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.

/ytdemisse/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101
NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

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

- The Power of Attorney to you in this application has been revoked by the assignee who has intervened as provided by 37 CFR 3.71. Future correspondence will be mailed to the new address of record (37 CFR 1.33).

/ytdemisse/

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):

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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 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

State

Zip

Country

Telephone

Email

Assignee Name and Address:

HUMAX HOLDINGS CO., LTD.
(Yubang-dong) 2, Yeongmun-ro, Cheoin-gu
Yongin-si, Gyeonggi-do 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 are supplied below is authorized to act on behalf of the assignee.

Signature

Date 29, May 2014

Name Yongdae, LEE

Telephone +82 31 776 6243

Title Assistant Manager (PLEASE PROVIDE)

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. 93-579) 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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**Title of Invention:** IMAGE DOWN-SAMPLING TRANSCODING METHOD AND DEVICE

| First Named Inventor/Applicant Name: | Yung-Lyul Lee |
| Customer Number: | 24735 |
| Filer: | Esther Hyeri Chong/Jody Mazzarse |
| Filer Authorized By: | Esther Hyeri Chong |
| Attorney Docket Number: | 076980.0104 |
| Receipt Date: | 08-SEP-2014 |
| Filing Date: | 30-NOV-2005 |
| Time Stamp: | 17:13:05 |
| Application Type: | Utility under 35 USC 111(a) |

**Payment information:**

Submitted with Payment: no

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**Warnings:**

**Information:**

| Total Files Size (in bytes) | 287441 |

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 11/289,649 Conf. No.: 5884
Filing Date November 30, 2005
First Named Inventor Yung-Lyul LEE et al.
Art Unit 2625
Examiner Name D. POPOVICI
Attorney Docket Number 5200-0125PUS1

Total Number of Pages in This Submission 4

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

☐ After Allowance Communication to TC
☐ Appeal Communication to Board of Appeals and Interferences
☐ Appeal Communication to TC (Appeal Notice, Brief, Reply Brief)
☐ Proprietary Information
☐ Status Letter
☐ Other Enclosure(s) (please identify below):
  Statement Under 3.73(b) and Power of Attorney

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/Patent Owner: HUMAX HOLDINGS CO., LTD.

Application No./Patent No.: 7,933,336 Filed/Issue Date: April 26, 2011

Titled: IMAGE DOWN-SAMPLING TRANSCODING METHOD AND DEVICE

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: Yung-Lyul LEE et al. To: HUMAX CO., LTD.

      The document was recorded in the United States Patent and Trademark Office at
      Reel 017280, Frame 0948, 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

Date

Esther H. Chong, Reg. No. 40953

Printed or Typed Name

Title

NOTE: 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 1.11 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.
UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICATION NO. | ISSUE DATE | PATENT NO. | ATTORNEY DOCKET NO. | CONFIRMATION NO.
---|---|---|---|---
11/289,649 | 04/26/2011 | 7933336 | 076980.0104 | 5884

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

ISSUE NOTIFICATION

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 1547 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):

Yung-Lyul Lee, Seoul, KOREA, REPUBLIC OF;
Euee-S. Jang, Seoul, KOREA, REPUBLