Therefore, Applicants respectfully request that the Examiner withdraw the non-statutory subject matter rejections of amended claims 1-4, 13, and 14, at least for this reason.

6. **Obviousness Rejections**

   As detailed above, claims 1-20 stand rejected as allegedly rendered obvious by Haskell in view of various other cited references. Applicants are canceling claims 5-12 and 15-20, without prejudice or disclaimer, thereby rendering the rejection of those claims moot. In order to establish a *prima facie* case of obviousness, the Office Action must fulfill three (3) basic criteria. MPEP 2142 and 2143. First, there must be some clear and explicit articulation of the reason(s) why it would have been obvious, either in the references themselves or in the
knowledge generally available to those of ordinary skill in the art, to modify the primary reference as proposed by the Office Action. Second, there must be a reasonable expectation of success. MPEP 2143.02. To satisfy this criteria, the Office Action must demonstrate that “one skilled in the art could have combined the elements as claimed by known methods with no change in their respective functions, and the combination would have yielded nothing more than predictable results to one of ordinary skill in the art.” MPEP 2143.02. Third, the cited references or the knowledge generally available to those of ordinary skill in the art must disclose or suggest all of the claim limitations. MPEP 2142. For the reasons set forth below, Applicants maintain that the Office Action fails to establish a prima facie case of obviousness with respect to claims 1-4, 13, and 14, as amended.

a. Claim 1.

As previously presented, claim 1 describes, in part, “selecting between an AC/DC prediction method and an AVC intra prediction encoding method for said macro block, the method which corresponds to the smaller of said AC/DC code amount and said AVC code amount.” As described in Applicants’ specification, “[a]n amount of coding means an amount obtained by encoding a predicted value by the use of the entropy coding.” Appl’n, Page 12, Lines 14-17. The Office Action contends that the prediction circuit shown in Haskell’s Fig. 7A performs these limitations of Applicant’s claim 1, because Haskell describes that “prediction analyzer 180 selects the prediction circuit that yields the greatest overall compression.” Office Action, Page 9, Lines 12-16 (emphasis in original). Nevertheless, Haskell does not disclose or suggest that the prediction circuit with the greatest overall compression is selected based on its code amount. In particular, Haskell does not disclose or suggest entropy encoding a value to obtain a code amount and using that code amount to select the compression method. Although Haskell’s Fig. 7A describes comparing the results of prediction blocks 150 and 170 with prediction analyzer 180, Haskell does not disclose or suggest that prediction blocks 150 or 170 perform an entropy coding. Rather, prediction blocks 150 and 170 merely provide predicted results; the actual coding is performed later by variable length coder 160. Haskell, Col. 3, Lines 12-17; Fig. 7A. The Office Action does not contend that any other cited reference discloses or suggests these missing limitations of claim 1, as previously presented.
Solely to expedite prosecution of this application, Applicants also are amending claim 1 to describe, in part, “the AC/DC code amount is generated by entropy encoding a particular value obtained through the AC/DC prediction, and the AVC code amount is generated by entropy encoding a further value obtained through the AVC intra prediction.” E.g., Appl’n, Page 12, Line 3, through Page 13, Line 16; Fig. 3. As discussed above, Haskell does not disclose or suggest performing an entropy encoding of a value to obtain a code amount and using that code amount to select a coding method. Rather, Haskell merely describes selecting a prediction circuit “that yields the best compression performance.” Haskell, Col. 7, Lines 58-61. The Office Action does not contend that any other cited reference discloses or suggests these missing limitations of claim 1. Therefore, the Office Action fails to establish a prima facie case of obviousness with respect to claim 1, as amended, and Applicants respectfully request that the Examiner withdraw the obviousness rejection of claim 1, at least for these reasons.


Applicant’s are amending claim 13 to describe, in part, “generating an AC/DC code amount by entropy encoding a particular value obtained through the AC/DC prediction, and generating an AVC code amount by entropy encoding a further value obtained through the AVC intra prediction.” In particular, Applicants’ describe that “[t]he decoder may include the encoder and the selective prediction encoding device.” Appl’n, Page 13, Lines 10-13. As discussed above with respect to claim 1, Haskell does not disclose or suggest performing an entropy encoding of a value to obtain a code amount. Rather, Haskell merely describes selecting a prediction circuit “that yields the best compression performance.” Haskell, Col. 7, Lines 58-61. The Office Action does not contend that any other cited reference discloses or suggests these missing limitations of claim 13. Therefore, the Office Action fails to establish a prima facie case of obviousness with respect to claim 13, as amended, and Applicants respectfully request that the Examiner withdraw the obviousness rejection of claim 13, at least for these reasons.

c. Claims 2-4 and 14

Claims 2-4 and 14 depend from and incorporate all the limitations of independent claims 1 and 13, respectively. “If an independent claim is non-obvious under 35 U.S.C. 103, then any claim depending therefrom is nonobvious.” MPEP 2143.03 (citations omitted). Applicants maintain that independent claims 1 and 13, as amended, are distinguishable over the
cited references. Therefore, Applicants respectfully request that the Examiner withdraw the obviousness rejections of claims 2-4 and 14, at least for this reason.

**Conclusion:**

Applicants submit that the above-captioned patent application, as amended, is in condition for allowance, and such disposition is earnestly solicited. If the Examiner believes that the prosecution of this application may be furthered by discussing the application, in person or by telephone, with Applicants’ representatives, we would welcome the opportunity to do so.

Applicants believe that no fees are due as a result of this response. Nevertheless, in the event of any variance between the fees determined by Applicants and the fees determined by the PTO, please charge or credit any such variance to the undersigned’s Deposit Account No. 02-0375.

Respectfully submitted,

BAKER BOTTS L.L.P.

Dated: October 1, 2010

By: /Aaron Perez-Daple/

Aaron Perez-Daple
Registration No. 57,766

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JBA/APD
### Electronic Acknowledgement Receipt

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**Title of Invention:** Selective prediction encoding and decoding methods and selective prediction encoding and decoding devices

**First Named Inventor/Applicant Name:** Euee-S Jang

**Customer Number:** 24735

**Filer:** Aaron Christopher Perez-Daple

**Application Type:** Utility under 35 USC 111(a)

**Payment information:**

- **Submitted with Payment:** no

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**Warnings:**

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**Total Files Size (in bytes):** 345368

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

### New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

### National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

### New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.
Fig. 3

START

MACRO BLOCK IS PREDETERMINED UNIT OF PROCESS?

YES

S330

PERFORM AC/DC PREDICTION

S335

CALCULATE AMOUNT OF AC/DC CODING

S350

CODE AMOUNT FROM AC/DC PREDICTION < CODE AMOUNT FROM AVC INTRA PREDICTION?

YES

S360

RECORD AC/DC FLAG

NO

S370

RECORD AVC INTRA FLAG

END

S340

PERFORM AVC INTRA PREDICTION

S345

CALCULATE AMOUNT OF AVC INTRA CODING

S320

PERFORM OTHER INTRA PREDICTION ENCODING
Fig. 4

CONTROL UNIT

MACRO BLOCK RECONIZING SECTION

CODING AMOUNT COMPARISON SECTION

FLAG RECORDING SECTION

AC/DC PREDICTION UNIT

AVC INTRA PREDICTION UNIT
|---------------------|------------|-----------|----------|----------|

**Fig. 5**
START

RECEIVE BIT STREAM

S620

CODE AMOUNT FROM AC/DC PREDICTION IS INCLUDED?

NO

YES S630

DECODE BIT STREAM BY USING INVERSE AC/DC PREDICTION

END

S640

DECODE BIT STREAM BY USING INVERSE INTRA PREDICTION
START

MACRO BLOCK IS PREDETERMINED UNIT OF PROCESS?

S310

NO

YES

S330

PERFORM AC/DC PREDICTION

S335

CALCULATE AMOUNT OF AC/DC CODING

S340

PERFORM AVC INTRA PREDICTION

S345

CALCULATE AMOUNT OF AVC INTRA CODING

S320

PERFORM OTHER INTRA PREDICTION ENCODING

S350

CODE AMOUNT FROM AC/DC PREDICTION < CODE AMOUNT FROM AVC INTRA PREDICTION?

YES

S360

RECORD AC/DC FLAG

NO

S370

RECORD AVC INTRA FLAG

END
START

RECEIVE BIT STREAM

S610

S620

CODE AMOUNT FROM AC/DC PREDICTION IS INCLUDED?

YES S630

NO

S640

YES S630

DECODE BIT STREAM BY USING INVERSE AC/DC PREDICTION

DECODE BIT STREAM BY USING INVERSE INTRA PREDICTION

END
# Patent Application Fee Determination Record

**APPLICATION AS FILED – PART I**

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  - N/A

- **SEARCH FEE**
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  - N/A

- **EXAMINATION FEE**
  - (37 CFR 1.16(o), (p), or (q))
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- **APPLICATION SIZE FEE**
  - (37 CFR 1.16(s))
  - If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).

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**APPLICATION AS AMENDED – PART II**

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- **FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))**

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- **FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))**

* If the entry in column 1 is less than the entry in column 2, write “0” in column 3.

** If the “Highest Number Previously Paid For” in THIS SPACE is less than 20, enter “20”.

*** If the “Highest Number Previously Paid For” IN THIS SPACE is less than 3, enter “3”.

The “Highest Number Previously Paid For” (Total or Independent) is the highest number found in the appropriate box in column 1.

---

Legal Instrument Examiner: Peggy Yarborough
Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

usptocorrespondence@bakerbotts.com
darlene.hoskins@bakerbotts.com
oncka.davis@bakerbotts.com
Office Action Summary

Application No. 11/266,188
Applicant(s) JANG ET AL.

Examiner DAVID P. RASHID
Art Unit 2624

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).

Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on 24 October 2005.
2a)☐ This action is FINAL. 2b)☒ This action is non-final.
3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under Ex parte Quayle, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-20 is/are pending in the application.
   4a) Of the above claim(s) ☐ is/are withdrawn from consideration.
5)☐ Claim(s) ☐ is/are allowed.
6)☒ Claim(s) 1-20 is/are rejected.
7)☐ Claim(s) ☐ is/are objected to.
8)☐ Claim(s) ☐ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.
10)☒ The drawing(s) filed on 24 October 2005 is/are: a)☐ accepted or b)☒ objected to by the Examiner.

   Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

   Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
   a)☒ All  b)☐ Some * c)☐ None of:
   1. ☒ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. ______.
   3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

   * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1)☒ Notice of References Cited (PTO-892)
2)☐ Notice of Draftsperson’s Patent Drawing Review (PTO-948)
3)☒ Information Disclosure Statement(s) (PTO/SB/08)
   Paper No(s)/Mail Date ______.

   4)☐ Interview Summary (PTO-413)
   Paper No(s)/Mail Date ______.
5)☐ Notice of Informal Patent Application
6)☐ Other: ______.

U.S. Patent and Trademark Office
PTOL-326 (Rev. 08-06) Office Action Summary Part of Paper No./Mail Date 20100622
DETAILED ACTION

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General Information Matter

[1] Please note, the instant Non-Provisional application (11/256,188) under prosecution at the United States Patent and Trademark Office (USPTO), has been assigned to Art Unit 2621. Please ensure, to aid in correlating any papers for 11/256,188, all further correspondence regarding the instant application should be directed to Art Unit 2621.

[2] 11/256,188 has been assigned to David Rashid (Examiner) at the USPTO. To aid in correlating any papers for 11/256,188, all further correspondence regarding the instant application should be directed to David Rashid.

Amendments & Claim Status

Priority


Information Disclosure Statement

[5] The information disclosure statement filed Apr. 8, 2009 and Dec. 3, 2009 complies with the provisions of 37 C.F.R. § 1.97, 1.98 and M.P.E.P. § 609. It has been placed in the application file, and the information referred to therein has been considered as to the merits.

Requirement for Information

[6] Applicant and the assignee of this application are required under 37 C.F.R. § 1.105 to provide the following information that the examiner has determined is reasonably necessary to the examination of this application.

M.P.E.P. § 704.11(b)(II), titled “WITH THE FIRST ACTION ON THE MERITS” (emphasis added), reads:

A requirement for information may be combined with a first action on the merits that includes at least one rejection, if, for example, either the application file or the lack of relevant prior art found in the examiner’s search justifies asking the applicant if he or she has information that would be relevant to the patentability determination. It is not appropriate to make a requirement for information based on a lack of relevant prior art with a first action on the merits allowance or Ex parte Quayle action.

M.P.E.P. § 704.11(a) reads, in relevant part:

37 C.F.R. § 1.105(a)(1)(i) lists specific examples of information that may be reasonably required. Other examples, not meant to be exhaustive, of information that may be reasonably required for examination of an application include:

... (O) Art related to applicant’s invention, applicant’s disclosure, or the claimed subject matter.

(P) Other factual information pertinent to patentability.

Relevant Prior Art Publication

The lack of relevant prior art publication, "Intra Prediction (T9/T10) and DC/Ac Prediction Results", International Organisation for Standardisation Coding of Moving Pictures and Associated Audio Information ISO/IEC JTC1/SC29/WG11 MPEG96/0939 Jul. 1996, found
in the Examiner’s search justifies asking the Applicant if s/he has either (i) a provided full copy of publication; or (ii) information that would be relevant to the patentability determination (e.g., a link to access the publication). In addition, the Examiner is to continue searching for the relevant prior art publication.

[7] In responding to those requirements that require copies of documents, where the document is bound text or a single article over 50 pages (such as the specification), the requirement may be met by providing copies of those pages that provide the particular subject matter indicated in the requirement, or where such subject matter is not indicated, the subject matter found in applicant’s disclosure.

[8] The fee and certification requirements of 37 C.F.R. § 1.97 are waived for those documents submitted in reply to this requirement. This waiver extends only to those documents within the scope of this requirement under 37 C.F.R. § 1.105 that are included in the applicant’s first complete communication responding to this requirement. Any supplemental replies subsequent to the first communication responding to this requirement and any information disclosures beyond the scope of this requirement under 37 C.F.R. § 1.105 are subject to the fee and certification requirements of 37 C.F.R. § 1.97.

[9] The applicant is reminded that the reply to this requirement must be made with candor and good faith under 37 C.F.R. § 1.56. Where the applicant does not have or cannot readily obtain an item of required information, a statement that the item is unknown or cannot be readily obtained may be accepted as a complete reply to the requirement for that item.

**Drawings**

[10] The following is a quote from 37 C.F.R. § 1.84(u)(2):

> Numbers and letters identifying the views must be simple and clear and must not be used in association with brackets, circles, or inverted commas. The view numbers must be larger than the numbers used for reference characters.

The drawings are objected to under 37 C.F.R. § 1.84(u)(2) for failing to include view numbers larger than the numbers used for reference characters.
Corrected drawing sheets in compliance with 37 C.F.R. § 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. The figure or figure number of an amended drawing should not be labeled as “amended.” If a drawing figure is to be canceled, the appropriate figure must be removed from the replacement sheet, and where necessary, the remaining figures must be renumbered and appropriate changes made to the brief description of the several views of the drawings for consistency. Additional replacement sheets may be necessary to show the renumbering of the remaining figures. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either “Replacement Sheet” or “New Sheet” pursuant to 37 C.F.R. § 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

**Specification**

The title of the invention is not descriptive. A new title is required that is clearly indicative of the invention to which the claims are directed.

**Claim Objections**

The following is a quotation of the second paragraph of 37 C.F.R. § 1.75(a):

The specification must conclude with a claim particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention or discovery.

Claims 1-4, 12, and 14 are objected to under 37 C.F.R. § 1.75(a), for failing to particularly point out and distinctly claim the subject matter which Applicant regards as the invention.

Claim 1, line 5, should be “from the AC/DC prediction” and “from the AVC intra prediction”.

Claim 4, line 2, should be “a[n] macro-block-layer (MB-layer) header”. Claims 12 and 14 by analogy.
Claim Rejections - 35 U.S.C. § 101

[15] 35 U.S.C. § 101 reads as follows:

Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

In Re Bilski – “Tied To” Criteria and/or Qualifying “Transformation”

[16] Claims 1-4, 13 and 14 are rejected under 35 U.S.C. § 101 as not falling within one of the four statutory categories of invention. Supreme Court precedent\(^1\) and recent Federal Circuit decisions\(^2\) indicate that a statutory “process” under 35 U.S.C. § 101 must (1) be tied to another statutory category (such as a particular apparatus), or (2) transform underlying subject matter (such as an article or material) to a different state or thing. While the instant claim(s) recite a series of steps or acts to be performed, the claim(s) neither transform underlying subject matter nor positively tie to another statutory category that accomplishes the claimed method steps, and therefore do not qualify as a statutory process.

With regard to (1) above, could be done mentally, by hand, or on a programmed computer. In addition, any inherently tied method-steps above are not central to the purpose of the invention by Applicant (i.e., they are insignificant pre- and post-solution activity that do not impose a meaningful limitation). The method-steps that do impose meaningful limits do not require a particular machine, and thus Claims 1-4, 13 and 14 are not eligible under (1) above.

With regard to (2) above, for the reasons given in (1), Claims 1-4, 13 and 14 are not eligible under (2) above. In addition, any article transformations that occur do not impose a meaningful limit on the claim's scope because they are not central to the purpose of the invention by Applicant (i.e., they are insignificant pre- and post-solution activity that do not impose a meaningful limitation). The method-steps that do impose meaningful limits do not transform any article.


\(^2\) *In re Bilski*, 88 USPQ2d 1385 (Fed. Cir. 2008).
It is suggested to tie a particular machine (e.g., a “processor” if supported in the specification, not “machine”) to a meaningful limit on the claim’s scope (e.g., the selecting method-step of Claim 1).

Apparatus Claim With no Recited Structure


Descriptive material can be characterized as either "functional descriptive material" or "nonfunctional descriptive material." In this context, "functional descriptive material" consists of data structures and computer programs which impart functionality when employed as a computer component. (The definition of 'data structure' is "a physical or logical relationship among data elements, designed to support specific data manipulation functions." The New IEEE Standard Dictionary of Electrical and Electronics Terms 308 (5th ed. 1993).) "Nonfunctional descriptive material" includes but is not limited to music, literary works and a compilation or mere arrangement of data.

When functional descriptive material is recorded on some computer-readable medium it becomes structurally and functionally interrelated to the medium and will be statutory in most cases since use of technology permits the function of the descriptive material to be realized. Compare In re Lowry, 32 F.3d 1579, 1583-84, 32 USPQ2d 1031, 1035 (Fed. Cir. 1994) (claim to data structure stored on a computer readable medium that increases computer efficiency held statutory) and Warmerdam, 33 F.3d at 1360-61, 31 USPQ2d at 1759 (claim to computer having a specific data structure stored in memory held statutory product-by-process claim) with Warmerdam, 33 F.3d at 1361, 31 USPQ2d at 1760 (claim to a data structure per se held nonstatutory).

In contrast, a claimed computer-readable medium encoded with a computer program is a computer element which defines structural and functional interrelationships between the computer program and the rest of the computer which permit the computer program's functionality to be realized, and is thus statutory. See Lowry, 32 F.3d at 1583-84, 32 USPQ2d at 1035.

Claims 5-12 and 15-20 are rejected under 35 U.S.C. 101 because the claimed invention is directed to non-statutory subject matter as follows. While the preamble of Claims 5-8, 11 and 12 define an “apparatus”, the body of the claim (comprised of e.g., “units” and “sections”) lacks definite structure indicative of a physical apparatus. While the preamble of Claims 9, 10, and 15-20 define an “encoder” and “decoder”, the body of the claim (comprised of e.g., “units” and “sections”) lack definite structure indicative of a physical apparatus.

Furthermore, the specification indicates that the invention may be embodied as pure software. See Specification at p. 4, l. 12 (citing “an MPEG-4 codec” which may be construed to
be all software portions). Therefore, the claim as a whole appears to be nothing more than an “apparatus” of pure software elements, thus defining functional descriptive material per se.

Claim Rejections - 35 U.S.C. § 103

[18] The following is a quotation of 35 U.S.C. § 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

[19] This application currently names joint inventors. In considering patentability of the claims under § 103(a), the examiner presumes that the subject matter of the various Claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 C.F.R. § 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. § 103(c) and potential § 102(e), (f) or (g) prior art under § 103(a).

[20] The factual inquiries set forth in Graham, that are applied for establishing a background for determining obviousness under § 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

Haskell in view of Johansen

[21] Claims 1-3, 5-10, and 15-20 are rejected under § 103(a) as being unpatentable over Haskell et al., U.S. Pat. No. 6,005,622 (“Haskell”) in view of Johansen et al., U.S. Pub. No. 2004/0233993 (“Johansen”).

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Regarding **Claim 1**, while Haskell discloses selective prediction encoding method (figs. 7a, 7b; 7:62-8:30\(^4\)) for identifying an encoding method (“the encoder predicts” at 1:34-54\(^5\)) for a macro block (fig. 2; “A macroblock typically consists of four blocks of luminance data and two blocks of chrominance data” at 2:31-46), comprising the steps of:

- performing AC/DC prediction and intra prediction for said macro block (title of invention “Intra Prediction (t9/T10) and DC/AC Prediction Results” suggests performing AC/DC prediction and intra prediction for said macro block to create results);
- generating an AC/DC code amount from AC/DC prediction and an code amount from intra prediction for said macro block (it is both implicit and inherent a code amount for both AC/DC and intra prediction are needed for item 180 to select "the greatest overall compression");
- selecting between an AC/DC prediction encoding method and an intra prediction encoding method for said macro block (“select[ing] the prediction circuit. . .” at 7:62-8:11), the method which corresponds to the smaller of said AC/DC code amount and said code amount (“prediction analyzer 180 selects the prediction circuit that yields the greatest overall compression” at 7:62-8:11, emphasis added; fig. 7a, item 170);
- performing the selected prediction encoding method to said macro block (title of invention “Intra Prediction (t9/T10) and DC/AC Prediction Results” suggests performing AC/DC prediction and intra prediction for said macro block to create results); and,

- recording an AC/DC flag (“180 also generates a signal identifying which of the prediction techniques was used” at 7:62-8:1) indicating the AC/DC prediction encoding method in a flag field when the AC/DC prediction encoding method is selected and an flag indicating the intra prediction encoding method in the flag field when the intra prediction encoding method is selected,

Haskell does not disclose wherein the intra prediction is Advanced Video Coding (AVC) intra prediction.

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\(^4\)“7:62-8:30” is short notation for “Col. 7, line 62 to Col. 8, line 30”.

\(^5\)“1:34-54” is short notation for “Col. 1, lines 34-35”.
Johansen teaches a method for video compression that includes wherein the intra prediction is Advanced Video Coding (AVC) intra prediction (¶ 0008).

It would have been obvious to one of ordinary skill in the art at the time the invention was made for the intra prediction of Haskell to be Advanced Video Coding (AVC) intra prediction as taught by Johansen for “predictions of pixels based on the adjacent pixels in the same picture rather than pixels of preceding pictures”. Johansen at ¶ 0008. “In video compression systems, the main goal is to represent the video information with as little capacity as possible. Capacity is defined with bits, either as a constant value or as bits/time unit. In both cases, the main goal is to reduce the number of bits.” Johansen at ¶ 0005.

Regarding Claim 2, Haskell discloses further comprising the step of checking whether said macro block (fig. 2; “A macroblock typically consists of four blocks of luminance data and two blocks of chrominance data” at 2:31-46) is a predetermined unit of process (e.g., “four blocks representing luminance components of the macroblock and two blocks representing chrominance components of the macroblock” at 3:61-67) and performing the steps of claim 1, only when said macro block is one of said predetermined units of process (e.g., when the macroblock is represented of the luminance and chrominance components above).

Regarding Claim 3, Haskell discloses wherein the step of selecting further comprises selecting one of the AC/DC prediction encoding method and the AVC intra prediction encoding method (title of invention “Intra Prediction (t9/T10) and DC/AC Prediction Results” suggests performing intra and AC/DC prediction for said macro block to create results) in accordance with a predetermined criterion (e.g., when the macroblock consist of “four blocks representing luminance components of the macroblock and two blocks representing chrominance components of the macroblock” at 3:61-67), when said AC/DC code amount and said AVC code amount are equal to each other (the predetermined criterion applies to all instances, and thus including when the AC/DC and AVC code amounts are equal to each other).

Regarding Claim 5, while Haskell discloses a selective prediction encoding device (e.g., fig. 3; figs. 7a-b) for encoding a macro block (fig. 2; “A macroblock typically consists of four blocks of luminance data and two blocks of chrominance data” at 2:31-46), comprising:

an AC/DC prediction unit (fig. 7a) for performing an AC/DC prediction (title of invention “Intra Prediction (t9/T10) and DC/AC Prediction Results” suggests performing AC/DC
prediction for said macro block to create results) to a macro block and for generating an AC/DC code amount (it is both implicit and inherent a code amount for AC/DC prediction is needed for item 180 to select "the greatest overall compression") for said macro block from AC/DC prediction;

an intra prediction unit (fig. 7a) for performing intra prediction (title of invention “Intra Prediction (t9/T10) and DC/AC Prediction Results” suggests performing intra prediction for said macro block to create results) to said macro block and for generating an code amount (it is both implicit and inherent a code amount for intra prediction is needed for item 180 to select "the greatest overall compression") of intra coding;

and a control unit, (fig. 7a) said control unit controlling the AC/DC prediction unit and the intra prediction unit, selecting one of an AC/DC prediction encoding method and an intra prediction encoding method (“select[ing] the prediction circuit. . .” at 7:62-8:11), which method corresponds to the smaller of said AC/DC code amount and said code amount (“prediction analyzer 180 selects the prediction circuit that yields the greatest overall compression” at 7:62-8:11, emphasis added; fig. 7a, item 170), and performing the selected encoding method,

Haskell does not disclose wherein the intra prediction is Advanced Video Coding (AVC) intra prediction.

Johansen teaches a method for video compression that includes wherein the intra prediction is Advanced Video Coding (AVC) intra prediction (¶ 0008).

It would have been obvious to one of ordinary skill in the art at the time the invention was made for the intra prediction of Haskell to be Advanced Video Coding (AVC) intra prediction as taught by Johansen for “predictions of pixels based on the adjacent pixels in the same picture rather than pixels of preceding pictures”. Johansen at ¶ 0008. “In video compression systems, the main goal is to represent the video information with as little capacity as possible. Capacity is defined with bits, either as a constant value or as bits/time unit. In both cases, the main goal is to reduce the number of bits.” Johansen at ¶ 0005.

Regarding Claim 6, Claim s recites substantially similar features as in Claim 2. Thus, references/arguments equivalent to those presented for Claim 2 are equally applicable to Claim 6.

Regarding Claim 7, Haskell discloses wherein said control unit comprises:
a coding amount comparison section (fig. 7a), said coding amount comparison section comparing the amount of AC/DC coding and the amount of intra coding (it is both implicit and inherent a code amount for both AC/DC and intra prediction are compared for item 180 to select "the greatest overall compression"), selecting one of the AC/DC prediction encoding method and the intra prediction encoding method which corresponds to the smaller of said AC/DC code amount and said code amount (“prediction analyzer 180 selects the prediction circuit that yields the greatest overall compression” at 7:62-8:11, emphasis added; fig. 7a, item 170), and performing the selected encoding method; and

a flag recording section (fig. 7a), said flag recording section (fig. 7a) recording a flag indicating the AC/DC prediction encoding method in an AC/DC flag field when the AC/DC prediction encoding method is selected and recording an flag indicating the intra prediction encoding method in the flag field when the intra encoding method is selected (“180 also generates a signal identifying which of the prediction techniques was used” at 7:62-8:1).

Regarding Claim 9, Haskell discloses an encoder (fig. 7a, item 100) comprising the selective prediction encoding device according to claim 5.

Regarding Claim 10, Haskell discloses a decoder (fig. 7b, item 200) comprising the selective prediction encoding device (e.g., fig. 3; figs. 7a-b) according to claim 5.

Regarding Claim 15, Claim 9 recites identical features as in Claim 15. Thus, references/arguments equivalent to those presented for Claim 9 are equally applicable to Claim 15.

Regarding Claim 16, Claim 9 recites identical features as in Claim 16. Thus, references/arguments equivalent to those presented for Claim 9 are equally applicable to Claim 16.

Regarding Claim 17, Claim 9 recites identical features as in Claim 17. Thus, references/arguments equivalent to those presented for Claim 9 are equally applicable to Claim 17.

Regarding Claim 18, Claim 10 recites identical features as in Claim 18. Thus, references/arguments equivalent to those presented for Claim 10 are equally applicable to Claim 18.
Regarding **Claim 19**, Claim 10 recites identical features as in Claim 19. Thus, references/arguments equivalent to those presented for Claim 10 are equally applicable to Claim 19.

Regarding **Claim 20**, Claim 10 recites identical features as in Claim 20. Thus, references/arguments equivalent to those presented for Claim 10 are equally applicable to Claim 20.

**Haskell in view of Johansen, and in further view of Regunathan**

[22] **Claim 4** is rejected under § 103(a) as being unpatentable over Haskell in view of Johansen, and in further view of Regunathan et al., U.S. Pub. No. 2005/0053158 ("Regunathan").

Regarding **Claim 4**, Haskell in view of Johansen does not disclose wherein the flag field is included in an MB-layer header of a bit stream.

Regunathan teaches a slice-layer in video codec that includes wherein a flag field is included in an MB-layer ("macroblocks (called a slice)" at Abstract) header of a bit stream (fig. 6; ¶ 0075-0077).

It would have been obvious to one of ordinary skill in the art at the time the invention was made for the flag field of Haskell in view of Johansen to be included in an MB-layer header of a bit stream as taught by Regunathan to provide “a slice-layer that is designed to be flexible, and provide an effective combination of error-resilience and compression efficiency.” Regunathan at ¶ 0015.

**Haskell in view of Regunathan**

[23] **Claims 11-14** are rejected under § 103(a) as being unpatentable over Haskell in view of Regunathan.

Regarding **Claim 11**, while Haskell discloses a selective prediction decoding device (fig. 7b, item 200; 8:12-30) comprising:

- a flag value recognizing unit (fig. 7b, item 280) for recognizing (“prediction analyzer 280 determines from the identifying signal generated by the prediction analyzer 180 whether gradient prediction or explicit prediction was used at the encoder 100” at 8:12-30) a prediction flag value
an AC/DC decoding unit (fig. 7b, item 200) for decoding the bit stream by an AC/DC prediction decoding process (title of invention “Intra Prediction (t9/T10) and DC/AC Prediction Results” suggests performing AC/DC prediction for said macro block to create results); an intra decoding unit (fig. 7b, item 200) for decoding the bit stream by an intra prediction decoding process (title of invention “Intra Prediction (t9/T10) and DC/AC Prediction Results” suggests performing intra prediction for said macro block to create results); and a control unit (fig. 7b, item 200) for controlling said AC/DC decoding unit and said intra decoding unit (fig. 7b, item 200), whereby one of said AC/DC decoding unit and said intra decoding unit is activated in accordance with the prediction flag value recognized by said flag value recognizing unit (8:12-30; fig. 7b),

Haskell does not disclose wherein the flag value is included in a header of a received bit stream.

Regunathan teaches a slice-layer in video codec that includes wherein a flag value is included in a header of a bit stream (fig. 6; ¶ 0075-0077).

It would have been obvious to one of ordinary skill in the art at the time the invention was made for the flag field of Haskell to be included in a header of a bit stream as taught by Regunathan to provide “a slice-layer that is designed to be flexible, and provide an effective combination of error-resilience and compression efficiency.” Regunathan at ¶ 0015.

Regarding Claim 12, Haskell in view of Regunathan does not disclose wherein the prediction flag value is recorded in a prediction flag field of an MB-layer header of the bit stream.

Regunathan teaches a slice-layer in video codec that includes wherein a prediction flag value is recorded in a prediction flag field of an MB-layer (“macroblocks (called a slice)” at Abstract) header of a bit stream (fig. 6; ¶¶ 0075-0077).

It would have been obvious to one of ordinary skill in the art at the time the invention was made for the prediction flag field of Haskell in view of Johansen to be recorded in a prediction flag field of an MB-layer header of a bit stream as taught by Regunathan to provide “a
slice-layer that is designed to be flexible, and provide an effective combination of error-resilience and compression efficiency.” Regunathan at ¶ 0015.

Regarding Claim 13, while Haskell discloses a selective prediction decoding method (fig. 7b; 8:12-30) for identifying a decoding method (title of invention “Intra Prediction (t9/T10) and DC/AC Prediction Results”) for a macro block (fig. 2; “A macroblock typically consists of four blocks of luminance data and two blocks of chrominance data” at 2:31-46), comprising the steps of:

recognizing a prediction flag value (“180 also generates a signal identifying which of the prediction techniques was used” at 7:62-8:11) identifying either an AC/DC coded macro block or an intra coded macro block (title of invention “Intra Prediction (t9/T10) and DC/AC Prediction Results” suggests performing AC/DC and intra prediction for said macro block to create results); and

decoding said received bit stream by one of an AC/DC prediction decoding process and an intra prediction decoding process in accordance with the recognized prediction flag value (8:12-30; fig. 7b)

Haskell does not disclose wherein the flag value is included in a header of a received bit stream.

Regunathan teaches a slice-layer in video codec that includes wherein a flag value is included in a header of a bit stream (fig. 6; ¶¶ 0075-0077).

It would have been obvious to one of ordinary skill in the art at the time the invention was made for the flag field of Haskell to be included in a header of a bit stream as taught by Regunathan to provide “a slice-layer that is designed to be flexible, and provide an effective combination of error-resilience and compression efficiency.” Regunathan at ¶ 0015.

Regarding Claim 14, Claim 12 recites identical features as in Claim 14. Thus, references/arguments equivalent to those presented for Claim 12 are equally applicable to Claim 14.

**Conclusion**

*Citation of Pertinent Prior Art*
Jang, Low-Complexity MPEG-4 Shape Encoding toward Realtime Object-Based Applications, ETRI Journal, Vol. 26, No. 2, pp. 122-135, Apr. 2004; and

[25] Any inquiry concerning this communication or earlier communications from the examiner should be directed to DAVID P. RASHID whose telephone number is (571)270-1578 and fax number (571)270-2578. The examiner can normally be reached Monday - Friday 7:30 - 17:00 ET.

If attempts to reach the examiner by telephone are unsuccessful, the examiner’s supervisor, Bhavesh Mehta can be reached on (571) 272-7453. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/David P. Rashid/
Examiner, Art Unit 2624

David P Rashid
Examiner
Art Unit 2624
# Notice of References Cited

## U.S. Patent Documents

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<td>12-1999</td>
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## Foreign Patent Documents

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## Non-Patent Documents

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*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(e).)*

Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

U.S. Patent and Trademark Office
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S63 9

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S64 4

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### BIB DATA SHEET

**CONFIRMATION NO. 5518**

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**APPLICANTS**
- Euee-S Jang, Seoul, KOREA, REPUBLIC OF;
- Yung-Lyul Lee, Seoul, KOREA, REPUBLIC OF;
- Sun-Young Lee, Seoul, KOREA, REPUBLIC OF;
- Sung-Won Park, Seoul, KOREA, REPUBLIC OF;
- Jong-Woo Won, Seoul, KOREA, REPUBLIC OF;
- Yong-Ho Cho, Seoul, KOREA, REPUBLIC OF;
- Chung-Ku Lee, Inchon, KOREA, REPUBLIC OF;

**CONTINUING DATA**

**FOREIGN APPLICATIONS**
- REPUBLIC OF KOREA 10-2004-0084918 10/22/2004 DPR

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- 11/17/2005

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**ADDRESS**

BAKER BOTTTS LLP  
C/O INTELLECTUAL PROPERTY DEPARTMENT  
THE WARNER, SUITE 1300  
1299 PENNSYLVANIA AVE, NW  
WASHINGTON, DC 20004-2400  
UNITED STATES

**TITLE**

Selective prediction encoding and decoding methods and selective prediction encoding and decoding devices

**FILING FEE RECEIVED**
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- Other ________________
- Credit
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## U.S. PATENTS

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## FOREIGN PATENT DOCUMENTS

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Examiner Signature /David Rashid/ Date Considered 06/22/2010

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

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1 See Kind Codes of USPTO Patent Documents at [www.USPTO.GOV](http://www.USPTO.GOV) or MPEP 901.04. 2 Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). 3 For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. 4 Kind of document by the appropriate symbol as indicated on the document under WIPO Standard ST.16 if possible. 5 Applicant is to place a check mark here if English language translation is attached.
### Search Notes

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/DAVID P RASHID/
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### FOREIGN PATENT DOCUMENTS

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CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ Fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ None

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

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This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.
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7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

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9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.
发明名称 用于隔行数字视频的宏数据块内的DC和AC系数预测

摘要
通过从相邻左半块和相邻顶块中选择预测器 DC和AC系数对 INTRA编码块的DC和 AC DCT变换系数进行差分编码。每个块根据帧模式，重新排序场模式和非重新排序场模式编码。根据所述的各自编码模式以及其中至少有 DC预测器的块选择AC预测器块。当顶块和当前块处于重新排序场模式，或都处于帧模式和非重新排序场模式以及DC预测器驻留在所述顶块内时，选择顶块作为AC预测器。
Chinese Patent Publication No. 1198639 (1998.11.11)  (*Intra-macroblock DC and AC coefficient prediction for interlaced digital video*)

ABSTRACT

DC and AC DCT transform coefficients of an INTRA coded block are differentially encoded by selecting predictor DC and AC coefficients from a left-hand neighboring block and a top neighboring block. Each block is coded according to a frame mode, a reordered field mode, and a non-reordered field mode. The AC predictor block is selected according to the respective coding modes of the blocks, and the block in which a DC predictor resides. The top block is selected as an AC predictor when the top block and current block are both reordered field mode, or both frame mode and/or non-reordered field mode, and the DC predictor resides in the top block. Zeroed AC spatial transform coefficients are used in place of the AC spatial transform coefficients from the selected block when the selected block is not INTRA coded, or does not reside in the same Video Object Plane (VOP) as the current block. DC coefficients may be non-linearly quantized.
权利要求书

1. 一种用于对数字视频图像中的当前 INTRA 编码块的空间变换系数进行编码的方法，包括如下步骤：
   识别相邻左手块、相邻顶块和与所述左手块和所述顶块相邻的左顶块；
   所述左手块、顶块和左顶块中的每一个都具有一个 DC 空间变换系数和多个 AC 空间变换系数；
   所述块中的每一个都以帧模式、重新排序场模式和没有重新排序场模式中的一种编码模式编码；和
   从所述左手块和所述顶块之一中选择 AC 空间变换系数，用于对所述当前块的相应 AC 空间变换系数进行差分编码；
   所述的选择步骤响应于所述当前块和所述顶块的编码模式。

2. 根据权利要求 1 所述的方法，还包括如下步骤：当所述的顶块是根据帧模式和没有重新排序场模式中的一种模式编码以及所述当前块是根据重新排序场模式编码时，从所述左手块选择 AC 空间变换系数。

3. 根据权利要求 1 或 2 所述的方法，还包括如下步骤：
   当所述当前块是根据帧模式和没有重新排序场模式中的一种模式编码以及所述顶块是根据重新排序场模式编码时，从所述左手块选择 AC 空间变换系数。

4. 根据在前权利要求中任一个的方法，还包括如下步骤：
   根据 (a) 所述左手块和所述左顶块的 DC 空间变换系数之间的梯度和 (b) 所述顶块和所述左顶块的 DC 空间变换系数之间的梯度，从所述左手块和所述顶块中选择用于对所述当前块的 DC 空间变换系数进行差分编码的 DC 空间变换系数。
5. 根据权利要求 4 所述的方法，还包括如下步骤:

根据所选择的 DC 空间变换系数从所述左手块或所述顶块中选择用于差分编码的 AC 空间变换系数。

6. 根据权利要求 4 所述的方法，还包括如下步骤:

当所述 DC 空间变换系数是从所述的顶块中选择，所述当前块是根据帧模式或非重新排序场模式编码以及所述的顶块是根据帧模式或非重新排序场模式编码时，从所述顶块中选择 AC 空间变换系数用于差分编码。

7. 根据权利要求 4 所述的方法，还包括如下步骤:

当所述的 DC 空间变换系数是从所述顶块中选择以及所述当前块和所述顶块都是根据重新排序场模式编码时，从所述顶块中选择 AC 空间变换系数用于差分编码。

8. 根据在前权利要求中任一个的方法，还包括如下步骤:

当所述选块不是 INTRA 编码时，利用归零 AC 空间变换系数代替来自所选择块的 AC 空间变换系数。

9. 根据在前权利要求中任一个的方法，其中当前块驻留在当前目标平面（VOP）中，所述方法还包括如下步骤:

当所述选块没有驻留在所述的当前 VOP 中时，利用归零 AC 空间变换系数代替来自所选择选块的 AC 空间变换系数。

10. 根据权利要求 4 到 7 所述的方法，还包括对当前块的 DC 空间变换系数非线性量化的步骤。

11. 一种用于对以数字位流形式传送的数字视频图象中的当前 INTRA 编码块的差分编码的空间变换系数进行解码以恢复所述当前块相应的全 AC 空间变换系数的方法，还包括如下步骤:

恢复所述的数字位流:
所述数字位流包括来自相邻左手块、相邻顶块、和与所述左手块和所述顶块相邻的左顶块的数据；

所述左手块、顶块和所述左顶块中的每一个都具有一个 DC 空间变换系数和多个 AC 空间变换系数；

所述块中的每一个都以根据帧模式、重新排序场模式和非重新排序场模式中的一种编码模式编码；

从所述左手块和所述顶块的一个中选择 AC 空间变换系数；和

将所选择的 AC 空间变换系数和所述当前块的相应差分编码的 AC 空间变换系数相加以恢复所述当前块的全 AC 空间变换系数；

所述的选择步骤相应所述当前块和所述顶块的编码模式。

12. 根据权利要求 11 所述的方法，还包括如下步骤：

所述顶块是根据帧模式和非重新排序场模式中的一种模式编码以及所述的当前块是根据重新排序场模式编码时，所述左手块选择 AC 空间变换系数用于所述的求和步骤。

13. 根据权利要求 11 或 12 所述的方法，还包括如下步骤：

所述当前块是根据帧模式和非重新排序场模式之一编码以及所述顶块是根据重新排序场模式编码时，所述左手块选择 AC 空间变换系数用于求和步骤。

14. 根据权利要求 11 到 13 中任一个的方法，其特征是，在以数字位流形式传送所述当前块的 DC 空间变换系数之前，通过根据（a）所述左手块和所述左顶块的 DC 空间变换系数之间的第一梯度和（b）所述顶块和所述左顶块的 DC 空间变换系数之间的第二梯度使用所述左手块和所述顶块之一的 DC 空间变换系数对所述当前块的 DC 空间变换系数进行差分编码，所述方法包括如下步骤：

确定所述的第一和第二梯度；和
根据所确定的梯度，从所述左手块和所述顶块中的一个选择 DC 空间变换系数，该空间变换系数被用于对所述当前块的 DC 空间变换系数进行差分编码。

15. 根据权利要求 14 所述的方法，还包括如下步骤；

根据所选择的 DC 空间变换系数，从所述左手块和所述顶块的一个中选择用于求和步骤的 AC 空间变换系数。

16. 根据权利要求 14 所述的方法，还包括如下步骤；

当从所述顶块中选择所述 DC 空间变换系数、所述的当前块是根据帧模式或非重新排序场模式编码以及所述的顶块是根据帧模式或非重新排序场模式编码时，从顶块选择 AC 空间变换系数用于求和步骤。

17. 根据权利要求 14 所述的方法，还包括如下步骤；

当从所述顶块中选择所述 DC 空间变换系数以及所述的当前块和所述的顶块都是根据重新排序场模式编码时，从顶块选择 AC 空间变换系数用于求和步骤。

18. 根据权利要求 11 到 17 中任一个的方法，还包括如下步骤；

当所选择的块不是 INTRA 编码时，利用归零 AC 空间变换系数代替来自所选择块的 AC 空间变换系数。

19. 根据权利要求 11 到 18 中任一个的方法，其特征是，所述当前块驻留在当前视频目标平面 (VOP) 中，所述方法还包括如下步骤；

当所选择块不是驻留在所述当前 VOP 中时，使用归零 AC 空间变换系数代替来自所选择块的 AC 空间变换系数。

20. 根据权利要求 11 到 19 中任一个的方法，其特征是；

所述选择步骤响应在所述信道中提供的代码字，所述代码字从所述左手块和所述顶块的一个中指定 AC 空间变换系数。

21. 根据权利要求 14 所述的方法，其特征是；
所述当前块的 DC 空间变换系数被非线性量化，所述方法还包括如下步骤:

从指出所述被选择块和当前块的相应量化级的所述数字位流中恢复数据; 和

根据所选择块和当前块的相应量化级定标当前块的 DC 空间变换系数以恢复被定标的 DC 空间变换系数。

22. 一种用于对数字视频图像中的当前 INTRA 编码块的空间变换系数编码的装置，包括:

装置，用于识别相邻左手块，相邻顶块和与所述左手块和顶块相邻的左顶块;

所述左手块，顶块和左顶块中的每一个都具有一个 DC 空间变换系数和多个 AC 空间变换系数;

所述块的每一个都以根据帧模式，重新排序场模式和非重新排序场模式中的一种编码模式被编码;

装置，用于从所述左手块和所述顶块的一个中选择 AC 空间变换系数用于对所述当前块的相应 AC 空间变换系数进行差分编码;

所述用于选择的装置响应所述当前块和顶块的编码模式。

23. 根据权利要求 22 所述的装置，其特征是:

当所述顶块是根据帧模式和非重新排序场模式中的一种模式编码以及所述当前块是根据重新排序模式编码时，所述用于选择的装置从所述左手块中选择 AC 空间变换系数。

24. 根据权利要求 22 或 23 所述的装置，其特征是:

当所述的当前块是根据帧模式和非重新排序场模式中的一种模式编码以及所述顶块是根据重新排序场模式编码时，所述用于选择的装置从所述左手块
中选择 AC 空间变换系数。

25. 根据权利要求 22 至 24 中任一个的装置，其特征是:

所述用于选择的装置根据 (a) 所述左下角和所述左上角的 DC 空间变换系数之间的梯度，和 (b) 所述右上角和所述左上角的 DC 空间变换系数之间的梯度，
从所述左下角和所述左上角的一个中选择一个 DC 空间变换系数用于对所述当前块的 DC 空间变换系数进行差分编码。

26. 根据权利要求 25 所述的装置，其特征是:

所述用于选择的装置根据所述选择的 DC 空间变换系数从所述左下角和所述左上角的一个中选择 AC 空间变换系数用于差分编码。

27. 根据权利要求 25 所述的装置，其特征是:

当从所述顶角中选择所述 DC 空间变换系数，所述当前角是根据帧模式或非重新排序场模式编码时，所述顶角是根据帧模式或非重新排序场模式编码时，所述用于选择的装置从所述顶角中选择 AC 空间变换系数用于差分编码。

28. 根据权利要求 25 所述的装置，其特征是:

当从所述顶角中选择 DC 空间变换系数以及所述当前角和所述顶角均根据重新排序场模式编码时，所述用于选择的装置从所述顶角中选择 AC 空间变换系数用于差分编码。

29. 根据权利要求 22 至 28 中任一个的装置，其特征是还包括:

装置，用于当所选择块不是 INTRA 编码时，利用归零 AC 空间变换系数代替来自所选择块的 AC 空间变换系数。

30. 根据权利要求 22 至 29 中任一个的装置，其特征是所述当前块驻留在当前视频目标平面 (VOP) 内，所述装置还包括:

装置，用于当所选择块没有驻留在所述当前 VOP 中时，利用归零 AC 空间变换系数代替来自所选择块的 AC 空间变换系数。
31. 根据权利要求 25 到 28 中任一个的装置，其特征是还包括：
装置，用于非线性量化当前块的 DC 空间变换系数。
32. 一种用于对以数据位流形式传送的数字视频图像中的当前 INTRA 编码块的空间变换系数进行解码以恢复所述当前块的相应全 AC 空间变换系数的装置，包括：
装置，用于恢复所述数据位流；
所述数据位流包括来自一个相邻左手块、一个相邻顶块和一个与所述左手块和所述顶块相邻的左顶块的数据；
所述左手块、顶块和左顶块中的每一个都包括一个 DC 空间变换系数和多个 AC 空间变换系数；
所述块的每一个都以根据帧模式、重新排序场模式和非重新排序场模式中的一种模式的编码模式编码；
第一装置，用于从所述左手块和所述顶块的一个中选择 AC 空间变换系数；和
装置，用于将所选择的 AC 空间变换系数和所述当前块的相应差分编码的 AC 空间变换系数相加，以恢复所述当前块的全 AC 空间变换系数；
所述用于选择的第一装置响应所述当前块和所述顶块的编码模式。
33. 根据权利要求 32 所述的装置，其特征是：
当所述顶块是根据帧模式或非重新排序场模式编码以及所述当前块是根据重新排序场模式编码时，用于选择的第一装置从所述左手块中选择用于求和装置的 AC 空间变换系数。
34. 根据权利要求 32 或 33 所述的装置，其特征是：
当所述当前块是根据帧模式或非重新排序场模式编码以及所述顶块是根据重新排序场模式编码时，用于选择的第一装置从所述左手块中选择用于求和
装置的AC空间变换系数。

35. 根据权利要求32到34中任一个的装置，其特征是：在以数字位流形式传送所述当前块的DC空间变换系数之前，通过根据(a)所述左手块和所述左顶块的DC空间变换系数之间的第一梯度和(b)所述顶块和所述左顶块的DC空间变换系数之间的第二梯度使用所述左手块和所述顶块之一的DC空间变换系数对所述当前块的DC空间变换系数进行差分编码，该装置还包括：

第一装置，用于确定所述第一和第二梯度；和

第二装置，用于根据所确定的梯度从左手块和顶块的一个中选择一个DC空间变换系数，该系数被用于对当前块DC空间变换系数进行差分编码。

36. 根据权利要求35所述的装置，其特征是：

用于选择的所述第一装置根据所选择的DC空间变换系数从所述左手块和所述顶块的一个中选择一个用于求和装置的AC空间变换系数。

37. 根据权利要求35所述的装置，其特征是：

当从所述顶块中选择所述DC空间变换系数、所述当前块是根据帧模式或非重新排序场模式编码以及所述顶块是根据帧模式或非重新排序场模式编码时，用于选择的所述第一装置从所述顶块中选择用于求和装置的AC空间变换系数。

38. 根据权利要求35所述的装置，其特征是：

当从所述顶块中选择所述DC空间变换系数以及所述当前块和所述顶块都根据重新排序场模式编码时，用于选择的所述第一装置从所述顶块中选择一个用于求和装置的AC空间变换系数。

39. 根据权利要求32到38中任一个的装置，其特征是还包括：

装置，用于当所选择块不是INTRA编码时，利用零AC空间变换系数代替来自所选择块的AC空间变换系数。
40. 根据权利要求 32 到 39 中任一个的装置，其特征是所述当前块驻留在当前视频目标平面 (VOP) 内，所述装置还包括：

装置，用于当所选择块不是驻留在所述当前 VOP 中时，利用归零 AC 空间变换系数代替来自所选择块的 AC 空间变换系数。

41. 根据权利要求 32 到 40 中任一个的装置，其特征是：

所述用于选择的第一装置响应在所述数字位流中提供的一个代码字，该代码字从所述左手块和所述顶块的一个中指定 AC 空间变换系数。

42. 根据权利要求 35 所述的装置，其特征是：

当前块的 DC 空间变换系数被非线性量化，该装置还包括：

装置，用于从指出所选择块和当前块各自的量化级的所述数字位流中恢复数据；和

装置，用于根据所选择块和当前块的各自量化级定标当前块的 DC 空间变换系数以恢复被定标的 DC 空间变换系数。
说明书

用于存取数字视频的宏数据
块内的 DC 和 AC 系数预测

本发明特别涉及到当当前宏数据块和/或相邻宏数据块是隔行（例如场）代码时用于对与宏数据块内数字视频相关的 DC 和 AC 系数编码的方法和装置。选择来自相邻宏数据块的预测器系数对当前宏数据块的系数进行编码以使编码系数最佳化。所述系数例如是从诸如离散余弦变换（DCT）的空间变换得到的。


MPEG-4 是一种新的编码标准，它提供了一种灵活的机制和开创了一组用于数字音频-可视数据的通信、访问和操作的编码工具。MPEG-4 的灵活结构支持各种编码工具的组合以及它们相应的功能性，以满足诸如数据库浏览、信息提取和相互作用通信等计算机、远距离通信和娱乐（如：电视和电影）等的需要。

MPEG-4 提供多种标准的核心技术，以允许有效地存储、传送和操作多媒体环境下的数据。MPEG-4 实现有效的压缩、目标可量测性、空间和时间可量测性以及误差恢复性。

MPEG-4 视频 VM 编码器/解码器（codec）是一种具有运动补偿的以块和目标
块为基础的混合编码器。利用使用重叠块运动补偿的 8 x 8 离散余弦变换 (DCT) 对纹理编码。使用以内容为基础的算术编码 (CAB) 算法或经过改进的 DCT 编码器将目标形状表示为字母映射并对其编码，两者都使用时间预测。当它们被从计算机表格中了解时，所述编码器能够处理空间。其它编码方法，诸如子波和弹性编码也可以用于特殊用途。

运动图象纹理编码是一种公知的用于视频编码的途径和可以被模型化为三等级处理。第一级是信号处理，包括运动估计和补偿 (ME/MC) 以及二维 (2-D) 空间变换。ME/MC 和空间变换的目标是按视频顺序取时间和空间的优点以便使量化速度分布和在复杂性约束下的熵信息最佳化。用于 ME/MC 的最公知技术是块匹配和最公知的空变换是 DCT。

另外，在某些情况下，当宏数据块被 INTRA 编码时，例如不参考时间在后或在前的预测器宏数据块，可以改善编码效率。INTRA 编码可用于具有重复运动、景象变化或重复变化等其中可以具有很小帧-帧相关性的明亮条件下的图象顺序。通过使用相邻块的系数作为预测器系数对当前块的 DCT 系数差分编码，编码效率可以进一步得到改善。

但是，利用诸如 MPEG-4 的编码方案，在视频目标平面 (VOP) 或其它图象区域中可以具有彼此靠近的一个帧模式宏数据块和一个场模式宏数据块。因此，在自适应编码系统中，场模式宏数据块可以被重新排序或不被重新排序。因此，希望具有一个系统用于选择用于对当前 INTRA 编码块的 AC 和 DC 的 DCT 系数差分编码的预测器系数，其中，以帧模式、非重新排序场模式和/或重新排序场模式对当前块和/或相邻块编码。

所述系统还提供 DC 变换系数的非线性量化。

本发明提供一个具有上述和其它优点的系统。

根据本发明，提供一种方法和装置，用于选择用于对当前 INTRA 编码块的
系数进行差分编码的预测器系数。

用于对数字视频图像中的当前 INTRA 编码块的空间变换系数进行编码的方法包括用于识别相邻左、右、上、下和与当前块以及顶块相邻的左顶块的步骤。所述左、右、上、下和左顶块中的每一个都具有一个 DC 空间变换系数和多个 AC 空间变换系数。另外，所有这些块中的每一个都以根据帧模式、重新排序场模式或非重新排序场模式的编码模式编码。预测器 AC 空间变换系数从左、右、上、下和左顶块中选择，以用于对当前块的 AC 空间变换系数差分编码。选择步骤考虑当前块和顶块的编码模式。

特别是，当根据帧模式或非重新排序场模式对顶块编码和根据重新排序场模式对当前块编码时，AC 空间变换系数可以从左、右、上、下和左顶块中选择。

当根据帧模式或非重新排序场模式对当前块编码和根据重新排序场模式对顶块编码时，AC 空间变换系数可以从左、右、上、下和左顶块中选择。

用于对当前块的 DC 空间变换系数进行差分编码的 DC 空间变换系数可以根据左、右、上、下和左顶块的 DC 空间变换系数之间的梯度和顶块和左顶块的 DC 空间变换系数之间的梯度从左、右、上、下和左顶块中选择。

AC 空间变换系数可以根据所选择的 DC 空间变换系数从左、右、上、下和左顶块中选择。

当 DC 空间变换系数是从顶块中选择、根据帧模式或非重新排序场模式对当前块编码以及根据帧模式或非重新排序场模式对顶块编码时，AC 空间变换系数可以从顶块中选择。

当 DC 空间变换系数从顶块中选择以及根据重新排序场模式对当前块和顶块编码时，AC 空间变换系数可以从所述顶块中选择。

当所选择的块不是被 INTRA 编码时可以利用归零 AC 空间变换系数代替来自所选择块的 AC 空间变换系数。
再有，当前块驻留在当前视频目标平面 (VOP) 内时，可以在所选择的块没有驻留在当前 VOP 中时利用归零 AC 空间变换系数代替来自所选择块的 AC 空间变换系数。

所述 DC 系数可以被非线性量化。

还提供了一种相应的解码方法。通过执行在编码器处使用的选择处理，解码器可以独立地识别预测器系数。或解码器可以从传送的位流中恢复用于识别预测器系数的代码字。

还提供了一种相应的装置。

图 1 的方框图示出了本发明的编码器。

图 2 显示了根据本发明来自自适应帧/场 DCT 方案中象素行的重新排序。

图 3 显示了根据本发明用于 INTRA 码块的 DC 系数预测。

图 4 (a) - (d) 显示了根据本发明当前块和候选预测器块的 4 种可能的排列。

图 5 显示了根据本发明用于 INTRA 码块的 AC 系数预测。

图 6 是的方框图示出了根据本发明的解码器。

图 7 显示了根据本发明的宏数据块包的结构。

提供了一种用于选择用于对当前 INTRA 码块宏数据块的系数差分编码的预测器系数的方法和装置。通过从左相邻块和顶相邻块选择预测器 DC 和 AC 系数对 DC 和 AC 系数进行差分编码。每个块根据帧模式、重新排序模式或非重新排序模式编码。根据所述块的各自编码模式和其中驻留 DC 预测器的块选择 AC 预测器块。当顶块和当前块都被以场模式、或以帧模式和/或非重新排序模式重新排序和 DC 预测器驻留在顶块中时，顶块被选择作为一个 AC 预测器块。当所选择块不是被 INTRA 码或不是驻留于作为当前块的同一个视频目标平面 (VOP) 内时，归零 AC 空间变换系数被用于来自所选择块的空间变换系数。
在这种情况下，DC 系数可以被类似地设置成非零值。

图 1 的方框图示出了本发明的编码器。该编码器适用于符合诸如在MPEG-4 标准中各种规定的视频目标平面 (VOP)。所述 VOP 是帧内图像元件。VOP 可以具有任意形状，和作为视频目标，VOP 的连续性是公知的。全矩形视频帧也可以被认为是一个 VOP。因此，这里，术语 "VOP" 将被用于指出任意和非任意 (例如，矩形) 图象区域形状。当属于一个特定 VOP 时，帧中的每个象素被识别。

VOP 可以被分为预测 VOP (P-VOP)、编码内 VOP (I-VOP) 或双向预测 VOP (B-VOP)。但是，单一的一个 VOP 可以包括不同类型的宏数据块。特别是，一个 VOP 可以包括一定数量的单独使用帧内模式或帧间模式编码的宏数据块 (MB)。利用帧内 (INTR) 编码，不必参考暂时在前或在后的 MB 对所述 MB 编码。利用帧间 (INTER) 编码，可以相对在后和/或在前的基准 (例如帧) 模对 MB 差分编码。用于一个 P-VOP 的帧 (例如，VOP) 必须是另一个 P-VOP 或 I-VOP，而不能是 B-VOP。一个 I-VOP 包括多个不被预测编码的自包含 (例如帧内编码的) 块。

此外，可以利用帧模式，重新排序模式或非重新排序模式对帧内和帧间编码的 MB 编码。B-VOP 可以使用 P-VOP 的正向预测以及后向预测、双向预测和直接模式，所有这些都属于帧间技术。B-VOP 不能直接使用参考尽管是预先经过变化的 MPEG-4 VM 8.0 下的帧内编码的 MB。用于 B-VOP 的帧 (例如，VOP) 必须是 P-VOP 或 I-VOP，而不能是其它 B-VOP。

以标号 100 表示的编码器包括一个形状编码器 110、运动估计函数 120、于动补偿函数 130 和纹理编码器 140，其中的每一个接收在端 105 处的视频象素数据输入。运动估计函数 120、运动补偿函数 130、纹理编码器 140 和形状编码器 110 还接收端 107 处诸如 MPEG-4 参数 VOP_of_arbitrary_shape 的 VOP 形状信息输入。当这个参数是零时，VOP 的形状为矩形，和因此不使用形状编
码器 110.

利用 INTRA 编码，重新构成的错 VOP 函数 150 提供由运动估计函数 120 和运动补偿函数 130 使用的重新构成错 VOP。在减法器 160 中从运动补偿在先 VOP 中减去当前 VOP 以提供一个在纹理编码器 140 处编码的余数。纹理编码器 140 对所述余数执行 DCT，以提供纹理信息（例如，变换系数）给多路转换器（MUX）180。纹理编码器 140 还提供一个信息，该信息与来自运动补偿器 130 的输出在加法器 170 处相加用于到在前重新构成的 VOP150 的输入。

对于 INTRA 编码，对来自当前块的象素数据，而不是来自所述余数的 DCT 系数执行 DCT。但是，如下面将要讨论的，DCT 系数本身可以使用来自与同一个 VOP 中当前块相邻的所选择块的 AC 和 DC 系数进行差分编码。

对于 INTRA 编码块，运动信息（例如，运动矢量）被从运动估计函数 120 提供给 MUX180，同时，指出 VOP 形状的形状信息信息从形状编码函数 110 提供给 MUX180。MUX180 提供相应多路转换的数据流给缓冲器 190，以用于数据通道上的连续通信。

输入给编码器的象素数据可以具有 YUV 4:2:0 的格式。并借助于一个矩形表示所述 VOP。所述约束矩形的左顶坐标被限制为不大于相邻矩形左顶坐标的新约偶数。因此，色度分量中约束矩形的左顶坐标是亮度分量中约束矩形左顶坐标的一半。

对于诸如具有快速运动或景物变化的某些视频序列，它可以非常有效地直接编码当前块而不必使用 VOP 间差分编码。因此，希望有一种判决准则用于自适应地选择对当前块直接（例如，INTRA 模式）编码或差分（例如，INTER 模式）编码。计算上述参数以进行 INTRA/INTER 判决:
其中，N是所述块的尺寸（例如，对于16 x 16的宏数据块，N=16）。项c(i, j)当前宏数据块的亮度取样，其中，“i” 是水平索引，“j” 是垂直索引。如果 A < (SADinter(MVx, MVy) - 2 * Nc)，选择 INTRA 模式，反之，使用 INTER 模式。SADinter 是当前宏数据块象素和最佳匹配宏数据块象素之间的逐个象素基础上所取差的绝对值。最佳匹配宏数据块分别由水平和垂直运动矢量参考。Nc是在当前 COP 中象素的数量。一个VOP 通常包括多个宏数据块。注意，在用于这个判决的 SADinter(MVx, MVy) 位于整数象素分辨率处。如果选择 INTRA 模式，没有其它的操作用于运动搜索。如果选择 INTER 模式，运动搜索继续用于半-象素分辨率 MV。

图2显示了在根据本发明的自适应帧/场 DCT 方案中象素行的重新排序。

当隔行（场级模式）视频被编码时，通过重新排序一个宏数据块的行以形成组成来自一个场的数据的 8 x 8亮度块，有时能够获得主能压缩（superior energy compaction）。然后对包括相同场象素行（即底场的一个顶）的重新排序的宏数据块执行 DCT。当

\[ \sum_{i=0}^{6} \sum_{j=0}^{15} (P_{2i,j} - P_{2i-1,j})^2 + (P_{2i-1,j} - P_{2i-2,j})^2 > \sum_{i=0}^{6} \sum_{j=0}^{15} (P_{2i,j} - P_{2i-2,j})^2 \]

时，使用场 DCT 行排序。

其中，Pi, j 是空间亮度取样，用于在执行 8 x 8 DCT 之前进行 INTRA 编码（或 INTER 差分编码）。项“i”和“j” 分别是水平和垂直索引。当 MPEG-4 标记 dct_type = 1（即，重新排序场模式）时，指出场 DCT 排列。非重新排序模
式和帧模式由 dct.type = 0 指出。对排序行的判决在对使用 INTRA 或 INTER- 
编码编码判决之后执行。

当使用场 DCT 模式时，宏数据块空间域内用于 INTRA 模式的亮度行 (或用于 
INTER 模式的亮度行) 被从帧 DCT 取向到场 DCT 结构排列。所生成的宏数据 
块通常被进行变换、量化和 VLC 编码。在对场 DCT 宏数据块解码的过程中，在 
从 IDCT 获得所有的亮度块之后执行相反的排列。在 4:2:0 的格式下，利用这种 
模式不能对色度数据有效编码。通常在 20 处示出了场模式图象，即一个 16 x 16 
宏数据块 (MB)。所述 MB 包括偶数行 202、204、206、208、210、212、 
214 和 216 以及奇数行 203、205、207、209、211、213、215 和 217。 
偶数和奇数行然后被交错，和分别形成顶和底场。

当图象 20 的象素行被排列以形成同场亮度块时，形成了通常在 25 处示出 
的 MB。通常在 245 处示出的箭头指出行 202-217 的重新排序。例如， MB200 
的第一个偶数行 202 也是 MB250 的第一个偶数行。偶数行 204 被重新排序成 
MB250 中的第二行，类似的，偶数行 204、206、208、210、212、214 和 
216 被分别重新排序成 MB250 的第三到第八行。由此，形成具有偶数行的 16 x 
8 个亮度区域。类似的，奇数行 203、205、207、209、211、213、215 
和 217 形成 16 x 8 区域 285。

关于纹理编码，对顶区 280 中的两个块和底区 285 中的两个块执行 8 x 8 
DCT。使用可分离的两维 DCT。如下面将要描述的，通过使用来自与当前块相 
邻的块的预测器系数对 DCT 系数差分编码能够实现其它的编码系数。

图 3 示出了根据本发明用于 INTRA 编码块的 DC 系数预测。DC 系数预测不 
受所述块是帧模式还是场模式影响。在熵编码之前，执行 DCT 的量化 DC 和某 
些 AC 系数的无损预测以集中闭环的系数分布从而使所述熵编码更加有效。 
用于当前块或直接关于该当前块，即在前向的自适应 DC 预测方法包括到当前
块左侧的块的量化 DC (QDC) 值。

此外，DC 系数的量化可以是线性的或非线性的。对于线性量化，利用用于 8 的亮度和色度分量的 DC 系数的步长，QDC = dc // 8，其中，“dc”是来自 11 位未量化变换系数值。“//”表示循环除法。

下面结合表 1 描述用于宏数据块内 DC 系数的非线性量化。

<table>
<thead>
<tr>
<th>表 1</th>
<th>用于量化器 (Qp) 范围的 scaler</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>dc_</td>
</tr>
<tr>
<td></td>
<td>1 到 4</td>
</tr>
<tr>
<td>亮度</td>
<td>8</td>
</tr>
<tr>
<td>色度</td>
<td>8</td>
</tr>
</tbody>
</table>

利用量化级 Qp 按照分段关系解释用于 DCT 块 DC 系数的非线性换算电路参数 (dc_scaler)。通过相应的非线性换算电路量化亮度和色度块的 DC 系数。例如，对于具有 1-4 Qp 范围的亮度块来讲，dc_scaler = 8，对于 Qp 值为 6 的亮度块，dc_scaler = 2 * Qp = 12。这样，使用 QDC = dc_ // dc_scaler 执行正向量化，和使用 dc = dc_scaler * QDC 计算重新构成的 DC 值。

DC 预测器系数的自适应选择以围绕当前块产生的水平和垂直 QDC 值为基础。例如，假设块 X 310 是一个当前正在被编码的 INTRA 宏数据块中 DCT 系数的 8 x 8 块，块 X 包括 DC 系数 312。块 A320 是一个与块 X 左手直接相邻的 8 x 8 块，块 C340 是一个与块 X 顶部直接相邻的 8 x 8 块，块 B330 是一个与块 C 左手直接相邻的 8 x 8 块。块 A 包括 DC 系数 322，块 C 包括 DC 系数 342，和块 B 包括 DC 系数 332。
对于 DC 系数的线性量化，块 X 的 QDC 预测器值 $QDC'X$ 在比较水平和垂直 QDC 梯度的基础上从块 A 的 QDC 值 $QDCA$ 或块 C 提的 QDC 值 $QDCC$ 中获得，特别是，如果 $|QDCA - QDCB| < |QDCB - QDCC|$，那么 $QDC'X = QDCC$。否则，$QDC'X = QDCA$。

然后如下获得差分的 DC 值 $DQDCX$: $DQDCX = QDCX - QDC'X$。差分的 DC 值被变换编码和以位流形式传递给一个解码器。对宏数据块的每个块单独重复执行该处理，和然后对 VOP 或帧中的每个宏数据块进行处理。在所述解码器中，从运算 $QDCX = DQDCX + QDC'X$ 中获得全 DC 系数。

如果 A、B 和 C 中的任何一个位于 VOP 或帧区域的外部，或它们不属于一个 INTRA 编码的宏数据块，它们的 QDC 预测值被假设为左侧为 2 (bits_per_pixel-1)。例如，当 bits_per_pixel = 8 时，使用 27 = 128 的值。类似用于亮度和一个块两个色度分量中每一个的方式选择 DC 预测值。

当用于块 A320、B330 和 C340 的 dc_scaler 不同时，可以对上述用于线性量化的方案进行改进以用于 DC 系数的非线性量化。即，对于这三个块的每一个块来讲，dc_scaler 都不相同。由于量化级逐个宏数据块可以不同，所以，这是可能发生的。

如果 $|QDC(1)A - QDC(1)B| < |QDC(1)B - QDC(1)C|$，

$$QDCX = QDC(1)C$$

另外，

$$QDCX = QDC(1)A$$

其中，$QDCA = dcX // dc scalarX$，

$$QDC(1)A = (QDCA * dc scalarA) // dc scalarX$$，和 $QDCA = dcA // dc scalarA$，

$$QDC(1)B = (QDCB * dc scalarB) // dc scalarX$$，和 $QDCB = dB // dc scalarB$
dc_scalarB,

\[ \text{QDC}(1)C = (\text{QDEC} \times \text{dc_scalarC}) \div \text{dc_scalarX} \], 和 \( \text{QDEC} = \text{dcC} \div \text{dc_scalarC} \).

特别是，根据其中驻留有 DC 系数的宏数据块和其中驻留有被选择预测块的宏数据块的量化级定标所述 DC 值。通常，\text{dc_scalar} 在逐个 MB 的基础上被指定。参数 QDC 和 Qp 可以以数字流的形式转送给解码器。Qp 被逐个 MB 编码和作为 MPEG-4 参数 DQUANT 传送。在所述解码器中，根据表 1，从 DQUANT 中获得 Qp，和从 Qp 获得 \text{dc_scalar}。QDC 预测器通过重新计算水平和垂直梯度和考虑其它预测块选择标准确定，和最后，使用未定标 QDC 值和 \text{dc_scalar} 值获得定标的 QDC 值 QDC(1)

图 4(a)–4(d)示出根据本发明当前块和电位预测器块的 4 种可能配置。DC 系数预测器的选择不受宏数据块中当前块 X 相对位置的影响。

图 4(a)示出了与图 3 所示配置对应的第一种配置。特别是，当前正在被编码的块 X310 是宏数据块 300 的左上手块，块 A320 是宏数据块 420 的右上手块，块 B 是宏数据块 430 的右下手块，和块 C340 是宏数据块 440 的左下手块。

图 4(b)示出了第二种配置，其中，块 X310 是宏数据块 300 的右上手块，块 A320 是宏数据块 300 的左上手块，块 B330 是宏数据块 440 的左下手块，和块 C 是宏数据块 440 的右下手块。

通常，相同宏数据块中的所有块都处于帧模式或都处于没有重新排序的场模式或都处于重新排序的场模式。相同宏数据块中的所有块都是 INTRA 编码或都是 INTER 编码。此外，相邻宏数据块中的块可以具有不同的模式。由此，在图 4(b)中，块 A320 和块 C340 要么都处于帧模式，要么都处于没有重新排序的场模式，要么都处于重新排序的场模式。类似的，块 B330 和块 C340 要么都处于帧模式，要么都处于没有重新排序的场模式，要么都处于重新排序的场模
式。

图 4 (c) 示出了第三种配置，其中，块 X310 是宏数据块 300 的左下角块，块 A320 是宏数据块 420 的右下角块。块 B 是宏数据块 420 的右上角块。块 A320 和块 B330 或处于帧模式、或处于没有重新排序的场模式、或处于重新排序的场模式。类似的，块 X310 和块 C340 或处于帧模式、或处于没有重新排序的场模式或处于重新排序的场模式。

图 4 (d) 示出了第四种配置，其中，块 X310 是右下角块，块 A320 是左下角块，块 B330 是左上角块，块 C340 是右上角块。由于块 A 、 B 、 C 和 D 位于同一个宏数据块内，所以，它们或都处于帧模式，或都处于没有重新排序的场模式，或都处于重新排序的场模式。

图 5示出了根据本发明用于 INTRA 编码块的 AC 系数预测。利用 AC 系数预测，选择左右相邻块或顶部相邻块用于对当前位置的 AC DCT 系数进行差分编码。本专业技术领域内的技术人员能够识别除了是 DC 系数的左上角系数以外 DCT 块中的所有系数都是 AC 系数。因此，对于 8 x 8 块来讲有 63 个 AC 系数和一个 DC 系数。“DC” 被称之为直流，它描述备用状态系数能量，而“AC”被称之为交流，它描述相对于 DC 电平变化的系数能量。

通常，AC 系数中的能量分布如下：接近一个块右下角部分的系数为零值或近似零值，和因此而不需要差分编码，而接近一个块左上角部分的系数需要被差分编码。

由于所述块可以是图 4 (a) – (d) 所示 4 种配置中的一种，所以，图 5 没有示出宏数据块的边界。另外，当每个宏数据块包含 64 个系数时，所有的系数并没有单独示出。块 X310 包括 AC 系数 314 的第一行和 AC 系数 316 的第一列，块 C 包括 AC 系数 344 的第一行，和块 A 包括 AC 系数 324 的第一列。

块 A320 中的 DC 系数 322 或块 C340 中的 DC 系数 342 被选择作为用于块
X310 中 DC 系数 312 的预测器。此外，来自在前编码块 (即，在同一个 VOP 内) 第一行或第一列的 AC 系数被用于预测当前块的相应系数。

对于每个编码块来讲，当所述当前块和预测块具有相同的 dct_type 时，所选择用于 DC 系数预测的方向还被用于选择用于 AC 系数预测的方向。即，当当前块和预测块都具有 dct_type = 0 (即：没有重新排序场模式，或帧模式) 或 dct_type = 1 (即：重新排序场模式) 时，DC 预测器块的 AC 系数被用于对当前块的 AC 系数进行差分编码。MPEG-4 标记 “dct_type” 已经如上结合图 2 进行了讨论。

在第一个例子中，假设当前块，即块 X310 被如图 4(a) 所示配置。如果块 X、A 和 C 具有相同的 dct_type，那么，DC 预测器块的 AC 系数被用于对当前块的 AC 系数进行差分编码。

例如，如果块 C340 是一个 DC 预测器块，那么，块 C 的 AC 系数 344 的第一行被用于在逐个系数的基础上预测块 X 的 AC 系数 314 的第一行。即，行 314 的第一个 AC 系数被用于预测行 314 的第一个 AC 系数，如箭头 346 所示；行 344 的第二个 AC 系数被用于预测行 314 的第二个 AC 系数，等等。类似的，块 C340D 的 AC 系数的第二行被用于预测行 X310 的 AC 系数的第二行，等等，直到块 C 的 AC 系数的最后一行被用于预测块 X 的 AC 系数的最后一行为止。注意，每个块的第一行具有 7 个 AC 系数，而其余行具有 8 个 AC 系数。

另外，仍然假设定块 A、B 和 C 具有相同的 dct_type，如果块 A 是一个 DC 系数块，那么，块 C 的 AC 系数 324 的第一列被用于在逐个系数的基础上预测块 X 的 AC 系数的第一列 316。例如，列 324 的第一个 AC 系数被用于预测列 316 的第一个 AC 系数，如箭头 326 所示。类似的，块 A 的 AC 系数的第二列被用于预测块 X 的 AC 系数的第二列，等等，直到块 A 的 AC 系数的最后一列被用于预测块 X 的 AC 系数的最后一列为止。注意，每个块的第一列具有 7 个 AC 系数。
数，而其余的列具有 8 个 AC 系数。

仍然假设使用图 4(a)所示的配置，如果块 X 和块 C 具有不同的 dct_type，那么，不必考虑 DC 预测器块，选择块 A 作为 AC 预测器块。即使是块 A 和块 X 具有不同的 dct_type，但由于在重新排序模式下行的重新排序不会对与没有重新排序模式块和帧模式块相关的水平空间频率的分布产生多大影响，所以在这种状态下，选择块 A 作为 AC 预测器。因此，使用块 A 作为 AC 预测器块仍然能够改善编码效率。

如果块 X 和块 C 具有相同的 dct_type 但块 X 和块 A 具有不同的 dct_type，那么，选择块 C 作为 AC 预测块而不考虑 DC 预测块。

由此，例如 DC 预测器可以来自块 C，而 AC 预测器可以来自块 A。另外，DC 预测器可以来自块 A 和 AC 预测器可以来自块 C。

通常，当块 C 和块 X 具有不同的 dct_type 时避免将块 C 作为 AC 预测器块的原因是象素行的重新排序改变了一个块中的空间能量，从而在具有不同 dct_type 的两个块之间的空间频率之向的相关性被有效地减少。

例如，假设块 X 是一个具有垂直边界并跨越所述块快速运动目标的图像。在这种情况下，块 X 可以被编码为重新排序模式块以避免对垂直边界产生波动或锯齿形影响。由于和底场之间的空间延迟引起的这种波动在所述块中被表示为垂直矩形。但是，如果所述运动图像的垂直边界的确没有延伸到块 C 中，那么，块 C 可以以非重新排序模式或帧模式编码。在这种情况下，由于 AC 系数间的相关性较差，所以，块 C 不能为块 X 提供良好的 AC 预测器系数。因此，块 A 被用作 AC 预测器块。块 A 通常提供较高的相关性。

在第二个例子中，假设当前块的配置如图 4(b) 所示。这里，块 A 和块 X 彼此具有相同的 dct_type，块 B 和块 C 彼此具有相同的 dct_type。如果块 X 和 C 彼此也具有相同的 dct_type，那么，DC 预测器块的 AC 系数被用于对当
前块的 AC 系数进行差分编码。如果块 X 和 C 具有不同的 dct_type，不能块 A
被用作 AC 预测器块，而不必考虑 DC 预测器块。

在第三个例子中，假设当前块的配置如图 4(c) 所示。块 X 和块 C 彼此具
有相同的 dct_type，块 A 和 B 彼此具有相同的 dct_type。如果块 X 和 A 彼此
也具有相同的 dct_type，那么，DC 预测器块的 AC 系数被用于对当前块的 AC
系数进行差分编码。如果块 X 和 A 具有不同的 dct_type，那么，块 C 被用作
AC 预测器块，而不考虑 DC 预测器块。

在第四个例子中，假设当前块的配置如图 4(d) 所示。由于块 A、B、C
和 X 都位于同一个宏数据块 300 当中，所以，它们具有相同的 dct_type。因
此，DC 预测器块的 AC 系数被用于对当前块的 AC 系数差分编码。

作为一般规律，只有当块 X 和块 C 具有相同的 dct_type 和 DC 预测器来自
块 C 时，块 C 才被用作 AC 预测器块。反之，块 A 被用作 AC 预测器块。此外，
AC 预测的执行类似于对亮度和两个色度分量的预测。

注意，当由于错误而选择了块 A (即，当块 X 和块 C 具有不同的 dct_type
时) 但实际上不存在块 A 时，诸如当块 X 位于一个行中第一宏数据块的左半
部分中时，零被用于 AC 预测器。

在图 4 和图 5 的例子中，每个块都被假设是 INTRA 编码和位于公共 VOP 边
界之内。但是，如果块 A、B 或 C 中的任何一个位于包含块 X 的边界之外或不
属于 INTRA 编码宏数据块，那么，它们的量化 AC (QAC) 值被假设取 0 值以用于
计算预测值。所述 QDC 值如所讨论的被设置成非零常数。

此外，为了补偿当前块 AC 系数中使用的在前水平相邻或垂直相邻块的
量化，需要对预测系数定标。预测被修改以便利用当前量化步长和预测块量化
步长之比定标所述预测器。

特别是，如果块 A 被选择作为用于当前块 (例如，块 X) 的 AC 预测器，被
定标的概念。AC 预测是:

$$QAC_{i0X} = \frac{QAC_{i0} \times QP_A}{QP_X}$$

其中，$QAC_{i0}$ 是用于第 $(i, 0)$ 个系数的未定标量化 AC 值，$QP_A$ 是用于块 A 的量化参数，$QP_X$ 是用于块 X 的量化参数。

如果块 C 被选择为 AC 预测器，被定标的垂直 AC 预测是:

$$QAC_{0jX} = \frac{QAC_{0j} \times QP_C}{QP_X}$$

其中，$QAC_{0j}$ 是用于第 $(0, j)$ 系数的未定标量化 AC 值，$QP_C$ 是用于块 C 的量化参数，和 $QP_X$ 是用于块 X 的量化参数。对 $(i, j)$ 表示在一个块中由水平 “i” 位置和垂直 “j” 位置构成的一个特定系数。例如，$(i, j) = (0, 0)$ 表示一个块中的左上手系数，和 $(i, j) = (8 \times 8)$ 表示一个块中的右下手系数。

如果块 A 或块 C 位于保留有块 X 的 VOP 之外，那么，对应的 QP 值被假设等于 $QP_X$。

虽然如结合图 3-5 所述通过减少表示数据的量，在 INTRA 块中 DCT 系数的差分编码通常特别能够改善编码效率，但是，并不总是这种情况。因此，当 AC 系数预测导致和原始信号比较的较大值误差时，希望禁止 AC 预测。但是，为了避免连续的额外数据，AC 预测能够在逐个宏数据块而不是在逐个块的基
础上被转换成导通或关断状态。用于选择 AC 预测导通或关断的判断是在比较
在宏数据块中将被预测的所有 AC 系数的绝对值的和与预测系数绝对值的的
基础上进行的。特别是，如果块 A 被选择作为 AC 预测块，判据 S 计算如下:

\[ S = \left( \sum_{i=1}^{7} |QAC_i0X| - \sum_{i=1}^{7} |QAC_i0X| - QAC_i0X \right) \]

假如块 C 被选择作为用于当前块的 DC 预测器，判据计算如下:

\[ S = \left( \sum_{j=1}^{7} |QAC_0jX| - \sum_{j=1}^{7} |QAC_0jX| - QAC_0jX \right) \]

接着，对于需要做出公共判决的宏数据块中的所有块来讲，计算信号 \( SS \)
和诸如 MPEG-4 标记“ACpred_flag” 的一个标记是设置/复位到使能/禁止
AC 预测。特别是，如果 \( SS = 0 \)，设置 ACpred_flag = 1，以使能 AC 预测。
反之，设置 ACpred_flag = 0，以禁止 AC 预测，在两种状态下的任何一种系
状态下，DC 预测仍被使能。ACpred_flag 被传送解码器，以用于恢复每个
块的 DCT 系数。

图 6 的框图示出了本发明的一个解码器。通常用标号 600 表示的解码器可
以被用于接收和解码从图 1 所示编码器传送的编码数据信号。编码视频图象数
据和差分编码运动矢量 (MV) 数据在端 640 被接收和提供给多路转换器
( DEMUX) 642 。对于 INTRA 宏数据块来讲，编码视频图象数据被差分编码成 DCT
变换系数以作为预测误差信号 (例如，余数)。对于 INTER 宏数据块来讲，视频
图象本身不被差分编码，但 DCT 系数可以使用同一个 VOP 中的相邻变换系数。
即根据 ACpred_flag 差分编码。

当 VOP 具有任意形状用于恢复接下来将被提供给运动补偿函数 650 和 VOP
重新构成函数 652 时，形状解码函数 644 处理数据。纹理编码函数 646 对变换
系数执行逆 DCT 以恢复用于 INTER 编码宏数据块的余数信息。

对于 INTRA 编码宏数据块 0KB，象素数据被直接恢复和提供给 VOP 重新构
成函数 652。特别是，当 Acpyed_flag = 0 时，由于 AC 系数不是被差分编码的，所
以，纹理编码函数 646 处的逆 DCT 直接恢复当前块的 AC 系数。使用顶
部或左上手块的 DC 系数 (例如预测器) 对 DC 系数差分编码。当所选择的预测器
块位于当前 VOP 之外或来自 INTER 编码块时，DC 预测器可以被零。通过使
当前块差分编码的 DC 系数和预测器 DC 系数相加，即通过运算 QDCX = DQDCX +
QDC’X 恢复全 DC 系数。

对于具有 Acpyrd_flag = 1 的 INTRA 编码宏数据块，当前块的 AC 和 DC
系数都被差分编码。DC 系数被恢复成如上讨论的用于当前 ACpred_flag = 0 的
情况，通过执行逆 DCT 获得当前块差分编码 AC 系数和使该差分编码 AC 系数和
预测器块的相应 AC 系数相加，即根据运算 QACX = DQACX + QAC’来恢复全 AC
系数。当所选择的预测器块位于当前 VOP 之外或不是 INTER 编码块时，所述
AC 预测器可以被归零。

由此，对于 INTYA 编码块来讲，它需要一个解码器去识别分别用于 AC 和
DC 系数的适当的预测器块。这可以通过在位流中提供一个或多个用于被用来指
出预测器块的每个宏数据块的代码字来实现。例如，代码字 “ 00 ” 可以指出
顶块是一个用于 AC 和 DC 系数的预测器，代码字 “ 01 ” 可以指出左手块是一
个用于 AC 和 DC 系数的预测器，代码字 “ 10 ” 可以指出左手块是一个用于 DC
系数的预测器而顶块是一个用于 AC 系数的预测器，和代码字 “ 11 ” 可以指出左
手块是一个用于 AC 系数的预测器而顶块是一个用于 DC 系数的预测器。
另外，代码字的其它位可以被用于指出归零预测器将被用于 DC 或 AC 系数。或解码器可以单独检查所选择的预测器块是否是被 INTRA 编码或是否是位于当前 VOP 之外，和当需要时将预测器系数设置为零或非零常数。

另外，在解码器 600 处的纹理解码函数 646 可以独立执行上面结合图 3-5 所述的选择算法以确定当前预测器的系数。在这种情况下，纹理解码函数 646 可以具有一个存储器，用于存储在对当前块处理过程中使用的左手块、顶块和左上手块的解码 DCT 系数。标记 dct_type 也必须是可变的，以用于这种情况下的每个宏数据块。可以构成一个适当的电路以利用软件、固化软件或硬件识别所希望的预测器系数以便对当前块解码。

对于诸如是在 B-VOP 中的 INTER 编码块和 MB，从纹理解码函数 646 提供给重新构成 VOP 函数 652 的象素信息表示在确定 MB 和基准图像之间的一个余项。基准图像可以是来自一个由正向或反向 MV 指出的单一锚 MB 的象素数据。另外，对于一个隔行 MB 来讲，基准图像是一个来自两个基准 MB，即一个过去的锚 MB 和一个将来的锚 MB 的象素数据的平均值。在这种情况下，解码器必须根据正向和反向 MB 在恢复确定 MB 象素数据之前计算平均象素数据。

对于 INTER 编码块和 MB 来讲，运动解码函数 648 处理解码 MV 数据以恢复差分 MV 和提供它们给运动补偿函数 650 和诸如 RAM 的矢量存储器 649。运动补偿函数 650 接收差分 MV 数据和根据位序列中的编码模式和当前 MB 的 PMV 索引以及在前 MB 确定 PMV。

一旦运动补偿函数 650 确定了全基准 MV 以及它与当前 MB 的差分 MV 之和，可以得到当前 MB 的全 MV。因此，运动补偿函数 650 现在可以从诸如 RAM 的 VOP 存储器 654 中提取帧最佳匹配数据，如果需要则计算平均值，和提供帧象素数据给 VOP 重新构成函数以重新构成当前 MB。

被提取或计算的最佳匹配数据被加回到 VOP 重新构成函数 652 处的象素余
项上以获得解码的当前块或块。重新构成的块被输出作为视频输出信号和被提供给 VOP 存储器 654 以提供新的帧数据。

图 7 显示了根据本发明的宏数据块结构。该结构指出解码器所接收数据的格式。注意，为简便起见，图示仅示出了 4 行。所述包实际上被串行传送，它始于顶行，并在该行内从左到右。第一行 716 包括场 first_shape_code、MVD.shape、CR、ST 和 BAC。第二行包括场 COD 和 MCBPC。第三行包括场 Acpred_flag753、CBPY、DQUANT、Interlaced_information、MVD、MVD2、MVD3 和 MVD4。第四行包括场 CODA、Alpha_ACpred_flag、CBPA、Alpha 块数据和块数据。上述场的每一个都是根据 MPEG-4 VM 8.0 规定的。

项 first_shape_code 指出 MB 是否位于一个 VOP 的边界框内。CR 指出二进制字母块的转换比。ST 指出水平或垂直扫描顺序。BAC 称之为二进制算术代码字。

COD 和 COSA 表示灰度标量形状编码。MCBPC 表示宏数据块类型和与色度相关的编码块模式。如上所述，Acpred_flag753 是一位标记，当它被设置为零时，表示只执行用于当前 INTRA 块的 DC 预测。Acpred_flag = 1 表示对当前 INTRA 块执行 AC 和 DC 预测。CBPY 表示用于亮度的编码块模式。DQUANT 指定逐个宏数据块量化器 Qp 值的变化。

在第三行 750 中场 Interlaced_information 指出所述宏数据块是否是隔行编码的。Interlaced_information 场可以被存储以当需要时被连续用于运动矢量存储器 1349 或解码器中的其它存储器。Interlaced_information 场还可以包括标记 dtc_type，如上所述，该标记指出在场编码宏数据块中的顶或底场象素行是否被恢复。

MVD、MVD2、MVD3 和 MVD4 表示运动矢量数据。Alpha_ACpred_flag 表示一个用于字母形状编码的 ACpred_flag。字母块数据表示在字母平面中已知
的二进制和灰度标量形状信息。

图7的的配置仅是一个例子。对于本专业技术领域内的技术人员来说用于将相关信息通知给解码器的各种其它配置是很明显的。

在本发明中使用的位流语法和MB包语法在MPEG-4 VM 8.0以及指定给Eifrig等人，申请日为1997年7月21日，发明名称为"用于视频目标平面的隔行数字视频的运动估计和补偿"美国专利申请No. 08/897,847中都已经做了描述，这里一并作为参考。

因此，可以看到，本发明提供了一种用于对INTRA编码块的DC和AC DCT变换系数差分编码的方案。通过从左手相邻块和顶相邻块选择预测器DC和AC系数对DC和AC系数差分编码。每个块被根据帧模式或没有重新排序场模式编码。根据所述块的各自编码模式和其中驻留有DC预测器的块选择AC预测器块。当顶块和当前块处于重新排序场模式或都处于帧模式时，顶块被选择作为AC预测器。归零空间变换系数被用于当所选择的块不是被INTRA编码或不是驻留于作为当前块的同一个视频目标平面(VOP)中时AC空间变换系数来自所选择块的场合。在这种情况下，DC系数被类似地设置成非零值。

特别是，本发明在以前方案的基础上改善了编码效率。以前的方案不能提供作为专用预测器块的顶块，或本发明解释了当前和专用块是以帧模式，没有重新排序场模式还是以重新排序场模式编码。当前块和顶块之间的空间频率相关性可以导致编码效率的改善。另外，包括当专用预测器位于当前视频目标平面(VOP)之外时提供归零预测器系数的MPEG-4标准的方案不必INTRA编码，或反之则不可得。

另外，所述方案与DCT系数的线性和非线性量化兼容。特别是，披露了DC系数的非线性量化，其中，根据其中驻留有所述系数的宏数据块和其中驻留有
被选择预测块的宏数据块的量化级在解码器处定标编码系数以恢复被定标的系数。

虽然结合各种特殊定的实施例对本发明进行了描述，但本专业技术领域内的技术人员很清楚，可以对它做出很多变动和修改而不脱离本发明权利要求所描述的精神和范围。例如，当本发明结合 DCT 变换系数加以讨论时，本发明还适用于其它空间变换的系数。
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图4a
图5
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图7
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**Title of Invention:**
Selective prediction encoding and decoding methods and selective prediction encoding and decoding devices

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(Not for submission under 37 CFR 1.99)

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## U.S. PATENTS

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number 11256188
Filing Date 2005-10-24
First Named Inventor JANG, Euee-S et al.
Art Unit 2621
Examiner Name
Attorney Docket Number 076980.0101

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

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☐ See attached certification statement.
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A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature /James B. Arpin/
Name/Print James B. Arpin
Date (YYYY-MM-DD) 2009-04-08
Registration Number 33,470

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**Title of Invention:**
Selective prediction encoding and decoding methods and selective prediction encoding and decoding devices

**First Named Inventor/Applicant Name:** Euee-S Jang

**Customer Number:** 24735

**Filer:** JAMES B ARPIN

**Filer Authorized By:**

**Attorney Docket Number:** 076980.0101

**Receipt Date:** 08-APR-2009

**Filing Date:** 24-OCT-2005

**Time Stamp:** 11:44:56

**Application Type:** Utility under 35 USC 111(a)

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Image coding method and image coding device

Abstract not available for CN 1492685 (A)
Abstract of corresponding document: US 2004066976 (A1)

With respect to an input image, a plurality of coded data respectively having different coding quantities are generated, and n reference images are created from these coded data. The reference images are subjected to image quality evaluation, and coded data is selected on the basis of the result of the image quality evaluation. In other words, coded data is selected on the basis of the result of the image quality evaluation of the reference images identical to images obtained in reproducing. Accordingly, the coding quantity can be controlled in consideration of the image quality, so as to definitely obtain coded data having an appropriate coding quantity and high image quality.
发明名称 图像编码方法和图像编码装置

摘要

对于一个输入影像生成多个分别具有不同编码量的编码数据，并且从这些编码数据建立 a 个基准影像。对基准影像进行影像质量评价，并且根据影像质量评价结果选择编码数据。换句话说，根据与再生中得到的影像相同的基准影像的影像质量评价结果选择编码数据。因此，可以在考虑到影像质量的情况下控制编码量，以便确切地得到具有适当编码量和高影像质量的编码数据。

知识产权出版社出版
权利要求书

1. 一种编码活动图像影像的图像编码方法，包括：
   对一个第一影像生成多个分别具有不同编码量的编码数据的第一步骤；
   通过解码所述多个编码数据建立用于预测编码的多个基准影像的第二步骤；
   对所述多个基准影像进行影像质量评价的第三步骤；和
   基于影像质量评价结果从所述多个编码数据中选择至少一个编码数据的第四步骤。

2. 根据权利要求1所述的图像编码方法，其中
   在第一步骤中设置多个目标编码量，并且通过在将所述多个编码数据的编码量分别收敛到所述多个目标编码量的编码量控制下进行的编码，对所述第一影像生成所述多个编码数据。

3. 根据权利要求2所述的图像编码方法，其中
   对每个帧设置所述多个目标编码量，和
   在编码量控制下，在每个宏块中控制编码参数。

4. 根据权利要求1所述的图像编码方法，其中
   在第一步骤中，通过使用多个不同编码参数进行的编码，对所述第一影像生成所述多个编码数据。

5. 根据权利要求1所述的图像编码方法，其中
   一帧接一帧提供所述第一影像，和
   在第四步骤中在每帧中选择所述至少一个编码数据。

6. 根据权利要求1所述的图像编码方法，其中
   一帧接一帧提供所述第一影像，
   在第一步骤中，通过参考另一帧的n（其中n是大于或等于2的整数）个基准影像，对所述第一影像建立n个预测编码影像，和
   对于所述n个预测编码影像中的每个预测编码影像，生成m（其中m
是大于或等于 2 的整数）个分别具有不同编码量的编码数据，从而生成 n×m 个编码数据作为所述多个编码数据。

7. 根据权利要求 6 所述的图像编码方法，其中
   在第四步骤中，从所述 n×m 个编码数据中选择 n 个编码数据，并且将
   分别对应于所述 n 个编码数据的 n 个基准影像用于另一帧的影像的预测编码。

8. 根据权利要求 1 所述的图像编码方法，其中
   在第三步骤中，将从所述多个基准影像中具有最大编码量的编码数据得到的基准影像设置为参照影像，和
   得到每个所述基准影像与所述参照影像的差值，并且使用所述差值获得影像质量评价的评价值。

9. 根据权利要求 8 所述的图像编码方法，其中
   在第四步骤中，从对应子具有落入一个容许范围内的评价值的基准影像的编码数据中选择所述至少一个编码数据。

10. 根据权利要求 8 所述的图像编码方法，其中
    在第三步骤中，从所述参照影像中提取高频分量，和
    在获得所述评价值的过程中，根据对应像素的所述高频分量调制所述差值。

11. 根据权利要求 8 所述的图像编码方法，其中
    评价由所述差值组成的差值影像的模型，并从所述模型中提取噪声信息，和
    将所述噪声信息附加地包括在对应于对应的一个所述基准影像的编码数据中。

12. 根据权利要求 1 所述的图像编码方法，其中
    在第三步骤中，在每个宏块中执行所述基准影像的影像质量评价，和
    在第四步骤中，在每个宏块中选择所述至少一个编码数据，并且组合在
各个宏块中选择的所述编码数据，以重构新的编码数据。

13. 根据权利要求12所述的图像编码方法，其中
在第四步骤中，在重构所述新的编码数据的过程中，将所述选择的编码数据中一些已经通过预测编码而编码的编码数据进行一次解码，以得到在重构之前没有经过预测编码而已编码的编码数据，并且在重构之后再次进行预测编码。

14. 根据权利要求1所述的图像编码方法，其中
一帧接一帧提供所述第一影像，
在第一步骤中，对所述第一影像执行帧间编码和帧内编码，和
在第四步骤中，选择帧间编码或帧内编码。

15. 根据权利要求1所述的图像编码方法，其中
在第四步骤中，不仅基于影像质量评价结果，而且也基于所述多个编码数据的编码量选择所述至少一个编码数据。

16. 根据权利要求15所述的图像编码方法，其中
在第四步骤中，将一个影像质量容许范围设置为从影像质量评价产生的所述评价值的容许范围，并且将一个编码量容许范围设置为所述编码量的容许范围，和
根据一个给定规则从具有落入到所述影像质量容许范围内的评价值和具有落入到所述编码量容许范围内的编码量的编码数据中选择所述至少一个编码数据。

17. 根据权利要求15所述的图像编码方法，其中
在第四步骤中，在每帧中将一个编码量容许范围设置为所述编码量的容许范围，

在每个宏块中通过影像质量评价选择所述至少一个编码数据，和

当整帧的编码量高于所述编码量容许范围时，为使所述帧的所述编码量落入到所述编码量容许范围内，在一个通过改变选择使影像质量降低较小并
且编码量降低较大的宏块中优先改变所述至少一个编码数据的选择。

18. 一种图像编码装置，包括:
对一个第一影像生成多个分别具有不同编码量的编码数据的图像编码单元;
通过部分解码所述图像编码单元生成的所述多个编码数据，产生多个用于预测编码的基准影像的部分解码单元;
评价所述部分解码单元产生的所述多个基准影像的影像质量的影像质量评价部分; 和
根据所述影像质量评价部分执行处理的结果，从所述多个编码数据中选择至少一个编码数据的编码数据选择部分。

19. 根据权利要求 18 所述的图像编码装置，进一步包括:
存储所述多个编码数据的第一存储部分; 和
存储所述多个基准影像的第二存储部分，
其中所述第一存储部分和所述第二存储部分由一个共用存储装置构成。

20. 根据权利要求 18 所述的图像编码装置，其中
所述图像编码单元和所述部分解码单元以分时方式操作，以按时间序列连续生成所述多个编码数据和所述多个基准影像的组合。
图像编码方法和图像编码装置

技术领域

本发明涉及活动图像影像压缩的图像编码，更具体地讲，涉及提高用户
录像机和摄像机所需的实时编码中使用的编码量控制精度的技术。

背景技术

图 17 是包括惯用编码量控制的图像编码方法的流程图。在惯用的编码
量控制中，通过根据在前编码数据的编码量确定在后续编码中使用的参数，
使编码量落入一个预定范围内（例如参见日本未审查专利公开平 7-107473）。首
先，输入图像影像的第一帧（SZ1），并且用在前确定的初始参数编码第
一宏块（SZ2）。应当注意，编码是在每个称为宏块的矩形区中进行的。对
于每个后续的宏块，计算在前编码宏块的编码量（SZ3），并且确定所计算
的编码量是大于还是小于一个预定目标值。从而控制编码参数，使得当所计
算的编码量较大时，当前处理的宏块的编码量较小，或当所计算的编码量较
小时，当前处理的宏块的编码量能够较大（SZ4）。当输入下一帧影像时
（SZ5），也使用在前处理的帧的编码量计算该编码量偏离目标值的差值
（SZ6），以便控制后面要使用的编码参数（SZ7）。重复执行步骤 SZ5 至
SZ7，直到处理完最后一帧（SZ8）。

然而，由于这种惯用方法使用了根据在前编码数据控制后面使用的编码
参数的反馈法，因此，不能保证总能够选择最佳编码量。例如，如果最初提
供了一个过大的编码量，那么不能给一个应当给予大编码量的后续影像足够
的编码量，因此，可能使影像质量大大下降。

此外，由于编码参数是通过对编码量的单独评价进行控制的，因而难以
根据影像的特性恰当地控制所要提供的编码量。
发明内容

本发明的目的是要在图像编码中实现考虑到影像质量情况下的编码量控制。

具体地讲，本发明的编码活动图像影像的图像编码方法包括：对于一个第一影像生成多个分别具有不同编码量的编码数据的第一步骤；通过解码多个编码数据建立多个用于预测编码的基准影像（reference image）的第二步骤；对多个基准影像进行影像质量评价的第三步骤；以及根据影像质量评价结果从多个编码数据中选择至少一个编码数据的第四步骤。

根据本发明，对一个第一影像生成多个分别具有不同编码量的编码数据，并且从这些编码数据建立多个基准影像。然后，对基准影像进行影像质量管理，并根据影像质量评价结果选择编码数据。换句话说，根据与再现时得到的影像相同的基准影像的影像质量评价结果，选择编码数据，从而能够在考虑到影像质量的情况下对编码量进行控制。因此，可以确切地得到具有适当编码量和高影像质量的编码数据。

在本发明的图像编码方法的第一步骤中，优选设置多个目标编码量，并且，通过在分别收敛多个编码数据的编码量到多个目标编码量的编码量控制下进行编码，对第一影像生成多个编码数据。此外，最好每帧设置多个目标编码量，并且在编码量控制中，控制每个宏块中的编码参数。

在本发明的图像编码方法的第一步骤中，优选利用多个不同编码参数进行编码，生成有关第一影像的多个编码数据。

在本发明的图像编码方法中，优选一帧接一帧地提供第一影像，并且在第四步骤中在每帧中选择至少一个编码数据。

在本发明的图像编码方法中，优选一帧接一帧地提供第一影像；在第一步骤中，通过参考另一帧的 n（其中，n 是大于或等于 2 的整数）个基准影像，产生有关第一影像的 n 个预测编码影像；并且对于 n 个预测编码影像中的每个预测编码影像，生成 m（其中，m 是大于或等于 2 的整数）个分别具
有不同的编码量的编码数据，从而生成作为多个编码数据的 n × m 个编码数据。此外，在第四步骤中，优选从 n × m 个编码数据中选择 n 个编码数据，并且用分别对应于 n 个编码数据的 n 个基准影像预测编码另一帧的影像。

在本发明的图像编码方法的第三步骤中，优选将多个基准影像中具有最大编码量的编码数据的基准影像设置为参照影像，获得每个基准影像与参照影像的差值，并且用这个差值获得影像质量评价的评价值。

因此，将一个从具有最大编码量的编码数据得到的、假设具有最高影像质量的基准影像设置为参照影像，并获得每个基准影像偏离该参照影像的差值，以便根据这个差值得到影像质量评价的评价值。从而，可以通过简单的方法进行高精度的影像质量评价。

在第四步骤中，优选从对应于具有落入允许范围内的评价值的基准影像的编码数据中选择至少一个编码数据。或者，在第三步骤中，优选从参照影像提取高频分量，并且在获得评价值的过程中，根据对应像素的高频分量调控差值。如此，根据对应像素的高频分量调控了影像之间的差值，所以可将影像的复杂度包括在用于影像质量评价的评价值中。从而，可以用对应人眼特性的尺度，精确地进行影像质量评价。或者，优选评价一个由差值组成的差值影像的模型，从该模型提取噪声信息，并且将噪声信息附加地包括在对应于相应的基准影像的编码数据中。如此，将提取的噪声信息包括在编码数据中，从而，噪声降低处理可以在再生编码数据中有效地发挥作用。结果，再生时影像质量可以得到进一步提高。

此外，在本发明的图像编码方法的第三步骤中，优选在每个宏块中进行基准影像的影像质量评价；并且在第四步骤中，在每个宏块中选择至少一个编码数据；并且在各宏块中选择的编码数据，以重构新的编码数据。

如此，在每个宏块中进行影像质量评价，以便在每个宏块中选择编码数据。从而，由于也可以在一个帧内根据影像质量评价控制编码量，所以可以进一步提高影像质量。
此外，在第四步骤的重构新的编码数据的过程中，优选将一些所选择的
已经通过预测编码方式编码的编码数据进行一次解码，以便获得在重构前未
经预测编码方式而编码的编码数据，并且在重构之后再次进行预测编码。

在本发明的图像编码方法中，优选一帧接一帧地提供第一影像；在第一
步骤中，对第一影像进行帧间编码和帧内编码；在第四步骤中，选择帧间编
码或帧内编码。因此，根据影像质量评价还进行被称为帧内/帧间确定的处
理，从而可以进一步提高影像质量。

在本发明的图像编码方法的第四步骤中，优选不仅根据影像质量评价结
果，而且也根据多个编码数据的编码量来选择至少一个编码数据。如此，除
了根据影像质量评价结果之外，还根据编码数据的编码量选择编码数据。从
而，可以实现严格考虑到影像质量而抑制编码量变化的编码量控制。结果，
可以限制再现中使用的解码装置的尺寸。

在第四步骤中，优选将一个影像质量容许范围设置为影像质量评价得到
的评价值的容许范围，将一个编码量容许范围设置为编码量的容许范围，并
且根据一个给定规则，从具有落入到影像质量容许范围的评价值和具有落入
到编码量容许范围的编码量的编码数据中选择至少一个编码数据。

在第四步骤中，优选在每帧中将一个编码量容许范围设置为编码量的容
许范围，通过每个宏块中的影像质量评价选择至少一个编码数据，并且当整
帧的编码量高于编码量容许范围时，为了使该帧的编码量落入到编码量容许
范围内，优选在一个通过选择的改变使影像质量降低较小并且使编码量减少
较大的宏块中改变至少一个编码数据的选择。如此，当整帧的编码量高于编
码量容许范围时，优选在一个影像质量降低较小并且编码量减少较大的宏块
中改变编码数据的选择。所以，在使影像质量降低最小的同时，可以限制编
码量的变化。

图像编码装置包括：用于对一个第一影像生成分别具有不同编码量的多
个编码数据的图像编码单元；用于通过对图像编码单元生成的多个编码数据
进行部分解码，以生成用于预测编码的多个基准影像的分解码单元；用于
评价部分解码单元生成的多个基准影像的影像质量的影像质量评价部分，和
用于根据影像质量评价部分进行处理的结果，从多个编码数据中选择至少一
个编码数据的编码数据选择部分。

根据本发明，影像编码单元对一个影像生成多个分别具有不同编码量的
编码数据，部分解码单元从这些编码数据建立多个基准影像。然后，影像质
量评价部分进行各个基准影像的影像质量评价，编码数据选择部分根据影像
质量评价的结果选择编码数据。换句话说，根据与再生中得到的影像相同的
基准影像的影像质量评价选择编码数据，从而能够考虑到影像质量而控制编
码量。结果，可以确切地得到具有适当编码量和高影像质量的编码数据。

较佳地，本发明的图像编码装置进一步包括：用于存储多个编码数据的
第一存储部分和用于存储多个基准影像的第二存储部分，并且第一存储部分
和第二存储部分是由一个共用的存储器构成的。因此，在原来就包括一个大
容量存储器的装置中，例如数字照相机，可以使用已有的存储器，以降低成本。

在本发明的图像编码装置中，图像编码单元和部分解码单元优选以分时
方式（time-sharing manner）工作，以在时间序列中连续地产生多个编码数
据和多个基准影像的组合。如此，无需提供额外的硬件来产生多个编码数据
和基准影像。换句话说，在 DVD 录像机之类的原来就具有高处理性能的装
置中，可以有效地利用该性能产生例如在高压缩率下也具有高影像质量的编
码数据，而无视其高压缩率，从而通过根据目的转换要产生的编码数据，可
以在更大的范围内使用这种装置。

附图说明

图 1 是根据本发明的实施例 1 的图像编码方法的流程图；
图 2 是显示根据本发明的实施例 1 的图像编码装置的示例构造的框图；
图 3 是评价影像质量的示例处理的流程图；
图 4 是根据本发明的实施例 2 的图像编码方法的流程图；
图 5 是根据本发明的实施例 3 的图像编码方法的流程图，其中在实施例 1 的图像编码方法中附加执行了帧内/帧间确定；
图 6 是根据本发明的实施例 3 的图像编码方法的流程图，其中在实施例 2 的图像编码方法中附加执行了帧内/帧间确定；
图 7 是根据本发明的实施例 4 的图像编码方法的流程图；
图 8 是显示根据实施例 4 的图像编码装置的示例构造的框图；
图 9 是重构编码数据的示例处理的流程图；
图 10 是显示重构编码数据的处理的示意图；
图 11A 和 11B 是显示考虑到编码量的编码数据选择的示意图；
图 12A 和 12B 是显示考虑到编码量的另一种编码数据选择的示意图；
图 13 是显示一个通用数字照相机的构造图；
图 14 是显示一个应用了本发明的数字照相机的图像编码单元的构造图；
图 15 是显示一个 DVD 录像机的示例构造的图；
图 16 是显示一个应用了本发明的 DVD 录像机的图像编码单元的构造的图；和
图 17 是惯用图像编码处理的流程图。

具体实施方式

现在参考附图说明本发明的优选实施例。

实施例 1

图 1 是显示根据本发明实施例 1 的图像编码方法的基本过程的流程图。如图 1 所示，输入一个活动图像影像的第一帧（S11），并且产生 n（其中 n 是大于或等于 2 的整数）个分别具有不同编码量的编码数据（S12；第一步骤）。分别解码 n 个编码数据，以便建立用于预测编码的 n 个基准影像（S13；第二步骤）。接下来，评价 n 个基准影像的影像质量（S14；第三步骤），

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并且根据影像质量评价结果，选择每个帧中要记录的最佳编码数据（S15；第四步骤），丢弃其它编码数据而不进行记录（S16）。重复执行步骤 S11 至 S16，直到处理完最后一帧（S17）。

在这种方法中，在一个帧内的每个宏块中要确定，是给一个基准影像与一个输入影像，即一个预测编码影像，之间的差值编码，还是在后续帧的编码中给一个输入影像自身编码（以下将这个确定称为“帧内/帧间确定”）。更具体地说，对于已经在每个宏块中进行过帧内/帧间确定的每个影像，产生 n 个编码数据。

在步骤 S12 中，设置 n 个目标编码量，并且在把帧影像的编码量收敛到每个目标编码量的编码量控制下进行编码。在这种编码量控制中，采用了惯例的反馈法。更具体地说，根据对每个帧设置的 n 个目标编码量，确定第一宏块的编码参数，以便根据这个编码参数进行编码，并且通过在前编码数据的编码量与目标编码量之间的差值的评价，确定每个后续宏块的编码参数。从而控制编码量，使得该帧的编码量最终能够收敛到目标编码量。

在步骤 S12 中，通过使用多个不同编码参数进行编码，可以生成多个分别具有不同编码量的编码数据。这里使用的编码参数一般是一个量化系数或一个量化步骤，或作为替代，可以将一个确定的 Huffman 表或一个确定的量化表用作参数。

图 2 是显示根据本实施例的一个图像编码装置的示例构造的框图。在图 2 中，运动向量检测部分 2、预测编码部分 3、DCT 处理部分 4、量化块 5 和可变长度编码块 6 一起构成了图像编码单元，并且逆量化块 8、逆 DCT 处理块 9 和基准影像建立块 10 一起构成了部分解码单元。为了简化构造，给部分解码单元提供量化块 5 的输出，而不是多个编码数据 CD1、CD2 和 CD3。

输入的活动图像影像数据被一次性存储在输入影像缓冲器 1 中。输入影像缓冲器 1 需要同基准影像存储器 11 检测运动向量和建立预测编码影像，
并且输入影像缓存器 1 的容量对应于形成一个宏块所需的行数。运动向量检测部分 2 将输入影像缓存器 1 中存储的影像与基准影像进行比较，以便检测每个宏块中输入影像相对于基准影像的运动向量。预测编码部分 3 根据所检测的运动向量数据获得输入影像与基准影像之间的差值，以便建立一个预测编码影像。

然后，对预测编码影像进行帧内编码。首先，在 DCT 处理部分 4 中，执行 DCT 以便生成一个 DCT 系数，将 DCT 系数在量化块 5 中量化。在图 2 所示的结构中，量化块 5 包括三个分别具有不同量化系数的量化部分 5a、5b 和 5c，以及各量化部分 5a、5b 和 5c 输出量化后的 DCT 系数。接下来，通过诸如 Huffman 编码之类的可变长度编码，在可变长度编码块 6 中对这些 DCT 系数进行编码，并且把如此产生的第一组编码数据 CD1、CD2 和 CD3 存储在一个编码数据缓存器 7 中。

另一方面，对量化后的 DCT 系数分别在量化块 8 中进行逆量化，然后在逆 DCT 块 9 中进行逆 DCT，以便解码成预测编码影像。然后，在基准影像存储块 10 中，根据运动向量数据将解码后的预测编码影像与存储在基准影像存储块 11 中的前一帧的基准影像相加，以便解码预测编码影像。如此，产生了一个要用于下一帧的一个输入影像的预测编码的基准影像，并且将其存储在基准影像存储块 11 中。在这个装置中，建立了三种基准影像。

影像质量评价部分 13 评价这三种基准影像的影像质量，并且根据评价结果选择一个基准影像。编码数据选择部分 14 从第一到第三编码数据 CD1、CD2 和 CD3 中选择对应于影像质量评价部分 13 选择的基准影像的编码数据，并且将所选择的编码数据记录在记录部分 15 中。

<影像质量评价>

图 3 是影像质量评价步骤 S14 中执行处理的示例的流程图。如图 3 所示，本实施例的影像质量评价基本上如下进行：将从具有最大编码量的编码数据得到的基准影像设置为参照影像（S141），获得每个像素中每个基准影像与
参照影像之间的差值（S144），并且将差值的绝对值积分，以用作影像质量评价的评价值（S146）。将与参照影像的差值作为评价尺度是因为可以把这个差值考虑为通过影像压缩造成的噪声。由于在本实施例中影像质量评价是在每帧中进行的，所以将差值的绝对值在整个影像上积分。但是，当影像质量评价是在每个宏块中进行的时候，则对每个宏块进行差值绝对值的积分。在步骤 S15 中，例如，选择了在步骤 S14 中得到的评价值落在一个预定容许范围内的基准影像，以便从对应于所选择的基准影像的编码数据中选择具有最大编码量的编码数据。

在本实施例中，由于一般认为编码量越大影像质量越高，所以将从具有最大编码量的编码数据得到的基准影像设置为参照影像。因此，在使用多个编码参数生成多个编码数据的情况下，将用达到最高影像质量的编码参数产生的编码数据得到的基准影像设置为参照影像。

但是，不能根据噪声的幅度简单地确定噪声对影像质量的影响。例如，当把复杂设计影像中造成的噪声与简单设计影像中造成的噪声进行比较时，简单设计影像中造成的噪声在整个影像中是显著的，因此可以说具有较大的影响。

因此，在图 3 所示的处理中，将影像中噪声的显著程度结合在评价值中。具体地讲，提取参照影像的高频分量，并且在获得评价值的过程中，根据对应像素的高频分量调制上述差值。具体地讲，高频分量越大，差值的绝对值设置得越小。

首先，对参照影像进行高通滤波（HPF）处理（S142）。从而，将低频分量从参照影像中除去。由于只具有高频分量的影像具有负值或正值，因此将这些值改变为绝对值，并且对结果进行低通滤波（LPF）处理（S143）。这个 LPF 处理并不总是必要的，但是具有使调制差值的延伸变得平缓的效果，将这种处理的结果定义为高频分量含量。将步骤 S144 中得到的差值的绝对值乘以一个对应于高频分量含量的系数（S145）。高频分量含量越大，
这个系数设置得越小，最后，将已经乘以系数的差值的绝对值在整个影像上或对于每个宏块进行积分（S146）。

利用这个差值可以进一步提高再现影像的影像质量。如上所述，可以把偏离参照影像的差值考虑为通过压缩产生的噪声分量。因此，评价由差值构成的差值影像的模型，以使提取对应于包括在影像中的噪声模型的噪声信息，并且将此噪声信息加在编码数据中。当在再生影像中执行除去对应于这个噪声信息的噪声模型的降噪处理时，可以从具有小编码量的编码数据中获得具有高影像质量的再现影像。更具体地讲，由于附加地包括了噪声信息，因此不需要检测再现影像中的噪声分量，从而可以准确地除去噪声。

实施例 2

在实施例 1 中，在每个帧中进行影像质量评价，以便选择编码数据。但是，在执行预测编码的情况下，将另一帧的基准影像用于编码，因此，这个其它帧的编码影响了影像质量。因此，如果可能，最好在多个帧上设置多个条件产生多个编码数据，以便评价从这些编码数据中得到的影像的影像质量。因此，在本发明的实施例 2 中，每两帧进行影像质量评价，以选择编码数据。更具体地讲，通过参考另一帧的多个基准影像产生多个预测编码影像，并且对于每个预测编码影像，产生分别具有不同编码量的编码数据。

图 4 是显示根据本实施例的图像编码方法的处理过程的流程图。在图 4 中，输入一个活动图像影像的第一帧（S21），并且对于这个帧影像生成 n（在这里 n 是大于或等于 2 的整数）个分别具有不同编码量的编码数据（S22）。分别编码这 n 个编码数据，以便建立 n 个基准影像（S23）。

接下来，输入下一帧的影像（S24），并且对这个输入的影像，通过参考 n 个基准影像产生有关这个输入影像的 n 个预测编码影像（S25）。对于 n 个预测编码影像中的每个预测编码影像，生成 m（其中 m 是大于或等于 2 的整数，并且通常等于 n）个分别具有不同编码量的编码数据，因此，生成了总共 n × m 个编码数据（S26）。解码这些编码数据，以便建立 n × m 个基
准影像(S27)。

对于这些基准影像, 以实施例1中相同的方法进行影像质量评价(S28), 并且根据影像质量评价的结果, 选择要记录的编解数据(S29)。以这种方式对两帧编解数据的组合进行影像质量评价。此外，根据影像质量评价的结果，从 n x m 个基准影像中选择 n 个基准影像(S29)。将这 n 个基准影像用于下一帧影像的预测编解。

重复执行这种处理，直到最后一帧处理完毕(S29)。在最后一帧的处理中，根据影像质量评价的结果，选择一个最终要记录的编解数据(S29)。

实施例3

在上述实施例中，对一帧中的每个宏块执行帧内/帧间确定，例如，选择了使用相同的编码参数并具有较小编码量的帧内编码或帧间编码。但是，由于编码已经使一个基准影像的影像质量下降，并且利用预测编解影像编码进一步使影像质量下降。因此，优选还通过影像质量评价进行帧内/帧间确定。在本实施例中，也通过影像质量评价进行帧内/帧间确定。

图5是在根据图1所示实施例1的图像编码方法中通过影像质量评价附加执行帧内/帧间确定得到的方法的流程图。与图1流程图的差别是步骤 S32 和 S33。在步骤 S32 中，对每个输入影像和预测编码影像产生 n 个分别具有不同编码量的编码数据，并且在步骤 S33 中，根据步骤 S32 产生的 2n 个编码数据建立 2n 个基准影像。对于这 2n 个基准影像, 执行影像质量评价(S14), 以便选择编码数据(S15)。从而，可以通过影像质量评价执行实施例1中的每帧内执行的帧间-帧内确定。

图6是根据在图4所示实施例2的图像编码方法中通过影像质量评价附加执行帧内/帧间确定得到的方法的流程图。与图4 的流程的差别是步骤 S46 和 S47。在步骤 S46, 对输入影像和 n 个预测编码影像的每个影像生成 m 个分别具有不同编码量的编码数据，并且在步骤 S47 中，根据步骤 S46 中生成的(n+1) x m 个编码数据建立(n+1) x m 个基准影像。对于这(n+1) x
m 个基准影像，执行影像质量评价 (S28)，以便选择编码数据 (S2A)。从而，可以通过影像质量评价进行实施例 2 中的每个帧内执行的帧内/帧间确定。

实施例 4

在每个上述实施例中，编码数据是根据影像质量评价在每帧中严格选择的。在实施例 3 中所述的通过在每帧中的影像质量评价执行帧内/帧间确定的情况下，宏块是所有预测编码影像或所有输入影像。因此，在本发明的实施例 4 中，也通过影像质量评价执行一帧中的每个宏块的编码质量控制。

图 7 是显示根据本发明的实施例 4 的图像编码方法中的过程的流程图。在图 7 中，输入活动图像影像的第一帧 (S51)，并且对这帧影像生成 n 个分别具有不同编码量的编码数据 (S52)。在这种情况下，n 个不同编码参数用于编码以生成 n 个编码数据。更具体地讲，通过使用相同的编码参数对所有宏块进行编码而获得各自的编码数据，而无需通过将不同编码参数提供给各宏块来控制编码量。

分别解码 n 个编码数据，以便建立 n 个基准影像 (S53)。然后，对 n 个基准影像进行影像质量评价 (S54)。对每个宏块执行影像质量评价，从而在每个宏块中选择一个最佳影像。换句话说，在各宏块中可能选择不同的基准影像。接下来，从 n 个编码数据中提取对应于所选择的有关每个宏块的基准影像的编码数据 (S55)，并且通过组合提取的编码数据产生新的编码数据 (S56)。丢弃原始编码数据 (S57)。然后，重复执行步骤 S51 至 S57 直到处理了最后一帧 (S58)。

图 8 是显示根据本实施例的图像编码装置的示例构造的框图，其中为了避免省略详细说明，与图 2 中元件相同的元件使用了相同的参考标记。在图 8 所示的构造中，提供了一个重构部分 21，用于根据来自编码数据选择部分 14 的指令，通过从存储在编码数据缓存器 7 中的第一至第三编码数据 CD1、CD2 和 CD3 重构生成新的编码数据。
<编码数据的重构>

图9是在编码数据重构步骤S56中执行的处理的示例的流程图。如果在每个宏块中独立地执行编码，那么简单地取出并组合必要的宏块的编码数据，以重构编码数据。但是，一部分数据可能已经进行了对另一个宏块的编码数据差值进行编码的预测编码（帧内预测编码）。在这种情况下，对所预测的编码数据进行一次解码，组合必要的宏块的解码数据，以获得新编码数据，对新编码数据再次进行预测编码。

图10是对包括帧内编码数据的编码数据进行重构处理的示意图。首先，从宏块的编码数据中提取帧内预测编码数据（S561）。这是由于不是宏块的所有编码数据都是帧内预测编码数据，而仅有例如DCT的DC系数的一部分类数据是帧内预测编码数据。接下来，解码帧内预测编码数据（S562）。如图10所示，直接使用第一宏块的数据（在这里是一个DC系数）。第二宏块的数据对应于和第一宏块数据的差值，从而通过加到第一宏块的数据上解码成原始数据。然后，将第三宏块的数据加到第二宏块的解码数据上，从而解码成第三宏块的原始数据。通过这样的处理，可以无需帧内预测编码得到已经编码的编码数据。

接下来，通过影像质量评价提取和组合对应于各宏块中选择的基准影像的编码数据，以便重构一个编码数据（S563）。在图10中，从三个编码数据CD1至CD3提取每个宏块的编码数据，以便重构一个新的编码数据。最终，在如此重构的新编码数据中，对一些应当进行预测编码的编码数据（在这里是DCT的DC系数）再次进行预测编码。

<考虑到编码量的编码数据的选择>

在单独通过影像质量评价控制编码量的情况下，编码量根据影像的复杂性变化而改变，因此，编码量变化很大。当编码量变化很大时，在再生时需要为解码数据准备大的缓冲器，这不利于减小设备尺寸和降低成本。因此，在下述方法中，不仅通过影像质量评价选择编码数据，而且也考虑编码量，
以便将编码量变化抑制到一定程度。

容许范围（指“编码量容许范围”）基本上是相对于编码量设置的，并且从对应于具有落入到上述影像质量容许范围内的影像质量的基准影像的编码数据中，选择具有落入到编码量容许范围内的编码量的编码数据，这样可以根据预定规则从这些所选择的编码数据中选择要记录的编码数据。以下参考图 11A 和 11B 说明这个处理。图 11A 示意性地示了基准影像的影像质量。在图 11A 中，纵坐标指示影像质量，并且影像质量越向上越高。图 11B 示意性地示了对应于各基准影像的编码数据的编码量。在图 11B 中，纵坐标指示编码量，并且越向上编码量越大。

在图 11A 中，具有最高影像质量的参照影像放在最高的位置，并且把要比较的基准影像排列在下方。在基准影像中，基准影像 1 至 5 具有落入到影像质量容许范围内的影像质量。在图 11B 中，把具有最大编码量的参照影像的编码数据放在最高的位置，并且把对应于基准影像的编码数据排列在下方。这种排列顺序遵守与影像质量的顺序相同。在这些编码数据中，编码数据 2 至 6 具有落入到编码量容许范围内的编码量。

在这种情况下，具有落入到编码量容许范围内的编码量并且对应于具有落入到影像质量容许范围内的影像质量的基准影像的编码数据是四个，具体地讲是编码数据 2 至 5。在这些编码数据中，选择要记录的编码数据。例如，在如实施例 1 中的每帧要执行影像质量评价的情况下，选择编码数据 2。或者，在如实施例 2 中的每两帧执行影像质量评价的情况下，例如选择编码数据 2 至 4。

作为替代，如图 12A 和 12B 所示，例如当对应于具有落入在影像质量容许范围内的影像质量的基准影像的编码数据中没有一个具有落入在编码量容许范围内的编码量时，可以选择具有编码量容许范围中最大编码量的编码数据，这是由于可以认为在具有落入到编码量容许范围内的编码量的编码数据中，这个编码数据具有最高影像质量。在这种情况下，也是在选择多个
编码数据的方法中，较佳地仅选择一个具有最大编码量的编码数据。这是由于通过多帧评价选择出具有过低影像质量的其它编码数据的可能性极小。

当对每帧应用这种方法时，由于编码量的变化范围很大，所以需要把容许范围设置到与变化范围相比更小的范围。但是，当对每个宏块应用这种方法时，由于变化范围较小，所以可以容易地将容许范围设置到与变化范围相比更大的范围。但是，在所有宏块中编码量以相同方式变化的情况下，在整个帧上编码量发生很大的变化，这是不可取的。

因此，优选相对于每帧设置编码量容许范围，在每个宏块中通过影像质量评价选择编码数据，并且当整个帧的编码量高于编码量容许范围时，要重新考虑每帧中编码数据的选择，以使编码量可以落入到容许范围内。在这种情况下，在通过选择改变使影像质量降低较小和使编码量降低较大的宏块中，优先改变要选择的编码数据。因此，可以通过使得整个帧中影像质量降低最小来控制编码量。

<装置的示例构造>

以下说明本发明的特定示例。首先，将本发明应用到一个数字照相机。图 13 是一个通用数字照相机的构造图。首先，CCD 影像传感器 32 将镜头 31 形成的光影像转换成电信号，模拟预处理器部分 33 预处理得到的信号，并且通过 A/D 转换器部分 34 将经过预处理的信号转换成数字信号。数字信号处理器部分 35 处理数字信号，以进行分色和压缩，这个处理需要具有大容量的存储器。在数字照相机中，用诸如 DRAM 之类的外部存储器 36 作为大容量存储器。将经过如此处理的数字信号记录在记录介质 37 上。

在这种方式中，由于数字照相机原本就装备有大容量存储器，因此，在本发明的应用中优选使用这个存储器。图 14 示出了应用了本发明的数字照相机的图像编码单元 40 的构造。这个图像编码单元 40 位于数字信号处理器部分 35 内，并且具有与图 2 所示的基本相同的构造和操作。一个存储器控制器 41 仲裁与各部分之间的数据输入或输出，并且向作为一个存储装置工
作的，诸如 DRAM 之类的大容量外部存储器 36 发送数据，和从其接收数据。在图 14 的构造中，存储器 36 具有用于存储多个基准影像的区域 42 和用于存储多个编码数据的区域 43。具体地讲，由基准影像建立部分 10 建立的基准影像经过存储器控制器 41 存储在外部存储器 36 中，编码数据也经过存储器控制器 41 存储在外部存储器 36 中。换句话说，图 2 构造中，对应于第一存储部分的编码数据缓存器 7 和对应于第二存储部分的基准影像存储块 11 都是由用作共用存储装置的外部存储器 36 构成的。

接下来，说明应用到诸如 DVD 录像机之类的利用 MPEG-2 的录像机的特定示例。图 15 示出了利用 MPEG-2 编码 TV 分辨率的活动图像影像的 DVD 录像机的示例构造。首先，一个 NTSC/PAL 解码器-A/D 部分 51 对 NTSC 或 PAL 信号执行 Y/C 分离、彩色解调和 AD 转换。接下来，MPEG-2 编码器 52 通过根据 MPEG-2 给数字信号编码生成编码数据。然后，流控制器 53 执行对 DVD 驱动器 54 的记录/再生流数据的仲裁和输入/输出控制。在再生中，MPEG-2 解码器 55 通过根据 MPEG-2 解码产生影像信号，并且 NTSC/PAL 编码器-D/A 部分 56 执行调制和 DA 转换，以便获得 NTSC 或 PAL 信号。MPEG-2 编码器 52 和 MPEG-2 解码器 55 分别连接到用于处理的大容量外部存储器 57 和 58。

DVD 录像机一般用于以高影像质量，用例如电视屏幕的相对较大的屏幕尺寸记录活动图像影像。因此，高处理性能和大容量存储器是不可缺少的，并且生成具有较低可压缩性的编码数据，以在这些条件下实现高影像质量。另一方面，也需要即使在（低分辨率的）小屏幕尺寸中也能获得具有尽可能小的编码量（即高可压缩性）的编码数据。为了满足这样的需要，在惯用技术中，转换分辨率，以便根据 MPEG-2 记录小屏幕的数据。但是，当应用本发明时，可以获得具有高影像质量和高可压缩性的编码数据。因此，不需要增大电路规模，就可以通过诸如 DVD 录像机之类的、原本就具有利用多个编码参数进行编码的高处理性能的图像编码装置的分时操作，容易地满足上
述需要。

图 16 示出了应用了本发明的 DVD 录像机的图像编码单元 60 的构造。除了量化部分 5A、可变长度编码部分 6A 和部分解码部分（包括逆量化部分 8A、逆 DCT 处理部分 9A 和基准影像建立部分 10A）每个都给予了与图 14 的构造不同的参考标号之外，这个构造与图 14 中所示的构造基本相同。此外，在 DCT 处理部分 4 和量化部分 5A 之间提供了一个用于存储 DCT 系数的 DCT 系数存储器 62。

首先，在 DVD 录像机的一般操作中，对一个影像生成一个编码数据。相反，在用高可压缩性编码小屏幕影像的情况下，将从 DCT 处理部分 4 输出的 DCT 系数存储在 DCT 系数存储器 62 中。对于这个存储的数据，以分时方式利用不同编码参数多次执行下述的处理：首先，对数据进行量化并且利用编码参数 a 进行可变长度编码。然后，将得到的数据进行逆量化、逆 DCT 和基准影像建立处理，以便获得基准影像 A。接下来，对数据进行量化并利用编码参数 b 进行可变长度编码。然后，将得到的数据进行逆量化、逆 DCT 和基准影像建立处理，以便获得基准影像 B。在使用其它不同编码参数的情况下，以相同的方式进行处理，对每个宏块进行这些处理，并且当对一屏的处理完成时，得到多个编码数据和基准影像。然后，根据上述每个实施例中所述的预定条件选择编码数据。

根据本发明，通过这种方式，基于与再生中获得的影像相同的基准影像的影像质量评价的结果选择编码数据，可以在考虑到影像质量的情况下控制编码量。因此，可以确切地得到具有适当编码量和高影像质量的编码数据。
图1
S14

将从具有最大编码量的编码数据得到的参考影像设置为参照影像.

对参照影像执行HPF处理

计算HPF处理后的影像的绝对值，并进行LPF处理（以得到高频分量含量）

得到每个参考影像与参照影像之间的差值

将差值的编码值乘以对应于高频分量含量的系数

积分差值的绝对值（以给出影像质量评价值）

图3
图5
开始
输入影像
S21
产生n个具有不同编码量的编码数据
S22
建立对应于编码数据的n个参考影像
S23
输入下一帧的影像
S24
通过参考n个参考影像建立n个预测编码影像
S25
对n个预测编码影像和输入影像的每个产生m个编码数据
S46
建立对应于编码数据的(n+1)x m个参考影像
S47
评价参考影像的影像质量
S28

S29
最后一帧？
是
否
S2A
选择n个编码数据，丢弃其它编码数据并选择n个参考影像
S2B
选择一个编码数据并丢弃其它编码数据
结束
图6
$S56$

$S561$  从编码数据提取预测编码数据

$S562$  解码预测编码数据

$S563$  组合所选宏块的数据

$S564$  对应当前宏块的数据进行预测编码

图9
参考影像的影像质量

影像质量

低

影像质量容许范围

10
20
30
40
50
60
70

参照影像

对应编码数据的编码量

大

编码量容许范围

10
20
30
40
50
60
70

图12A

图12B
图17

开始

SZ1
输入第一帧的影像

SZ2
使用初始参数开始在每个宏块中编码

SZ3
积分编码宏块的比特量

SZ4
根据与目标值的差值改变用于编码下一宏块的参数

SZ5
输入下一帧的影像

SZ6
积分在前帧和当前帧的编码宏块的比特量

SZ7
根据与目标值的差值改变用于编码下一宏块的参数

SZ8
最后一帧？

是

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Apparatus and method for compressing motion vector field

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Apparatus, and an associated method, motion compensates coding of video sequences. Motion compensated prediction is utilized in the representation of motion vector fields. Reduced numbers of bits are required to represent the motion vector field while maintaining a low prediction error, thereby facilitating improved communication of, and recreation of, video frames forming a video sequence.
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权利要求书 14 页 说明书 30 页 附图 3 页

[54] 发明名称 用于压缩运动矢量场的装置和方法

[57] 摘要

视频序列的运动补偿编码的装置和相关方法。运动补偿预测被用于运动矢量场的表示。需要减少数量的比特来表示运动矢量场，同时保持低预测误差，这便便于改进形成视频序列的视频帧的传送和重建。
1. 在一种操作视频序列的方法中，所述视频序列包括至少当前视频帧和参考视频帧，所述当前视频帧包括至少一个第一相邻段和第二相邻段，用于所述当前帧的运动补偿预测的方法的改进包括：

检索之前储存的第一运动场模型，所述第一运动场模型是第一运动矢量场的模型，它关于所述参考视频帧中的象素来描述所述第一相邻段中象素的位移；

确定第二运动矢量场，它关于所述参考视频帧中的象素来描述所述当前视频帧的所述第二相邻段中的象素的位移；

利用运动模型来模拟所述第二运动矢量场，以形成第二运动场模型；

根据所述第一运动场模型来近似所述第二运动场模型，以形成预测场模型；

将所述第二运动场模型与所述预测场模型进行比较，并形成求精场（refinement field）模型，所述求精场模型表示所述第二运动场模型和所述预测场模型之间的差异；

通过对所述预测场模型和所述求精场模型求和来建立所述第二运动场模型的其它模型表示；

计算第一成本函数（cost function），其中所述第一成本函数包括遭受的第一图像失真的量度（measure）和在使用所述第二运动场模型时所需的第二数据量的量度；

计算第二成本函数，其中所述第二成本函数包括遭受的第二图像失真的量度和在使用所述第二运动场的所述其它模型表示时所需的第二数据量的量度；

将所述第一和第二成本函数进行比较，并确定所述第一和第二成本函数中哪一个具有较小绝对值；

在所述第二运动矢量场模型和所述第二运动矢量场的所述其它模
型表示之间选择与所述较小绝对值相关联的供选择的一个，以指示被
选运动场模型，并储备所述被选运动场模型。
2. 如权利要求 1 所述的方法，其特征在于还包括:
对有关所述被选运动场模型的信息进行编码。
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3. 如权利要求 2 所述的方法，其特征在于还包括:
向解码器传送所述编码信息，用于解码。
4. 如权利要求 2 所述的方法，其特征在于还包括:
将所述编码信息储存在存储装置中。
5. 如权利要求 1 所述的方法，其特征在于所述第一运动场模型、
所述第二运动场模型、所述第三运动场模型和所述预设运动场模型和所述
求精场模型中的各个都被构成为运动场基本函数的和，每一个所述运
动场基本函数都与某个运动系数相乘。
6. 如权利要求 5 所述的方法，其特征在于所述运动场基本函数是
正交函数。
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7. 如权利要求 6 所述的方法，其特征在于所述第一运动场模型、
所述第二运动场模型、所述预设运动场模型和所述求精场模型中的各个都
是仿射运动场模型。
8. 如权利要求 1 所述的方法，其特征在于所述至少一个第一相邻
段和所述第二相邻段是四边形的。
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9. 如权利要求 1 所述的方法，其特征在于还包括:
将所述至少一个第一相邻段分成多个子段，并利用至少一个所述
子段的运动场模型以形成所述预设运动场模型。
10. 如权利要求 1 所述的方法，其特征在于所述预设运动场模型是通
过对所述至少一个相邻段的运动场模型进行投影来形成的。
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11. 如权利要求 1 所述的方法，其特征在于所述预设运动场模型是通
过对从一个以上的第一相邻段确定的所述第二运动矢量场的近似求平
均来形成的。
12. 如权利要求 1 所述的方法，其特征在于所述预设运动场模型是通
过对从一个以上的第一相邻段确定的所述第二场模型的近似求平均来形成的。

13. 如权利要求1所述的方法，其特征在于计算所述第一成本函数的所述步骤是利用拉格朗日准则（Lagrangian criterion）来执行的。

14. 如权利要求13所述的方法，其特征在于所述拉格朗日准则具有 \( L=D+\lambda \cdot B \) 的形式，其中 \( D \) 是在对给定运动系数组进行编码时遭受的失真，\( B \) 是表所述运动系数所需的比荷数，\( \lambda \) 是乘法拉格朗日参数（multiplying Lagrangian parameter）。

15. 如权利要求1所述的方法，其特征在于利用共同的基本函数组来表示所述预测运动场和所述求精运动场。

16. 如权利要求1所述的方法，其特征在于还包括：

   确定第一阈值；

   识别在所述求精场模型的所有运动系数中具有最小值的所述求精场模型的运动的系数；

   确定通过把所述最小运动系数设置为零所遭受的第三成本函数；

   在所述预测运动场没有超过所述第一阈值的情况下，通过把所述最小值的运动系数设置为零来形成所述求精场的近似；

17. 如权利要求1所述的方法，其特征在于如果所述被选运动场模型是所述第二运动场模型，则所述方法还包括：

   把所述预测场模型的所有运动系数设置为零；

   把所述求精场模型的所有运动系数设置为等于所述第二运动场模型的所述运动系数。

18. 如权利要求17所述的方法，其特征在于所述对信息编码以依赖于所述被选场模型的方式发生。

19. 如权利要求18所述的方法，其特征在于如果所述被选场模型是所述第二运动场模型，则所述对信息编码包括对所述求精场模型进行编码的步骤。

20. 如权利要求18所述的方法，其特征在于如果所述被选场模型
是所述其它模型表示，则所述对信息编码包括以下步骤：
对所述预测场模型进行编码；
对所述求精场模型进行编码。

21. 如权利要求 20 所述的方法，其特征在于所述对所述求精场模型进行编码包括以下步骤：
通过对第一和第二值中供选择的一个设置运动参数指示符，指示所述编码信息包括所述求精场模型的所述运动参数；
通过设置运动参数模式指示符，指示所述运动参数中那些具有非零值；

22. 如权利要求 21 所述的方法，其特征在于通过指示幅值和符号来对各个所述非零运动参数值进行编码。

23. 如权利要求 20 所述的方法，其特征在于对所述预测场模型进行编码包括以下步骤：
通过对第一和第二值中供选择的一个设置运动参数指示符，指示所述编码信息不包括运动参数值；
通过设置方向鉴别指示符，指示关于所述至少一个第一相邻段的所述第二相邻段的建立所述其它模型表示的方向。

24. 如权利要求 23 所述的方法，其特征在于对所述预测场模型进行编码还包括以下步骤：
通过设置子段鉴别指示符，指示建立所述其它模型表示的所述至少一个第一相邻段的子段。

25. 在一种操作视频序列的方法中，所述视频序列包括至少当前视频帧和参考视频帧，所述当前视频帧包括至少一个第一相邻段和第二相邻段，用于所述当前视频帧的运动补偿预测的方法的改进包括：
检索至少一个之前储存的第一运动场模型，所述至少一个第一运动场模型是第一运动矢量场的模型，它关于所述参考视频帧中的象素来描述所述至少一个第一相邻段中象素的位移；

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确定第二运动矢量场，它关于所述参考视频帧中的象素来描述所述
当前视频帧的所述第二相邻段中的象素的位移；
利用运动模型来模拟所述第二运动矢量场，以形成第二运动场模
型；
根据所述至少一个第一运动场模型来近似所述第二运动场模型，
以形成预测场模型；
26. 在一种用于对包括至少一个当前视频帧的视频序列进行操作
的视频设备中，所述当前视频帧具有至少一个第一相邻段和第二相邻
段，一种用于形成所述第二相邻段的运动矢量场的近似的装置的改
进，所述装置包括：
运动矢量场建立器，它被连接以接收表示第一仿射运动模型指示
并接收所述第二相邻段的指示，所述第一仿射运动模型形成表示所述
第一相邻段的第一运动矢量场的近似，所述运动矢量场建立器用于对
表示所述第一仿射运动模型的指示进行响应而形成第二仿射运动模
型，所述第二仿射运动模型形成所述第二相邻段的运动矢量场的近
似。
27. 如权利要求26所述的装置，其特征在于所述视频序列还包括
参考视频帧，所述运动矢量场建立器还被连接以接收所述参考视频帧
的指示，所述第二仿射运动模型是对表示所述第一仿射模型和所述参
考视频帧的被选部分的指示中供选择的一个进行响应。
28. 如权利要求27所述的装置，其特征在于所述运动矢量场建立
器还计算第二运动矢量场，计算的所述第二运动矢量场响应所述参考
视频帧的所述被选部分。
29. 如权利要求28所述的装置，其特征在于所述运动矢量场建立
器还确定所述第二运动矢量场和所述第二仿射运动模型之间的差异，
其差异构成求精场模型。
30. 如权利要求29所述的装置，其特征在于所述运动矢量场建立
器还建立所述第二运动矢量场的其它表示模型，所述第二运动矢量场
的所述其他表示模型是由所述求精模型和所述第二仿真运动模型的组合构成的。

31. 如权利要求30所述的装置，其特征在于所述运动矢量场建立器还确定成本函数，所述成本函数至少部分地是与所述第二运动矢量场和所述第二仿真运动模型中至少一个被选的有关的数据要求和图像失真的表示。

32. 如权利要求31所述的装置，其特征在于所述运动矢量场建立器还利用所述第二运动矢量场和所述第二仿真运动模型中被选的一个，所作选择响应于所述成本函数。

33. 如权利要求27所述的装置，其特征在于所述运动矢量场建立器还选择表示所述第一仿真模型和所述参考视频帧的所述被选部分的指示中供选择的一个，所述第二仿真运动模型是对此进行响应而形成的。

34. 如权利要求26所述的装置，其特征在于所述第一仿真运动模型具有与其相关联的第一仿真运动函数，所述运动矢量场建立器还对所述第一仿真运动模型的值进行投影以形成所述第二仿真运动模型。

35. 如权利要求26所述的装置，其特征在于所述当前视频帧还具有第三相邻段，所述第三相邻段与所述第一相邻段和所述第二相邻段相邻，所述运动矢量场建立器还被连接以接收所述第二相邻段的指示，所述运动矢量场建立器还用于响应所述第一仿真运动模型和所述第二仿真运动模型中被选的供选择的一个，而形成第三仿真运动模型。

36. 如权利要求35所述的装置，其特征在于所述运动矢量场建立器还选择所述第一仿真运动模型和所述第二仿真运动模型中所述供选择的一个，所述第三仿真运动模型是对此进行响应而形成的。

37. 如权利要求26所述的装置，其特征在于所述视频设备构成视频序列发生器，所述视频序列发生器具有编码器，并且所述运动矢量场建立器构成所述编码器的一部分。
38. 如权利要求26所述的装置，其特征在于所述视频设备构成视频序列接收机，所述视频序列接收机具有解码器，并且所述运动场建立器构成所述解码器的一部分。

39. 在一种操作视频序列的方法中，所述视频序列包括至少一个当前视频帧，所述当前视频帧具有至少一个第一相邻段和第二相邻段，一种用于形成所述第二相邻段的运动矢量场的近似的方法的改进，所述方法包括:

形成表示所述第一相邻段的第一运动矢量场;

用第一仿射运动模型来作所述第一运动矢量场的模型; 以及

对所述建模操作期间建模的所述第一运动矢量场进行响应，形成第二仿射运动矢量模型，所述第二仿射运动模型形成所述第二相邻段的运动矢量场的近似。

40. 如权利要求39所述的方法，其特征在于所述当前视频帧还包括第三相邻段，所述第三相邻段与所述第一相邻段和所述第二相邻段相邻，所述方法还用于形成所述第三相邻段的运动矢量场的近似，所述方法包括以下操作:

响应于所述第一仿射运动模型和所述第二仿射运动模型中供选择的一个而形成所述第三仿射运动模型。

41. 如权利要求39所述的方法，其特征在于所述视频序列还包括参考视频帧，并且在形成所述第二仿射运动模型的所述操作期间形成的所述第二仿射运动矢量场是对所述第一运动矢量场和所述参考帧的一个部分中供选择的一个作出响应。

42. 如权利要求41所述的方法，其特征在于还包括以下的附加操作：选择所述第一运动矢量场和所述参考帧中的一个，所述第二仿射运动模型是对此进行响应而形成的。

43. 在一种用于对包括至少一个当前视频帧和参考视频帧的视频序列进行操作的视频设备中，所述当前视频帧具有至少一个第一相邻段和第二相邻段，一种用于形成运动矢量场的近似的装置的改进，所
述装置包括：

运动矢量场建立器，它被连接以接收表示所述第一相邻段和所述第二相邻段中被选的一个或的指示及表示所述参考视频帧的部分的指示，所述运动矢量场建立器用于确定所述第一和第二相邻段中所述被选的一个和所述参考视频帧的被选部分之间的映射，并用于用仿射运动模型来近似所述映射，所述仿射运动模型形成所述运动矢量场的近似。

44. 如权利要求43所述的装置，其特征在于所述第一相邻段和所述第二相邻段中所述被选的一个包括所述第一相邻段，并且形成所述运动矢量场的所述近似的一个或的所述仿射运动模型包括所述第一仿射运动模型，所述第一仿射运动模型表示所述第一相邻段。

45. 如权利要求43所述的装置，其特征在于所述第一相邻段和所述第二相邻段中所述被选的一个还包括所述第二相邻段，所述运动矢量场建立器还包括所述第二相邻段和所述参考视频帧的所述被选部分与所述第一相邻段中供选择的一个之间的映射，并且形成所述运动矢量场的所述近似的一个或的所述仿射运动模型还包括所述第二仿射运动模型，所述第二仿射运动模型表示所述第二相邻段。

46. 如权利要求43所述的装置，其特征在于所述视频序列包括视频序列发生器，所述视频序列发生器具有编码器，并且所述运动矢量场建立器包括编码器的一部分。

47. 如权利要求43所述的装置，其特征在于所述视频序列包括视频序列接收机，所述视频序列接收机具有解码器，并且所述运动矢量场建立器包括所述解码器的一部分。

48. 在一种对视频序列进行解码的方法中，所述视频序列包括至少一个当前视频帧和参考帧，所述当前帧包括至少一个第一相邻段和第二相邻段，一种用于对所述当前视频帧进行解码的方法的改进包括以下步骤：

接收信息类型的指示；
接收所述第二相频段的段重建信息；
响应所述指示而选择段重建模式；
按照所述被选段重建模式来重建所述第二相频段。
49. 如权利要求 48 所述的方法，其特征在于所述被选段重建模式是段重建模式中的一种，所述段重建模式组包括：
    第一段重建模式，其中所述段重建信息包括要重建所述相邻段的所述步骤中使用的所述相邻段的指示。
    第二段重建模式，其中所述段重建信息包括运动系数信息。
50. 如权利要求 49 所述的方法，其特征在于所述段重建模式组还包括：
    第三段重建模式，其中所述段重建信息包括来自所述参考帧的象索值的指示；
    第四段重建模式，其中所述段重建信息包括来自所述当前帧的象索值的指示。
51. 如权利要求 49 所述的方法，其特征在于所述第一相频段的指示包括有关所述第一相邻段相对于所述第二相频段的位置的信息。
52. 如权利要求 51 所述的方法，其特征在于所述第一相邻段的指示还包括有关所述第一相邻段中子段的信息。
53. 如权利要求 49 所述的方法，其特征在于所述运动系数信息包括具有至少一个非零运动系数值的指示。
54. 如权利要求 53 所述的方法，其特征在于所述具有至少一个非零运动系数值的指示包括非零系数模式指示和至少一个非零系数值。
55. 如权利要求 49 所述的方法，其特征在于所述段重建模式包括利用从表示所述第一相邻段的第一运动场模型导出的预测运动场模型。
56. 如权利要求 55 所述的方法，其特征在于通过将所述第一相邻段的所述第一运动场模型投影到所述第二相邻段来建立所述预测运动场模型。
57. 如权利要求 49 所述的方法，其特征在于所述第二段重建模式包括利用求精运动场模型。

58. 如权利要求 57 所述的方法，其特征在于所述求精运动场模型是通过至少一个运动系数值的指示来表示的。

59. 如权利要求 57 所述的方法，其特征在于所述求精运动场模型表示第二运动场模型和所述预测运动场模型之间的差异，其中所述第二运动场模型是从所述参考帧导出的所述第二段的表示。

60. 如权利要求 57 所述的方法，其特征在于所述求精运动场模型是所述参考帧导出的所述第二段的表示。

61. 在一种对视频序列进行编码的方法中，所述视频序列包括至少一个当前视频帧和参考视频帧，所述当前视频帧包括至少一个第一相邻段和第二相邻段，一种用于当前视频帧的运动补偿预测的方法的改进包括：

为所述第二相邻段定义一组编码模式；

计算一组成本函数，每一个所述成本函数与所述编码模式组中的一种模式相关联；

在所述成本函数组中选择具有最小绝对值的一个成本函数；

定义所述编码模式组中与所述最小绝对值相关联的一种编码模式作为用于所述第二相邻段的被选编码模式；

按照所述被选编码模式对有关所述第二相邻段的信息进行编码。

62. 如权利要求 61 所述的方法，其特征在于还包括：

向解码器发送所述编码信息，用于解码。

63. 如权利要求 61 所述的方法，其特征在于还包括：

将所述编码信息储存在存储单元中。

64. 如权利要求 61 所述的方法，其特征在于所述编码模式组包括：

第一编码模式，其中来自所述第一相邻段的运动场模型被投影到所述第二相邻段以形成预测运动场模型，并且所述第二相邻段由所述
预测运动场模型来表示；

第二编码模式，其中所述第二相邻段由从所述参考场导出的运动场模型来表示；

第三编码模式，其中来自所述第一相邻段的运动场模型被投影到所述第二相邻段以形成投影场模型，并且所述第二相邻段由所述预测运动场模型和求精运动场模型来表示；

65. 如权利要求 64 所述的方法，其特征在于所述编码模式组还包括：

第四编码模式，其中利用来自所述参考帧的象素值对所述第二相邻段进行编码；

第五编码模式，其中利用来自所述当前帧的象素值对所述第二相邻段进行编码。

66. 如权利要求 64 所述的方法，其特征在于所述求精运动场模型表示从所述参考场导出的所述运动场模型和所述预测运动场模型之间的差异。

67. 如权利要求 64 所述的方法，其特征在于所述预测运动场模型、所述求精运动场模型和从所述参考场导出的所述运动场模型包括一组基本函数，每一个所述基本函数都与某个运动系数值相乘。

68. 如权利要求 67 所述的方法，其特征在于所述基本函数是正交函数。

69. 如权利要求 68 所述的方法，其特征在于所述预测运动场模型、所述求精运动场模型和从所述参考场导出的所述运动场模型是仿射运动场模型。

70. 如权利要求 61 所述的方法，其特征在于所述成本函数组中的每一个成本函数都包括接收的图像失真的量度和在使用给定的一个所述编码模式时所需数据量的量度。

71. 如权利要求 70 所述的方法，其特征在于利用拉格朗日准则来计算所述成本函数组中的每一个成本函数。
72. 如权利要求 71 所述的方法，其特征在于所述拉格朗日准则具有 \( L = D + \lambda \cdot B \) 的形式，其中 \( D \) 是在对给定运动系数组进行编码时受到的失真的量度，\( B \) 是表示所述运动系数所需的比特数，而 \( \lambda \) 是拉格朗日参数。

73. 如权利要求 67 所述的方法，其特征在于利用共同的基本函数组来表示所述预测运动场和所述求精运动场。

74. 如权利要求 67 所述的方法，其特征在于通过去除运动系数来近似所述求精运动场模型。

75. 如权利要求 64 所述的方法，其特征在于所述当前帧包括多个第一相邻段，所述方法还包括以下步骤:

- 形成多个预测运动场模型，一个预测运动场模型对应于所述多个第一相邻段中各自的相邻段；
- 形成多个求精运动场模型，各个求精运动场模型对应于所述多个预测运动场模型中给定的一个预测运动场模型。

76. 如权利要求 75 所述的方法，其特征在于所述预测运动场模型是以一个以上第一相邻段为基础形成的。

77. 如权利要求 76 所述的方法，其特征在于所述预测运动场模型是通过对来自一个以上的第一相邻段的运动场模型的投影求平均而形成的。

78. 如权利要求 64 所述的方法，其特征在于所述方法还包括把所述第一相邻段分为多个子段并利用至少一个所述子段的运动场模型来形成所述预测运动场模型。

79. 如权利要求 61 所述的方法，其特征在于所述对信息进行编码以依赖于所述被选场模式的方式而发生。

80. 如权利要求 79 所述的方法，其特征在于：如果所述被选编码模式是所述第二编码模式，则所述方法还包括将所述求精运动场模型的所有运动系数设置为等于从所述参考帧导出的所述运动场模型的所述运动系数。
81. 如权利要求 80 所述的方法，其特征在于所述对信息进行编码包括对所述求精运动场模型进行编码的步骤。
82. 如权利要求 79 所述的方法，其特征在于：如果所述被选编码模式是所述第一编码模式，则所述对信息进行编码包括对所述预测运动场模型进行编码的步骤。
83. 如权利要求 79 所述的方法，其特征在于：如果所述被选编码模式是所述第三编码模式，则所述对信息进行编码包括以下步骤：
   对所述预测运动场模型进行编码；
   对所述求精运动场模型进行编码。
84. 如权利要求 81 所述的方法，其特征在于所述对所述求精运动场模型进行编码包括以下步骤：
   通过对第一和第二值中供选择的一个设置运动系数指示符来指示所述编码信息包括所述求精场模型的所述运动系数；
   通过设置运动系数指示符来指示所述求精场模型的所述运动系数中哪些具有非零值；
   对所述非零值进行编码。
85. 如权利要求 83 所述的方法，其特征在于所述对所述求精运动场模型进行编码包括以下步骤：
   通过对第一和第二值中供选择的一个设置运动系数指示符来指示所述编码信息包括所述求精场模型的所述运动系数；
   通过设置运动系数模式指示符来指示所述求精场模型的所述运动系数中的哪些具有非零值；
   对所述非零值进行编码。
86. 如权利要求 84 所述的方法，其特征在于各个所述非零系数值是通过指示幅度和符号来进行编码的。
87. 如权利要求 82 所述的方法，其特征在于对所述预测运动场模型进行编码包括通过对第一和第二值中供选择的一个设置运动系数指示符来指示所述编码信息不包括运动系数值。
88. 如权利要求 87 所述的方法，其特征在于对所述预测运动方模
t型进行编码还包括指示某个方向，所述方向用于识别形成所述预测运
动方模型的所述第一相邻段相对于所述第二相邻段的相对位置。

89. 如权利要求 88 所述的方法，其特征在于对所述预测运动方模
t型进行编码还包括通过设置子段鉴别指示符来指示形成所述预测运
动方模型的所述第一相邻段的子段。

90. 如权利要求 83 所述的方法，其特征在于对所述预测运动方模
t型进行编码包括通过对第一和第二值中供选择的一个设置运动系数指
示符来指示所述编码信息不包括运动系数值。

91. 如权利要求 90 所述的方法，其特征在于对所述预测运动方模
t型进行编码还包括指示某个方向，所述方向用于识别形成所述预测运
动方模型的所述第一相邻段相对于所述第二相邻段的相对位置。

92. 如权利要求 91 所述的方法，其特征在于对所述预测运动方模
t型进行编码还包括通过设置子段鉴别指示符来指示形成所述预测运动
方模型的所述第一相邻段的子段。
用于压缩运动矢量场的装置和方法

本发明一般涉及对视频序列进行编码中利用运动补偿的方法。更具体地说，本发明涉及利用运动补偿预测对视频序列进行编码和解码的装置以及相关方法。从视频帧的相邻段并通过利用正交仿射运动矢量场（orthogonal affine motion vector field）模型来预测段的运动场。通过本发明的一个实施例的操作，运动矢量场可由数量减少了的比特来构成，同时仍保持低预测误差。

发明背景

数字通信技术中的进步已经允许发展新型和改进型通信系统。更进一步的进步将允许不断改进利用这种进步的通信和通信系统。

例如，已经建议了用于能够形成视频帧的数字视频数据通信的通信系统。电视会议期间利用的视频图像就是有利地利用了数字视频序列的应用示例。

但是，视频帧一般由大量的象素组成，各个象素可用一组数字比特表示。并且，表示任何视频序列都需要大量的视频帧。由于形成一个典型的视频序列所需的每帧中的大量象素以及大量的帧，因此表示视频序列所需的数据总量很快就变大。例如，一例性视频帧包括 640×480 象素的阵列，各象素具有 RGB（红、绿、蓝）颜色，其中各颜色分量用 8 比特表示，每帧总共 7372800 比特。

视频序列，就象记录在胶片上的普通运动图像一样，包括一系列静止图像，形成运动的错觉是通过相对快速地显示连续图像，比如说以每秒 15 至 30 帧的速率进行显示。由于相对快的帧速率，连续帧中的图像趋向于很相似。一般的景物包括一些举例背景景物的静止组成部分和一些采用各种不同形式的运动组成部分，所述运动
部分比如为新闻播音员的脸、移动的车辆等。另一方面，记录景物的摄像机本身是运动的，这时图像的所有组成部分具有相同类型的运动。在许多情况下，它表明一个视频帧和下一视频帧之间的总变化相当小。当然，这取决于运动的特性：运动越快，从一帧到下一帧的变化越大。

问题出现传送视频序列中，主要涉及必须从发送设备向接收机发送的信息量。序列的各帧包括矩形矩阵形式的象索阵列，为了得到清晰图像，需要高分辨率，也就是说，帧需要包括大量的象素。目前已有大量标准化图像格式，其中包括 352×288 象素的 CIF（公用中分辨 HOW 图像格式）和 176×144 象素的 QCIF（1/4 公用中分辨率图像格式）。 QCIF 格式一般被用于第一代移动视频电话设备，并在可能用于这种设备的小型（3 至 4cm²）LCD 显示器上提供可以接受的清晰图像。当然，较大的显示设备一般需要更高空间分辨率的图像，以便显示时这些图像能以足够的空间清晰度出现。

对图像的每一象素，必须提供颜色信息。如在上面提到的，颜色信息一般是按照基色分量红、绿和蓝（RGB）或利用相关亮度/色度模型进行编码，所述模型称为 YUV 模型，如下面将要描述的，它提供一些编码好处。尽管有几种可以提供颜色信息的方式，但所有颜色表示法都具有相同的问题，即正确表示出现在自然景色中的颜色范围所需的信息量的问题。为了建立人的视觉系统可接受质量的彩色图像，各个颜色分量一般必须用 8 比特分辨率表示。因此，图像的各个象素需要 24 个信息比特，这样 QCIF 分辨率的彩色图像就需要 176×144×(3×8)=608256 比特。此外，如果该 QCIF 图像构成每秒 15 帧的帧速率的视频序列的一部分，要编码该序列就需要总共 9123840 比特/秒。

因此，数据量有时必须通过相对低比特率的通信信道发送，诸如通过以低于 64kbps 工作的无线通信信道发送。

视频编码方案被用于减少表示这样的视频序列所需的数据量。
许多视频编码方案的核心是提供运动补偿预测的方法。运动补偿预测一般提供通过消除帧之间的时间冗余（temporal redundancies）来改进帧补偿的方法。对操作进行预测是基于下述事实：在短系列的相同一般图像（the same general image）中，大多数对象保持在相同位置，而其它对象仅移动短距离。这种运动作为二维运动矢量来描述。

利用 YUV 颜色模型可以获得一些编码优势。这利用了人的视觉系统的一种特性，即人的视觉系统对光强（亮度）变化较之颜色的变化更加敏感。因此，如果图像用一种亮度分量和两种色度分量（如 YUV 模型中）表示，有可能在空间上对色度分量进行二次抽样（降低其分辨率）。这样作可以减少对图像中彩色信息进行编码所需的压缩信息，具有可接受的图像质量降低。可有几种方式来执行空间二次抽样。但一般用表示亮度信息的一个 16×16 象素块和表示两种色度分量的一个 8×8 象素块来对图像中每一个 16×16 象素块进行编码。换句话说，在 x 和 y 方向按 2 的因数对色度分量进行二次抽样。所得到的一个 16×16 亮度块和两个 8×8 色度块的组合通常被称为宏块。利用这种编码方案，对 QCIF 图像进行编码所需的压缩信息总量计算如下：QCIF 分辨率为 176×144。所以图像中包含 11×9 个 16×16 象素亮度块。每个亮度块具有两个与之相关联的 8×8 象素的二次抽样色度块，也就是图像中有 11×9 个宏块。如果亮度和色度分量用 8 比特分辨率编码，则每个宏块所需的总比特数是 1×（16×16×8）+ 2×（8×8×8）= 3072 比特。对整个 QCIF 图像进行编码所需的比特数现在是 99×3072 = 304128 比特，即是没有执行色度子抽样所需的数量的一半（见上述内容）。但是，这仍是相当大的信息量，如果以这种方式编码的 QCIF 图像是每秒 15 帧视频序列的一部分，则仍需要总共 4561920 比特/秒。

视频编码需要处理大量的信息。这当然意味着对视频图像进行编码需要强大的信号处理设备，如果这些图像以其原始形式发送，则
需要宽带宽的通信信道。但是，在许多场合不可能提供高容量的传输信道。特别是在电视电话应用中，视频信号必须通过现有的固定线路通信信道（即通过传统的公共电话网）发送或利用诸如移动电话网提供的无线电通信链路发送，情况更是如此。现在已经有许多为这些系统中的视频编码制定准则的国际电信标准。国际电信联盟 (ITU) 标准的 H.261 和 H.263 就是示例。标准 H.261 给出了以 64kbps 为倍数工作的传输系统（这些一般是固定线路电话网）中视频编码的建议，而 H.263 对可用带宽小于 64kbps 的系统提供了类似的建议。这两个标准实际上关系非常密切，并且都利用能够减少必须传送的信息量的运动预测编码技术。

在移动电视电话中，目的是通过可用带宽约 20kbps 的传输信道发送视频序列。典型的帧速率应该足够提供良好的运动错觉，因此应该在每秒 10 和 15 帧之间。因此应该意识到，为了将需要约 4.5Mbps 的视频序列与只能传送 20kbps 的信道相匹配，需要非常大的压缩率（约 225:1）。这就是运动预测编码以及其它技术开始起作用的情况。

运动预测编码的基本思路是考虑到视频序列中存在的大量时间冗余。如上面所解释的，在以比较快的帧速率（即大于每秒 10 帧）记录的典型视频序列中，从一帧到下一帧只有很小的变化。通常背景是静止的，只有图像的某些部分经历某种形式的运动。另一方面，如果照相机本身在动，则所有组成部分都经历某种一致的运动。

因此在试图减少发送视频序列时的信息量的时候，可利用连续帧之间的高度相关性。换句话说，一帧可以从之前的所谓参考参考帧来预测通常是直接在当前被编码的帧之前的帧，但也不一定。在这样一种编码方案中，一般只有当前帧和参考帧之间的不同之处被编码并被发送到接收机。一般来说，这种编码被称为 INTER 编码。这种编码方案必须要求发射机和接收机都保留参考帧（例如之前编码的帧）的记录。在发射机中，视频编码器对当前帧和参考帧进行比较，识别两帧之间的差异，将之编码，并向接收机传送有关变化
的信息，在接收机中，通过将所述两帧之间的差异信息加到参考（如之前）帧中而在视频解码器中重建当前帧。储存在编码器和解码器中的帧接着被更新，这样当前帧就成为新的参考，并继续以相同的方式从一帧处理到下一帧。

当然有一些场合不能使用这种预测。显然，视频序列的第一帧总是必须被编码并被发送到接收机中的解码器。显然也没有之前的帧可以用作预测编码的参考。相似的情况发生在景物剪辑的情形。这时当前帧可能和之前的帧非常不同，以致没有可能预测，因此，新的帧必须被编码和发送。这种编码一般被称为 INTRA 编码。许多编码方案也使用周期性 INTRA 帧编码。例如，每 10 或 20 帧发送一个 INTRA 帧。这样做可以中和编码错误的影响，编码错误可能逐渐累积，最终导致重建图像中不可接受的失真。

运动预测编码可以被看作是上面介绍的 INTER 编码技术的扩展。上述内容描述了差异信息如何被发送到接收机，从而能够参考某个之前的帧来对当前视频帧进行解码。提供差异信息的最简单又最明显的方式将是发送当前图像中与参考图像中相应的像素不同的各个像素的像素值（YUV 数据）。但是，实际上这种解决方案没有提供通过非常低比特率的信道进行视频传输所必要的数据率的减少。运动预测编码采用不同的途径。如上所述，编码器和解码器都保留参考帧的记录，并参考所储存的帧对当前帧进行编码。在解码器中，参考所储存的之前的帧和编码器发送的差异信息来重建当前图像。

在编码器中，为了确定当前帧和参考帧之间的对应关系，一段一段地将当前图像分割为规则的象素块。例如比较可以从一个块到另一个块地进行。虽不可按其它方式分割帧；或许试图更好地识别帧中包含的差异象素并能够更准确地确定帧中的运动。

利用预定的分段方案，在当前帧的各段和参考帧之间进行比较，
以便确定该段中的象素和参考帧中的某组象素之间的“最佳匹配”。注意到对参考帧没有固定的分段；最佳对应于当前帧的给定段的象素在某些限制条件下可在参考帧中的任何位置，所述某些限制在下面会被解释。这样，运动预测编码可被视为识别当前图像中一组象素的原点的尝试，即试图通过回顾参考帧来确定象素值是如何从一帧到下一帧传播的。

一旦找到当前帧中给定段的最佳匹配，就利用“运动矢量”对段和参考帧之间的对应关系进行编码。运动矢量可以被看作是x和y（水平和垂直）分量的位移矢量，它实际上从当前帧的段指到参考帧中的象素位置。因此运动矢量实际上通过与参考帧进行比较识识别当前帧中象素的原点。编码一直进行到当前帧中各段的原点都被识别为止，所得的表示可以被认为是描述两个帧之间整体对应关系的“运动矢量场”。

利用运动矢量一段一段地编码完整的视频帧产生对当前帧非常有效的表示，因为有关各段运动矢量的编码信息需要相对非常少的比特。但是，编码过程并不完美，存在错误和信息丢失。通常，错误的发生是由于不能正确识别参考帧中的对应象素值。例如，可能存在从一帧到下一帧的图像内容的某种变化，因此在当前帧中出现参考帧中没有对应物的新象素。此外，许多预测运动编码器限制了帧之间允许的运动类型。这种限制发生如下：为了进一步减少表示运动矢量所需的信信息量，通常预测编码器一般使用“运动模型”描述象素值从一帧到下一帧传播的方式。利用运动模型，依据一组“基本函数”来描述运动矢量场。依据这些数学基本函数来表示从一帧到下一帧的象素值传播是。通常，运动被表示为涉及这些基本函数与某些系数值相乘的和，按为提供运动矢量场的最佳近似的这样一种方式来确定这些系数。运动矢量场的这种重新表达式（re-expression）必然引入某种附加误差，因为运动模型不能准确描述运动矢量场：但是，这种方法有一个显著的优点，因为现在只有运动
模型系数必须被发送到解码器，这个优点的出现，因为按照所需精度度的实现和程度，预先选择运动矢量基本函数，并且使得编码器和解码器都知道这些函数。许多目前建议的视频编码方案利用运动预测编码，具体地说，H.263 标准，这些视频编码方案是基于平移运动场模型，即该模型的基本函数只能够表示 x 和 y（水平和垂直）方向中的直线运动。因此无法表示连续帧之间可能发生像素旋转和倾斜，这不可避免地在预测运动中引入误差。

最后，为了补偿运动矢量场编码处理引入的误差，典型的运动预测编码器包括误差估计功能。有关预测误差的信息和运动场模型系数一起被发送到解码器。为了估计运动场编码处理引入的误差，运动预测编码器一般也包括解码部分，该解码部分与接收机种的一样。一旦利用上述运动预测方法编码了当前帧，编码器的解码部分就重建当前帧，并将其与当前帧的原始版本相比较。于是就有可能建立“预测误差帧”，其中包含编码当前帧和原始当前帧之间的不同。这个信息连同运动场模型系数，或许还有有关当前帧分段的信
息一起被发送到解码器。

即使利用了这样的数据，表示视频序列仍然需要大量数据。

利用减少了的比特率或降低了的比特率的速率对视频序列进行编码而同时保持低预测误差的改进方法将因此是有利的。

按照与视频数据相关的背景信息，发展了本发明的重大改进。

发明概述

因此，本发明有利地提供了用于利用运动补偿预测来操作视频序列的装置和相关方法。

提供一种方法，通过将视频帧分成段并从某个段的相邻段来预测该段的运动场，以及通过利用正交仿射运动矢量场模型，来表示运动矢量场。本发明的一个实施例的操作提供了一种快速简洁对运动矢量场进行编码而同时仍保持低预测误差的方式。由此提供质量
改进的共同构成视频序列的视频帧的通信。

通过本发明的实施例的操作，提供一种减少表示运动矢量场所需信息量而同时保持低预测误差量的方式。

提供一种形成运动矢量场的用于编码器的运动场编码器。应用由仿射运动矢量场模型构成。相反，例如，对于纯粹的平移运动模型，通过利用仿射模型可以获得运动场的更灵活的表达式。诸如变焦、旋转、转向（sheer）、或平移的典型自然运动不能由仿射运动矢量场模型来表示。仅仅利用平移模型的传统系统不能表示其它形式的运动。

视频帧的相邻帧的仿射运动矢量场的相似性通过利用仿射预测运动矢量场而被利用。如果，例如，两个相邻帧具有相似的运动矢量场，则其中一个运动矢量场能通过另一个运动矢量场经外加一个小的、或甚至忽略不计的、也就是零的求精（refinement）来算得。对于视频帧的各个帧，选择一种仿射运动模型，它利用尽可能少的非零系数达到令人满意的低预测误差。此外，利用正交基本函数。

正交基本函数对相应运动系数的量化敏感度低，这样系数就能用少量比特来表示。也就是说，运动系数的有效传输需要要被量化到低精确程度的系数。但是，在用少量比特进行表示时，传统使用的基本函数的类型导致不可接受的预测误差增加。由于对应于正交基本函数的系数对量化更加健壮，因此在本发明实施例的操作中有有利地利用了正交基本函数。

在本发明的一个方面，对视频编码器提供运动场编码器。运动场编码器可用于形成压缩运动矢量场，所述压缩运动矢量场由一组当前帧的所有象素的运动矢量构成。运动矢量场由预测运动矢量场和求精运动矢量场构成。

在本发明的另一个方面，对视频编码器提供了运动补偿预测装置。运动补偿预测装置接收由运动场编码器形成的压缩运动矢量场的指示。运动补偿预测装置建立预测帧。预测装置能够通过计算帧
各个段的运动矢量场来重建帧的象素。根据预测运动矢量场和求精运动矢量场来计算运动矢量场。

在本发明的又一个方面，对视频解码器提供运动补偿预测装置。运动补偿预测装置接收预测运动矢量场和求精运动矢量场系数的指示。

因此，在这些和其它方面，提供用于操作视频序列的视频设备的装置。视频序列至少包括当前视频帧，所述当前视频帧至少具有第一相邻段和第二相邻段。所述装置形成第二相邻段的运动矢量场的近似。所述装置包括运动矢量场建立器，它被连接用来接收表示第一部分运动模型的指示，形成表示第一相邻段的运动矢量场的近似。运动矢量场建立器对表示第一部分运动模型的指示进行响应，形成第二部分运动模型，第二部分运动模型形成第二相邻段的运动矢量场的近似。

通过下面简要描述的附图，本发明优选实施例的以下详细描述及后附权利要求书，可以更完整了解本发明及其范围。

附图说明
图 1 示出本发明一个实施例可工作的视频通信系统的编码器和解码器。

图 2 示出运动场编码器的功能方框图，它构成图 1 所示通信系统的一部分。

图 3 示出运动补偿预测装置的功能方框图，它构成图 1 所示通信系统的编码器和解码器的一部分。

图 4 示出在本发明一个实施例的操作期间把视频帧分为段的方式。

图 5 中的表表示在本发明的实施例的操作期间利用的选择比特的示例值和意义。
详细描述

本发明报告的一个实施例的运动预测视频编码的新方法进一步减少了在低比特率视频编码系统中从编码器向解码器传送的数据量，同时保持良好的图像质量。该方法包括新方法，它利用相同帧中已编码的段进一步预测当前帧中段的象素值。

在一个示例性实施例中，当新的视频序列要被编码和发送时，序列中的第一帧以 INTRA 格式被发送，象先有技术和上面描述的那样。所述帧接着被储存在编码器和解码器中，并构成序列中下一（即第二）帧的参考帧。

当编码器开始对第二帧进行编码时，它通过检查帧的第一帧来开始编码处理。在优选实施例中，当前帧被分成一组 16 × 16 象素段，但这不是所述方法的根本，可以设想其它分段方案。编码从上面最左段开始，并从左到右和上到下进行到整个帧（即编码处理按行从上到下进行）。

确定描述参考帧和当前帧的第一帧之间的象素值的映射的运动矢量场，接着使用所谓的“仿射”运动模型来近似运动矢量并生成一组运动系数。仿射运动模型是一种特殊类别的运动模型，其数学形式诸如允许帧之间的平移、旋转和歪斜运动。它包括 6 个基本函数。因此运动矢量基本上由涉及六个基本函数与适当选择的“运动系数”相乘的和来代替。于是仅仅向解码器发送运动系数（或它的子集）就足够了，因为编码器和解码器两处都知道基本函数本身。对当前帧的任何给定段产生最佳仿射运动模型的参考帧中的象素组可以驻留在参考帧的任何区域中，至少理论上是这样。这里应该强调的是，此方法的目的不仅仅是使预测误差最小，也是为了找到产生“率失真（rate-distortion）”意义上的段的最佳匹配的仿射运动场模型。这意味着最佳匹配是通过考虑图像失真量度和达到所述失真度（level of distortion）所需数据量的量度两者来确定的。

由于帧的第一（上面最左边）段没有之前编码的相邻段，不能
采取进一步的动作，编解码器运行到当前帧的第二段。接着确定在参考帧和当前帧的第二段之间提供最佳映射的仿射运动场模型，其中利用与之前描述的相同种类的率失真、最佳匹配估计。如前所述，象素值的相应区可以驻留在参考帧的任何地方，并且实际上可以与之前被确定为当前帧第一段的最佳匹配的部分相重叠。

第二段具有一个之前编码的相邻段（即第一段）。编解码器现在考虑根据之前为第一段确定的仿射运动模型来模拟第二段。是根据为第二段本身新近确定的仿射运动系数“更有效”。基本原理如下：由于用于第一段的运动系数已被确定并发送到解码器，有可能在编码第二段的时候减少必须发送到解码器的信息量。因此提高编码效率。

但是，用于第一段的运动系数不太可能正好与那些最准确模拟第二段的运动矢量场的运动系数一样。所以，不是简单地那样利用为第一段计算的运动系数，而是执行一种投影，以便将第一段的运动场映射到第二段。即使执行了这种投影，有关第一和第二段运动场之间差异的一些信息仍有可能必须被发送到解码器，以避免在重建图像中的不可接受的失真。因此，编解码器比较 a）发送特别为第二段确定的运动系数数据所需的数据量和 b）在第二段的运动矢量场是从第一段的运动模型的投影加上一些“求精”信息来确定时所需的数据量。在选择发送什么信息时，编解码器也必须考虑由预测处理引入到图像的失真。这种选项之间的比较可以被认为是确定选择特定选项的“成本”，即要发送的信息量和允许的失真量之间的一种折衷。

这种方法对运动预测编解码的好处可能不会马上表现出来。但是，在许多情况中发现，在从相邻段投影运动场模型之后，需要非常少的、或者甚至为 0 的求精信息。这一点能够导致必须从编解码器发送到解码器的数据量的显著减少，在需要 0 求精信息的情况下，第二段的运动矢量场可以仅仅根据已经储存在解码器中的运动系数来预
此范例到目前为止，仅仅考虑了帧的第一和第二段。如上所述，按照本发明优选实施例中采用的分段方案，第二段只有一个能被用于预测其运动系数的相邻段。这一点对帧的第二行上其它所有帧都一样。所有这样的段只能具有紧靠其左边的之前编码的相邻段。但是，在图像的第二及后续行，在各行上面的之前编码的段也可以用。因此，后续行的段具有左和上面的相邻段。这一点对除了各行中的第一段的所有其它段都适用，各行中的第一段仅仅只有直接在其上的之前编码的相邻段。所以，当考虑帧中要编码的一般段时，对运动系数的预测存在几种可能性。一般情况下，编码器可以试着采用给定段的上面段或左段的运动场模型来预测该给定段的运动系数。另一方面，可利用两个相邻段的运动场模型来形成某种平均。在各种情况下，从相邻段预测的运动场模型被称为“预测场”，而预测场和特别对给定段本身确定的运动场模型之间的差异被称为“求精场”。在优选实施例中，预测场和求精场都是仿射运动场模型。预测场和求精场之和应等于通过将仿射运动模型应用到给定段本身所确定的运动场模型。在不可能从给定段的相邻段预测该给定段的运动场模型的情况下，预测场被设为零，而求精场等于特别对给定段本身确定的运动场模型。

从上面的描述中认识到，给定段能以几种不同的方式被编码。在编码器中利用那个选项的选择是基于之前描述的“率失真”的考虑而作出的。因此，根据选择的编码选项，有几种不同类型的必须被发送到解码器，所述信息必须以清楚的方式被发送到解码器，从而使段能被正确重建和显示。各种编码选项如下：1）给定段可以被表示为预测场和求精场之和。2）给定段可以仅被表示为预测场。这种情况在给定段能适当根据一个或多个之前被编码的相邻段的运动场来表示，而不需要求精信息的时候，或者编码器已经发现将求精场减少到零有效的情况下发生。3）有问题的段可以利用通过参考
帧特别对给定段确定的运动模型来进行编码。在这种情况下，如上所述，预测场被设为零，而求精场被设为等于从参考帧确定的运动场模型。

基本上，为了能够正确重建给定段，有两类必须发送到解码器的信息。它们是：1）选择信息，它使解码器能够选择正确的相邻段在预测中使用；2）运动系数信息。每当利用预测场对段进行编码时，不论是否存在相关的求精场，都有必要提供有关用于预测的相邻段的信息。不必发送任何运动系数数据，因为解码器已经知道（即存储在其中）之前编码的相邻段的运动场模型。如果例如预测是基于一个以上相邻段、或相邻段已被分为子段而一个或多个子段的运动场模型被用于形成预测场，则也有可能需要附加信息。在使用求精场时，必须提供运动系数值。在这种情况下，应该记住只需要发送运动系数数据，因为解码器和编码器都知道运动模型基本函数。

从编码器发送到解码器的数据流因此可能包含运动系数数据和各种指示解码器执行不同操作的选择数据（即，非运动系数数据）。例如，如果解码器接收到非运动系数数据，则它应该利用选择数据指示的相邻段和子段来建立预测运动场模型。如果它接收到运动系数数据，则解码器必须利用发送的运动系数值和储存的运动模型基本函数来建立求精运动场模型。在本发明优选实施例中由编码器提供的数据流的格式将在下文中进行详细描述。

其它一些求精方法都是可能的，如本发明的优选实施例中，相邻段可以被分为更小的子段。具体地说，各个 16×16 象素段可以被分为四个 8×8 象素块，这些子段的运动场模型可被用于得到预测场。在这种情况下，一个一般的 16×16 象素段具有四个紧邻的 8×8 象素子段，它们可被认为是两个正在上面和两个紧靠左边。在这种情况下，决定处理更复杂了，但与前面所述中描述的操作方式仍基本相同。子段大小的选择不限于刚才介绍的例子，可以考虑各种其它子段的大小。例如，4×8 或 8×4 象素块都可以被用作子段。
如上所述，在按照本发明的方法应用于实际中时，常常发现需要很少的求精信息，一般段的运动模型能以非常高的精度从其相邻段的运动场模型来预测。本发明还包括一个特性，求精场或整个求精场的各个系数可被设为零，如这在“率失真意义”上有效的话。换句话说，在考虑到减少要发送的数据量时，求精场可被设为 0，如果这样做引入的图像失真可以接受。这个附加特性进一步减少了必须从编码器发送到解码器的数据量。

首先参考图 1，一般用 10 表示的一种通信系统，可用于视频序列发生器和视频序列接收机之间的视频序列通信。图中画出视频序列发生器的编码器 12，表示出构成视频序列接收机的一部分的解码器 14。为了简单起见，没有示出视频序列发生器和接收机上各自的其它部件。通信路径 16 被分为对通信系统各部分的互连。通信路径可以采用任何形式，包括例如无线电链路。

这里示出编码器 12 被连接用于接收线路 18 上的视频输入。视频输入被提供给运动估计器 22 和减法器 24 的输入端。运动估计器也被连接用于接收存储帧存储器 26 中的参考帧的指示。运动估计器计算正被编码的帧和之前的帧之间的象素的运动矢量，即当前视频输入 V_n(x, y) 和参考帧 R_ref(x, y) 之间的象素的运动矢量。

一旦编码器对各个段进行了编码，重建所需的信息就可以被发送到解码器，并且解码器就可以开始重建所述段。因为各帧是按一段一段的原则编码的，并且预测处理中只使用之前编码的段，因此解码器中帧的重建可以立即开始，不必等到整个帧都被编码。一经得到有关各段的信息，就将该信息发送到解码器，并在接收机中基本与编码处理同时对帧进行解码。在电视电话应用中，使端到端的延迟保持最小是有利的。当然，该方法也可适用于视频存储和检索系统，其中即时传输不是必须要求的。在那种情况下，不要求即时发送数据并且也可能在当前帧中使用其它相邻段用于预测目的。
运动估计器 22 被连接到运动场编码器 28。运动场编码器 28 能用于形成一个运动矢量场，该运动矢量场是当前帧的所有象素的一组运动矢量。运动场编码器产生的场通过线路 32 提供给复用器 34，其后通过通信路径 16 被传送到视频序列接收机及其解码器 14。

所示编码器还包括运动补偿 (MC) 预测装置 36。预测装置 36 被连接到帧存储器 26。预测装置 36 能用于产生预测帧，所述预测帧被提供给减法器 24 和加法器 38。

减法器 24 形成的差值被提供给预测误差编码器 42。该预测误差编码器确定当前输入视频帧和该帧的 MC 预测版本之间的象素值的差异，以便产生预测误差的指示。并且，预测误差编码器 42 又被连接到复用器 34 以及预测误差解码器 46。预测误差解码单元对预测误差进行解码，所述预测误差由加法器 38 加到 MC 预测当前帧，所得结果储存在帧存储器 26 中。

这里示出的解码器 14 包括分用器 52、预测误差解码器 54、运动补偿预测装置 36、加法器 56 以及帧存储器 26。编码器和解码器的预测装置 36 以及各个设备中的帧存储器 26 用相同的数字表示。

运动估计器 22 计算正被编码的称为当前帧 I_n(x, y) 的帧和参考帧 R_ref(x, y) 之间的象素的运动矢量 (△x(x, y), △y(x, y))。参考帧是之前被编码和发送的帧之一，在给定瞬间在编码器和解码器的帧存储器 26 中可以得到。

△x(x, y) 和 △y(x, y) 分别是水平和垂直位移值。当前帧中被称为运动矢量场的所有象素的运动矢量组通过运动场编码器 28 被压缩，其后，如上所述，被发送到解码器。

为了指示运动矢量场的压缩一般是有损耗的，压缩的运动矢量被表示为 (△x(x, y), △y(x, y))。在运动补偿预测装置 36 中，压缩的运动矢量和参考帧被用于建立预测帧 P_n(x, y)。预测帧是利用由运动估计器 22 和运动场编码器 28 以及参考帧 R_ref(x, y) 的象素值确定的运动矢量场来计算的当前帧 I_n(x, y) 的编码版本。
下列公式示出了计算预测帧的方法:

公式 1

\[ P_n(x, y) = R_{ref}(x + \Delta x(x, y), y + \Delta y(x, y)) \]

预测误差，即当前帧和预测帧之间的差异，如下:

公式 2

\[ E_n(x, y) = I_n(x, y) - P_n(x, y) \]

预测误差被压缩并发送到解码器 14。压缩的预测误差被表示为 \( \tilde{E}_n(x, y) \)。

在解码器 14 中，当前编码的帧 \( I_n(x, y) \) 的像素通过利用接收的运动矢量在参考帧 \( R_{ref}(x, y) \) 中找到预测像素并通过按如下公式加上接收的预测误差 \( \tilde{E}_n(x, y) \) 而被重建:

公式 3

\[ I_n(x, y) = R_{ref}(x + \Delta x(x, y), y + \Delta y(x, y)) + \tilde{E}_n(x, y) \]

编码帧和原始帧之间的差异用如下公式表示，并且被称为重建误差:

公式 4

\[ D_n(x, y) = I_n(x, y) - \tilde{I}_n(x, y) \]

由 MC 预测装置 36 形成的运动补偿预测帧 \( P_n(x, y) \) 以这样一种方式被建立，使重建误差量最小，同时使表示运动矢量场所需的信息量最小。
典型视频序列的帧包含多个具有不同运动的段。所以，运动补偿预测的执行是通过将帧 \( I_n(x, y) \) 划分为若干段并估计这样的帧和参考帧之间这样的段的运动。分段信息是运动表达式的固有部分。除非使用缺省帧分段，并且为编码器和解码器所知，否则描述帧的最终划分的附加信息必须被发送给解码器。实际上，一个段一般包括至少几十个象素。为了简洁表示这样的象素的运动矢量，它们的值最好用具有几个参数的函数来描述。这样的函数被称为运动矢量场模型。为了下面的描述，图像段的运动矢量应利用下面一般的加法表达式近似：

\[
\Delta x(x, y) = \Delta x_{pr} (x, y) + \Delta x_{ref} (x, y) \quad \Delta y(x, y) = \Delta y_{pr} (x, y) + \Delta y_{ref} (x, y)
\]

上述公式的第二项被称为求精运动矢量场，并表示为如下线性组合：

\[
\Delta x_{ref} (x, y) = \sum_{n=1}^{N} c_n f_n (x, y) \quad \Delta y_{ref} (x, y) = \sum_{n=M+1}^{N+M} c_n f_n (x, y)
\]

参数 \( c_n \) 被称为求精运动系数。所述系数在编码器中被压缩、通过通信路径 16 被发送，然后在解码器中被恢复。

函数 \( f_n \) 被称为基本函数，并且为编码器 12 和解码器 14 所知。矢量组 \((\Delta x_{pr}, x, y), (\Delta y_{pr}, x, y)\) 被称为预测运动矢量场，并为编码器 12 和解码器 14 所知。

运动补偿预测之后得到的公式 2 中的预测误差帧 \( E_n(x, y) \) 一般利用离散余弦变换（DCT）的二维变换进行编码。这个处理被称为预测误差编码，其目的是减少预测误差。由于预测误差编码一般有损耗，这种导致重建误差。

编码器 12 的主要任务是找到适当的运动系数组，所述运动系数组要被编码并发送到解码器。通常，通过增加分配给编码系数的比
特数来减少作为结果的所遭受的失真。但是，失真的减少并非总是值得增加比特数。通常，处理这样的折衷的一种方式是使下面的拉格朗日准则（Lagrangian criterion）最小。

公式7

\[ L = D + \lambda \cdot B \]

在这个公式中，项D表示在由给定的系数组进行编码时所受的失真，即误差。发送系数的成本用比特数B表示。因子\( \lambda \)是称为拉格朗日参数的恒量。

在本发明一个实施例的操作中，视频帧的给定段的运动矢量场是两个仿射运动矢量场之和，即预测运动矢量场和求精运动矢量场之和。用如下公式表示：

公式8

\[ \Delta x(x,y) = \Delta x_{pdr}(x,y) + \Delta x_{refine}(x,y) \quad \Delta y(x,y) = \Delta y_{pdr}(x,y) + \Delta y_{refine}(x,y) \]

预测运动矢量场是以几种方式中的其中一种方式从一个或多个相邻段的运动矢量场得到的。例如，在一个实现中，预测运动矢量场是通过将例如邻近段的相邻段的仿射运动矢量场外插到当前段覆盖的区域得到的。由于当前段可以有几个相邻段，一般向解码器提供信号信息（signaling information），以便指定将使用那一段。在另一个实现中，预测运动矢量场是利用编码器和编码器已知的某种特定方法来组合几个相邻段的仿射运动矢量场而得到的。这样的方法是例如对水平和垂直运动矢量场分量求平均或确定均值。

求精运动矢量场具有按如下公式表示的仿射模型。

公式9

\[ \Delta x_{refine}(x,y) = \sum_{n=1}^{3} c_n f_n(x,y) \quad \Delta y_{refine}(x,y) = \sum_{n=1}^{3} c_{n+3} f_n(x,y) \]
其中基本函数 $f_1 \ldots, f_3$ 是仿射正交函数。基本函数关于确定给定段界限的矩形是正交的。同时，系数 $c_1, \ldots, c_6$ 是对应于正交基本函数各组的求精运动矢量场系数。

由运动场编码器在编码器 12 进行编译期间对帧中的每一个段确定求精运动系数，具体地说明是运动场编码器 28 进行。

图 2 更详细地说明了运动场编码器 28。这里表示的编码器 28 包括预测运动场的选择器和建立器 62、运动分析器 64、运动系数取消装置 66 及量化器 68。

选择器和建立器 62 可用于给定段，以确定当前帧的之前编码段、或这样的段的组合。其运动矢量场最适合预测例如当前段的给定段的运动场。根据“胜出”候选的运动矢量场，如上所述地计算预测运动场。通常，信令信息被发送给解码器以指定几个候选段中最适合的那个。

运动分析器 64 能用于找到求精运动矢量场的新表达式。也就是说，得到一种数学上有用的表达式。新表达式随后被用于运动系数取消装置 66 中快速而灵活地确定求精运动系数。

运动系数取消装置 66 能用于确定应设为 0 的求精系数，并计算剩下的非零系数的值，从而使拉格朗日准则最小，如下式：

$$L(c) = D(c) + \lambda \cdot B(c)$$

其中 $D(c)$ 和 $B(c)$ 是与利用求精运动系数 $c$ 和给定段进行编码相对应的预测误差和比特的量度，常数 $\lambda$ 是拉格朗日参数。当设置某些求精运动矢量场系数为 0 时，预测误差增加。但是，当更多的系数被设为 0 时，编码器需要向解码器发送的比特数减少。因此，拉格朗的日的值在某些求精运动系数被设为 0 时可以降低。

量化器 68 能用于量化剩余的非零求精运动矢量系数，以便于这样的系数适合于熵编码及从编码器向解码器的传输。
图 3 示出运动补偿 (MC) 预测装置 36 分别形成如图 1 所示的编码器和解码器 12 和 14 的一部分。编码器和解码器的 MC 预测装置 36 的功能单元相似，并且 MC 预测装置能用在编码器和解码器中通过计算帧间各段的运动矢量量来重建当前帧的象素。根据预测运动矢量 (Δx_{prd} (x, y), Δy_{prd} (x, y)) 和求精运动矢量量来计算运动矢量量。在示例性实施例中，求精运动矢量量由反量化值表示。在解码器 14 中，从一个或几个已解码的相邻段来得到预测运动矢量量。在解码和反量化器 76 执行反量化之后，在解码器中可以得到求精运动矢量量系数。如图所示，MC 预测装置还包括运动矢量量建立器、段预测装置 80 和预测运动矢量量建立器 81。

如图 2 所示，到运动场编码器 62 的运动分析器 64 的输入包括估计运动矢量量 (Δx(x, y), Δy(x, y))。运动矢量量由运动估计器 22 (图 1 所示) 提供。以传统的方式在运动估计器 22 中计算运动矢量量。预测运动矢量量也提供给运动分析器。并且，要编码的段 S 的几何形状及参考和当前帧 (分别为 R_{ref} (x, y) 和 I_n (x, y)) 也作为输入提供给运动分析器，其中所述给定段 S 的几何形状也就是给定段 S 的大小和形状。

运动分析器用于执行几种操作。首先，运动分析器执行误差线性化。给定段 Si 的预测误差 D_i 用公式 11 表示，D_i 包括 P 个象素坐标 (x_p, y_p)，p = 1, 2...P 组成，其预测运动场表示为 (Δx_{prd} (x_p, y_p), Δy_{prd} (x_p, y_p)) 并且其求精运动矢量量由公式 9 给出的仿射运动模型近似。

公式 11

\[ D_i = \sum_{p=1}^{P} (I_n(x_p, y_p) - R_{ref}(x_p + \Delta x_{pre}(x_p, y_p) + \Delta x_{ref}(x_p, y_p), y_p + \Delta y_{pre}(x_p, y_p) + \Delta y_{ref}(x_p, y_p))) \]

在线性化期间，公式 11 的 R_{ref} (x, y) 值利用某种已知近似方法来近似，以便它变为线性依赖于 (Δx_{ref} (x_p, y_p), Δy_{ref} (x_p, y_p))。
公式 12

\[ D_i = \sum_{p=1}^{P} (e_{p,1}e_1 + e_{p,2}e_2 + \ldots + e_{p,6}e_6 - w_p)^2 \]

e 和 w 的值取决于使用的近似方法的类型。

其后，利用运动分析器建立矩阵。由于在公式 (12) 中的平方值下的元素是系数 c_6 的线性组合，因此公式的最小化正好等于下列矩阵表达式的最小化。

公式 13

\[ (E_i e_i - w_i)^T (E_i e_i - w_i) \]

其中 E_i, w_i 和 e_i 下:

公式 14

\[ E_i = \begin{bmatrix} e_{1,1} & e_{1,2} & \ldots & e_{1,N+M} \\ e_{2,1} & e_{2,2} & \ldots & e_{2,N+M} \\ \vdots & \vdots & \ddots & \vdots \\ e_{P,1} & e_{P,2} & \ldots & e_{P,N+M} \end{bmatrix}, w_i = \begin{bmatrix} w_1 \\ w_2 \\ \vdots \\ w_P \end{bmatrix}, e_i = \begin{bmatrix} e_1 \\ e_2 \\ \vdots \\ e_{N+M} \end{bmatrix} \]

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根据 E_i 和 w_i，矩阵 A_i 和矢量 d_i 计算如下:

公式 15

\[ A_i = E_i^T E_i. \]

公式 16

\[ d_i = E_i^T w_i \]
运动分析器产生一个包括 \((N+M) \times (N+M)\) 的上三角形矩阵 \(R_i\) 的输出，所述 \(R_i\) 具有如下形式:

\[
R_i = \begin{bmatrix}
  x & x & x & \ldots & x \\
  0 & x & x & \ldots & x \\
  0 & 0 & x & \ldots & x \\
  \vdots & \vdots & \vdots & \ddots & \vdots \\
  0 & 0 & 0 & \ldots & x \\
\end{bmatrix}
\]

其中符号 \(x\) 表示通过计算下式表示的矩阵 \(A_i\) 的 Cholesky 因式分解得到的非 0 元素：

公式 17

\[
A_i = R_i^T R_i
\]

运动分析器也生成矢量 \(z_i\)，它是通过求解下列公式组得到的:

公式 18

\[
R_i z_i = d_i
\]

矩阵 \(R_i\) 和矢量 \(z_i\) 都是运动分析器的输出参数，这样的参数一起构成适合于在运动系数取消装置 66 中操作的求精运动矢量场的表达式。

运动分析器 64 的输出构成了运动系数取消装置 66 的输入。当设置某些求精运动场系数为 0 时取消装置 66 执行的操作包括例如取消那些与能用 \(z_i\) 从 \(R_i\) 中去掉的系数对应的元素。所得结果是一个修正了的矩阵 \(R\) 和矢量 \(z\)。

可以使用各种方式指定或缺席地隐含段或相邻段组，其中预估运动场是从其导出的。而且，可以使用不同方式来产生预估运动场
$\Delta x_{\text{pred}}(x, y) , \quad \Delta y_{\text{pred}}(x, y) , \quad \text{以线性化上面的公式 (11), 以及求解公式组 (18).}$

图 4 显示由单独视频帧 84, 图中示出被分为多个段 86，在这里是 30 个。这里的各个段 86 是由 16 × 16 象素块构成的，并且，各个段还可以被分割以形成更小的段。这里有些段 86 被分割而形成 8 × 8 象素块 88, 段 86 通常被称为宏块。帧的编码是通过从左到右和从上到下、一个宏块到一个宏块地扫描来执行的。

如上所述，给定段的运动矢量场服从公式 (8) 中给出的加法运动模型。下面将描述获得预测、求解和最终运动预测场的方式。在示例性实施例中，运动预测或运动求解场可以是 0。所以，关于运动矢量场，可以采用各种方式给定段 $S_i$ 进行编码。例如，可以利用从相邻段外插的预测运动矢量场对段进行编码。或者，可以利用从相邻段外插的预测运动矢量场压缩求解运动矢量场一起对段进行编码。或者，另一方面，可以仅仅利用压缩运动矢量场对段进行编码，而不利用预测场。但是，如果预测场设为 0，则发送求解信息。也可以利用零运动矢量场，例如利用参考帧 $R_{\text{ref}}(x, y)$ 的复制对段进行编码。以及，例如可以利用没有采用运动矢量场的内部编码 (intra coding) 方法对段进行编码。

在示例性实施例中，不依赖预测运动矢量场或求解运动矢量场的存在，给定运动补偿段 $S_i$ 的最终运动矢量场具有由下列公式给出的仿射模型，其中的上标 $i$ 表示系数与相应段 $S_i$ 相关联的事实。

公式 19

$$\Delta x(x, y) = \beta_1 \cdot (y - y_0) + \beta_2 \cdot (y - y_0) + \beta_3 \cdot (x - x_0)$$
$$\Delta x(x, y) = \beta_4 \cdot (y - y_0) + \beta_5 \cdot (y - y_0) + \beta_6 \cdot (x - x_0)$$

其中 $x_0$ 和 $y_0$ 是段中上面最左边象素的坐标，而 $\beta_1 \quad \beta_2 \quad \beta_3 \quad \beta_4 \quad \beta_5 \quad \beta_6$ 是按照下面所述计算的仿射系数。
在解码器 14 的示例性实施例中，通过整数精度执行操作。这是通过利用与固定精度相对应的定点实现来取得的。结果，在下文提到的所有系数都是整数值，包括公式（19）的系数。在其它实施例中，可以使用其它精度。

在示例性实施例中，向解码器 14 发送 1 比特，以使用信号通知是否使用相邻段的预测值，但只在至少有一个预测相邻候选时这样作。只有在相邻段 S_k 是非零运动矢量场的情况下，相邻段 S_k 才是用于预测段 S_i 的运动矢量场的候选。

同样，在这个示例性实施例中，只从当前段的左边和正好上方最近的相邻块来执行预测。所以，相邻段的数量最多为 4，即，上面两个 8×8 象素块，左边两个 8×8 象素块。在这个实施例中，只要发送到解码器的比特表示使用从相邻段的预测，就在编码器及解码器中计算预测候选的数量和位置。如果具有两个、三个或四个预测候选，则向解码器 14 发送一个或两个选择比特，以表示要使用候选。选择信息例如由一个预测方向比特及其后跟着的鉴别比特组成，其中预测方向比特可能存在，也可能不存在，鉴别比特也一样。

图 5 示出一般以 92 表示的表，其中列出了本发明的示例性实现中选择比特的意义和值。标记 X 表示没有或根据上下文逻辑无关。

方向比特表示当前正被预测的段的上面或左边是否有候选相邻段。鉴别比特指定两个剩余候选中的哪一个必须被用于运动矢量场的预测。那就是说，当选择上面的或左边的段时，具有两种选择可能性。鉴别比特识别该选择。在表中给出的最后四种情况中，根据最适合候选段的位置，鉴别比特可能存在，也可能不存在。例如，如果方向比特在只有一个候选时表示“从左”，那么就不需要鉴别比特。在解码器 14 中，在对方向比特进行解码之后，胜出候选的方向就已知了。

一旦为当前段的预测选择了相邻段，预测运动矢量场就简单地
是当前段所覆盖象素区中的相邻段的运动矢量场的外插，表示如下:

公式 20

\[
\Delta x_{\text{prd}}(x, y) = \beta_1^k + \beta_2^k \cdot (y - y_0^k) + \beta_3^k (x - x_0^k)
\]
\[
\Delta y_{\text{prd}}(x, y) = \beta_4^k + \beta_5^k \cdot (y - y_0^k) + \beta_6^k (x - x_0^k)
\]

其中 \(x_0^k\) 和 \(y_0^k\) 是相邻段 \(S_k\) 中上面最左边象素的坐标，而 \(\beta_1^k, \ldots, \beta_6^k\)
是与段 \(S_k\) 的运动场对应的整数值系数。在公式 20 中，上标 \(k\) 表示系数与相邻段 \(S_k\) 相关联。

对公式 19 和 20 的分析表示：相邻段 \(S_k\) 的运动矢量场通过简单地外插到当前段 \(S_i\) 中的象素中而变成段 \(S_i\) 的预测运动矢量场。

求解运动矢量场表现为公式 9 给出的仿射正交模型，但是，在优选实施例中，求解系数被转换为一组辅助求解系数。辅助求解系数允许快速计算最终预测运动场。

在优选实施例中，对应于正交仿射基本函数组的公式 9 中的求解系数首先被转换为不同的一组辅助系数，这些系数对应于基本函数组 \(\{1, (y - y_0)(x - x_0)\}\)，其中 \(x_0, y_0\) 是段中上面最左边象素的坐标。这个转换被执行，以便取得预测和求解运动矢量场的共同基本函数表达式，即，以便使用相同的基本函数组。通过这样做，根据两组系数的和来计算最终运动矢量场，稍后将对此进行描述。根据求解系数 \(c_1, \ldots, c_6\) 来计算段 \(S_i\) 的以下辅助系数 a1 … a6。对于 16 × 16 象素块的段，计算如下：

公式 21

\[
\begin{bmatrix}
  a_1 \\
  a_2 \\
  a_3 \\
\end{bmatrix} =
\begin{bmatrix}
  4096 & 6664 & 6664 \\
  0 & -889 & 0 \\
  0 & 0 & -889 \\
\end{bmatrix}
\begin{bmatrix}
  c_1 \\
  c_2 \\
  c_3 \\
\end{bmatrix}
\]
\[
\begin{bmatrix}
  a_4 \\
  a_5 \\
  a_6 \\
\end{bmatrix} =
\begin{bmatrix}
  0 & -889 & 0 \\
  0 & 0 & -889 \\
\end{bmatrix}
\begin{bmatrix}
  c_4 \\
  c_5 \\
  c_6 \\
\end{bmatrix}
\]

对于 8x8 象素块的段 \(S_i\)，计算形式如下：
公式 22

\[
\begin{bmatrix}
  a_1 \\
  a_2 \\
  a_3
\end{bmatrix} =
\begin{bmatrix}
  8192 & 12513 & 12513 \\
  0 & -3575 & 0 \\
  0 & 0 & -3575
\end{bmatrix}
\begin{bmatrix}
  e_1 \\
  e_2 \\
  e_3
\end{bmatrix}
\]
以及

\[
\begin{bmatrix}
  a_4 \\
  a_5 \\
  a_6
\end{bmatrix} =
\begin{bmatrix}
  8192 & 12513 & 12513 \\
  0 & -3575 & 0 \\
  0 & 0 & -3575
\end{bmatrix}
\begin{bmatrix}
  e_4 \\
  e_5 \\
  e_6
\end{bmatrix}
\]

结果，下列整数值位移表示段 $S_i$ 的求精运动矢量场：

公式 23

\[
\Delta x_{refn} (x, y) = a_1 + a_2 \cdot (y - y_0') + a_3 (x - x_0')
\]

\[
\Delta x_{refn} (x, y) = a_4 + a_5 \cdot (y - y_0') + a_6 (x - x_0')
\]

其中 $x_0'$和 $y_0'$是段 $S_i$ 中上面最左边象素的坐标，上标 $i$ 表示这些坐标与当前段 $S_i$ 相关联。

在示例性实现中，给定段的最终仿射系数组用以下公式进行计算，其中所述给定段使用相邻段 $S_k$ 用于运动场预测，公式中的上标 $i$ 和 $k$ 表示相应系数分别与 $S_i$ 和 $S_k$ 相关联：

公式 24

\[
\beta_1' = a_1 + \Delta y_{pred} (x_0', y_0')
\]

\[
\beta_2' = a_2 + \beta_2^k
\]

\[
\beta_3' = a_3 + \beta_3^k
\]

以及

\[
\beta_4' = a_4 + \Delta y_{pred} (x_0', y_0')
\]

\[
\beta_5' = a_5 + \beta_5^k
\]

\[
\beta_6' = a_6 + \beta_6^k
\]

根据整数值系数 $\beta_1 \ldots \beta_6$，利用公式 19 产生段 $S_i$ 的最终运动矢量组。下面描述运动矢量被用于从参考帧计算象素强度（pixel intensities）的方式。

在示例性实现中，无论是否期待求精或非求精运动系数，比特流中运动系数的出现是通过一个比特发信号通知的，这个比特被称为运动系数指示符（MCI）。

同样，在示例性实现中，当段 $S_i$ 的运动系数被发送时，被称为
运动系数模式（MCP）的变长码首先被发送，以指示哪些系数具有非零值。全零模式是唯一的无效模式，因为这种可能性可以单独通过MCI比特发送信号。可以由MCP码字表示的有效模式的总数为63。这是仿射模型的特性。由于它具有4个系数，因此有2^4，即64个可能结果。由于零是无效的，所以MCP码字有63个可能值。跟在MCP码字后面的是由MCP模式表示的各个非零运动系数的编码值。各个非零系数的编码值跟在MCP码字后面。运动系数c_j被编码为幅度变长码字，表示c_j绝对值，后面跟有表示c_j符号的符号比特。在示例性实现中，使用相同的变长编码表来为不同系数的幅度进行编码。

可以使用不同的编码表。零幅度不包括在有效选项中，因为这种可能性可以由MCP码字表示。

通过利用公式19计算的最终运动矢量场分量对应于下面公式所示的离散化步骤:

公式25

\[ D = \frac{1}{65536} = 0.0000152587 \quad 890625 \]

如果 (Δx(x, y), Δy(x, y)) 表示段S_t的最终运动补偿位移，则在之前帧中的相应非整数坐标为:

公式26

\[
\begin{align*}
x' &= x + Δx(x, y) \cdot D \\
y' &= y + Δy(x, y) \cdot D
\end{align*}
\]

在优选实施例中，参考帧R_ref是M×N象素的大小，具有{0, 1, ..., 255}范围的强度值。有效象素坐标{x',y'}只在范围{0,1,...,M-1}×{0,1,...,N-1}中被定义。当运动补偿预测需要计算参考帧R_ref中非整数位置的亮度和色度值时，采用离散型的三次卷积内插（cubic convolution interpolation）。在示例性实现中，如下所述，当计算参
考帧中的重建值时采用定点精度。
首先，对应于段 $S_i$ 中象素 $(x, y)$ 的整数值位移 $(\Delta x(x, y), \Delta y(x, y))$ 用模 65536 的形式表示如下:
公式 27

$$
\Delta x(x, y) = dx \cdot 65536 + \delta x, \delta x \in \{0, 1, \ldots, 65535\}
$$

$$
\Delta y(x, y) = dy \cdot 65536 + \delta y, \delta y \in \{0, 1, \ldots, 65535\}
$$

其中 $dx$, $dy$, $\delta x$ 和 $\delta y$ 都是整数值，而后面两个总是非负数。
$4 \times 4$ 的三次卷积窗的 $x'_j, y'_k$ 整数值坐标被定义如下:
公式 28

$$
x'_j = \text{sat}(x + dx + j - 2, M - 1), j = 1, 2, 3, 4
$$

$$
x'_k = \text{sat}(y + dy + k - 2, N - 1), k = 1, 2, 3, 4
$$

其中 $\text{sat}(u, v)$ 是如下式表示的饱和函数:
公式 29

$$
\text{sat}(u, v) = \begin{cases} 
0 & u < 0 \\
\min(u, v) & 0 \leq u \leq v \\
v & u > v
\end{cases}
$$

因此，用于三次卷积的 16 个整数象素值 $r_{jk}$ 如下:
公式 29

$$
r_{jk} = R_{ref}(x'_j, y'_k) \\
\text{where } j, k = 1, 2, 3, 4
$$

其中 $x'_j, y'_k$ 是公式 28 中计算的整数值坐标。
接着，计算卷积系数。在下面，通过舍位的整数除法用 “/” 表
示，两者或其操作数总是非负整数。通过利用整数舍位，下面 $u_j, v_k (j,k=1,2,3,4)$ 被计算如下:

公式 31

$$
\begin{align*}
u_1 &= \text{spl}(\delta x / 256 + 256) \\

v_1 &= \text{spl}(\delta y / 256 + 256) \\

u_2 &= \text{spl}(\delta x / 256) \\

v_2 &= \text{spl}(\delta y / 256) \\

u_3 &= \text{spl}(256 - (\delta x / 256)) \\

v_3 &= \text{spl}(256 - (\delta y / 256)) \\

u_4 &= 16384 -(u_1 + u_2 + u_3) \\

v_4 &= 16384 -(v_1 + v_2 + v_3)
\end{align*}
$$

其中 $\delta x$ 和 $\delta y$ 是公式 27 的整数值，而 spl(s) 是正整数变元的整数值函数。

公式 32

$$
\text{spl}(s) = \begin{cases} 
16384-(s^2 \cdot (1280-3 \cdot s)+1024)/2048 & s \in \{0,1, ..., 255\} \\
-(t \cdot (65536+t^2-512 \cdot t)+1024)/204 & s \in \{256, ..., 511\}, t=s-256 \\
0 & \text{其它情况}
\end{cases}
$$

接着计算参考象素值。通过利用舍位的整数除法，参考象素值被计算如下:

公式 33

$$
\begin{align*}
r &= \text{sat} \left( \begin{bmatrix} r_{11} & r_{21} & r_{31} & r_{41} \\ r_{12} & r_{22} & r_{32} & r_{42} \\ r_{13} & r_{23} & r_{33} & r_{43} \\ r_{14} & r_{24} & r_{34} & r_{44} \end{bmatrix} \begin{bmatrix} u_1 \\ u_2 \\ u_3 \\ u_4 \end{bmatrix} \right) \\
&= \text{sat} \left( \begin{bmatrix} v_1 \\ v_2 \\ v_3 \\ v_4 \end{bmatrix} \right)
\end{align*}
$$

其中公式 30 给出整数值系数 $r_{jk}$，公式 31 给出整数值系数 $u_j, v_k (j,k=1,2,3,4)$，而公式 29 给出函数 sat(...)。

在运动分析器，通过采用 $R_{set}(x,y)$ 的一阶泰勒展开来执行线性化步骤:

公式 34
\[ x'_p = x_p + \Delta x(x_p, y_p) \]
\[ y'_p = y_p + \Delta y(x_p, y_p) \]

关于 \( x \) 和 \( y \):
公式 35

\[
R_{ref}(x_p + \Delta x_{prd}(x_p, y_p) + \Delta x_{ref}(x_p, y_p), y_p + \Delta y_{prd}(x_p, y_p) + \Delta y_{ref}(x_p, y_p)) \\
= R_{ref}(x'_p, y'_p) + (\Delta x_{ref}(x_p, y_p) + \Delta x_{prd}(x_p, y_p) - \Delta x(x_p, y_p)) \cdot G_x(x'_p, y'_p) \\
+ (\Delta y_{ref}(x_p, y_p) + \Delta y_{prd}(x_p, y_p) - \Delta y(x_p, y_p)) \cdot G_y(x'_p, y'_p)
\]

\( G_x(x'_p, y'_p) \) 和 \( G_y(x'_p, y'_p) \) 是参考帧相对于 \( x \) 和 \( y \) 的导数值。利用这种近似法，公式 14 中的矩阵 \( E_i \) 和矢量 \( w_i \) 的元素为:
公式 36

\[
e_{x^k} = \begin{cases} 
\frac{f_k(x_p, y_p)}{G_x(x'_p, y'_p)}, & k = 1, 2, \ldots, N \\
\frac{f_k(x_p, y_p)}{G_y(x'_p, y'_p)}, & k = N + 1, N + 2, \ldots, N + M
\end{cases}
\]

公式 37

\[
w_p = \ln(x_p, y_p) - R_{ref}(x'_p, y'_p) + G_x(x'_p, y'_p) \Delta x(x_p, y_p) + G_y(x'_p, y'_p) \Delta y(x_p, y_p) - \\
G_x(x_p, y_p) \Delta x_{prd}(x_p, y_p) - G_y(x_p, y_p) \Delta y_{prd}(x_p, y_p)
\]

以上所述针对的是实现本发明的优选示例，本发明的范围不应该限于本文描述。本发明的范围由后附权利要求书来定义。
图1
图 4

表 1

<table>
<thead>
<tr>
<th>从上的候选数</th>
<th>从左的候选数</th>
<th>出现方向比特</th>
<th>出现鉴别比特</th>
<th>胜出候选的方向</th>
<th>选择比特数</th>
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</tbody>
</table>

图 5
Title: APPARATUS AND METHOD FOR COMRESSING A MOTION VECTOR FIELD

Abstract: Apparatus, and an associated method, motion compensates coding of video sequences. Motion compensated prediction is utilized in the representation of motion vector fields. Reduced numbers of bits are required to represent the motion vector field while maintaining a low prediction error, thereby facilitating improved communication of, and recreation of, video frames forming a video sequence.
The present invention relates generally to a manner by which to utilize motion compensation in coding a video sequence. More particularly, the present invention relates to apparatus, and an associated method, for encoding, and decoding, a video sequence utilizing motion compensated prediction. Motion fields of a segment are predicted from adjacent segments of a video frame and by using orthogonal affine motion vector field models. Through operation of an embodiment of the present invention, motion vector fields are formed with a reduced number of bits while still maintaining a low prediction error.

BACKGROUND OF THE INVENTION

Advancements in digital communication techniques have permitted the development of new and improved types of communications. Additional advancements shall permit continued improvements in communications and communication systems which make use of such advancements.

For instance, communication systems have been proposed for the communication of digital video data capable of forming video frames. Video images utilized during video conferencing are exemplary of applications which can advantageously make use of digital video sequences.

A video frame is, however, typically formed of a large number of pixels, each of which is representable by a set of digital bits. And, a large number of video frames are typically required to represent any video sequence. Because of the large number of pixels per frame and the large number of frames required to form a typical video sequence, the amount of data required to represent the video sequence quickly becomes large. For instance, an exemplary video frame includes an array of 640 by 480 pixels,
each pixel having an RGB (red, green, blue) color representation of eight bits per color component, totaling 7,372,800 bits per frame.

Video sequences, like ordinary motion pictures recorded on film, comprise a sequence of still images, the illusion of motion being created by displaying consecutive images at a relatively fast rate, say 15 - 30 frames per second. Because of the relatively fast frame rate, the images in consecutive frames tend to be quite similar. A typical scene comprises some stationary elements, for example the background scenery and some moving parts which may take many different forms, for example the face of a newsreader, moving traffic and so on. Alternatively, the camera recording the scene may itself be moving, in which case all elements of the image have the same kind of motion. In many cases, this means that the overall change between one video frame and the next is rather small. Of course, this depends on the nature of the movement: the faster the movement, the greater the change from one frame to the next.

Problems arise in transmitting video sequences, principally concerning the amount of information that must be sent from the transmitting device to the receiver. Each frame of the sequence comprises an array of pixels, in the form of a rectangular matrix. To obtain a sharp image, a high resolution is required i.e. the frame should comprise a large number of pixels. Today, there are a number of standardized image formats, including the CIF (common intermediate format) which is 352 x 288 pixels and QCIF (quarter common Intermediate format) which is 176 x 144 pixels. QCIF format is typical of that which will be used in the first generation of mobile video telephony equipment and provides an acceptably sharp image on the kind of small (3 - 4cm square) LCD displays that may be used in such devices. Of course, larger display devices generally require images with higher spatial resolution, in order for those images to appear with sufficient spatial detail when displayed.

For every pixel of the image, color information must be provided. Typically, and as noted above, color information is coded in terms of the
primary color components red, green and blue (RGB) or using a related 
luminance/chrominance model, known as the YUV model which, as described 
below, provides some coding benefits. Although there are several ways in 
which color information can be provided, the same problem is common to all 
color representations; namely the amount of information required to correctly 
represent the color range present in natural scenes. In order to create color 
images of an acceptable quality for the human visual system, each color 
component must typically be represented with 8 bit resolution. Thus each 
pixel of an image requires 24 bits of information and so a QCIF resolution 
color image requires $176 \times 144 \times (3 \times 8) = 608256$ bits. Furthermore, if that 
QCIF image forms part of a video sequence with a frame rate of 15 frames per 
second, a total of $9,123,840$ bits/s is required in order to code that sequence.

As such, amounts of data sometimes must be transmitted over relatively 
low bit-rate communication channels, such as wireless communication 
channels operating below 64 kilobits per second.

Video coding schemes are utilized to reduce the amount of data 
required to represent such video sequences. A key of many video coding 
schemes is a manner by which to provide motion compensated prediction. 
Motion compensated prediction, generally, provides a manner by which to 
improve frame compression by removing temporal redundancies between 
frames. Operation is predicated upon the fact that, within a short sequence of 
the same general image, most objects remain in the same location whereas 
others move only short distances. Such motion is described as a two-
dimensional motion vector.

Some coding advantage can be obtained using the YUV color model. 
This exploits a property of the human visual system, which is more sensitive 
to intensity (luminance) variations than it is to color variations. Thus, if an 
image is represented in terms of a luminance component and two chrominance 
components (as in the YUV model), it is possible to spatially sub-sample 
(reduce the resolution of) the chrominance components. This results in a
reduction in the total amount of information needed to code the color information in an image with an acceptable reduction in image quality. The spatial subsampling may be performed in a number of ways, but typically each block of 16 x 16 pixels in the image is coded by 1 block of 16 x 16 pixels representing the luminance information and 1 block of 8 x 8 pixels for both chrominance components. In other words, the chrominance components are sub-sampled by a factor of 2 in the x and y directions. The resulting assembly of one 16 x 16 luminance block and two 8 x 8 chrominance blocks is commonly referred to as a macroblock. Using this kind of coding scheme, the amount of information needed to code a QCIF image can be calculated as follows: The QCIF resolution is 176 x 144. Thus the image comprises 11 x 9 16 x 16 pixel luminance blocks. Each luminance block has two 8 x 8 pixel sub-sampled chrominance blocks associated with it, i.e., there are also 11 x 9 macroblocks within the image. If the luminance and chrominance components are coded with 8 bit resolution, the total number of bits required per macroblock is $1 \times (16 \times 16 \times 8) + 2 \times (8 \times 8 \times 8) = 3072$ bits. Thus the number of bits required to code the entire QCIF image is now $99 \times 3072 = 304128$ bits i.e. half the number required if no chrominance sub-sampling is performed (see above). However, this is still a very large amount of information and if a QCIF image coded in this way is part of a 15 frame per second video sequence, a total of 4,561,920 bits/s are still required.

Video coding requires processing of a large amount of information. This necessarily means that powerful signal processing devices are required to code video images and, if those images are to be transmitted in their original form, a high bandwidth communication channel is required. However, in many situations it is not possible to provide a high capacity transmission channel. This is particularly true in video telephony applications, where the video signals must be transmitted over existing fixed line communication channels (i.e. over the conventional public telephone network) or using radio communication links, such as those provided by mobile telephone networks.
A number of international telecommunications standards already exist, laying down the guidelines for video coding in these kinds of systems. The H.261 and H.263 of the International Telecommunications Union (ITU) standards are exemplary. Standard H.261 presents recommendations for video coding in transmission systems operating at a multiple of 64 kilobits/s (these are typically fixed line telephone networks), while H.263 provides similar recommendations for systems in which the available bandwidth is less than 64 kilobits per second. The two standards are actually very closely related and both make use of a technique known as motion predictive coding in order to reduce the amount of information that must be transferred.

In mobile videotelephony the aim is to transmit a video sequence over a transmission channel with an available bandwidth of approximately 20 k bits per second. The typical frame rate should be sufficient to provide a good illusion of motion and thus should be between 10 and 15 frames per second.

Thus it will be appreciated that a very large compression ratio (approximately 225:1) is required in order to match a video sequence requiring some 4.5 Megabits per second to a channel capable of transferring only 20 kilobits per second. This is where motion predictive coding, as well as other techniques, comes into play.

The basic idea behind motion predictive coding is to take into account the very large amount of temporal redundancy that exists in video sequences. As explained above, in a typical video sequence recorded at comparatively rapid frame rate (i.e. greater than 10 frames per second), there are only small changes from one frame to the next. Usually the background is stationary and only some parts of the image undergo some form of movement. Alternatively, if the camera itself is moving, all elements undergo some consistent movement.

Thus it is possible to take advantage of this high degree of correlation between consecutive frames when trying to reduce the amount of information when transmitting a video sequence. In other words, one frame can be
predicted from a previous, so-called reference frame, which is usually, but not necessarily, the frame immediately preceding that currently being coded. In such a coding scheme, it is typically only the differences between the current frame and the reference frame, which are coded and transmitted to the receiver. In general, this kind of coding is referred to as INTER coding. It is a necessary requirement of such a coding scheme that both the transmitter and receiver keep a record of the reference frame (e.g. previous coded frame). At the transmitter the video encoder compares the current frame with the reference, identifies the differences between the two frames, codes them and transfers information about the changes to the receiver. In the receiver the current frame is then reconstructed in a video decoder by adding the difference information to the reference (e.g. previous) frame. The frame stores in the encoder and decoder are then updated so that the current frame becomes the new reference and the process continues in an identical fashion from one frame to the next.

There are of course, some situations in which this kind of prediction cannot be used. It is obvious that the first frame of a video sequence must always be coded and transmitted as such to the decoder in the receiver. Clearly there is no previous frame that can be used as a reference for predictive coding. A similar situation occurs in the case of a scene cut. Here the current frame may be so different from the previous one that no prediction is possible and again the new frame must be coded and transmitted as such. This kind of coding is generally referred to as INTRA coding. Many coding schemes also use periodic INTRA frame coding. For example one INTRA frame may be sent every ten or twenty frames. This is done to counteract the effect of coding errors that gradually accumulate and eventually cause unacceptable distortion in the reconstructed image.

Motion predictive coding can be viewed as an extension of the INTER coding technique introduced above. The account given above describes how difference information is sent to the receiver to enable decoding of a current
video frame with reference to some previous frame. The simplest and most obvious way to provide the difference information would be to send the pixel values (YUV data) of each pixel in the current image that differs from the corresponding pixel in the reference image. However, in practice this solution does not provide the reduction in data rate necessary to enable video transmission over very low bit rate channels. Motion predictive coding adopts a different approach. As previously described, both encoder and decoder maintain a record of a reference frame and the current frame is coded with reference to that stored frame. At the decoder, the current image is reconstructed with reference to the stored previous frame and the difference information transmitted from the encoder.

In the encoder, the current frame is examined on a segment-by-segment basis in order to determine the correspondence between itself and the reference frame. A number of segmentation schemes may be adopted. Frequently, the current image is simply divided into regular blocks of pixels e.g. the comparison may be done macroblock by macroblock. Alternatively, the frame may be divided on some other basis; perhaps in an attempt to better identity the different elements of the image contained therein and thus enable a more accurate determination of the motion contained within the frame.

Using the predefined segmentation scheme, a comparison is made between each segment of the current frame and the reference frame in order to determine the "best match" between the pixels in that segment and some group of pixels in the reference frame. Note that there is no fixed segmentation applied to the reference frame; the pixels that correspond best to a given segment of the current frame may, within certain limitations explained below, have any location within the reference. In this way motion predictive coding can be viewed as an attempt to identity the origin of a group of pixels in the current image i.e. it tries to establish how pixels values propagate from one frame to the next by looking back into the reference frame.
Once a best match has been found for a given segment within the current frame, the correspondence between the segment and the reference frame is coded using "motion vectors". A motion vector can be considered as a displacement vector with x and y (horizontal and vertical) components, which actually points back from the segment of the current frame to pixel locations in the reference frame. Thus motion vectors actually identify the origin of pixels in the current frame by comparison with the reference frame. Coding continues until the origin of each segment in the current frame has been identified. The resulting representation can be thought of as a "motion vector field" describing the overall correspondence between the two frames.

Coding of a complete video frame, segment-by-segment, using motion vectors produces a very efficient representation of the current frame, as comparatively very few bits are required to code information about the motion vectors for each segment. However, the coding process is not perfect and there are errors and loss of information. Typically, errors arise because it is not possible to identify exactly corresponding pixel values in the reference frame. For example, there may be some change in image content from one frame to the next, so new elements appear in the current frame which have no counterparts in the reference frame. Furthermore, many predictive motion encoders restrict the type of motion allowed between frames. This restriction arises as follows: In order to further reduce the amount of information required to represent the motion vector field, motion predictive encoders typically use a "motion model" to describe the way in which pixel values may be propagated from one frame to the next. Using a motion model, the motion vector field is described in terms of a set of "basis functions." The propagation of pixel values from one frame to the next is represented in terms of these mathematical basis functions. Typically, the motion is represented as a sum involving the basis functions multiplied by certain coefficient values, the coefficients being determined in such a way as to provide the best approximation of the motion vector field. This re-expression of the motion
vector field necessarily introduces some additional error, as the motion model is unable to describe the motion vector field exactly. However, this approach has a significant advantage because now only the motion model coefficients must be transmitted to the decoder. This advantage arises because the motion field basis functions are chosen in advance, according to the implementation and the level of accuracy deemed necessary, and as such they are known to both the encoder and decoder. Many currently proposed video coding schemes that make use of motion predictive coding, and in particular the H.263 standard, are based on a translational motion field model i.e. one whose basis functions can only represent straight line movement in the x and y (horizontal and vertical) directions. Thus rotations and skewing of picture elements that may occur between consecutive frames cannot be represented and this inevitably introduces errors into the predicted motion.

Finally, and in order to compensate for the errors introduced by the motion field coding process, typical motion predictive encoders include an error estimation function. Information about the prediction error is transmitted to the decoder, together with the motion field model coefficients. In order to estimate the error introduced in the motion field coding process, a motion predictive encoder typically also includes a decoding section, identical to that found in the receiver. Once the current frame has been encoded using the motion predictive methods described above, the decoding section of the encoder reconstructs the current frame and compares it with the original version of the current frame. It is then possible to construct an "prediction error frame," containing the difference between the coded current frame and the original current frame. This information, together with the motion field model coefficients and perhaps some information about the segmentation of the current frame, is transmitted to the decoder.

Even with the use of such an exemplary, significant amounts of data are still required to represent a video sequence.
An improved manner by which to code video sequences utilizing reduced amount of bits or reduced bit rates, while maintaining low prediction error would therefore be advantageous.

It is in light of this background information related to video data that the significant improvements of the present invention have evolved.

**SUMMARY OF THE INVENTION**

The present invention, accordingly, advantageously provides apparatus, and an associated method, for operating upon a video sequence utilizing motion compensated prediction.

A manner is provided by which to represent a motion vector field by dividing a video frame into segments and predicting a motion field of a segment from its adjacent segments and by using orthogonal affine motion vector field models. Operation of an embodiment of the present invention provides a manner by which to quickly, and compactly, encode motion vector fields while also retaining a low prediction error. Communication of improved-quality video frames together forming a video sequence is thereby provided.

Through operation of an embodiment of the present invention, a manner is provided by which to reduce the amount of information needed to represent the motion vector field while preserving, at the same time, a low amount of prediction error.

A motion field coder for an encoder is provided by which to form the motion vector field. Use is made of affine motion vector field modeling. In contrast, for instance, to a purely translational motion model, a more flexible representation of the motion field can be obtained using the affine modeling. Typical natural motion, such as zooming, rotation, sheer, or translation is able to be represented by affine motion vector field models. Conventional systems which utilize only a translational model are unable to represent other forms of motion.
The similarity of affine motion vector fields of neighboring segments of a video frame is exploited by utilizing affine prediction motion vector fields. If, for instance, two neighboring segments have similar motion vector fields, one of the motion vector fields can be computed from the other merely with the addition of a small, or even negligible, i.e., zero, refinement field. For each segment of a video frame, an affine motion model is selected which achieves satisfactorily low prediction error with as few non-zero coefficients as possible. Furthermore, orthogonal basis functions are utilized. The orthogonal basis functions have low sensitivity to quantization of corresponding motion coefficients so that the coefficients are able to be represented with a small number of bits. That is to say, efficient transmission of the motion coefficients requires the coefficients to be quantized to low precision levels. However, types of basis functions conventionally utilized results in unacceptable increases in prediction error when represented by a small number of bits. As the coefficients corresponding to orthogonal basis functions are much more robust to quantization, advantageous utilization of the orthogonal basis function is made during operation of an embodiment of the present invention.

In one aspect of the present invention, a motion field coder is provided for a video encoder. The motion field coder is operable to form a compressed motion vector field which is formed of a set of motion vectors of all pixels of a current frame. The motion vector field is formed of a prediction motion vector field and a refinement motion vector field.

In another aspect of the present invention, a motion compensated predictor is provided for a video encoder. The motion compensated predictor receives indications of the compressed motion vector field formed by the motion field coder. The motion compensated predictor constructs a prediction frame. The predictor is operable to reconstruct the pixels of a frame by calculating the motion vector fields of each segment thereof. The motion
vector field is computed based on a prediction motion vector field and refinement motion vector field.

In yet another aspect of the present invention, a motion compensated predictor is provided for a video decoder. The motion compensated predictor receives indications of a predicted motion vector field and refinement motion vector field coefficients.

In these and other aspects, therefore, apparatus for a video device for operation upon a video sequence is provided. The video sequence is formed at least of a current video frame having at least a first neighboring segment and a second neighboring segment. The apparatus forms approximations of a motion vector field of the second neighboring segment. The apparatus includes a motion vector field builder coupled to receive indications representative of a first affine motion model forming an approximation of a first motion vector field representative of the first neighboring segment. The motion vector field builder forms a second affine motion model responsive to the indications representative of the first affine motion model. The second affine motion model forms the approximation of the motion vector field of the second neighboring segment.

A more complete appreciation of the present invention and the scope thereof can be obtained from the accompanying drawings which are briefly summarized below, the following detailed description of the presently-preferred embodiments of the invention, and the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates an encoder and decoder of a video communication system in which an embodiment of the present invention is operable.

Figure 2 illustrates a functional block diagram of a motion field coder which forms a portion of the communication system shown in Figure 1.
Figure 3 illustrates a functional block diagram of a motion compensated predictor which forms a portion of the encoder and also of the decoder of the communication system shown in Figure 1.

Figure 4 illustrates a manner by which a video frame is divided into segments during operation of an embodiment of the present invention.

Figure 5 illustrates a table indicating exemplary values and meaning of selection bits utilized during operation of an embodiment of the present invention.

DETAILED DESCRIPTION

The new manner of motion predictive video coding of an embodiment of the present invention report further reduces the amount of data to be transferred from encoder to decoder in a low bit-rate video coding system, while maintaining good image quality. The manner includes a new way of further predicting the pixel values of segments in the current frame using already coded segments of that same frame.

In one exemplary implementation, when a new video sequence is to be coded and transmitted, the first frame in the sequence is transmitted in INTRA format, as known from prior art and described above. That frame is then stored in the encoder and in the decoder and forms a reference frame for the next (i.e. second) frame in the sequence.

When the encoder begins encoding the second frame, it starts the coding process by examining the first segment of the frame. In the preferred embodiment, the current frame is divided into a set of 16 x 16 pixel segments, but this is not essential to the method and other segmentation schemes may be envisaged. Encoding is started from the upper leftmost segment and proceeds from left-to-right and top-to-bottom throughout the frame (i.e. the coding process is performed in rows, progressing from top to bottom).

A motion vector field that describes the mapping of pixel values between the reference frame and the first segment of the current frame is
determined and then a so-called "affine" motion model is used to approximate that motion vector and to generate a set of motion coefficients. The affine motion model is a special class of motion model whose mathematical form is such as to allow translational, rotational and skewing movements between frames. It comprises 6 basis functions. Thus the motion vectors are essentially replaced by a sum involving the six basis functions multiplied by appropriately chosen "motion coefficients." It is then sufficient to transmit only the motion coefficients (or a subset thereof) to the decoder, as the basis functions themselves are known to (i.e. stored in) both encoder and decoder.

The group of pixels in the reference frame that yields the best affine motion model for any given segment of the current frame may reside, at least in theory, in any region of the reference frame. It should be emphasized here that an aim of this method is not merely to minimize the prediction error, but to find the affine motion field model that yields the best match for a segment in a "rate-distortion" sense. This means that the best match is determined by taking into account both a measure of image distortion and a measure of the amount of data required to achieve that level of distortion.

Since the first (upper leftmost) segment of the frame has no previously coded neighbors, no further action can be taken and the encoder proceeds to the second segment of the current frame. Then the affine motion field model providing the best mapping between the reference frame and the second segment of the current frame is determined, using the same kind of rate-distortion, best-match evaluation as previously described. As before, the corresponding region of pixel values may reside anywhere in the reference frame and may indeed overlap with that previously determined as the best match for the first segment of the current frame.

The second segment has one previously coded neighboring segment (i.e. the first segment). The encoder now considers whether it is "more efficient" to model the second segment in terms of the affine motion model previously determined for the first segment, rather than according to the newly
determined affine motion coefficients for the second segment itself. The rationale is as follows: Since the motion coefficients for the first segment have already been determined and transmitted to the decoder, it may be possible to reduce the amount of information that must be transmitted to the decoder while encoding the second segment. Hence an improvement in coding efficiency may be obtained.

However, it is unlikely that the motion coefficients for the first segment are exactly identical to those that most accurately model the motion vector field of the second segment. Therefore, the motion coefficients calculated for the first segment are not simply used as such, but a projection is performed in order to map the motion field of the first segment into the second segment. Even after this projection has been performed, it is still likely that some information about the difference between the motion fields of the first and second segments must also be sent to the decoder, in order to avoid unacceptable distortion in the reconstructed image. Thus, the encoder performs a comparison between the amount of data of required a) to transmit motion coefficient data determined specifically for the second segment and b) that required if the second segment's motion vector field is determined from a projection of the motion model of the first segment plus some "refinement" information. When making its choice of what information to transmit, the encoder must also take into account distortions that may introduced into the image by the prediction process. This comparison between options can be thought of as determining the "cost" of choosing a particular option, a trade-off between the amount of information to be transmitted and the amount of distortion allowed.

The benefit of this approach to motion predictive coding may not be immediately apparent. However, in many cases, it is found that after projection of the motion field model from a neighboring segment, very little or even zero refinement information is required. This can result in a significant reduction in the amount of data that must be transmitted from
encoder to decoder. In the case where zero refinement information is required, the motion vector field of the second segment can be predicted purely on the basis of motion coefficients already stored in the decoder.

So far in this example, only the first and second segments of the frame have been considered. As explained above, according to the segmentation scheme used in the preferred embodiment of the invention, the second segment has only one neighbor that can be used to predict its motion coefficients. The same is true for all other segments on the first row of the frame. All such segments can only have previously coded neighbors immediately to their left. However, on the second and subsequent rows of the image, previously coded segments are also available above each segment. Thus, segments in subsequent rows have neighbors to the left and above. This is true for all segments except the first in each row, which only has a previously coded neighbor directly above it. Thus, when considering a general segment in a frame to be coded, there are several possibilities for the prediction of motion coefficients. In a general case, the encoder can try to predict the motion coefficients for a given segment using the motion field model for the segment above it or to the left. Alternatively, it can form some kind of average, using the motion field model for both neighbors. In each case, the motion field model predicted from the neighboring segment(s) is referred to as the "prediction field" and the difference between the prediction field and the motion field model determined specifically for the segment itself is termed the "refinement field." In the preferred embodiment, both the prediction and refinement fields are affine motion field models. The sum of the prediction field and the refinement field should thus be equivalent to the motion field model determined by applying the affine motion model to the segment itself. In a situation where it is not possible to predict the motion field model for a given segment from any of its neighbors, the prediction field is set to zero and the refinement field becomes equal to the motion field model determined specifically for the segment itself.
As will be appreciated from the description above, there are several different ways in which a given segment can be coded. The choice of which option to use is made in the encoder on the basis of the “rate-distortion” considerations previously described. Consequently, several different types of data must be transmitted to the decoder, depending on the chosen coding option, and that information must be transmitted to the decoder in an unambiguous way, so that the segment can be correctly reconstructed and displayed. The various coding options are as follows. 1.) A given segment can be represented as a sum of a prediction field and a refinement field. 2.) The segment may be represented as a prediction field only. This situation may arise when the segment can be adequately represented in terms of the motion field of one or more of its previously coded neighbors and no refinement information is necessary, or in a case where the encoder has found it efficient to reduce the refinement field to zero. 3.) The segment in question may be coded using a motion model determined specifically for the segment using the reference frame. In this case, as described above, the prediction field is set to zero and the refinement field is set equal to the motion field model determined from the reference frame.

Basically, there are two types of information that must be transmitted to the decoder in order to enable correct reconstruction of a given segment. These are: 1.) selection information, enabling the decoder to select the correct neighboring segment(s) to use in prediction; 2.) motion coefficient information. Whenever a segment is coded using a prediction field, whether there is an associated refinement field or not, it is necessary to provide information about the neighboring segment(s) used in the prediction. It is not necessary to transmit any motion coefficient data because the motion field model(s) of the previously coded neighboring segment(s) are already known to (i.e., stored in) the decoder. Extra information may also be required if, for example, prediction is based on more than one neighboring segment, or neighboring segments have been divided into sub-segments and the motion
field model of one or more of the sub-segments is used to form the prediction field. When a refinement field is used, motion coefficient values must be provided. In this case, it should be remembered that it is only necessary to transmit motion coefficient data because the motion model basis functions are known to the decoder as well as the encoder.

The data stream transmitted from encoder to decoder is therefore likely to contain both motion coefficient data and a variety of selection data (i.e., non-motion coefficient data) instructing the decoder to perform different operations. For example, if the decoder receives non-motion coefficient data, it should construct a prediction motion field model using the neighboring segment(s) or sub-segment(s) indicated by the selection data. If it receives motion coefficient data, the decoder must construct a refinement motion field model using the transmitted motion coefficient values and the stored motion model basis functions. The format of the data stream provided by the encoder in the preferred embodiment of the invention is described in detail later in the text.

Some further refinements of the method are possible. In the preferred embodiment of the invention, neighboring segments can be divided into smaller sub-segments. Specifically, each 16 x 16 pixel segment may be divided into four 8x8 pixel blocks and the motion field models for those sub-segments can be used to derive prediction fields. In this case, a general 16x16 pixel segment has four immediately neighboring 8x8 pixel sub-segments that may be considered, two directly above and two immediately to the left. In this situation, the decision process is a little more complicated, but works in an essentially identical fashion to that described in the preceding paragraphs. The choice of sub-segment size is not limited to the example just-presented and a variety of other sub-segment sizes can be envisaged. For example, 4x8 or 8x4 pixel blocks could be used as sub-segments.

As stated above, when the method according to the invention is applied in practice, it is often found that very little refinement information is required
and the motion model of a general segment can be predicted with quite high precision from the motion field models of its neighbors. The invention includes a further feature, whereby individual coefficients of the refinement field or the entire refinement field may be set to zero, if that is efficient in a "rate-distortion sense." In other words, the refinement field may be set to zero if the image distortion introduced in doing that is acceptable when considering the reduction in the amount of data to be transmitted. This additional feature further reduces the amount of data that must be transmitted from encoder to decoder.

Referring first to Figure 1, a communication system, shown generally at 10, is operable to communicate a video sequence between a video sequence generator and a video sequence receiver. In the illustration of the Figure, the encoder 12 of the video sequence generator is shown, and a decoder 14 which forms a portion of the video sequence receiver is also shown. Other elements of the video sequence generator and receiver, respectively, for purposes of simplicity, are not shown. A communication path 16 is shown to interconnect the portions of the communication system. The communication path can take any of various forms, including, e.g., a radio-link.

The encoder 12 is shown to be coupled to receive a video input on the line 18. The video input is provided to a motion estimator 22 and to an input of a subtractor 24. The motion estimator is also coupled to receive indications of a reference frame stored at a frame memory 26. The motion estimator calculates motion vectors of pixels between a frame being coded, i.e., the current video input $I_m(x, y)$, and a prior, i.e., reference frame, $R_{ref}(x, y)$.

Once the encoder has coded each segment, the information necessary for its reconstruction can be transmitted to the decoder and the decoder can start reconstructing the segment. Because each frame is coded on a segment-by-segment basis and only previously coded segments are used in the prediction process, reconstruction of the frame at the decoder can start at once
i.e. there is no need to wait until the entire frame has been encoded. Information about each segment is transmitted to the decoder as soon as it becomes available and decoding of the frame occurs at the receiver essentially in parallel with the encoding process. In videotelephony applications this has the advantage that end-to-end delay is kept to a minimum. Of course, the method can also be applied in video storage and retrieval systems where immediate transmission is not a necessary requirement. In that case, there is no requirement for data to be transmitted immediately and it might also be possible to use other neighboring segments in the current frame for prediction purposes.

The motion estimator 22 is coupled to a motion field coder 28. The motion field coder 28 is operable to form a motion vector field which is a set of motion vectors of all pixels of the current frame. The field generated by the motion field coder is provided by way of the line 32 to a multiplexor 34 thereafter to be communicated upon the communication path 16 to the video sequence receiver and the decoder 14 thereof.

The encoder is further shown to include a motion compensated (MC) predictor 36. The predictor 36 is also coupled to the frame memory 26. The predictor 36 is operable to generate a prediction frame which is supplied to the subtractor 24 and also to a summer 38.

Difference values formed by the subtractor 24 are provided to a prediction error coder 42. The prediction error coder determines the differences in pixel value between the current input video frame and the MC predicted version of the frame in order to produce an indication of the prediction error. And, in turn, the prediction error coder 42 is coupled to the multiplexor 34 and to a prediction error decoder 46. The prediction error decoding block decodes the prediction error which is added to the MC predicted current frame by the adder 38 and the result is stored in the frame memory 26.
The decoder 14 is here shown to include a demultiplexor 52, a prediction error decoder 54, a motion compensated predictor 36, a summer 56, and a frame memory 26. The predictor 36 of the encoder and of the decoder are commonly numbered as are the frame memories 26 of the respective devices.

The motion estimator 22 calculates motion vectors \((\Delta x(x, y), \Delta y(x, y))\) of pixels between the frame being coded, referred to as the current frame \(I_n(x, y)\), and the reference frame \(R_{ref}(x, y)\). The reference frame is one of the previously coded and transmitted frames which at a given instant is available in the frame memory 26 of the encoder and also of the decoder.

\(\Delta x(x, y)\) and \(\Delta y(x, y)\) are the values of the horizontal and vertical displacements, respectively. The set of motion vectors of all pixels in the current frame, referred to as a motion vector field, is compressed by the motion field coder 28 and thereafter, as noted above, sent to the decoder.

To indicate that the compression of the motion vector field is typically lossy, the compressed motion vectors are denoted as \((\tilde{\Delta}x(x, y), \tilde{\Delta}y(x, y))\). In the motion compensated predictor 36, the compressed motion vectors and the reference frame are used to construct a prediction frame, \(P_n(x, y)\). The prediction frame is a coded version of the current frame \(I_n(x, y)\) calculated using the motion vector field determined by the motion estimator 22 and the motion field coder 28 and the pixel values of the reference frame \(R_{ref}(x, y)\).

The following equation shows the manner in which the prediction frame is calculated:

\[
P_n(x, y) = R_{ref}\left(x + \tilde{\Delta}x(x, y), y + \tilde{\Delta}(x, y)\right)
\]

The prediction error, i.e., the difference between the current frame and the prediction frame, is as follows:
EQUATION 2

\[ E_s(x,y) = I_s(x,y) - P_n(x,y) \]

The prediction error is compressed and sent to the decoder 14. The compressed prediction error is denoted as \( \overline{E}_s(x,y) \).

At the decoder 14, pixels of the current coded frame \( \overline{I}_n(x,y) \), are reconstructed by finding the prediction pixels in the reference frame \( R_{ref}(x, y) \) using the received motion vectors and by adding the received prediction error \( \overline{E}_s(x,y) \) as follows:

EQUATION 3

\[ \overline{I}_n(x,y) = R_{ref}(x + \tilde{\Delta}x(x,y), y + \tilde{\Delta}(x,y)) + \overline{E}_s(x,y) \]

The difference between the coded frame and the original frame is designated as follows:
EQUATION 4

\[ D_n(x, y) = I_n(x, y) - \tilde{I}_n(x, y) \]

5 and is referred to as the reconstruction error.

The motion compensated prediction frame \( P_n(x, y) \), formed by the MC predictor 36 is constructed in such a way as to minimize the amount of reconstruction error, and at the same time, minimize the amount of information needed to represent the motion vector field.

A frame of a typical video sequence contains a number of segments with different motion. Therefore, motion compensated prediction is performed by dividing the frame \( I_n(x, y) \) into several segments and estimating the motion of such segments between such frame and a reference frame. Segmentation information is an inherent part of motion representation. Unless a default frame segmentation is used, and known both to the encoder and to the decoder, additional information describing the final partition of the frame must be transmitted to the decoder. In practice, a segment typically includes at least a few tens of pixels. In order to represent the motion vectors of such pixels compactly, it is desirable that their values be described by a function of a few parameters. Such a function is referred to as a motion vector field model. For the purposes of the following description, the motion vectors of an image segment shall be approximated using the following general, additive expression:

EQUATION 5

\[ \Delta x(x, y) = \Delta x_{pr} (x, y) + \Delta x_{r} (x, y) \quad \Delta y(x, y) = \Delta y_{pr} (x, y) + \Delta y_{r} (x, y) \]

The second terms of the above equation are referred to as refinement motion vector fields and are expressed as linear combinations as follows:
EQUATION 6

\[ \Delta x_{\text{refine}}(x, y) = \sum_{n=N_1}^{N} c_n f_n(x, y) \quad \Delta y_{\text{refine}}(x, y) = \sum_{n=N_1}^{N+M} c_n f_n(x, y) \]

The parameters \( c_n \) are referred to as refinement motion coefficients. The coefficients are compressed at the encoder transmitted upon the communication path 16, and then recovered at the decoder 14.

The functions \( f_n \) are referred to as basis functions and are known to both the encoder 12 and to the decoder 14. The set of vectors

\[ (\Delta x_{\text{pred}}(x, y), \Delta y_{\text{pred}}(x, y)) \]

is referred to as a prediction motion vector field and is also known to both the encoder and to the decoder.

The prediction error frame, \( E_{\text{pred}}(x, y) \) see equation 2, resulting after motion compensated prediction is typically encoded by using a two-dimensional transform such as a discrete cosine transform (DCT). This process is referred to as prediction error coding and aims to reduce the prediction error. Since the prediction error coding is usually lossy, this results in a reconstruction error.

A primary task of the encoder 12 is to find a suitable set of motion coefficients which are to be encoded and transmitted to the decoder. Usually, by increasing the number of bits allocated to the coding of coefficients, the resultant, incurred distortion is reduced. However, the decrease in distortion is not always worth the increased number of bits. Typically, a way to deal with such a tradeoff is to minimize the following Lagrangian criterion as follows:

EQUATION 7

\[ L = D + \lambda \cdot B \]
In this equation, the term $D$ represents the incurred distortion, i.e., error, when encoding by a given set of coefficients. The cost of sending the coefficients is represented by the number of bits $B$. The factor $\lambda$ is a constant referred to as the Lagrangian parameter.

In operation of an embodiment of the present invention, the motion vector field of a given segment of a video frame is a sum of two affine motion vector fields, namely, the prediction motion vector field and the refinement motion vector field as follows:

\begin{align*}
\Delta x(x,y) &= \Delta x_{\text{pred}}(x,y) + \Delta x_{\text{refine}}(x,y) \\
\Delta y(x,y) &= \Delta y_{\text{pred}}(x,y) + \Delta y_{\text{refine}}(x,y)
\end{align*}

The prediction motion vector field is obtained from the motion vector field of one or more neighboring segments in one of several ways. For instance, in one implementation, the prediction motion vector field is obtained by extrapolating the affine motion vector field of a neighboring, e.g., adjacent, segment inside the area covered by the current segment. As the current segment can have several neighboring segments, usually signaling information is provided to the decoder in order to specify which segment shall be used. In another implementation, the prediction motion vector field is obtained from a combination of affine motion vector fields of several neighboring segments using some particular method which is known both to the encoder and to the decoder. Such method is, for example, averaging or determining the median, of horizontal and vertical motion vector field components.

The refinement motion vector field has an affine model expressed as follows:

\begin{align*}
\Delta x_{\text{refine}}(x,y) &= \sum_{n=1}^{3} c_n f_n(x,y) \\
\Delta y_{\text{refine}}(x,y) &= \sum_{n=1}^{3} c_{n+3} f_n(x,y)
\end{align*}
in which the basis functions $f_1, \ldots, f_3$ are affine orthogonal functions. The basis functions are orthogonal with respect to a rectangle circumscribing the given segment. And, the coefficients $c_1, \ldots, c_6$, are refinement motion vector field coefficients corresponding to the orthogonal set of basis functions.

The refinement motion coefficients are determined for every segment in the frame by the motion field coder during encoding by the encoder 12, and, in particular, by the motion field coder 28.

Figure 2 illustrates the motion field coder 28 in greater detail. The coder 28 is here shown to include a selector and builder of prediction motion fields 62, a motion analyzer 64, a motion coefficient remover 66, and a quantizer 68.

The selector and builder 62 is operable, for a given segment, to determine a previously-encoded segment of the current frame, or a combination of such segments, whose motion vector field, or fields, is best suitable for predicting the motion field of a given, e.g., current segment. Based on the motion vector field of the "winning" candidate, or candidates, the prediction motion field is computed as described above. Usually, signaling information is transmitted to the decoder to specify the most suitable amongst the several candidate segments.

The motion analyzer 64 is operable to find a new representation of a refinement motion vector field. That is to say, a mathematically efficient representation is made. The new representation is later used at the motion coefficient remover 66 for a quick and flexible determination of refinement motion coefficients.

The motion coefficient remover 66 is operable to determine which of the refinement coefficients should be set to zero and to calculate the value of remaining non-zero coefficients so as to minimize the Lagrangian criterion as follows:
EQUATION 10

\[ L(c) = D(c) + \lambda \cdot B(c) \]

in which \( D(c) \) and \( B(c) \) are measures of prediction error and bits corresponding to encoding the given segment by using the refinement motion coefficients \( c \). The constant \( \lambda \) is a Lagrangian parameter. When setting some of the refinement motion vector field coefficients to zero, the prediction error is increased. However, when more coefficients are set to zero, the number of bits required to be transmitted by the encoder to the decoder is reduced.

Therefore, the value of the Lagrangian can decrease when some of the refinement motion coefficients are set to zero.

The quantizer 68 is operable to quantize the remaining non-zero refinement motion vector coefficients in order to make such coefficients suitable for entropy coding and transmission from the encoder to the decoder.

Figure 3 illustrates the motion compensated (MC) predictor 36 forming portions of both the encoder and decoder 12 and 14 respectively, as shown in Figure 1. The functional elements of the MC predictor 36 are similar for both the encoder and the decoder and the MC predictor is operable, at both the encoder and decoder to reconstruct the pixels of a current frame by calculating the motion vector fields of each segment within the frame. The motion vector field is computed based upon a prediction motion vector field

\[ (\Delta x_{\text{pred}}(x,y), \Delta y_{\text{pred}}(x,y)) \]

and the refinement motion vector field coefficients. In the exemplary implementation, the refinement motion vector fields are represented by their inverse quantized values. At the decoder 14 the prediction motion vector field is derived from one or several neighboring segments which have already been decoded. The refinement motion vector field coefficients are available at the decoder after the decoding and inverse quantization performed by the inverse quantizer 76. As illustrated, the MC predictor further includes a motion vector field builder, a segment predictor 80 and a prediction motion vector field builder 81.
As Figure 2 illustrates, inputs to the motion analyzer 64 of the motion field coder 62 include the estimation motion vector field \((\Delta x(x, y), \Delta y(x, y))\). The motion vector field is provided by the Motion Estimator 22 (shown in Figure 1). The motion vector field is calculated in the motion estimator 22 in a conventional fashion. The prediction motion vector field is also provided to the motion analyzer. And, the geometry, that is, the size and shape, of the segment, \(S\), which is to be coded and the reference and current frames \((R_{ref}(x, y))\) and \(I_n(x, y)\), respectively) are also provided as inputs to the motion analyzer.

The motion analyzer is operable to perform several operations. First, the motion analyzer performs error linearization. The prediction error \(D_i\) of a given segment \(S_i\), which consists of \(P\) pixel coordinates \((x_p, y_p)\), \(p = 1, 2, \ldots, P\) and whose prediction motion field is denoted by \((\Delta x_{prd}(x_p, y_p), \Delta y_{prd}(x_p, y_p))\) and whose refinement motion vector field is approximated by an affine motion model as given by equation 9 is:

\[
D_i = \sum_{p=1}^{P} \left[ I_n(x_p, y_p) - R_{ref}(x_p + \Delta x_{prd}(x_p, y_p), y_p + \Delta y_{prd}(x_p, y_p), y_p + \Delta y_{refl}(x_p, y_p)) \right]
\]

During linearization, the value of \(R_{ref}(x, y)\) of equation 11 is approximated using some known approximation method so that it becomes linearly dependent on \((\Delta x_{refl}(x_p, y_p), \Delta y_{refl}(x_p, y_p))\). Then, the square prediction error \(D_i\) can be approximated as follows:

\[
D_i = \sum_{p=1}^{P} (e_{p,1}c_1 + e_{p,2}c_2 + \ldots + e_{p,k}c_k - w_p)^2
\]
The values of $e$ and $w$ are dependent upon the type of approximation method utilized.

Thereafter, matrices are constructed by the motion analyzer. As the elements under the square in equation (12) are linear combinations of coefficients $c_n$, minimization of the equation is fully equivalent to minimization of the following matrix expression:

**EQUATION 13**

$$(E_i c_i - w_i)(E_i c_i - w_i)$$

Where $E_i$, $w_i$, and $c_i$ are as follows:

**EQUATION 14**

$$E_i = \begin{bmatrix} e_{1,1} & e_{1,2} & \cdots & e_{1,N+M} \\ e_{2,1} & e_{2,2} & \cdots & e_{2,N+M} \\ \vdots & \vdots & \ddots & \vdots \\ e_{p,1} & e_{p,2} & \cdots & e_{p,N+M} \end{bmatrix}, w_i = \begin{bmatrix} w_1 \\ w_2 \\ \vdots \\ w_p \end{bmatrix}, c_i = \begin{bmatrix} c_1 \\ c_2 \\ \vdots \\ c_{N+M} \end{bmatrix}$$

Based on $E_i$ and $w_i$, a matrix $A_i$ and a vector $d_i$ are calculated as follows:

**EQUATION 15**

$$A_i = E_i^T E_i$$

**EQUATION 16**

$$d_i = E_i^T w_i$$

The motion analyzer generates an output which includes an $(N+M) \times (N+M)$ upper triangular matrix $R_i$ which has the following form:
where the symbol x denotes a nonzero element which is obtained by calculating a Cholesky factorization of matrix $A_i$ as follows:

\[
R_i = \begin{bmatrix}
  x & x & x & \ldots & x \\
  0 & x & x & \ldots & x \\
  0 & 0 & x & \ldots & x \\
  \vdots & \vdots & \vdots & \ddots & \vdots \\
  0 & 0 & 0 & \ldots & x 
\end{bmatrix}
\]

The motion analyzer also generates a vector $z_i$ which is obtained by solving the following set of equations:

\[
A_i R_i = R_i R_i.
\]

EQUATION 17

The matrix $R_i$ and the vector $z_i$ are the output parameters of the motion analyzer and together such output parameters constitute a representation of a refinement motion vector field suitable for manipulation at the motion coefficient remover 66.

The output of the motion analyzer 64 forms the input to the motion coefficient remover 66. The operations performed by the remover 66 when setting some of the refinement motion field coefficients to zero include, for instance, removing those elements that correspond to coefficients that can be removed from $R_i$ with $z_i$. The result is a modified matrix $R$ and vector $z$.

Various manners can be utilized to specify, or imply by default, the segment or the set of neighboring segments from which the prediction motion field is derived. Also, different manners can be utilized to generate the
prediction motion field \( \Delta x_{prd}(x, y) \), \( \Delta y_{prd}(x, y) \), to linearize equation (11) above, and to solve the set of equations (18).

Figure 4 illustrates a single video frame 84, here shown to be divided into a plurality, here thirty, segments 86. Each of the segments 86 is here formed of a sixteen pixel by sixteen pixel block. And, each of the segments can further be divided to form smaller segments. Here some of the segments 86 are divided to form eight pixel by eight pixel blocks 88. The segments 86 are commonly referred to as macroblocks. The coding of a frame is performed by scanning from left-to-right and top-to-bottom, macroblock by macroblock.

As described previously, the motion vector field of a given segment obeys the additive motion model given in equation (8). The way in which the prediction, the refinement, and the final motion prediction fields are obtained is described below. In the exemplary implementation, either of the motion prediction or motion refinement fields can be zero. Therefore, with respect to motion vector fields, a given segment \( S_i \) can be coded in any of various manners. For instance, the segment can be coded using only prediction motion vector fields extrapolated from a neighboring segment. Or, the segment can be coded by using a prediction motion vector field extrapolated from a neighboring segment together with a compressed refinement motion vector field. Alternately, the segment can be coded using only a compressed motion vector field without utilization of a prediction field. If the prediction field is set to zero, however, refinement information is sent. The segment can also be coded by using a zero motion vector field, e.g., a copy from the reference frame \( R_{ref}(x,y) \). And, for example, the segment can be coded using intra coding in which no motion vector field is utilized.

In the exemplary implementation, independent of the presence of a prediction motion vector field or a refinement motion vector field, the final motion vector field of a given motion compensated segment \( S_i \) has an affine model given by the following equation, here in which the superscript \( i \)
indicates the fact that the coefficients are associated with a corresponding segment $S_i$:

\[
\Delta x(x,y) = \beta_1^i + \beta_2^i \cdot (y - y_o^i) + \beta_3^i \cdot (x - x_o^i) \\
\Delta x(x,y) = \beta_4^i + \beta_5^i \cdot (y - y_o^i) + \beta_6^i \cdot (x - x_o^i)
\]

wherein $x_o^i$ and $y_o^i$ are coordinates of the upper left-most pixel in the segment and $\beta_1^i, \ldots \beta_6^i$ are the affine coefficients calculated as described below.

In the exemplary implementation of the decoder 14, operations are performed by utilizing integer precision. This is achieved by utilizing a fixed point implementation corresponding to a fixed precision. As a result, all of the coefficients referred to hereinbelow are integer-valued, including the coefficients of equation (19). In other implementations, other precisions are utilized.

In the exemplary implementation, one bit is sent to the decoder 14 to signal whether the prediction field of a neighbor is used or not, but only in the case when there is at least one prediction neighbor candidate. A neighboring segment $S_k$ is a candidate for prediction of motion vector field of a segment $S_i$ only if it has a nonzero motion vector field.

Also in the exemplary implementation, prediction is performed only from a nearest neighboring block at the left or just above the current segment. Therefore, the number of neighboring segments can be at most four, i.e., two eight by eight pixel blocks above and two eight by eight pixel blocks at the left. In this implementation, whenever the bit sent to the decoder indicates that prediction from a neighboring segment is used, the number and location of prediction candidates is calculated, in both the encoder and decoder. If there are, e.g., two, three, or four prediction candidates, then one or two selection bits are sent to the decoder 14 to indicate the candidate to be used.
The selection information is made, e.g., of one prediction direction bit which may, or may not, exist, followed by one discrimination bit, which also may, or may not, exist.

Figure 5 illustrates a table, shown generally at 92, which lists the meanings and values of selection bits in an exemplary implementation of the present invention. The mark x denotes absence or logical don’t cares depending on context. The direction bit indicates whether candidate neighbor segments are available above or to the left of the segment currently being predicted. The discrimination bit specifies which of two remaining candidates must be used for prediction of motion vector fields. That is to say, when the segments above or to the left are chosen, two selection possibilities are available. The discrimination bit identifies the selection. In the final four cases shown in the table, the discrimination bit may, or may not, exist depending on the location of the most suitable candidate segment. For instance, if the direction bit indicates “from left” where there is only a single candidate, then the discrimination bit is not needed. In the decoder 14, the direction the winning candidate is known after decoding the direction bit.

Once the neighboring segment has been selected for the prediction of the current segment, the prediction motion vector field is simply the extrapolation of the motion vector field of the segment inside the pixel domain covered by the current segment as follows:

\[
\begin{align*}
\Delta x_{prd}(x,y) &= \beta_1^k + \beta_2^k \cdot (y-y_o^k) + \beta_3^k \cdot (x-x_o^k) \\
\Delta y_{prd}(x,y) &= \beta_4^k + \beta_5^k \cdot (y-y_o^k) + \beta_6^k \cdot (x-x_o^k)
\end{align*}
\]

where \(x_o^k, y_o^k\) are coordinates of the upper left-most pixel in the neighboring segment \(S_k\) and \(\beta_1^k, \ldots, \beta_6^k\) are integer-valued coefficients corresponding to
the motion field of segment $S_k$. In equation 20, the superscript $k$ indicates that the coefficients are associated with the neighboring segment $S_k$.

Analysis of equations 19 and 20 indicates that the motion vector field of the neighboring segment $S_k$ has become the prediction motion vector field of the segment $S_i$ by simply extrapolating it to the pixels inside the current segment $S_i$.

The refinement motion vector field assumes the affine orthogonal model given in equation 9. However, in the preferred implementation, the refinement coefficients are converted into a set of auxiliary refinement coefficients. The auxiliary refinement coefficients enable a fast computation of the final predicted motion field.

In the preferred implementation, refinement coefficients in equation 9 which correspond to an orthogonal affine set of basis functions are first converted to a different set of auxiliary coefficients. These coefficients correspond to the set of basis functions \{1, (y-y_o), (x-x_o)\} where $x_o$, $y_o$ are coordinates of the upper-left most pixel in the segment. This conversion is performed in order to achieve a common basis function representation for both prediction and refined motion vector fields, i.e., in order to use the same set of basis functions. By doing so, the final motion vector field is computed based on the summation of two sets of coefficients, as will be described later. Based upon the refinement coefficients, $c_1, \ldots, c_6$ the following auxiliary coefficients $a_1, \ldots, a_6$ are calculated for segments $S_i$. For segments which are sixteen by sixteen pixel blocks; this is done as follows:

\[ a_1 = \begin{bmatrix} 4096 & 6664 & 6664 \\ 0 & -889 & 0 \\ 0 & 0 & -889 \end{bmatrix} \cdot \begin{bmatrix} c_1 \\ c_2 \\ c_3 \end{bmatrix} \text{ and } a_4 = \begin{bmatrix} 4096 & 6664 & 6664 \\ 0 & -889 & 0 \\ 0 & 0 & -889 \end{bmatrix} \cdot \begin{bmatrix} c_4 \\ c_5 \\ c_6 \end{bmatrix}. \]
For segments $S_i$ which are eight by eight pixel blocks, the calculation takes the form:
EQUATION 22

\[
\begin{bmatrix}
  a_1 \\
  a_2 \\
  a_3 \\
\end{bmatrix} =
\begin{bmatrix}
  8192 & 12513 & 12513 \\
  0 & -3575 & 0 \\
  0 & 0 & -3575 \\
\end{bmatrix}
\cdot
\begin{bmatrix}
  c_1 \\
  c_2 \\
  c_3 \\
\end{bmatrix}
\text{ and }
\begin{bmatrix}
  a_4 \\
  a_5 \\
  a_6 \\
\end{bmatrix} =
\begin{bmatrix}
  8192 & 12513 & 12513 \\
  0 & -3575 & 0 \\
  0 & 0 & -3575 \\
\end{bmatrix}
\]

As a result, the following integer-valued displacements represent the refinement motion vector field of segment $S_i$:

EQUATION 23

\[
\Delta x_{\text{refine}} (x, y) = a_1 + a_2 \cdot (y - y_o) + a_3 \cdot (x - x_o).
\]

\[
\Delta y_{\text{refine}} (x, y) = a_4 + a_5 \cdot (y - y_o) + a_6 \cdot (x - x_o).
\]

where $x_o$ and $y_o$ are coordinates of the upper left-most pixel within the segment $S_i$. The superscript $i$ indicates that these coordinates are associated with the current segment $S_i$.

In the exemplary implementation, the final set of affine coefficients for a given segment which uses the neighboring segment $S_k$ for motion field prediction is calculated as in the following equation in which the superscripts $i$ and $k$ indicate that the corresponding coefficients are associated with $S_i$ and $S_k$, respectively:

EQUATION 24

\[
\begin{align*}
\beta_1 &= a_1 + \Delta x_{\text{pred}} (x_o, y_o) \\
\beta_2 &= a_2 + \beta_2^k \\
\beta_3 &= a_3 + \beta_3^k
\end{align*}
\]

\[
\begin{align*}
\beta_4 &= a_4 + \Delta y_{\text{pred}} (x_o, y_o) \\
\beta_5 &= a_5 + \beta_5^k \\
\beta_6 &= a_6 + \beta_6^k
\end{align*}
\]
Based upon the integer-valued coefficients of $\beta_1 \ldots \beta_6$, the set of final motion vectors for the segment $S_i$ is generated using equation 19. The way by which the motion vectors are used to calculate the pixel intensities from the reference frame is described below.

In the exemplary implementation, the presence of motion coefficients in the bitstream is signaled by one bit whenever refinement or nonrefinement motion coefficients can be expected. This bit is referred to as a motion coefficient indicator (MCI).

Also in the exemplary implementation, when motion coefficients are transmitted for a segment $S_i$, a variable-length code, referred to as a motion coefficient pattern (MCP) is first sent to indicate which coefficients have nonzero values. An all-zero pattern is the only non-valid pattern, as this possibility can be signaled by the MCI bit alone. The total number of valid patterns which can be indicated by the MCP codeword is sixty-three. This is a property of the affine model. As it has six coefficients, there are $2^6$, i.e., 64, possible results. Thus, the MCP codeword has 63 possible values as zero is not valid. Following the MCP codeword are the encoded values of each non-zero motion coefficient indicated by the MCP pattern. The encoded values of each non-zero coefficient follow the MCP codeword. A motion coefficient $c_j$ is encoded as an amplitude variable-length codeword indicating the absolute value of $c_j$ followed by a sign bit indicating the sign of $c_j$. In the exemplary implementation, the same variable-length coding table is used to encode the amplitude of different coefficients. Different coding tables can be used.

Zero-amplitude is not amongst the valid options as this possibility can be indicated by the MCP codeword.

The final motion vector field components calculated by using equation 19 correspond to a discretization step of:

\[
D = \frac{1}{65536} = 0.0000152587890625
\]
If \((\Delta x(x,y), \Delta y(x,y))\) denote final motion compensation displacements for segment \(S_i\), then the corresponding non-integer coordinates in the previous frame are:

\[
\begin{align*}
x' &= x + \Delta x(x,y) \cdot D \\
y' &= y + \Delta y(x,y) \cdot D
\end{align*}
\]

In the preferred implementation, the reference frame \(R_{\text{ref}}\) is of a size of \(M \times N\) pixels with intensity values in the range \(\{0, 1, \ldots, 255\}\). The valid pixel coordinates \((x', y')\) are defined only in the range of \(\{0, 1, \ldots, M-1\} \times \{0, 1, \ldots, N-1\}\). When motion compensated prediction requires evaluating the luminance and chrominance values at non-integer locations in the reference frame \(R_{\text{ref}}\) a discrete version of cubic convolution interpolation is used. In the exemplary implementation, fixed point precision is employed when calculating reconstruction values in the reference frame as described below.

First, the integer-valued displacements \((\Delta x(x,y), \Delta y(x,y))\) corresponding to the pixel \((x,y)\) in segment \(S_j\) are expressed in modulo-65536 form as follows:

\[
\begin{align*}
\Delta x(x,y) &= dx \cdot 65536 + \delta x, & \delta x \in \{0,1,\ldots,65535\} \\
\Delta y(x,y) &= dy \cdot 65536 + \delta y, & \delta y \in \{0,1,\ldots,65535\}
\end{align*}
\]

where \(dx, dy, \delta x,\) and \(\delta y\) are integer values with the latter two being always non-negative.

The \(x', y'\) integer-valued coordinates of the four by four cubic convolution window are defined as:
EQUATION 28
\[ x_j^i = \text{sat}(x + dx + j \cdot 2, M-1), \quad j = 1, 2, 3, 4 \]
\[ x_k^i = \text{sat}(y + dy + k \cdot 2, N-1), \quad k = 1, 2, 3, 4 \]

Wherein \( \text{sat}(u, v) \) is the saturation function as follows:

\[
\text{sat}(u, v) = \begin{cases} 
0 & \text{if } u < 0 \\
u & \text{if } 0 \leq u \leq v \\
v & \text{if } u > v 
\end{cases}
\]

Consequently, the sixteen integer pixel values \( r_{jk} \) used in the cubic convolution are as follows:

EQUATION 29
\[
r_{jk} = R_{ref}(x^i_j, y^i_k) \quad j, k = 1, 2, 3, 4
\]

where \( x^i_j, y^i_k \) are the integer-valued coordinates computed in equation 28.

Then, the convolution coefficients are computed. In the following, the integer division by truncation is denoted by "/'" and both or its operands are always non-negative integers. By using integer truncation, following \( u_j, v_k \) \( j, k = 1, 2, 3, 4 \) are computed:

EQUATION 31
\[
\begin{align*}
u_1 &= \text{spl}(\delta y / 256 + 256) \\
u_2 &= \text{spl}(\delta y / 256) \\
u_3 &= \text{spl}(256 - (\delta y / 256)) \\
u_4 &= 16384 - (u_1 + u_2 + u_3)
\end{align*}
\]

where \( \delta x, \delta y \) are the integer values of equation 27 and \( \text{spl}(s) \) is the integer-valued function of positive integer argument:
EQUATION 32

\[
\text{spl}(s) = \begin{cases} 
16384 - (s^2 \cdot (1280 - 3 \cdot s) + 1024) / 2048 & \text{if } s \in \{0,1,\ldots,255\} \\
-((t \cdot (65536 + t^2 - 512 \cdot t) + 1024) / 2048) & \text{if } s \in \{256,\ldots,511\}, t = s - 256 \\
0 & \text{otherwise}
\end{cases}
\]

Then the reference pixel value is computed. By using integer division
by truncation, the reference pixel value is computed as follows:

EQUATION 33

\[
r = \text{sat}\left(\begin{bmatrix} r_{11} & r_{21} & r_{31} & r_{41} \\ r_{12} & r_{22} & r_{32} & r_{42} \\ r_{13} & r_{23} & r_{33} & r_{43} \\ r_{14} & r_{24} & r_{34} & r_{44} \end{bmatrix} \begin{bmatrix} u_1 \\ u_2 \\ u_3 \\ u_4 \end{bmatrix} / 256 \right) + 2^{19} / 2^{20} \leq 255
\]

where integer-valued coefficients \( r_{jk} \) are given by equation 30 and integer-valued coefficients \( u_j, v_{k,j}, k = 1, 2, 3, 4 \) are given by equation 31 and function \( \text{sat}(.,.) \) is given by equation 29.

At the motion analyzer, the step of linearization is performed by
employing a first order Taylor expansion of \( R_{ref}(x,y) \) around:

EQUATION 34

\[
x_p' = x_p + \Delta x(x_p,y_p) \\
y_p' = y_p + \Delta y(x_p,y_p)
\]

with respect to \( x \) and \( y \):
EQUATION 35

\[ R_{\text{ref}}(x_p + \Delta x_{\text{pred}}(x_p, y_p), y_p + \Delta y_{\text{pred}}(x_p, y_p) + \Delta y_{\text{refine}}(x_p, y_p)) \approx R_{\text{ref}}(x'_p, y'_p) \]

\[ + \Delta x_{\text{refine}}(x_p, y_p) + \Delta x_{\text{pred}}(x_p, y_p) - \Delta x(x_p, y_p) \cdot G_x(x_p', y_p') \]

\[ + \Delta y_{\text{refine}}(x_p, y_p) + \Delta y_{\text{pred}}(x_p, y_p) - \Delta y(x_p, y_p) \cdot G_y(x_p', y_p') \]

\( G_x(x_p', y_p') \) and \( G_y(x_p', y_p') \) are values of the derivative of the reference frame \( R_{\text{ref}} \) with respect to \( x \) and \( y \). Using such an approximation, the elements of matrix \( E_i \) and vector \( w_i \) in equation 14 are:

EQUATION 36

\[ e_{pk} = \begin{cases} 
  f_k(x_p, y_p)G_x(x'_p, y'_p), & k = 1, 2, \ldots, N \\
  f_k(x_p, y_p)G_y(x'_p, y'_p), & k = N + 1, N + 2, \ldots, N + M 
\end{cases} \]

EQUATION 37

\[ w_p = I_n(x_p, y_p) - R_{\text{ref}}(x_p', y_p') + G_x(x_p', y_p')\Delta x(x_p, y_p) + G_y(x_p', y_p')\Delta y(x_p, y_p) - \]

\[ G_x(x_p', y_p')\Delta x_{\text{pred}}(x_p, y_p) - G_y(x_p', y_p')\Delta y_{\text{pred}}(x_p, y_p) \]

The previous descriptions are of preferred examples for implementing the invention and, the scope of the invention should not necessarily be limited by this description. The scope of the present invention is defined by the following claims:
We claim:

1. In a method of operating on a video sequence, said video sequence being formed of at least a current video frame and a reference video frame, the current video frame comprising at least one first neighboring segment and a second neighboring segment, an improvement of a method for motion compensated prediction of the current video frame comprising:
   retrieving a previously stored first motion field model, said first motion field model being a model of a first motion vector field describing the displacements of pixels in the first neighboring segment with respect to pixels in the reference video frame;
   determining a second motion vector field describing displacements of pixels in the second neighboring segment of the current video frame with respect to pixels in the reference video frame;
   modeling said second motion vector field using a motion model to form a second motion field model;
   approximating said second motion field model on the basis of said first motion field model to form a prediction field model;
   comparing said second motion field model with said prediction field model and forming a refinement field model, said refinement field model representing the difference between said second motion field model and said prediction field model;
   constructing an alternative model representation of said second motion field model by making a summation of said prediction field model and said refinement field model;
   calculating a first cost function wherein said first cost function includes a measure of a first image distortion incurred and a measure of a first amount of data required when using said second motion field model;
   calculating a second cost function wherein said second cost function includes a measure of a second image distortion incurred and a
measure of a second amount of data required when using said alternative model representation of said second motion field;
comparing said first and second cost functions and determining which of said first and second cost functions has a smaller absolute value;
choosing that alternate one of said second motion field model and said alternative model representation of said second motion vector field associated with said smaller absolute value to indicate a chosen motion field model and storing said chosen motion field model.

2. A method according to claim 1 further including:
encoding information about said chosen motion field model.

3. A method according to claim 2 further including:
transmitting said coded information to a decoder for decoding.

4. A method according to claim 2 further including:
storing said coded information in a storage means.

5. A method according to claim 1 wherein each of said first motion field model, said second motion field model, said second motion field model, said prediction field model and said refinement field model is formed as a sum of motion field basis functions, each of said motion field basis functions being multiplied by a motion coefficient.

6. A method according to claim 5 wherein said motion field basis functions are orthogonal functions.

7. A method according to claim 6 wherein each of said first motion field model, said second motion field model, said prediction field model and said refinement field model is an affine motion field model.
8. A method according to claim 1 wherein said at least one first neighboring segment and said second neighboring segment are quadrilateral.

9. A method according to claim 1 further including:
   dividing said at least one first neighboring segment into a plurality of sub-segments and using a motion field model of at least one of said sub-segments to form said prediction field model.

10. A method according to claim 1 wherein said prediction field model is formed by projecting the motion field model of said at least one neighboring segment.

11. A method according to claim 1 wherein said prediction field model is formed by averaging approximations of said second motion vector field determined from more than one first neighboring segment.

12. A method according to claim 1 wherein said prediction field model is formed by averaging approximations of said second field model determined from more than one first neighboring segment.

13. A method according to claim 1 wherein said step of calculating said first cost function is performed using a Lagrangian criterion.

14. A method according to claim 13 wherein said Lagrangian criterion has the form \( L = D + \lambda b \) where \( D \) is the distortion incurred when encoding a given set of motion coefficients, \( B \) is number of bits required to represent the motion coefficients and \( \lambda \) is a multiplying Lagrangian parameter.

15. A method according to claim 1 wherein said prediction motion field and said refinement motion field are represented using a common set of basis functions.

16. A method according to claim 1 further including:
defining a first threshold value;
identifying a motion coefficient of said refinement field model with the smallest value of all motion coefficients of said refinement field model;
determining a third cost function incurred by setting said smallest motion coefficient to zero;
forming an approximation of said refinement field by setting said smallest valued motion coefficient to zero, in a situation in which said third image distortion does not exceed said first threshold value.

17. A method according to claim 1 wherein if said chosen motion field model is said second motion field model, said method further includes:
   setting all motion coefficients of said prediction field model to zero;
   setting all motion coefficients of said refinement field model equal to said motion coefficients of said second motion field model.

18. A method according to claim 17 wherein said encoding of information takes place in a manner depending on the chosen field model.

19. A method according to claim 18 wherein if said chosen field model is said second motion field model, said encoding of information includes the step of encoding said refinement field model.

20. A method according to claim 18 wherein if said chosen field model is said alternative model representation, said encoding of information includes the steps of:
    encoding said prediction field model;
    encoding said refinement field model.

21. A method according to claim 20 wherein said encoding of said refinement field model includes the steps of:
indicating, by said a motion coefficient indicator to one alternate of a first and a second value, that said encoded information includes said motion coefficients of said refinement field model;

indicating, by setting a motion coefficient pattern indicator, which of said motion coefficients have non-zero values;

encoding said non-zero motion coefficient values.

22. A method according to claim 21 wherein each of said non-zero motion coefficient values is encoded by indicating an amplitude value and a sign.

23. A method according to claim 20 wherein encoding of said prediction field model includes the steps of:

indicating, by setting a motion coefficient indicator to one alternate of a first and a second value, that said encoded information does not include motion coefficient values;

indicating, by setting a direction discrimination indicator, the direction with respect to said second neighboring segment of said at least one first neighboring segment from which said alternative model representation is constructed.

24. A method according to claim 23 wherein encoding of said prediction field model includes the further step of:

indicating, by setting a sub-segment discrimination indicator, a sub-segment of said at least one first neighboring segment from which said alternative model representation is constructed.

25. In a method of operating on a video sequence, said video sequence being formed of at least a current video frame and a reference video frame, the current video frame comprising at least one first neighboring segment and a second neighboring segment, an improvement of a method for motion compensated prediction of the current video frame including:
retrieving at least one previously stored first motion field model, said at least one first motion field model being a model of a first motion vector field describing the displacements of pixels in the at least one first neighboring segment with respect to pixels in the reference video frame;

determining a second motion vector field describing displacements of pixels in the second neighboring segment of the current video frame with respect to pixels in the reference video frame;

modeling said second motion vector field using a motion model to form a second motion field model;

approximating said second motion field model on the basis of said at least one first motion field model to form a prediction field model.

26. In a video device for operating upon a video sequence formed at least of a current video frame, the current video frame having at least a first neighboring segment and a second neighboring segment, an improvement of apparatus for forming an approximation of a motion vector field of the second neighboring segment, said apparatus comprising:

a motion vector field builder coupled to receive indications representative of a first affine motion model forming an approximation of a first motion vector field representative of the first neighboring segment and to receive indications of the second neighboring segment, said motion vector field builder for forming a second affine motion model responsive to the indications representative of the first affine motion model, the second affine motion model forming the approximation of the motion vector field of the second neighboring segment.

27. The apparatus of claim 26 wherein the video sequence is further formed of a reference video frame and wherein said motion vector field builder is further coupled to receive indications of the reference video frame and wherein the second affine motion model is responsive to an alternate one
of the indications representative of the first affine model and a selected portion of the reference video frame.

28. The apparatus of claim 27 wherein said motion vector field builder further calculates a second motion vector field, the second motion vector field calculated responsive to the selected portion of the reference video frame,

29. The apparatus of claim 28 wherein said motion vector field builder further determines differences between the second motion vector field and the second affine motion model, differences therebetween forming a refinement field model.

30. The apparatus of claim 29 wherein said motion vector field builder further constructs an alternative-representation model of the second motion vector field, the alternative-representation model of the second motion vector field formed of a combination of the refinement field model and of the second affine motion model.

31. The apparatus of claim 30 wherein said motion vector field builder further determines a cost function, the cost function at least in part a representation of image distortion and of data requirements related to at least a selected one of the second motion vector field and the second affine motion model.

32. The apparatus of claim 31 wherein said motion vector field builder further utilizes a selected one of the second motion vector field and the second affine motion model, selection made responsive to the cost function.

33. The apparatus of claim 27 wherein said motion vector field builder further selects which alternate one of the indications representative of the first affine model and the selected portion of the reference video frame responsive to which the second affine motion model is formed.
34. The apparatus of claim 26 wherein the first affine motion model has first affine motion coefficients associated therewith and wherein said motion vector field builder further projects values of the first affine motion model to form the second affine motion model.

35. The apparatus of claim 26 wherein the current video frame further has a third neighboring segment, the third neighboring segment adjacent to both the first neighboring segment and to the second neighboring segment, wherein said motion vector field builder is further coupled to receive indications of the second neighboring segment, and wherein said motion vector field builder is further for forming a third affine motion model responsive to a selected alternate one of the first affine motion model and the second affine motion model.

36. The apparatus of claim 35 wherein said motion vector field builder further selects which of the alternate one of the first affine motion model and the second affine motion model responsive to which the third affine motion model is formed.

37. The apparatus of claim 26 wherein the video device forms a video sequence generator having an encoder and wherein said motion vector field builder forms a portion of the encoder.

38. The apparatus of claim 26 wherein the video device forms a video sequence receiver having a decoder and wherein said motion field builder forms a portion of the decoder.

39. In a method for operating upon a video sequence formed of at least a current video frame, the current video frame having at least a first neighboring segment and a second neighboring segment, an improvement of a method for forming an approximation of a motion vector field of the second neighboring segment, said method comprising:
forming a first motion vector field representative of the first neighboring segment;
modeling the first motion vector field with a first affine motion model; and
forming a second affine motion vector model responsive to the first motion vector field modeled during said operation of modeling, the second affine motion model forming the approximation of the motion vector field of the second neighboring segment.

40. The method of claim 39 wherein the current video frame further comprises a third neighboring segment, the third neighboring segment adjacent to both the first neighboring segment and to the second neighboring segment, said method further for forming an approximation of a motion vector field of the third neighboring segment, said method comprising the further operation of:

forming a third affine motion model responsive to an alternate one of the first affine motion model and the second affine motion model.

41. The method of claim 39 wherein the video sequence is further formed of a reference video frame and wherein the second affine motion vector field formed during said operation of forming the second affine motion model is responsive to an alternate one of the first motion vector field and a portion of the reference frame.

42. The method of claim 41 further comprising the additional operation of selecting which of the first motion vector field and the reference frame responsive to which the second affine motion model is formed.

43. In a video device for operating upon a video sequence formed at least of a current video frame and a reference video frame, the current video frame having at least a first neighboring segment and a second neighboring
segment, an improvement of apparatus of forming an approximation of a motion vector field, said apparatus comprising:

a motion vector field builder coupled to receive indications representative of a selected one of the first neighboring segment and the second neighboring segment and indications representative of portions of the reference video frame, said motion vector field builder for determining a mapping between the selected one of the first and second neighboring segments and a selected portion of the reference video frame and for approximating the mapping with an affine motion model, the affine motion model forming the approximation of the motion vector field.

44. The apparatus of claim 43 wherein the selected one of the first neighboring segment and the second neighboring segment comprises the first neighboring segment and wherein the affine motion model forming the approximation of the motion vector field comprises a first affine motion model, the first affine motion model representative of the first neighboring segment.

45. The apparatus of claim 43 wherein the selected one of the first neighboring segment and the second neighboring segment further comprises the second neighboring segment, said motion vector field builder further for determining a mapping between the second neighboring segment and an alternate one of the selected portion of the reference video frame and the first neighboring segment, and wherein the affine motion model forming the approximation of the motion vector field further comprises a second affine motion model, the second affine motion model representative of the second neighboring segment.

46. The apparatus of claim 43 wherein the video device comprises a video sequence generator having an encoder and wherein said motion vector field builder comprises a portion of the encoder.
47. The apparatus of claim 43 wherein the video device comprises a video sequence receiver having a decoder and wherein said motion vector field builder comprises a portion of the decoder.

48. In a method of decoding a video sequence, said video sequence being formed of at least a current frame and a reference frame, the current frame comprising at least a first neighboring segment and a second neighboring segment, an improvement of a method for decoding said current video frame comprising the steps of:

- receiving an indication of an information type;
- receiving segment reconstruction information for said second neighboring segment;
- selecting a segment reconstruction mode responsive to said indication;
- reconstructing said second neighboring segment according to said selected segment reconstruction mode.

49. A method according to claim 48, wherein said selected segment reconstruction mode is one of a set of segment reconstruction modes comprising:

- a first segment reconstruction mode wherein said segment reconstruction information comprises an indication of a first neighboring segment to be used in said step of reconstructing said neighboring segment;
- a second segment reconstruction mode wherein said segment reconstruction information comprises motion coefficient information.

50. A method according to claim 49, wherein said set of segment reconstruction modes further comprises:
a third segment reconstruction mode wherein said segment reconstruction information comprises an indication of pixel values from said reference frame;

a fourth segment reconstruction mode wherein said segment reconstruction information comprises an indication of pixel values from said current frame.

51. A method according to claim 49, wherein said indication of a first neighboring segment comprises information about the position of said first neighboring segment with respect to said second neighboring segment.

52. A method according to claim 51, wherein said indication of a first neighboring segment further comprises information about a sub-segment within said first neighboring segment.

53. A method according to claim 49 wherein said motion coefficient information comprises an indication of at least one non-zero motion coefficient value.

54. A method according to claim 53, wherein said indication of at least one non-zero motion coefficient value comprises a non-zero coefficient pattern indication and at least one non-zero coefficient value.

55. A method according to claim 49, wherein said first segment reconstruction mode comprises using a prediction motion field model derived from a first motion field model representing said first neighboring segment.

56. A method according to claim 55, wherein said prediction motion field model is constructed by projecting said first motion field model from said first neighboring segment into said second neighboring segment.

57. A method according to claim 49, wherein said second segment reconstruction mode comprises using a refinement motion field model.
58. A method according to claim 57, wherein said refinement motion field model is represented by an indication of at least one motion coefficient value.

59. A method according to claim 57, wherein said refinement motion field model represents a difference between a second motion field model and said prediction motion field model, wherein said second motion field model is a representation of said second segment derived from said reference frame.

60. A method according to claim 57, wherein said refinement motion field model is a representation of said second segment derived from said reference frame.

61. In a method of encoding a video sequence, said video sequence being formed of at least a current video frame and a reference video frame, the current video frame comprising at least a first neighboring segment and a second neighboring segment, an improvement of a method for motion compensated prediction of the current video frame comprising:

   defining a set of coding modes for said second neighboring segment;
   calculating a set of cost functions, each one of said cost functions being associated with one of said set of coding modes;
   choosing that one of said set of cost functions with a smallest absolute value;
   defining that one of said set of coding modes associated with said smallest absolute value as a chosen coding mode for said second neighboring segment;
   encoding information about said second neighboring segment according to said chosen coding mode.
62. A method according to claim 61 further comprising:
transmitting said encoded information to a decoder for decoding.

63. A method according to claim 61 further comprising:
storing said coded information in a storage means.

64. A method according to claim 61 wherein said set of coding
modes comprises:
   a first coding mode wherein a motion field model from said first
   neighboring segment is projected into said second neighboring segment to
   form a prediction motion field model and said second neighboring segment is
   represented by said prediction motion field model;
   a second coding mode wherein said second neighboring segment
   is represented by a motion field model derived from said reference frame;
   a third coding mode wherein a motion field model from said first
   neighboring segment is projected into said second neighboring segment to
   form a projection field model and said second neighboring segment is
   represented by said prediction motion field model and a refinement motion
   field model.

65. A method according to claim 64 wherein said set of coding
modes further comprises:
   a fourth coding mode wherein said second neighboring segment
   is encoded using pixel values from said reference frame;
   a fifth coding mode wherein said second neighboring segment is
   encoded using pixel values from said current frame.

66. A method according to claim 64 wherein said refinement motion
field model represents a difference between said motion field model derived
from said reference frame and said prediction motion field model.

67. A method according to claim 64 wherein said prediction motion
field model, said refinement motion field model and said motion field model
derived from said reference frame comprise a set of basis functions, each one of said basis functions being multiplied by a motion coefficient value.

68. A method according to claim 67 wherein said basis functions are orthogonal functions.

69. A method according to claim 68 wherein said prediction motion field model, said refinement motion field model and said motion field model derived from said reference frame are affine motion field models.

70. A method according to claim 61 wherein each one of said set of cost functions comprises a measure of an image distortion incurred and a measure of an amount of data required when using a given one of said coding modes.

71. A method according to claim 70 wherein each one of said set of cost functions is calculated using a Lagrangian criterion.

72. A method according to claim 71 wherein said Lagrangian criterion has the form \( L = D + \lambda \times B \) where \( D \) is a measure of the distortion incurred when encoding a given set of motion coefficients, \( B \) is the number of bits required to represent the motion coefficients and \( \lambda \) is a Lagrangian parameter.

73. A method according to claim 67 wherein said prediction motion field and said refinement motion field are represented using a common set of basis functions.

74. A method according to claim 67 wherein said refinement motion field model is approximated by removing a motion coefficient.

75. A method according to claim 64 wherein said current frame comprises a plurality of first neighboring segments, said method further comprising:
forming a plurality of prediction motion field models, one for each of said plurality of first neighboring segments;
forming a plurality of refinement motion field models, each corresponding to a given one of said plurality of prediction motion field models.

76. A method according to claim 75 wherein said prediction motion field model is formed on the basis of more than one first neighboring segment.

77. A method according to claim 76 wherein said prediction motion field model is formed by averaging projections of motion field models from more than one first neighboring segment.

78. A method according to claim 64 wherein said method further comprises dividing said first neighboring segment into a plurality of sub-segments and using a motion field model of at least one of said sub-segments to form said prediction field motion model.

79. A method according to claim 61 wherein said encoding of information takes place in a manner depending on the chosen field model.

80. A method according to claim 79 wherein if said chosen coding mode is said second coding mode, said method further comprises setting all motion coefficients of said refinement motion field model equal to said motion coefficients of said motion field model derived from said reference frame.

81. A method according to claim 80 wherein said encoding of information comprises the step of encoding said refinement motion field model.

82. A method according to claim 79 wherein if said chosen coding mode is said first coding mode, said encoding of information comprises the step of encoding said prediction motion field model.
83. A method according to claim 79 wherein if said chosen coding mode is said third coding mode, said encoding of information comprises the steps of:

   encoding said prediction motion field model;

   encoding said refinement motion field model.

84. A method according to claim 81 wherein said encoding of said refinement motion field model comprises the steps of:

   indicating by setting a motion coefficient indicator to one alternate of a first and a second value that said encoded information includes said motion coefficients of said refinement field model;

   indicating by setting a motion coefficient indicator, which of said motion coefficients of said refinement field model have non-zero values;

   encoding said non-zero values.

85. A method according to claim 83 wherein said encoding of said refinement motion field model comprises the steps of:

   indicating by setting a motion coefficient indicator to one alternate of a first and a second value that said encoded information includes said motion coefficients of said refinement field model;

   indicating by setting a motion coefficient pattern indicator, which of said motion coefficients of said refinement field model have non-zero values;

   encoding said non-zero values.

86. A method according to claim 84 wherein each of said non-zero coefficient values is encoded by indicating an amplitude and a sign.

87. A method according to claim 82 wherein encoding of said prediction motion field model comprises indicating, by setting a motion coefficient indicator to one alternate of a first and a second value, that said encoded information does not include motion coefficient values.
88. A method according to claim 87 wherein encoding of said prediction motion field model further comprises indicating a direction identifying the relative position with respect to said second neighboring segment of said first neighboring segment from which said prediction motion field model is formed.

89. A method according to claim 88 wherein encoding of said prediction motion field model further comprises indicating by setting a sub-segment discrimination indicator, a sub-segment of said first neighboring segment from which said prediction motion field model is formed.

90. A method according to claim 83 wherein encoding of said prediction motion field model comprises indicating, by setting a motion coefficient indicator to one alternate of a first and a second value, that said encoded information does not include motion coefficient values.

91. A method according to claim 90 wherein encoding of said prediction motion field model further comprises indicating a direction identifying the relative position with respect to said second neighboring segment of said first neighboring segment from which said prediction motion field model is formed.

92. A method according to claim 91 wherein encoding of said prediction motion field model further comprises indicating by setting a sub-segment discrimination indicator, a sub-segment of said first neighboring segment from which said prediction motion field model is formed.
**Fig. 4**

**Table 1**

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INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 H04N/26

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
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<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<td>GB 2 329 783 A (DAE WOO ELECTRONICS CO LTD) 31 March 1999 (1999-03-31) abstract claims</td>
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</table>

X Further documents are listed in the continuation of box C. X Patient family members are listed in annex.

Date of the actual completion of the international search 17 November 2000

Date of mailing of the international search report 27/11/2000

Name and mailing address of the ISA

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Authorized officer

Foglia, P
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<td>A</td>
<td>WO 97 40628 A (NOKIA MOBILE PHONES LTD; KARCZEWICZ MARTA (FI); NIEWEGOWSKI JACEK) 30 October 1997 (1997-10-30) page 8 - page 14</td>
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<tr>
<td>A</td>
<td>US 5 778 192 A (KATSAGGELOS AGGELOS ET AL) 7 July 1998 (1998-07-07) abstract column 6, line 35 - column 12, line 15</td>
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<td>A</td>
<td>NICOLAS H ET AL: &quot;TEMPORAL REDUNDANCY REDUCTION USING A MOTION MODEL HIERARCHY AND TRACKING FOR IMAGE SEQUENCE CODING&quot; SPIE VISUAL COMMUNICATIONS AND IMAGE PROCESSING, XX, XX, vol. 2094, 8 November 1993 (1993-11-08), pages 1548-1557, XP002050743 paragraph '0001!' - paragraph '0004!'</td>
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<tr>
<td>A</td>
<td>WO 97 16025 A (NOKIA MOBILE PHONES LTD; KARCZEWICZ MARTA (FI); NIEWEGOWSKI JACEK) 1 May 1997 (1997-05-01) the whole document</td>
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**[MAIL STOP AMENDMENT]**

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**METHOD OF PAYMENT (check one)**

1. [ ] The Commissioner is hereby authorized to charge indicated fees and credit any over payments to Deposit Account No. 02-0375 in the name of Baker Botts L.L.P.

   Charge any additional fee required under 37 C.F.R. §§ 1.16 and 1.17 to Deposit Account No. 02-0375.

2. [x] Check Enclosed. The Commissioner is hereby authorized to charge any variance between the amount enclosed and the Patent Office charges to Deposit Account No. 02-0375 in the name of Baker Botts L.L.P, The Warner, Suite 1300, 1299 Pennsylvania Avenue, N.W., Washington, D.C. 20004-2400.

**FEE CALCULATION**

1. **BASIC FILING FEE**  [x] Large Entity  [ ] Small Entity

   - Utility Filing Fee  $300.00
   - Design Filing Fee  $
   - Plant Filing Fee  $
   - Reissue Filing Fee  $
   - Provisional Filing Fee  $

   **Fee Paid**  $300.00

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**EXTRA CLAIMS FEES**

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**TOTAL EXTRA CLAIMS FEES**  $200.00

**SUBMITTED BY**

**Typed or Printed Name**  James E. Dipple

**Signature**

**Date**  February 1, 2006

**Registration No.**  33,470

**Deposit Account User ID**  02-0375
NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION

FILED UNDER 37 CFR 1.53(b)

Filing Date Granted

Items Required To Avoid Abandonment:

An application number and filing date have been accorded to this application. The item(s) indicated below, however, are missing. Applicant is given TWO MONTHS from the date of this Notice within which to file all required items and pay any fees required below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

- The statutory basic filing fee is missing.
  Applicant must submit $300 to complete the basic filing fee for a non-small entity. If appropriate, applicant may make a written assertion of entitlement to small entity status and pay the small entity filing fee (37 CFR 1.27).
- The oath or declaration is unsigned.

The applicant needs to satisfy supplemental fees problems indicated below.

The required item(s) identified below must be timely submitted to avoid abandonment:

- Additional claim fees of $200 as a non-small entity, including any required multiple dependent claim fee, are required. Applicant must submit the additional claim fees or cancel the additional claims for which fees are due.
- To avoid abandonment, a surcharge (for late submission of filing fee, search fee, examination fee or oath or declaration) as set forth in 37 CFR 1.16(f) of $130 for a non-small entity, must be submitted with the missing items identified in this letter.

SUMMARY OF FEES DUE:

Total additional fee(s) required for this application is $1330 for a Large Entity

- $300 Statutory basic filing fee.
- $130 Surcharge.

02/02/2006 HAL111 00000126 11256188

01 FC:1011  300.00 DP
02 FC:1111  500.00 DP
03 FC:1311  200.00 DP
04 FC:1051  130.00 DP
05 FC:1201  200.00 DP
- The application search fee has not been paid. Applicant must submit $500 to complete the search fee.
- The application examination fee has not been paid. Applicant must submit $200 to complete the examination fee for a large entity

- Total additional claim fee(s) for this application is $200

  - $200 for 1 independent claims over 3.

Replies should be mailed to: Mail Stop Missing Parts
Commissioner for Patents
P.O. Box 1450
Alexandria VA 22313-1450

A copy of this notice MUST be returned with the reply.

Office of Initial Patent Examination (571) 272-4000, or 1-800-PTO-9199, or 1-800-972-6382
PART 2 - COPY TO BE RETURNED WITH RESPONSE
DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

As the below named inventor(s), I/we declare that:

This declaration is directed to:

- [ ] The attached application, or
- [X] Application No. 11/256,188, filed on October 24, 2005.
- [ ] as amended on ________________________ (if applicable);

I/we believe that I/we am/are the original and first inventor(s) of the subject matter which is claimed and for which a patent is sought;

I/ we have reviewed and understand the contents of the above-identified application, including the claims, as amended by any amendment specifically referred to above;

I/we acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me/us to be material to patentability as defined in 37 CFR 1.56, including material information which became available between the filing date of the prior application and the National or PCT International filing date of the continuation-in-part application, if applicable; and

All statements made herein of my/own knowledge are true, all statements made herein on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001, and may jeopardize the validity of the application or any patent issuing thereon.

FULL NAME OF INVENTOR(S)

<table>
<thead>
<tr>
<th>Inventor one:</th>
<th>Euee-S Jang</th>
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<tr>
<td>Signature:</td>
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<td>Citizen of:</td>
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<th>Inventor two:</th>
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Additional inventors are being named on one (1) additional form(s) attached hereto.

Burden Hour Statement: This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is used by the public to file (and the PTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This form is estimated to take 1 minute to complete. This time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Assistant Commissioner for Patents, Washington, DC 20231.
DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

As the below named inventor(s), I/we declare that:

This declaration is directed to:

☐ The attached application, or  
☑ Application No. 11/256,188, filed on October 24, 2005,
☐ as amended on __________________________ (if applicable);

I/we believe that I/we am/are the original and first inventor(s) of the subject matter which is claimed and for which a patent is sought;

I/ we have reviewed and understand the contents of the above-identified application, including the claims, as amended by any amendment specifically referred to above;

I/we acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me/us to be material to patentability as defined in 37 CFR 1.56, including material information which became available between the filing date of the prior application and the National or PCT International filing date of the continuation-in-part application, if applicable; and

All statements made herein of my/own knowledge are true, all statements made herein on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001, and may jeopardize the validity of the application or any patent issuing thereon.

FULL NAME OF INVENTOR(S)

Inventor one: Jong-Woo Won
Signature: [Signature]
Citizen of: Republic of Korea

Inventor two: Yong-Ho Cho
Signature: [Signature]
Citizen of: Republic of Korea

Inventor three: Chung-Ku Lee
Signature: [Signature]
Citizen of: Republic of Korea

Inventor four: [Signature]
Citizen of: [Citizen]

☐ Additional inventors are being named on additional form(s) attached hereto.
REQUEST FOR ONE-MONTH EXTENSION OF TIME TO RESPOND AND RESPONSE TO NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION UNDER 37 CFR 1.53(B)

MAIL STOP MISSING PARTS
Commissioner of Patents
U.S. Patent and Trademark Office
Customer Service Window
Randolph Building
401 Dulany Street
Alexandria, VA 22314

Sir:

REQUEST FOR ONE-MONTH EXTENSION OF TIME TO RESPOND

Applicants respectfully request a one-month extension of time to respond to the Communication mailed November 17, 2005, until and including February 17, 2006. Applicants are enclosing a check including the amount of $120 for the one-month extension fee under 37 C.F.R. § 1.17(a)(1) (Fee Code 1251). In the event of any variance between this amount and the fees determined by the U.S. Patent and Trademark Office (PTO), please charge or credit that variance to the undersigned's Deposit Account No. 02-0375.

RESPONSE TO NOTICE TO FILE MISSING PARTS

In response to the attached Notice to File Missing Parts Of Nonprovisional Application Under 37 CFR 1.53(b) mailed November 17, 2005, by the PTO, Applicants are enclosing an executed Declaration for Patent Application; the filing, Search and Examination Fees; Excess Claim Fees; the Late Filing Surcharge; and the one-month extension fee.
In the event of any variance between this amount and the fees determined by the PTO, please charge or credit that variance to the undersigned's Deposit Account No. 02-0375.

Respectfully submitted,

BAKER BOTTS, L.L.P.

James B. Arpin
Registration No. 33,470

Dated: February 1, 2006

Baker Botts, L.L.P.
The Warner - Suite 1300
1299 Pennsylvania Avenue, N.W.
Washington, D.C. 20004-2400
Tel: (202) 639-7700
Fax: (202) 639-7890

JBA/djw

Enclosures
NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION

FILED UNDER 37 CFR 1.53(b)

Filing Date Granted

Items Required To Avoid Abandonment:

An application number and filing date have been accorded to this application. The item(s) indicated below, however, are missing. Applicant is given TWO MONTHS from the date of this Notice within which to file all required items and pay any fees required below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

- The statutory basic filing fee is missing.
  Applicant must submit $300 to complete the basic filing fee for a non-small entity. If appropriate, applicant may make a written assertion of entitlement to small entity status and pay the small entity filing fee (37 CFR 1.27).
- The oath or declaration is unsigned.

The applicant needs to satisfy supplemental fees problems indicated below.

The required item(s) identified below must be timely submitted to avoid abandonment:

- Additional claim fees of $200 as a non-small entity, including any required multiple dependent claim fee, are required. Applicant must submit the additional claim fees or cancel the additional claims for which fees are due.
- To avoid abandonment, a surcharge (for late submission of filing fee, search fee, examination fee or oath or declaration) as set forth in 37 CFR 1.16(f) of $130 for a non-small entity, must be submitted with the missing items identified in this letter.

SUMMARY OF FEES DUE:

Total additional fee(s) required for this application is $1330 for a Large Entity

- $300 Statutory basic filing fee.
- $130 Surcharge.
• The application search fee has not been paid. Applicant must submit $500 to complete the search fee.
• The application examination fee has not been paid. Applicant must submit $200 to complete the examination fee for a large entity

• Total additional claim fee(s) for this application is $200
  • $200 for 1 independent claims over 3.

Replies should be mailed to: Mail Stop Missing Parts
Commissioner for Patents
P.O. Box 1450
Alexandria VA 22313-1450

A copy of this notice MUST be returned with the reply.

Office of Initial Patent Examination (571) 272-4000, or 1-800-PTO-9199, or 1-800-972-6382
PART 3 - OFFICE COPY
IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Euee-S JANG et al.

Examiner: To be assigned
Group Art Unit: To be assigned
Confirmation No.: To be assigned

Serial No.: 11/256,188
Filed: October 24, 2005

FOR: SELECTIVE PREDICTION ENCODING
AND DECODING METHODS AND
SELECTIVE PREDICTION ENCODING
AND DECODING DEVICES

SUBMISSION OF CERTIFIED COPY OF PRIORITY DOCUMENT

Commissioner of Patents
U.S. Patent and Trademark Office
Customer Service Window
Randolph Building
401 Dulany Street
Alexandria, VA 22314

Sir:

Applicants are enclosing a certified copy of Korean Patent Application No. 10-2004-0084918, filed in Korea on October 22, 2004. The document provides a basis for Applicants' claim for priority. No fee is believed due as a result of this submission. However, if a fee is due upon the filing of the priority document, please charge the undersigned's Deposit Account No. 02-0375.

Respectfully submitted,

BAKER BOTTS L.L.P.

Dated: November 14, 2005

Baker Botts L.L.P.
The Warner; Suite 1300
1299 Pennsylvania Avenue, N.W.
Washington, D.C. 20004-2400
(202) 639-7700 (telephone)
(202) 639-7890 (facsimile)
JBA/dh
Enclosure

DC01:430559.1
This is to certify that the following application annexed hereto is a true copy from the records of the Korean Intellectual Property Office.

Application Number: 10-2004-0084918
Date of Application: 2004년 10월 22일 (OCT 22, 2004)
Applicant(s): 주식회사 휴맥스

2005 년 11 월 02 일

COMMISSIONER
【서지사항】
【서류명】 서지사항 보정서
【수신처】 특허청장
【제출일자】 2004.12.14
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【심사청구일자】 2004.10.22
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【접수일자】 2004.10.22
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【보정할 사항】
【보정대상항목】 발명자
【보정방법】 정정
【보정내용】
【발명자】
【명의의 국문표기】 장의선
【성명의 영문표기】 JANG, Euee S.
【주민등록번호】 681220-1481119
【우편번호】 133-791
【주소】 서울 성동구 행당1동 한양대학교 산학빌딩 501호
【국적】 KR

【발명자】
【성명의 국문표기】 이영렬
【성명의 영문표기】 LEE, Yung-Lyul
【주민등록번호】 611030-1047211
【우편번호】 138-160
【주소】 서울 송파구 가락동 192 근동 APT. 1-704호
【국적】 KR

【발명자】
【성명의 국문표기】 이선영
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【주민등록번호】 731028-2228312
【우편번호】 133-791
【주소】 서울 성동구 행당1동 한양대학교 산학빌딩 707호
【국적】 KR

【발명자】
【성명의 국문표기】 박성원
【성명의 영문표기】 PARK, Sungwon
【주민등록번호】 761025-1637922
【우편번호】 133-791
【주소】 서울 성동구 행당1동 한양대학교 산학빌딩 707호
【국적】 KR

【발명자】
【성명의 국문표기】 원종우
【성명의 영문표기】 WON, JongWoo
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【주소】 서울 성동구 행당1동 한양대학교 산학빌딩 707호
【국적】 KR
【발명자】
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【발명자】
【성명의 국문표기】 이충규
【성명의 영문표기】 LEE, Chung Ku
【주민등록번호】 670224-1155119
【우편번호】 403-011
【주소】 인천 부평구 부평1동 동아아파트 15동 304호
【국적】 KR
【취지】 특허법시행규칙 제13조  실용신안법시행규칙 제8조의 규정에 의하여 위와 같이 제출합니다. 대리인
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【서류명】 서지사항 보정서
【수신처】 특허청장
【제출일자】 2004.12.07
【제출인】
【명칭】 (주)휴맥스
【출원인코드】 1-1998-000063-1
【사건과의 관계】 출원인
【대리인】
【성명】 이경란
【대리인코드】 9-1998-000651-6
【포괄위임등록번호】 2004-073908-7
【사건의 표시】
【출원번호】 10-2004-0084918
【출원일자】 2004.10.22
【심사청구일자】 2004.10.22
【발명의 명칭】 동영상 코덱 성능 향상을 위한 선택적 예측 부호화 방법 및 장치
【제출원인】
【접수번호】 1-1-2004-0483614-04
【접수일자】 2004.10.22
【보정할 서류】 특허출원서
【보정할 사항】
【보정대상항목】 발명자
【보정방법】 정정
【보정내용】
【발명자】
【성명의 국문표기】 장의선
【성명의 영문표기】 JANG, Euee S.
【주민등록번호】 681220-1481119
【우편번호】 133-791
【주소】 서울 성동구 행당1동 한양대학교 산학빌딩 501호
【국적】 KR

【발명자】
【성명의 국문표기】 이영열
【성명의 영문표기】 LEE, Yung-Lyul
【주민등록번호】 611030-1047211
【우편번호】 138-160
【주소】 서울 송파구 가락동 192 극동 APT. 1-704호
【국적】 KR

【발명자】
【성명의 국문표기】 이선영
【성명의 영문표기】 LEE, SunYoung
【주민등록번호】 731028-2228312
【우편번호】 133-791
【주소】 서울 성동구 행당1동 한양대학교 산학빌딩 707호
【국적】 KR

【발명자】
【성명의 국문표기】 박성원
【성명의 영문표기】 PARK, Sungwon
【주민등록번호】 761025-1637922
【우편번호】 133-791
【주소】 서울 성동구 행당1동 한양대학교 산학빌딩 707호
【국적】 KR

【발명자】
【성명의 국문표기】 원종우
【성명의 영문표기】 WON, JongWoo
【주민등록번호】 790320-1155518
【우편번호】 133-791
【주소】 서울 성동구 행당1동 한양대학교 산학빌딩 707호
【국적】 KR

【발명자】
【성명의 국문표기】 조용호
【성명의 영문표기】 CH0, YongHo
【주민등록번호】 770621-1029628
【우편번호】 133-791
【주소】 서울 성동구 행당1동 한양대학교 산학빌딩 707
【국적】 KR

【발명자】
【성명의 국문표기】 이충구
【성명의 영문표기】 LEE, Chung Ku
【주민등록번호】 670224-1155119
【우편번호】 403-011
【주소】 인천 부평구 부평1동 동아아파트 15동 304호
【국적】 KR

【취지】 특허법 시행규칙 제13조·실용신안법 시행규칙 제8조의 규정에 의하여 위와 같이 제출합니다. 대리인
이경란 (인)

【수수료】
【보정료】 3,000 원
【기타 수수료】 0 원
【합계】 3,000 원
【서지사항】
【서류명】 서지사항 보정서
【수신처】 특허청장
【제출일자】 2004.11.03
【제출인】
【명칭】 (주)휴맥스
【출원인코드】 1-1998-000063-1
【사건과 관계】 출원인
【대리인】
【성명】 이경란
【대리인코드】 9-1998-000651-6
【포괄위임등록번호】 2004-073908-7
【사건의 표시】
【출원번호】 10-2004-0084918
【출원일자】 2004.10.22
【심사청구일자】 2004.10.22
【발명의 명칭】 동영상 코덱 성능 향상을 위한 선택적 예측 부호화 방법 및 장치
【제출원인】
【발송번호】 1-5-2004-0074753-42
【발송일자】 2004.11.02
【보정할 서류】 특허출원서
【보정할 사항】
【보정대상항목】 참부서류
【보정방법】 제출
【보정내용】
【첨부서류】
1. 중소기업기본법시행령 제2조에의한 중소기업에 해당함을 증명하는 서류_1통
2. 기타첨부서류 [중소기업기본법 제2조 3항] _1통

【취지】
특허법시행규칙 제13조·실용신안법시행규칙 제8조의 규정에 의하여 위와 같이 제출합니다. 대리인
이경란 (인)

【수수료】
【보정료】 원
【기타 수수료】 0 원
【합계】 0 원
【서지사항】
【서류명】  특허출원서
【권리구분】  특허
【수신처】  특허청장
【제출일자】  2004.10.22
【발명의 근본명칭】  동영상 코덱 성능 향상을 위한 선택적 예측 부호화 방법 및 장치
【발명의 영문명칭】  Selective prediction coding method and device for improvement in performance on video codec
【출원인】
【명칭】  (주)휴맥스
【출원인코드】  1-1998-000063-1
【대리인】
【성명】  이경란
【대리인코드】  9-1998-000651-6
【포괄위임등록번호】  2004-073908-7
【발명자】
【성명의 근본명칭】  장의선
【성명의 영문명칭】  JANG, Euee S.
【주민등록번호】  681220-1481119
【우편번호】  133-791
【주소】  서울 성동구 행당1동 한양대학교 산학빌딩 501호
【국적】  KR
【발명자】
【성명의 근본명칭】  이영열
【성명의 영문명칭】  LEE, Yung-Lyu
【주민등록번호】  611030-1047211
【우편번호】  138-160
【주소】 서울 송파구 가락동 192 극동 APT. 1-704호
【국적】 KR

【발명자】
【성명의 국문표기】 이선영
【성명의 영문표기】 LEE, SunYoung
【주민등록번호】 731028-2228312
【우편번호】 133-791
【주소】 서울 성동구 행당1동 한양대학교 산학빌딩 707호
【국적】 KR

【발명자】
【성명의 국문표기】 박성원
【성명의 영문표기】 PARK, Sungwon
【주민등록번호】 761025-1637922
【우편번호】 133-791
【주소】 서울 성동구 행당1동 한양대학교 산학빌딩 707호
【국적】 KR

【발명자】
【성명의 국문표기】 원종우
【성명의 영문표기】 WON, JongWoo
【주민등록번호】 790320-1155518
【우편번호】 133-791
【주소】 서울 성동구 행당1동 한양대학교 산학빌딩 707호
【국적】 KR

【발명자】
【성명의 국문표기】 조용호
【성명의 영문표기】 CHO, YongHo
【주민등록번호】 770621-1029628
【우편번호】 133-791
【주소】 서울 성동구 행당1동 한양대학교 산학빌딩 707
【국적】 KR
【성질】 청구
【취지】 특허법 제42조의 규정에 의한 출원, 특허법 제60조의 규정에 의한 출원심사 를 청구합니다. 대리인
이경란 (인)

【수수료】
【기본출원료】 0 면 36,000원
【가산출원료】 21 면 0원
【우선권주장료】 0 건 0원
【심사청구료】 8 항 365,000원
【합계】 403,000원
【감면사유】 중소기업
【감면후 수수료】 201,500원

【첨부서류】 1. 중소기업기본법시행령 제2조에 의한 중소기업에 해당함을 증명하는 서류_1통 2. 기타첨부서류 [중소기업기본법 제2조 3항]_1통
【요약서】

【요약】

본 발명은 선택적 예측 부호화 방법 및 장치에 관한 것으로서, 보다 상세하게는 MPEG 4 코덱의 DC/AC 예측 부호화와 AVC 코덱의 인트라 예측 부호화를 선택적으로 사용하여 비트량과 화질면에서 압축 성능을 향상시키기 위한 방법 및 장치에 관한 것이다. 바람직한 실시예에 의할 때, 선택적 예측 부호화 방법은 (a) 메크로 블록에 대하여, AC/DC 예측 및 AVC 인트라 예측을 각각 수행하고, AC/DC 예측값 및 AVC 인트라 예측값을 생성하는 단계; (b) AC/DC 예측값과 AVC 인트라 예측값을 비교하여 보다 작은 예측값을 가지는 부호화 모드로 부호화 방식을 선택하는 단계; 및 (c) AC/DC 예측으로 선택한 경우, 플레그 필드에 AC/DC 예측 부호화 방식으로 부호화되었음을 표시하고, AVC 인트라 예측으로 선택한 경우 플레그 필드에 AVC 인트라 예측 부호화 방식으로 부호화되었음을 표시하는 단계를 포함한다.

【대표도】

도 3

【색인어】

인트라 코딩, DC/AC, 예측, MPEG, AVC, VIDEO
【명세서】

【발명의 명칭】

동영상 코덱 성능 향상을 위한 선택적 예측 부호화 방법 및 장치(Selective prediction coding method and device for improvement in performance on video codec)

【도면의 간단한 설명】

<1> 도 1은 종래 기술에 따른 MPEG 4의 DC/AC 예측 방법을 나타낸 도면.

<2> 도 2는 종래 기술에 따른 AVC 인트라 예측 방법을 나타낸 도면.

<3> 도 3은 본 발명의 바람직한 실시예에 따른 선택적 예측 부호화 방법을 나타낸 순서도.

<4> 도 4는 본 발명의 바람직한 실시예에 따른 선택적 예측 부호화 장치를 나타낸 도면.

<5> 도 5a는 본 발명의 바람직한 실시예에 따른 제1 테스트 영상에 대한 성능 비교 결과를 나타낸 도면.

<6> 도 5b는 본 발명의 바람직한 실시예에 따른 제2 테스트 영상에 대한 성능 비교 결과를 나타낸 도면.

<7> <도면의 주요부분에 대한 부호의 설명>
400 : 선택적 예측 부호화 장치
410 : 제어부
411 : 메크로블록 식별부
413 : 예측값 비교부
415 : 플래그 표시부
420 : AC/DC 예측부
430 : AVC 인트라 예측부

【발명의 상세한 설명】

【발명의 목적】

【발명이 속하는 기술분야 및 그 분야의 종래기술】

본 발명은 선택적 예측 부호화 방법 및 장치에 관한 것으로서, 보다 상세하게는 MPEG 4 코덱의 AC/DC 예측 부호화와 AVC 코덱의 인트라 예측 부호화를 선택적으로 사용하여 압축률 및 화질면에서 기존의 MPEG 4 코덱의 성능을 향상시키기 위한 선택적 예측 부호화 방법 및 장치에 관한 것이다.

종래 기술에 의한 동영상 부호화 방법은 I-프레임과 같이 화면내 부호화를 수행하는 인트라 코딩 및 P-프레임 또는 B-프레임과 같이 화면간 부호화를 수행하는 인터 코딩으로 구분할 수 있다. 이하, 도 1 및 2를 참조하여 종래 기술에 따른 인트라 프레임의 코딩에 있어 예측 부호화 방법을 설명하기로 한다.
도 1은 종래의 기술인 MPEG 4 인트라 코딩시 사용되는 DC/AC 예측에 사용되는 도면이다.

DC/AC 예측은 인트라 모드로 부호화에 있어서, 메크로 블록의 압축 효율을 높이기 위한 방법이며, 일부 시스템에 따라 MPEG 4에서 사용되는 인트라 코딩에서 사용되는 예측 방법은 DC/AC 예측에 기반을 두고, 이미 코딩된 참조되는 블록의 DC/AC 값의 방향을 보고 현재 코딩되는 블록의 위치를 예측한 후 코딩하는 방법이다.

여기서, DC 계수(100)는 다른 블록의 DC 계수들과의 차이 정보를 이용하여 부호화하고, AC계수(110)는 미리 정해진 순서에 따라 1차원으로 나타내며, Run Length, Huffman 코딩 등을 이용하여 부호화하도록 구성된다. 도 1을 참조하면, 메크로 블록 단위에 DCT연산을 행하고 얻어진 DCT계수를 포함하는 양자화 테이블이 도시되어 있다. 여기서, DC성분과 AC성분으로 나누어 독립적으로 양자화하며, 양자화에 사용하는 양자화 테이블에는 규정치가 존재하지 않고 개별적으로 설정될 수 있다. 양자화된 DCT계수는, 바로 앞 블록의 DC계수를 예측치로 한 차분치를 부호화하고, 나머지 AC성분은 블록마다 지그재그 스캔(130)에 의해 일렬로 나열한 후 부호화한다.

도 2는 종래의 기술인 AVC 인트라 코딩시 사용되는 AVC 인트라 예측을 설명한 도면이다.

도 2를 참조하면, AVC 인트라 예측은 메크로 블록 단위로 주변 블록의 정보를 가지고 4가지 방향(210, 220, 230, 240)에 대해서 예측을 하고 가장 낮은 움직
임 보상 에러(SAD : Sum of Absolute Difference), 예를 들면 MSE(Mean Square Error)를 가지는 방향을 선택하여 코딩 효율을 높이는 방식이다.

이러한 종래 기술에 의할 때, DC/AC 예측에 비하여 AVC 인트라 예측이 효율이 좋은 것으로 생각하여, AVC 인트라 예측만을 이용하여 인트라 예측을 수행하며, 소정의 메크로 블록에 대하여는 효율이 떨어지지 아니하는 DC/AC 예측 방법을 병행하여 사용할 수 있는 효율적인 부호화 예측 방법은 존재하지 아니하는 설정이다.

【발명이 이루고자 하는 기술적 과제】

따라서 본 발명은 상기의 종래 기술들의 장점을 취합하여 MPEG 4 코덱의 성능 향상을 위한 것으로서, MPEG 4 코덱의 AC/DC 예측 부호화와 AVC 코덱의 인트라 예측 부호화를 선택적으로 사용할 수 있는 예측 부호화 장치를 제공함에 그 목적이 있다. 즉, 본 발명의 목적은 MPEG 4 에 AVC의 인트라 예측 방법을 적용하여, 압축량 곧 비트량을 기준으로 압축 효율이 좋은 방법으로 부호화를 선택적으로 수행할 수 있는 방법 및 장치를 제공함에 있다.

또한, 본 발명의 다른 목적은 부호화 기술 중 인트라 예측 코딩 방법을 선택적으로 적용함으로서, 같은 압축 효율에 비해 화질의 향상을 가능하도록 함에 있으며, 그 외의 다른 본 발명의 목적들은 이하에 서술되는 바람직한 실시예를 통하여 보다 명확해질 것이다.
【발명의 구성】

상술한 목적들을 달성하기 위하여 본 발명의 일측면에 따르면, AC/DC 예측부호화와 AVC 코덱의 인트라 예측 부호화를 선택적으로 사용할 수 있는 선택적 예측부호화 방법이 개시된다.

바람직한 실시예에 의할 때, 선택적 예측부호화 방법은 (a) 메크로 블록에 대하여, AC/DC 예측 및 AVC 인트라 예측을 각각 수행하고, AC/DC 예측값 및 AVC 인트라 예측값을 생성하는 단계; (b) 상기 AC/DC 예측값과 상기 AVC 인트라 예측값을 비교하여 보다 작은 예측값을 가지는 부호화 모드로 부호화 방식을 선택하는 단계; 및 (c) 상기 AC/DC 예측으로 선택한 경우, 플래그 필드에 AC/DC 예측 부호화 방식으로 부호화되었음을 표시하고, 상기 AVC 인트라 예측으로 선택한 경우 플래그 필드에 AVC 인트라 예측 부호화 방식으로 부호화되었음을 표시하는 단계를 포함한다.

여기서, 상기 메크로 블록이 미리 설정된 처리 단위인지 여부를 판단하여, 미리 설정된 처리 단위의 메크로 블록에 대하여 상기 (a) 단계 내지 (c) 단계를 수행한다. 또한, 상기 (b) 단계는 상기 AC/DC 예측값과 상기 AVC 인트라 예측값이 동일한 경우, 미리 설정된 기준에 따라 어느 하나의 방식으로 부호화하도록 설정된다.

상술한 목적들을 달성하기 위하여 본 발명의 다른 측면에 따르면, AC/DC 예측부호화와 AVC 코덱의 인트라 예측 부호화를 선택적으로 사용할 수 있는 선택적 예측부호화 장치가 개시된다.
바람직한 실시예에 의할 때, 선택적 예측 부호화 장치는 미리 설정된 처리 단위의 메크로 블록에 대하여, AC/DC 예측을 수행하고, AC/DC 예측값을 생성하기 위한 AC/DC 예측부; 상기 메크로 블록에 대하여 AVC 인트라 예측을 수행하고, AVC 인트라 예측 값을 생성하기 위한 AVC 인트라 예측부; 및 상기 AC/DC 예측값과 상기 AVC 인트라 예측 값을 비교하여 보다 작은 예측값을 가지는 부호화 모드로 부호화 방식을 선택하도록, 상기 AC/DC 예측부 및 AVC 인트라 예측부를 제어하기 위한 제어부를 포함한다.

여기서, 상기 제어부는 부호화할 메크로 블록이 미리 설정된 처리 단위의 메크로 블록 인지 여부를 판단하기 위한 메크로 블록 식별부; 상기 AC/DC 예측값과 상기 AVC 인트라 예측값을 비교하여 보다 작은 예측값을 가지는 부호화 모드를 결정하기 위한 예측값 비교부; 및 상기 AC/DC 예측으로 선택한 경우, 플래그 필드에 AC/DC 예측 부호화 방식으로 부호화되었음을 표시하고, 상기 AVC 인트라 예측으로 선택한 경우 플래그 필드에 AVC 인트라 예측 부호화 방식으로 부호화되었음을 표시하기 위한 플래그 표시부를 포함한다. 또한, 상기 예측값 비교부는 상기 AC/DC 예측값과 상기 AVC 인트라 예측값이 동일한 경우, 미리 설정된 기준에 따라 어느 하나의 방식으로 선택한다. 여기서, 상기 선택적 예측 부호화 장치를 포함하는 부호화 장치 및 부호화 장치를 구성할 수 있음을 당연하다.

이하, 본 발명의 실시예에 따른 선택적 예측 부호화 방법 및 장치를 첨부 도면을 참조하여 상세히 설명하기로 하며, 첨부 도면을 참조하여 설명함에 있어, 도
면 부호에 상관없이 동일하거나 대응하는 구성 요소는 동일한 참조번호를 부여하고 이에 대한 중복되는 설명은 생략하기로 한다.

그리고 AVC는 4*4 블록 단위를 기준으로 9가지의 방향을 갖는 Intra 예측 방법이 사용되기도 하나, 본 발명에서는 설명의 편의상 동일한 크기를 가지는 처리 단위를 기준으로 설명하기로 한다. 예를 들면, MPEG 4의 기본 처리 단위는 8*8 단위로 DCT(Discrete Cosine Transform) 연산이 되며, AVC는 4*4 단위로 Transform 연산을 한다. 이하 MPEG 4 코덱에 따른 8*8 또는 16*16으로 처리하는 경우를 기준으로 설명하기로 하나, MPEG 4 코덱의 구성은 4*4로 변환하여 4*4를 기준으로 처리할 수도 있다.

선택적 예측 부호화 방법

도 3은 본 발명의 바람직한 실시예에 따른 선택적 예측 부호화 방법을 도시한 순서도이다.

일반적으로 MPEG 4의 DC/AC 예측 방법과 AVC의 인트라 예측 방법 중 AVC의 인트라 예측 방법만을 인트라 예측 부호화 방법으로 사용되고 있다. AVC는 4*4 블록 단위의 처리를 지원하기 때문에, 인트라 예측 방법 중 4*4 단위의 9가지 예측모델을 사용하거나, AVC 코덱에 대응하여 최적화되어 있는 경우에는 장점을 가지고 있기는 하나, MPEG 4에 적용하는 경우에 있어서는, 각계에 따라 DC/AC 예측 방법이 인트라 예측 방법에 비하여 효율성이 증가하는 경우가 발생한다. 본 발명은 이러한
경우를 인식하여 효율적인 부호화 방법으로 부호화를 수행할 수 있다.

이하, 도 3을 참조하여 본 발명에 따른 선택적 예측 부호화 방법을 설명하기로 한다.

단계 S310에서, 부호화할 메크로 블록의 처리 단위를 판단한다. 8*8 또는 16*16 블록 단위의 메크로 블록에 대하여는 본 발명에 따른 선택적 예측 부호화 방법을 적용하고, 그 외의 경우에는 단계 S320에서 AVC 인트라 예측 부호화를 수행하거나, 그 외 기존 또는 항후에 개발될 인트라 예측 부호화 방법을 수행할 수 있다.

미리 설정된 처리 단위의 메크로 블록에 대하여, 단계 S330에서, AC/DC 예측을 수행하고, 단계 S335에서, AC/DC 예측값을 생성한다. 그리고 상기 메크로 블록에 대하여, 단계 S340에서, AVC 인트라 예측을 수행하고, 단계 S345에서, AVC 인트라 예측값을 생성한다. 여기서, AVC 예측을 수행하고, AC/DC 예측을 수행할 수도 있으며, 동시에 수행될 수도 있다.

단계 S350에서, AC/DC 예측값과 AVC 인트라 예측값을 비교하여 보다 작은 예측값을 가지는 부호화 모드로 부호화하도록 구성된다. 즉, AC/DC 예측값이 작은 경우, 단계 S360에서 상기 AC/DC 예측으로 선택하고, 플래그 필드에 AC/DC 예측 부호화 방식으로 부호화되었음을 표시한다. 마찬가지로, AVC 인트라 예측값이 작은 경우, 단계 S370에서 상기 AVC 인트라 예측으로 선택하고, 플래그에 AVC 인트라 예측 부호화 방식으로 부호화되었음을 표시한다. 여기서, AC/DC 예측값 및 AVC 인트라 예측 값이 동일한 경우, 미리 설정된 디폴트값에 따라 어느 하나의 방식으로 확정적으로 선택되도록 설정될 수 있다.
선택적 예측 부호화 장치

본 발명에 따른 선택적 예측 부호화 장치는 인코더 또는 디코더에 구비되며, MPEG 4 코덱의 AC/DC 예측 부호화와 AVC 코덱의 인트라 예측 부호화를 선택적으로 적용할 수 있다. 여기서, 디코더는 인코더를 포함하며, 본 발명에 따른 선택적 예측 부호화 장치는 인코더 및 디코더에 공동적으로 포함될 수 있으나, 이하, 설명의 인코더에 포함되는 경우를 기준으로 설명하기로 한다.

본 발명에 따른 선택적 예측 부호화 장치(400)는 제어부(410), AC/DC 예측부 (420), AVC 인트라 예측부(430)를 포함할 수 있다. 그리고 제어부(410)는 메크로블록 식별부(411), 예측값 비교부(413) 및 플래그 표시부(415)를 포함한다.

메크로블록 식별부(411)는 부호화할 메크로블록 인지 여부를 판단하고, 미리 설정된 처리 단위의 메크로블록에 대하여는 본 발명에 따른 선택적 예측 부호화 방법을 적용하는 기능을 수행한다.

예측값 비교부(413)는 AC/DC 예측값과 AVC 인트라 예측값을 비교하여 보다 작은 예측값을 가지는 부호화 모드로 부호화하는 기능을 수행한다.

플래그 표시부(415)는 AC/DC 예측으로 선택한 경우, 플래그 필드에 AC/DC 예측 부호화 방식으로 부호화되었음을표시하고, AVC 인트라 예측으로 선택한 경우, 플래그에 AVC 인트라 예측 부호화 방식으로 부호화되었음을 표시한다.

AC/DC 예측부(420)는 AC/DC 예측을 수행하고, AC/DC 예측값을 생성한다. 그
리고 AVC 인트라 예측부(430) AVC 인트라 예측을 수행하고, AVC 인트라 예측값을 생성한다.

성능 및 속도 비교

이하, MPEG 4를 기반으로 DC/AC 예측과 AVC에서 사용하고 있는 예측 중 16x16 블록 단위의 4가지 모드를 MPEG 4 코덱에 적용한 실험 결과를 설명하기로 한다. 여기서, 메크로 블록 단위(16x16)로 처리가 이루어지는 MPEG 4에서 실험을 수행하였다. 이하, 본 발명의 바람직한 실시예에 따른 제1 테스트 영상에 대한 성능 비교 결과를 나타낸 도 5a 및 본 발명의 바람직한 실시예에 따른 제2 테스트 영상에 대한 성능 비교 결과를 나타낸 도 5b를 기준으로 설명하기로 한다. 도면 5a 및 도면 5b에서 사용하는 실제 테스트 영상(Akiyo, Foreman)은 YUV(4:2:0) 색상 포맷, 352 * 240 의 해상도를 갖는 MPEG 공식 테스트 이미지이다. 그리고 범례(500)에서 DC/AC는 종래 MPEG 4 방식, Intra는 AVC 인트라 예측을 적용한 MPEG 4 방식, Best(bits)는 본 발명의 선택적 예측 부호화를 적용한 MPEG 4 방식을 나타낸다.

도 5a를 참조하면, AC/DC 예측을 적용한 MPEG 4(510), 인트라 예측을 적용한 MPEG 4(520), 선택적인 예측부호화를 적용한 MPEG 4(530)에 대한 RD 그래프가 도시되어 있다. 여기서, 제1 테스트영상(Akiyo)은 뉴스를 진행하는 동영상으로서, MPEG 4 방식과 Intra 예측을 적용한 MPEG 4 방식에 비해, 본 발명의 RD 곡선에서 같은 비트량에 약 0.1 db 의 영상 개선 효과가 있는 것을 볼 수 있다.
마찬가지로, 동 5b를 참조하면, AC/DC 예측을 적용한 MPEG 4(550), 인트라 예측을 적용한 MPEG 4(560), 선택적 인 예측부호화를 적용한 MPEG 4(570)에 대한 RD 그래프가 도시되어 있다. 여기서, 제 2 테스트영상(Foreman)은 공사 현장의 인부가 있는 동영상으로서, MPEG 4 방식과 Intra 예측을 적용한 MPEG 4 방식에 비해, 본 발명의 RD 곡선에서, 같은 비트당에 약 0.5db의 영상 개선 효과가 있는 것을 볼 수 있다.

【발명의 효과】

상술한 바와 같이 본 발명은 MPEG 4 코덱의 AC/DC 예측 부호화와 AVC 코덱의 인트라 예측 부호화를 선택적으로 사용하여, 압축 성능을 향상시킬 수 있는 효과가 있다.

또한, 본 발명은 부호화 기술 중 인트라 예측 코딩 방법을 선택적으로 적용함으로서, 같은 압축 효율에 비해 화질의 향상시킬 수 있는 효과도 있다.

상기에서는 본 발명의 바람직한 실시예를 참조하여 설명하였지만, 해당 기술분야에서 통상의 지식을 가진 자라면 하기의 특허 청구의 범위에 기재된 본 발명의 사상 및 영역으로부터 벗어나지 않는 범위 내에서 본 발명을 다양하게 수정 및 변경시킬 수 있음을 이해할 수 있을 것이다.
【특허청구범위】

【청구항 1】

선택적 예측 부호화 방법에 있어서,

(a) 메크로 블록에 대하여, AC/DC 예측 및 AVC 인트라 예측을 각각 수행하고, AC/DC 예측값 및 AVC 인트라 예측값을 생성하는 단계;

(b) 상기 AC/DC 예측값과 상기 AVC 인트라 예측값을 비교하여 보다 작은 예측값을 가지는 부호화 모드로 부호화 방식을 선택하는 단계; 및

(c) 상기 AC/DC 예측으로 선택한 경우, 플래그 필드에 AC/DC 예측 부호화 방식으로 부호화되었음을 표시하고, 상기 AVC 인트라 예측으로 선택한 경우 플래그 필드에 AVC 인트라 예측 부호화 방식으로 부호화되었음을 표시하는 단계

를 포함하는 것을 특징으로 하는 선택적 예측 부호화 방법.

【청구항 2】

제1항에 있어서,

상기 메크로 블록이 미리 설정된 처리 단위인지 여부를 판단하여, 미리 설정된 처리 단위의 메크로 블록에 대하여 상기 (a) 단계 내지 (c) 단계를 수행하는 것을 특징으로 하는 선택적 예측 부호화 방법.
【청구항 3】

제1항에 있어서,

상기 (b) 단계는

상기 AC/DC 예측값과 상기 AVC 인트라 예측값이 동일한 경우, 미리 설정된 기준에 따라 어느 하나의 방식으로 부호화하도록 설정된 것을 특징으로 하는 선택적 예측 부호화 방법.

【청구항 4】

선택적 예측 부호화 장치에 있어서,

미리 설정된 처리 단위의 메크로 블록에 대하여, AC/DC 예측을 수행하고, AC/DC 예측값을 생성하기 위한 AC/DC 예측부;

상기 메크로 블록에 대하여 AVC 인트라 예측을 수행하고, AVC 인트라 예측값을 생성하기 위한 AVC 인트라 예측부; 및

상기 AC/DC 예측값과 상기 AVC 인트라 예측값을 비교하여 보다 작은 예측값을 가지는 부호화 모드로 부호화 방식을 선택하도록, 상기 AC/DC 예측부 및 AVC 인트라 예측부를 제어하기 위한 제어부.

를 포함하는 것을 특징으로 하는 선택적 예측 부호화 장치.
【청구항 5】

제4항에 있어서,

상기 제5항에 있어서,

부호화할 메크로 블록이 미리 설정된 처리 단위의 메크로블록인지 여부를 판단하기 위한 메크로블록 식별부;

상기 AC/DC 예측값과 상기 AVC 인트라 예측값을 비교하여 보다 적은 예측값을 가지는 부호화 모드를 결정하기 위한 예측값 비교부; 및

상기 AC/DC 예측으로 선택한 경우, 플래그 필드에 AC/DC 예측 부호화 방식으로 부호화되었음을 표시하고, 상기 AVC 인트라 예측으로 선택한 경우 플래그 필드에 AVC 인트라 예측 부호화 방식으로 부호화되었음을 표시하기 위한 플래그 표시부를 포함하는 것을 특징으로 하는 선택적 예측 부호화 장치.

【청구항 6】

제5항에 있어서,

상기 예측값 비교부는 상기 AC/DC 예측값과 상기 AVC 인트라 예측값이 동일한 경우, 미리 설정된 기준에 따라 어느 하나의 방식으로 선택하는 것을 특징으로 하는 선택적 예측 부호화 방법.
【청구항 7】

상기 제4항 내지 제6항 중 어느 한 항에 기재된 선택적 예측 부호화 장치를 포함하는 것을 특징으로 하는 부호화 장치.

【청구항 8】

상기 제4항 내지 제6항 중 어느 한 항에 기재된 선택적 예측 부호화 장치를 포함하는 것을 특징으로 하는 복호화 장치.
【도면】

【도 1】
[도 2]

0(Vertical)  210

1(Horizontal)  220

Mean(HH)  230

3(plane)  240
[도 3]

시작

미리 설정된 액크로 볼록 처리된위?

예

AC/DC 예측
S330
S335

AC/DC 예측값 산출

아니오

AVC 인트라 예측
S340
S345

AVC 인트라 예측값 산출

그외 인트라 예측 부호화

그외 인트라 예측부호화

예

AC/DC 예측값
S350

AVC 인트라 예측값

아니오

AC/DC 플래그
S360

AVC 인트라 플래그
S370

종료
【도 4】

【도 5a】

【도 5b】
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October 24, 2005

UTILITY PATENT APPLICATION TRANSMITTAL

Attorney Docket Number: 076980.0101
First Named Inventor: Euce-S JANG et al.
Title: Selective Prediction Encoding And Decoding Methods And Selective Prediction Encoding and Decoding Devices

TO: MAIL STOP
Commissioner for Patents
U.S. Patent and Trademark Office
Customer Service Window
Randolph Building
401 Dulany Street
Alexandria, VA 22314

Sir:

Attached are the following for filing with the U.S. Patent and Trademark Office:

1. □ Fee Transmittal Form
2. ✓ Specification - Total Pages: 25 (Including Abstract)

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3. ✓ Drawings - Total Sheets: 8 (Fig(s). 1-8)
4. Oath or Declaration - Total Pages: 2

   a. □ Newly executed (original or copy)
      ✓ New (unexecuted)

   b. □ Copy from a prior application
      (for continuation/divisional with Box 17 completed)

   i. □ DELETION OF INVENTOR(s):
       Signed statement attached deleting inventor(s) named in prior application.
Commissioner for Patents  
October 24, 2005  
Page 2

5. ☐ Incorporation By Reference (useable if Box 4b is marked)  
The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under Box 4b, is considered as being part of the disclosure of the accompanying application and is hereby incorporated by reference therein.

6. ☐ CD-Rom Computer Program (Appendix)

7. ☐ Nucleotide and/or Amino Acid Sequence Submission (if applicable, all necessary)
   a. ☐ Computer Readable Copy
   b. ☐ Paper Copy (identical to computer copy)
   c. ☐ Statement verifying identity of above copies

8. ☐ Assignment and Assignment Recordation Form

9. ☐ 37 C.F.R. 3.73(b) Statement ☐ Power of Attorney

10. ☐ English Translation Document (if applicable)

11. ☐ Information Disclosure Statement with PTO-1449 and Reference(s)
    ☐ Copies of Information Disclosure Statement Citations

12. ☒ Preliminary Amendment

13. ☒ Return Receipt Postcard

14. ☐ Small Entity Statement(s) ☐ Independent Inventor  
    ☐ Small Business Concern  ☐ Non-Profit Organization
    ☐ Statement Filed in Prior Application; Status Still Proper and Desired

15. ☒ Foreign Priority is Claimed as Follows:  
    ☐ If Foreign Priority is Claimed, Certified Copy of the Above Priority Document(s) is Submitted Herewith

16. ☒ Other: _Application Data Sheet_

17. ☐ Continuation ☐ Divisional ☐ Continuation-in-Part of Prior Application No.: ____________ filed ________________
    ☐ Complete Application Based on Provisional Application No.: ____________ filed ________________

18. ☐ A new power of attorney or authorization of agent (PTO/SB/81) is as follows:
The power of attorney is to:

Please remove as power of attorney:

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20. A check in the amount of $ ___ is enclosed. In the event any variance exists between the amount enclosed and the Patent Office charges, please charge or credit any such variance to Deposit Account No. 02-0375.

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Respectfully submitted,

by: James B. Arpin
Registration No 33,470

Enclosures
BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to encoding and decoding methods and encoding and decoding devices, and more particularly, to selective prediction encoding and decoding methods and selective prediction encoding and decoding devices that can improve performance of a video codec.

2. Description of the Related Art

Generally, a video coding method can be classified into an intra-coding method of performing an intra-screen encoding method such as I frame and an inter-coding method of performing an inter-screen encoding method such as P frame or B frame. A conventional prediction encoding method of coding an intra frame will be described with reference to Figs. 1 and 2.

Fig. 1 is a diagram illustrating a quantization table used for AC/DC prediction of a conventional MPEG-4 intra coding method.

The AC/DC prediction shown in Fig. 1 is used for improving a compression ratio of a macro block in an intra mode coding. In an example of the intra mode coding used in MPEG-4 which is based on the AC/DC prediction, a
position of a current block in a reference block is determined with reference to a direction of the AC/DC coefficients of the reference block, a AC/DC prediction value of the current block is calculated, and then the current block is encoded in accordance with the calculated AC/DC prediction value by the use of an entropy (or Huffman) coding process.

The DC coefficient 100 of the current block is encoded using a difference between the DC coefficient and DC coefficients of a left or upper block. The AC coefficient 110 is encoded by the use of a Run Length coding or a Huffman coding after the values of the first row or column are predicted in the direction used in the DC prediction. A quantization table including DCT coefficients obtained by performing a DCT operation in a unit of macro block is shown in Fig. 1. Here, DC components and AC components are independently quantized. It should be noticed, however, that the DC components and the AC components are independently quantized in the intra mode, but both components are simultaneously quantized in the inter mode. In the quantization table, no predetermined value exists but the coefficients may be set individually or may have one constant value. The DC coefficient and the AC coefficient in the quantized DCT coefficients are independently predicted. A difference value between the DC coefficient of the current block and the DC coefficient of the left or upper block thereof is
encoded by the use of the entropy coding. A difference value between the AC coefficient of the current block and the AC coefficient in the first row or column of the reference block in the direction determined in the DC prediction is obtained, other AC components are encoded by the use of the entropy coding after arranging the AC component values of the current block in one line by a zigzag scan. However, it is obvious to those skilled in the art that the AC prediction may not be always performed and a block not requiring the AC prediction may exist.

Fig. 2 is an explanatory diagram illustrating an AVC (Advanced Video Coding) intra prediction of a conventional AVC intra coding method.

The AVC intra prediction shown in Fig. 2 is used for improving a coding efficiency of a macro block, by performing a prediction in four directions 210, 220, 230, and 240 with information on surround blocks in a unit of macro block and selecting one direction in which a value of motion compensation error (SAD: Sum of Absolute Difference) such as MSE (Mean Square Error) is smallest. For reference, the AVC intra prediction employs 4x4 mode (nine modes-direc tions) and 16x16 (four modes-directions) for luminance and 8x8 mode (four modes-directions) for chrominance.

Since it has been conventionally considered that the coding efficiency of the AVC intra prediction is greater than that of the AC/DC prediction, the intra coding has
been performed using only the AVC intra prediction. In some macro blocks, the AC/DC prediction may often provide a compression ratio greater than the AVC intra prediction. However, an efficient coding prediction which can utilize two predictions in parallel has not been developed. In addition, a method of efficiently decoding bit streams encoded by the use of various selective encoding methods has not been yet developed.

10 SUMMARY OF THE INVENTION

The present invention is contrived to improve performance of an MPEG-4 codec by combining the merits of the related arts. It is an object of the present invention is to provide selective prediction encoding method and device which can selectively use an AC/DC prediction encoding method of an MPEG-4 codec and an intra prediction encoding method of an AVC codec. That is, it is an object of the present invention to provide a method and a device that can selectively perform an encoding method having a high compression ratio based on an amount of compression, that is, a bit rate by applying an AVC intra prediction to MPEG-4.

It is another aspect of the present invention to provide selective prediction encoding and decoding methods and selective prediction encoding and decoding devices that can improve the compression ratio and image quality of an MPEG-4 codec by selectively using an AC/DC prediction
encoding method of an MPEG-4 codec and an intra prediction encoding method of an AVC codec and using decoding methods corresponding thereto.

It is still another aspect of the present invention to provide selective prediction encoding and decoding methods and selective prediction encoding and decoding devices that can improve image quality without variation in compression ratio by selectively using an intra prediction encoding method among encoding methods.

Other objects of the present invention will become apparent from exemplary embodiments to be described later.

According to an aspect of the present invention, there is provided a selective prediction encoding method comprising steps of: (a) performing an AC/DC prediction and an AVC (Advanced Video Coding) intra prediction to a macro block and generating code amount from AC/DC prediction and an amount of AVC intra coding; (b) selecting one of an AC/DC prediction encoding method and an AVC intra prediction encoding method, which corresponds to the smaller of the amount of AC/DC coding and the amount of AVC intra coding; and (c) performing the selected prediction encoding method to the macro block, wherein a flag indicating the AC/DC prediction encoding method is recorded in a flag field when the AC/DC prediction encoding method is selected and a flag indicating the AVC intra prediction encoding method is recorded in the flag field when the AVC intra prediction encoding method is selected.
It may be checked whether the macro block is a predetermined unit of process and then the steps (a) to (c) may be performed to the macro block, only when the macro block is the predetermined unit of process.

In the step (b), one of the AC/DC prediction encoding method and the AVC intra prediction encoding method may be selected in accordance with a predetermined criterion, when the amount of AC/DC coding and the amount of AVC intra coding are equal to each other.

The flag field may be included in an MB-layer header of a bit stream.

According to another aspect of the present invention, there is provided a selective prediction encoding device comprising: an AC/DC prediction unit performing an AC/DC prediction to a macro block and generating code amount from AC/DC prediction; an AVC (Advanced Video Coding) intra prediction unit performing AVC intra prediction to the macro block and generating an amount of AVC intra coding; and a control unit controlling the AC/DC prediction unit and the AVC intra prediction unit, selecting one of an AC/DC prediction encoding method and an AVC intra prediction encoding method which corresponds to the smaller of the amount of AC/DC coding and the amount of AVC intra coding, and performing the selected encoding method.

The control unit may check whether the macro block is a predetermined unit of process and may control the AC/DC prediction unit and the AVC intra prediction unit to
generate the amounts of coding only when the macro block is the predetermined unit of process.

The control unit may include: a coding amount comparison section comparing the amount of AC/DC coding and the amount of AVC intra coding, selecting one of the AC/DC prediction encoding method and the AVC intra prediction encoding method which corresponds to the smaller of the amount of AC/DC coding and the amount of AVC intra coding, and performing the selected encoding method; and a flag recording section recording a flag indicating the AC/DC prediction encoding method in a flag field when the AC/DC prediction encoding method is selected and recording a flag indicating the AVC intra prediction encoding method in the flag field when the AVC intra prediction encoding method is selected.

The coding amount comparison section may select one encoding method of the AC/DC prediction encoding method and the AVC intra prediction encoding method in accordance with a predetermined criterion, when the amount of AC/DC coding and the amount of AVC intra coding are equal to each other.

According to another aspect of the present invention, there is provided an encoder or a decoder comprising the selective prediction encoding device described above.

According to still another aspect of the present invention, there is provided a selective prediction decoding device comprising: a flag value recognizing unit recognizing a prediction flag value included in a header of
a received bit stream; an AC/DC decoding unit decoding the
bit stream by the use of an AC/DC prediction decoding
process; an intra decoding unit decoding the bit stream by
the use of an intra prediction decoding process; and a
control unit controlling the AC/DC decoding unit and the
intra decoding unit to activate one of the AC/DC decoding
unit and the intra decoding unit in accordance with the
prediction flag value recognized by the flag value
recognizing unit. In this case, the prediction flag value
may be recorded in a prediction flag field of an MB-layer
header of the bit stream.

According to still another aspect of the present
invention, there is provided a selective prediction
decoding method comprising steps of: recognizing a
prediction flag value included in a header of a received
bit stream; and decoding the bit stream by the use of one
of an AC/DC prediction decoding process and an intra
prediction decoding process in accordance with the
recognized prediction flag value. In this case, the
prediction flag value may be recorded in a prediction flag
field of an MB-layer header of the bit stream.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other features and advantages of the
present invention will become more apparent by describing
in detail exemplary embodiments thereof with reference to
the attached drawings in which:
Fig. 1 is a diagram illustrating a quantization table used for AC/DC prediction of a conventional MPEG-4 intra coding method;

Fig. 2 is an explanatory diagram illustrating an AVC (Advanced Video Coding) intra prediction of a conventional AVC intra coding method;

Fig. 3 is a flowchart illustrating a selective prediction encoding method according to an exemplary embodiment of the present invention;

Fig. 4 is a block diagram illustrating a selective prediction encoding device according to an exemplary embodiment of the present invention;

Fig. 5 is a diagram schematically illustrating MB-layer syntax of MPEG-4 Standard according to an exemplary embodiment of the present invention;

Fig. 6 is a flowchart illustrating a selective prediction decoding method according to an exemplary embodiment of the present invention;

Fig. 7 is a graph illustrating a performance comparison result about a first test image according to an exemplary embodiment of the present invention; and

Fig. 8 is a graph illustrating a performance comparison result about a second test image according to an exemplary embodiment of the present invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

Hereinafter, exemplary embodiments of the present
invention will be described in detail with reference to the attached drawings such that the present invention can be easily put into practice by those skilled in the art. In the drawings, like elements are denoted by like reference numerals and thus repeated description thereof is omitted.

An AVC (Advanced Video Coding) intra prediction employs $4 \times 4$ mode (nine modes-directions in a unit of $4 \times 4$ block) and $16 \times 16$ (four modes-directions in a unit of $16 \times 16$ block) for luminance and $8 \times 8$ mode (four modes-directions in a unit of $8 \times 8$ block) for chrominance. However, a unit of process having the same size is described for the purpose of convenient explanation in the following description. For example, in MPEG-4 Standard, a DCT (Discrete Cosine Transform) operation is performed using an $8 \times 8$ block as a basic unit of process, but in AVC Standard (that is, MPEG-4 AVC Standard), a transform operation is performed using a $4 \times 4$ block as a basic unit of process. A basic unit of process in the present invention may be an $n \times m$ block (where $n$ and $M$ are any natural number). Hereinafter, $8 \times 8$ blocks or $16 \times 16$ blocks used mainly in an MPEG-4 codec will be described as a basic unit of process, but the blocks in the MPEG-4 codec may be converted into $4 \times 4$ blocks which are used as a basic unit of process.

(Selective Prediction Encoding Method)

Fig. 3 is a flowchart illustrating a selective prediction encoding method according to an exemplary embodiment of the present invention.
Generally, the AC/DC prediction is used in MPEG-4 standard and the intra prediction is used in MPEG-4 AVC standard. Since the AVC standard supports the transform operation in a unit of 4×4 blocks, the intra prediction employing nine prediction models in a unit of 4×4 blocks is most suitable for the AVC codec. However, when the intra prediction is applied to MPEG-4, an efficient compression ratio cannot be obtained due to increase in bit for displaying the nine prediction models. However, in case of the 16×16 prediction model, the 16×16 intra prediction may be more efficient than the AC/DC prediction, depending upon blocks. According to the present invention, even in such a case, an efficient encoding method can be performed.

Now, the selective prediction encoding method according to an exemplary embodiment of the present invention will be described with reference to Fig. 3.

In step S310, a unit of process for a macro block to be encoded is determined. For example, the selective prediction encoding method according to the present invention can be applied to the macro block which is a predetermined unit of n×m (where n and m are a natural number) block (for example, a unit of 8×8 or 16×16 block) and in step S320, the AVC intra prediction encoding method or other intra prediction encoding methods having been developed or to be developed in the future may be performed to the other blocks. Of course, it is obvious that the selective prediction encoding method according to the
present invention can be applied to any macro block having any unit of block.

In step S330, the AC/DC prediction is performed to the macro block as a predetermined unit of process (or regardless of a unit of process) and in step S335, a value obtained through the AC/DC prediction is encoded by the use of an entropy encoding. The AC/DC prediction may be performed after the AVC prediction is performed or both predictions may be simultaneously performed.

In step S350, code amount from AC/DC prediction and an amount of AVC intra coding are compared with each other and one of an AC/DC prediction encoding method and an AVC intra prediction encoding method which corresponds to the smaller amount of coding is performed. An amount of coding means an amount obtained by encoding a predicted value by the use of the entropy coding, which is obvious to those skilled in the art. When the amount of AC/DC coding is smaller, the AC/DC prediction encoding method is selected in step S360 and a flag indicating the AC/DC prediction encoding method is recorded in a flag field (for example, a prediction flag field: see Fig. 5). Similarly, when the amount of AVC intra coding is smaller, the AVC intra prediction encoding method is selected in step S370 and a flag indicating the AVC intra prediction encoding method is recorded in the flag field. When the amount of AC/DC coding is equal to the amount of AVC intra coding, it may be set that one encoding method is selected in accordance
with a predetermined default value.

(Selective Prediction Encoding Device)

Fig. 4 is a block diagram illustrating a selective prediction encoding device according to an exemplary embodiment of the present invention.

The selective prediction encoding device according to the present invention can be provided in an encoder or a decoder and can selectively perform the AC/DC prediction encoding method of an MPEG-4 codec and the intra prediction encoding method of an AVC codec. The decoder may include the encoder and the selective prediction encoding device according to the present invention may be commonly provided in the encoder and the decoder. In the following description, it is supposed that the selective prediction encoding device according to the present invention is included in the encoder.

As shown in Fig. 4, the selective prediction encoding device 400 includes a control unit 410, an AC/DC prediction unit 420, and an AVC intra prediction unit 430. The control unit 410 includes a macro block recognizing section 411, a coding amount comparing section 413, and a flag recording section 415.

The macro block recognizing section 411 checks whether a macro block to be encoded is a predetermined macro block and performs the selective prediction encoding method according to the present invention to the macro block when it is the predetermined macro block. However,
as described above, when it is set that the present invention can be applied regardless of the unit (size) of blocks, the macro block recognizing section 411 can be omitted.

The coding amount comparing section 413 compares the amount of AC/DC coding with the amount of AVC intra coding and encodes the macro block by the use of the encoding method having the smaller amount of coding among them.

The flag recording section 415 records a flag indicating the AC/DC prediction encoding method in a predetermined flag field (for example, a prediction flag field: see Fig. 5), when the AC/DC prediction encoding method is selected, and records a flag indicating the AVC intra prediction encoding method in the predetermined flag field (for example, a prediction flag field: see Fig. 5), when the AVC intra prediction encoding method is selected.

The AC/DC prediction unit 420 performs the AC/DC prediction and generates code amount from AC/DC prediction. The AVC intra prediction unit 430 performs the AVC intra prediction and generates an amount of AVC intra coding.

(Structure of Header of Bit Stream)

Fig. 5 is a diagram schematically illustrating MB-layer syntax of MPEG-4 Standard according to an exemplary embodiment of the present invention.

The MB-layer syntax of the MPEG-4 standard shown in Fig. 5 includes a header part and a data part. The header part includes a prediction flag of k bits (where k is a
natural number) indicating which of the AC/DC prediction encoding method and the intra prediction encoding method is used.

The selective prediction encoding device according to the present invention can determine what decoding process should be used by the use of the flag value recorded in the prediction flag field.

(Selective Prediction Decoding Device)

A selective prediction decoding device according to the present invention can have a structure similar to that of a general decoding device, except that an element (for example, flag value recognizing section) recognizing the flag value recorded in the header part of the received bit stream and elements (for example, AC/DC decoding unit and intra decoding unit) performing a decoding process by the use of an inverse AC/DC prediction or an inverse intra prediction in accordance with the recognized flag value are further provided. In addition, a control unit allowing a decoding process corresponding to the recognized flag value to be performed may be further provided. Since those skilled in the art can sufficiently understand the structure of the decoding device through the explanation described above, detailed description of the decoding device will be omitted.

Fig. 6 is a flowchart illustrating a selective prediction decoding method according to an exemplary embodiment of the present invention.
Referring to Fig. 6, a decoding device receives a bit stream from an encoding device in step S610. The bit stream is a bit stream to which the AC/DC prediction encoding method and the intra prediction encoding method are selectively performed.

In step S620, the decoder checks whether a flag value recorded in a prediction flag of a header part of MB-layer syntax corresponds to the AC/DC prediction encoding method.

When the flag value corresponds to the AC/DC prediction encoding method, an MPEG-4 AC/DC prediction decoding process is performed to the bit stream in step S630.

When the flag value does not correspond to the AC/DC prediction encoding method (that is, when the flag value corresponds to the AVC intra prediction encoding method), an MPEG-4 AVC intra prediction decoding process is performed to the bit stream in step S640.

(Comparison in Performance and Bit Rate)

Now, in the AC/DC prediction and the AVC intra prediction, a result of a test in which four modes of 16x16 block are applied to the MPEG-4 codec will be described. The test was executed in accordance with MPEG-4 in which all the processes are performed in a unit of macro block (16x16). The test result is described with reference to Fig. 7 which shows a performance comparison result about a first test image according to an exemplary embodiment of the present invention and Fig. 8 which shows a performance
comparison result about a second test image according to an exemplary embodiment of the present invention. The actual test images (Akiyo and Foreman) used in Figs. 7 and 8 are formal test images for MPEG with a YUV (4:2:0) color format and a resolution of 352x288. In the figures, AC/DC indicates an MPEG-4 employing the AC/DC prediction encoding method, Intra indicates an MPEG-4 employing the AVC intra prediction encoding method, and Best (bits) indicates an MPEG-4 employing the selective prediction encoding method according to the present invention.

RD curves for MPEG-4 710 employing the AC/DC prediction encoding method, MPEG-4 720 employing the intra prediction encoding method, and MPEG-4 730 employing the selective prediction encoding method according to the present invention are shown in Fig. 7. As for the first test image (Akiyo) which is a video of news broadcasting, the RD curve of the selective prediction encoding method according to the present invention is improved in image quality by about 0.1 db for the same bit rate, compared with the conventional MPEG-4 employing the AC/DC prediction encoding method and the MPEG-4 employing the intra prediction encoding method.

Similarly, RD curves for MPEG-4 810 employing the AC/DC prediction encoding method, MPEG-4 820 employing the intra prediction encoding method, and MPEG-4 830 employing the selective prediction encoding method according to the present invention are shown in Fig. 8. As for the second
test image (Foreman) which is a video including laborers in
a site of construction, the RD curve of the selective
prediction encoding method according to the present
invention is improved in image quality by about 0.5 db for
the same bit rate, compared with the conventional MPEG-4
employing the AC/DC prediction encoding method and the
MPEG-4 employing the intra prediction encoding method.

As described above, according to the present
invention, it is possible to improve the compression
ability by selectively using the AC/DC prediction encoding
method of MPEG-4 codec and the intra prediction encoding
method of AVC codec.

According to the present invention, it is also
possible to improve the compression ratio and the image
quality of the MPEG-4 codec by selectively using the AC/DC
prediction encoding method of MPEG-4 codec and the intra
prediction encoding method of AVC codec and using a
decoding method corresponding thereto.

In addition, it is possible to improve the image
quality with the same compression efficiency by selectively
using the intra prediction encoding method among encoding
methods.

Although the exemplary embodiments and the modified
examples of the present invention have been described, the
present invention is not limited to the embodiments and
examples, but may be modified in various forms without
departing from the scope of the appended claims, the
detailed description, and the accompanying drawings of the present invention. Therefore, it is natural that such modifications belong to the scope of the present invention.
WHAT IS CLAIMED IS:

1. A selective prediction encoding method comprising steps of:
   (a) performing AC/DC prediction and AVC (Advanced Video Coding) intra prediction for each macro block and calculating the code amount from AC/DC prediction and the code amount from AVC intra prediction;
   (b) Choosing between AC/DC prediction encoding method and AVC intra prediction encoding method, which corresponds to the smaller of the code amount than the other; and
   (c) performing the selected prediction encoding method to the macro block,
       wherein a flag indicating the AC/DC prediction encoding method is recorded in a flag field when the AC/DC prediction encoding method is selected and a flag indicating the AVC intra prediction encoding method is recorded in the flag field when the AVC intra prediction encoding method is selected.

2. The selective prediction encoding method according to claim 1, wherein it is checked whether the macro block is a predetermined unit of process and the steps (a) to (c) are performed to the macro block, only when the macro block is
the predetermined unit of process.

3. The selective prediction encoding method according to claim 1, wherein in the step (b), one of the AC/DC prediction encoding method and the AVC intra prediction encoding method is selected in accordance with a predetermined criterion, when the amount of AC/DC coding and the amount of AVC intra coding are equal to each other.

4. The selective prediction encoding method according to claim 1, wherein the flag field is included in an MB-layer header of a bit stream.

5. A selective prediction encoding device comprising:

   an AC/DC prediction unit performing an AC/DC prediction to a macro block and generating code amount from AC/DC prediction;

   an AVC (Advanced Video Coding) intra prediction unit performing AVC intra prediction to the macro block and generating an amount of AVC intra coding; and

   a control unit controlling the AC/DC prediction unit and the AVC intra prediction unit, selecting one of an AC/DC prediction encoding method and an AVC intra prediction encoding method which corresponds to the smaller of the amount of AC/DC coding and the amount of AVC intra coding, and performing the selected encoding method.
6. The selective prediction encoding device according to claim 5, wherein the control unit checks whether the macro block is a predetermined unit of process and controls the AC/DC prediction unit and the AVC intra prediction unit to generate the amounts of coding only when the macro block is the predetermined unit of process.

7. The selective prediction encoding device according to claim 5, wherein the control unit includes:

a coding amount comparison section comparing the amount of AC/DC coding and the amount of AVC intra coding, selecting one of the AC/DC prediction encoding method and the AVC intra prediction encoding method which corresponds to the smaller of the amount of AC/DC coding and the amount of AVC intra coding, and performing the selected encoding method; and

a flag recording section recording a flag indicating the AC/DC prediction encoding method in a flag field when the AC/DC prediction encoding method is selected and recording a flag indicating the AVC intra prediction encoding method in the flag field when the AVC intra prediction encoding method is selected.

8. The selective prediction encoding device according to claim 7, wherein the coding amount comparison section selects one encoding method of the AC/DC prediction encoding method and the AVC intra prediction encoding
method in accordance with a predetermined criterion, when
the amount of AC/DC coding and the amount of AVC intra
coding are equal to each other.

9. An encoder comprising the selective prediction
encoding device according to any one of claims 5 to 8.

10. A decoder comprising the selective prediction
encoding device according to any one of claims 5 to 8.

11. A selective prediction decoding device comprising:
   a flag value recognizing unit recognizing a
   prediction flag value included in a header of a received
   bit stream;
   an AC/DC decoding unit decoding the bit stream by the
   use of an AC/DC prediction decoding process;
   an intra decoding unit decoding the bit stream by the
   use of an intra prediction decoding process; and
   a control unit controlling the AC/DC decoding unit
   and the intra decoding unit to activate one of the AC/DC
   decoding unit and the intra decoding unit in accordance
   with the prediction flag value recognized by the flag value
   recognizing unit.

12. The selective prediction decoding device according to
claim 11, wherein the prediction flag value is recorded in
a prediction flag field of an MB-layer header of the bit
stream.

13. A selective prediction decoding method comprising steps of:

recognizing a prediction flag value included in a header of a received bit stream; and

decoding the bit stream by the use of one of an AC/DC prediction decoding process and an intra prediction decoding process in accordance with the recognized prediction flag value.

14. The selective prediction decoding method according to claim 13, wherein the prediction flag value is recorded in a prediction flag field of an MB-layer header of the bit stream.
ABSTRACT OF DISCLOSURE

There are provided selective prediction encoding and decoding methods and selective prediction encoding and decoding devices. The selective prediction encoding device selects and performs one of an AC/DC prediction encoding method and an intra prediction encoding method which corresponds to the smaller of code amount from AC/DC prediction and an amount of AVC intra coding, records information indicating the selected encoding method in a header of a bit stream, and transmits the bit stream to the selective prediction decoding device. The selective prediction decoding device decodes the transmitted bit stream by the use of a decoding process corresponding to the information recorded in the header. Accordingly, it is possible to improve compression ratio and image quality by using the selective prediction encoding and decoding methods.
|-------------|----------------------|------------|------------|----------|-----|---------|

**FIG. 5**
START

RECEIVE BIT STREAM ~ S610

S620

CODE AMOUNT FROM AC/DC PREDICTION IS INCLUDED?

NO

YES ~ S630

DECODE BIT STREAM BY USING INVERSE AC/DC PREDICTION

DECODE BIT STREAM BY USING INVERSE INTRA PREDICTION

S640

END
DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

As the below named inventor(s), I/we declare that:

This declaration is directed to:

☑ The attached application, or
☐ Application No. __________________, filed on ________________

☐ as amended on __________________________ (if applicable);

I/we believe that I/we am/are the original and first inventor(s) of the subject matter which is claimed and for which a patent is sought;

I/ we have reviewed and understand the contents of the above-identified application, including the claims, as amended by any amendment specifically referred to above;

I/we acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me/us to be material to patentability as defined in 37 CFR 1.56, including material information which became available between the filing date of the prior application and the National or PCT International filing date of the continuation-in-part application, if applicable; and

All statements made herein of my/own knowledge are true, all statements made herein on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001, and may jeopardize the validity of the application or any patent issuing thereon.

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Burden Hour Statement: This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is used by the public to file (and the PTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This form is estimated to take 1 minute to complete. This time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Assistant Commissioner for Patents, Washington, DC 20231.
DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

As the below named inventor(s), I/we declare that:

This declaration is directed to:

☑️ The attached application, or
☐ Application No. __________________, filed on____________________ ,
  ☐ as amended on _______________________(if applicable);

I/we believe that I/we am/are the original and first inventor(s) of the subject matter which is claimed and for which a patent is sought;

I/ we have reviewed and understand the contents of the above-identified application, including the claims, as amended by any amendment specifically referred to above;

I/we acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me/us to be material to patentability as defined in 37 CFR 1.56, including material information which became available between the filing date of the prior application and the National or PCT International filing date of the continuation-in-part application, if applicable; and

All statements made herein of my/own knowledge are true, all statements made herein on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001, and may jeopardize the validity of the application or any patent issuing thereon.

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Burden Hour Statement: This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is used by the public to file (and the PTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This form is estimated to take 1 minute to complete. This time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Assistant Commissioner for Patents, Washington, DC 20231.
Preliminary Amendment

Commissioner for Patents
U.S. Patent and Trademark Office
Customer Service Window
Randolph Building
401 Dulany Street
Alexandria, VA 22314

Sir:

Please amend the above-captioned, patent application prior to the first Office Action on the merits and calculate the excess claim fees due based on the amended claims, as follows:

Amendments to the Claims are reflected in the listing of claims which begins on page 2 of this paper.

Remarks and Conclusion begin on page 6 of this paper.
Amendments to the Claims:
This listing of claims will replace all prior versions and listings of the claims in the above-referenced patent application:

Listing of Claims:
Claim 1.  (Currently Amended) A selective prediction encoding method for identifying an encoding method for a macro block, comprising the steps of:

(a) performing AC/DC prediction and AVC—(Advanced Video Coding (AVC) intra prediction for each said macro block; and calculating the generating an AC/DC code amount from AC/DC prediction and the an AVC code amount from AVC intra prediction for said macro block;

(b) Choosing selecting between an AC/DC prediction encoding method and an AVC intra prediction encoding method for said macro block, the method which corresponds to the smaller of the said AC/DC code amount and said AVC code amount than the other; and

(e) performing the selected prediction encoding method to the said macro block; and,

wherein a recording an AC/DC flag indicating the AC/DC prediction encoding method is recorded in a flag field when the AC/DC prediction encoding method is selected and [[a]] an AVC flag indicating the AVC intra prediction encoding method is recorded in the flag field when the AVC intra prediction encoding method is selected.

Claim 2.  (Currently Amended) The selective prediction encoding method according to claim 1, further comprising the step of checking wherein it is checked whether the said macro block is a predetermined unit of process and performing the steps (a) to (e) of claim 1 are performed to the macro block, only when the said macro block is the one of said predetermined units of process.

Claim 3.  (Currently Amended) The selective prediction encoding method according to claim 1, wherein in the step of selecting (b), further comprises selecting one of the AC/DC prediction encoding method and the AVC intra prediction encoding method is selected in accordance with a predetermined criterion, when the said AC/DC code amount of AC/DC encoding and the said AVC code amount of AVC intra coding are equal to each other.

Claim 4.  (Original) The selective prediction encoding method according to claim 1, wherein the flag field is included in an MB-layer header of a bit stream.
Claim 5. (Currently Amended) A selective prediction encoding device for encoding a macro block, comprising:

an AC/DC prediction unit for performing an AC/DC prediction to a macro block and for generating an AC/DC code amount for said macro block from AC/DC prediction;

an AVC (Advanced Video Coding (AVC)) intra prediction unit for performing AVC intra prediction to the said macro block and for generating an AVC code amount of AVC intra coding; and

a control unit, said control unit controlling the AC/DC prediction unit and the AVC intra prediction unit, selecting one of an AC/DC prediction encoding method and an AVC intra prediction encoding method, which method corresponds to the smaller of the said AC/DC code amount and said AVC code amount of AC/DC coding and the amount of AVC intra coding, and performing the selected encoding method.

Claim 6. (Currently Amended) The selective prediction encoding device according to claim 5, wherein the said control unit checks whether the said macro block is a predetermined unit of process and controls the AC/DC prediction unit and the AVC intra prediction unit to generate the amounts of coding said AC/DC code amount and said AVC code amount only when the said macro block is the one of said predetermined units of process.

Claim 7. (Currently Amended) The selective prediction encoding device according to claim 5, wherein the said control unit includes:

a coding amount comparison section, said coding amount comparison section comparing the amount of AC/DC coding and the amount of AVC intra coding, selecting one of the AC/DC prediction encoding method and the AVC intra prediction encoding method which corresponds to the smaller of the said AC/DC code amount and said AVC code amount of AC/DC coding and the amount of AVC intra coding, and performing the selected encoding method; and

a flag recording section, said flag recording section recording a flag indicating the AC/DC prediction encoding method in an AC/DC flag field when the AC/DC prediction encoding method is selected and recording an AVC flag indicating the AVC intra prediction encoding method in the flag field when the AVC intra prediction encoding method is selected.
Claim 8. (Currently Amended) The selective prediction encoding device according to claim 7, wherein the coding amount comparison section selects one encoding method of from between the AC/DC prediction encoding method and the AVC intra prediction encoding method in accordance with a predetermined criterion, when the said AC/DC code amount and said AVC code amount of AC/DC coding and the amount of AVC intra coding are equal to each other.

Claim 9. (Currently Amended) An encoder comprising the selective prediction encoding device according to any one of claims claim 5 to 8.

Claim 10. (Currently Amended) A decoder comprising the selective prediction encoding device according to any one of claims claim 5 to 8.

Claim 11. (Currently Amended) A selective prediction decoding device comprising:

- a flag value recognizing unit for recognizing a prediction flag value included in a header of a received bit stream;
- an AC/DC decoding unit for decoding the bit stream by the use of an AC/DC prediction decoding process;
- an intra decoding unit for decoding the bit stream by the use of an intra prediction decoding process; and
- a control unit for controlling the said AC/DC decoding unit and the said intra decoding unit to activate, whereby one of the said AC/DC decoding unit and the said intra decoding unit is activated in accordance with the prediction flag value recognized by the said flag value recognizing unit.

Claim 12. (Original) The selective prediction decoding device according to claim 11, wherein the prediction flag value is recorded in a prediction flag field of an MB-layer header of the bit stream.

Claim 13. (Currently Amended) A selective prediction decoding method for identifying a decoding method for a macro block, comprising the steps of:

- recognizing a prediction flag value identifying either an AC/DC coded macro block or an intra coded macro block, which flag value is included in a header of a received bit stream; and
decoding the said received bit stream by the use of one of an AC/DC prediction decoding process and an intra prediction decoding process in accordance with the recognized prediction flag value.

Claim 14. (Original) The selective prediction decoding method according to claim 13, wherein the prediction flag value is recorded in a prediction flag field of an MB-layer header of the bit stream.

Claim 15. (New) An encoder comprising the selective prediction encoding device according to claim 6.

Claim 16. (New) An encoder comprising the selective prediction encoding device according to claim 7.

Claim 17. (New) An encoder comprising the selective prediction encoding device according to claim 8.

Claim 18. (New) A decoder comprising the selective prediction encoding device according to claim 6.

Claim 19. (New) A decoder comprising the selective prediction encoding device according to claim 7.

Claim 20. (New) A decoder comprising the selective prediction encoding device according to claim 8.
Remarks:

Applicants are amending claims 9 and 10, so that those claims are no longer in multiple dependent form and is adding new claims 15-20. Applicants also are amending claims 1-3, 5-8, 11, and 13 to clarify claim language. This amendment is intended to reduce the filing fees and to facilitate and expedite prosecution, and the scope of the claims is not narrowed by this amendment. No new matter is added by these amendments, and these amendments are fully supported by the specification. Applicants respectfully request entry of these amendments.

This amendment does not change the total number of independent claims present in the application. Moreover, no additional excess claim fees are required as a result of this amendment, and, as a result of this amendment, no multiple dependent claim fee now is due. Nevertheless, in the event of any variance between the fees determined by Applicants and those determined by the U.S. Patent and Trademark Office, please charge or credit any such variance to the Undersigned’s Deposit Account No. 02-0375.

Conclusion:

Applicants respectfully submit that this application, as amended, is in condition for allowance, and such disposition is earnestly solicited. If the Examiner believes that an interview with Applicants’ representatives, either in person or by telephone, would expedite prosecution of this application, we would welcome such an opportunity.

Respectfully submitted,
BAKER BOTTS L.L.P.

Dated: October 24, 2005

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Application Data Sheet

Application Information
Application Type:: Regular
Subject Matter:: Utility
Title:: Selective Prediction Encoding And Decoding Methods And Selective Prediction Encoding And Decoding Devices
Attorney Docket Number:: 076980.0101
Request for Early Publication?:: No
Request for Non-Publication?:: No
Suggested Drawing Figure:: 1
Total Drawing Sheets:: 8
Small Entity:: No

Applicant Information
Applicant Authority Type:: Inventor
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Family Name:: Jang
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Country of Residence:: Republic of Korea
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Applicant Authority Type:: Inventor
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Given Name:: Yung-Lyul
Family Name:: Lee

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Country of Residence: Republic of Korea
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                        192 Garak-dong, Songpa-gu
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Applicant Information
Applicant Authority Type: Inventor
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Country of Residence: Republic of Korea
Street of mailing address: #707 Sanhak Bldg., Hanyang University
                        Haendang1-dong, Seongdong-gu
Postal or Zip Code: 133-791

Applicant Information
Applicant Authority Type: Inventor
Primary Citizenship
Country: Republic of Korea

DC01:428747

Initial 10/24/05
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**Applicant Information**

**Applicant Authority Type::** Inventor

**Primary Citizenship**

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**Applicant Information**

**Applicant Authority Type::** Inventor

**Primary Citizenship**

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Correspondence Information
Correspondence Customer
Number:: 24735
Phone Number:: (202) 639-7700
Fax: Number:: (202) 639-7890
E-Mail address:: jim.arpin@bakerbotts.com

Representative Information
Domestic Priority Information
Foreign Priority Information

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Assignment Information
Assignee name:: HUMAX Co., Ltd.
Street or mailing address:: HUMAX Venture Tower 271-2,
Seohyeon-dong, Bundang-gu
City of mailing address:: Seongnam-si Gyeonggi-do
Country of mailing address:: Republic of Korea
Postal or Zip Code of mailing address:: 463-050
## PATENT APPLICATION FEE DETERMINATION RECORD

### Application as Filed - Part I

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**BASIC FEE**
(37 CFR 1.16(a), (b), or (c))
- Rate: $300
- Fee: $500

**SEARCH FEE**
(37 CFR 1.16(b), (i), or (m))
- Rate: $200

**EXAMINATION FEE**
(37 CFR 1.16(i), (p), or (q))
- Rate: $100
  - Number of Claims: 20
  - Rate: $25
  - Fee: $50

**INDEPENDENT CLAIMS**
(37 CFR 1.16(b))
- Rate: $100
- Fee: $200

**APPLICATION SIZE FEE**
(37 CFR 1.16(s))
- If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR
- Rate: $1200
- Fee: $1200

**MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(i))**
- Rate: N/A
- Fee: N/A

*If the difference in column 1 is less than zero, enter "0" in column 2.

### Application as Amended - Part II

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**AMENDMENT A**
(37 CFR 1.16(i))
- Rate: N/A
- Fee: N/A

**AMENDMENT B**
(37 CFR 1.16(i))
- Rate: N/A
- Fee: N/A

*If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or independent) is the highest number found in the appropriate box in column 1.

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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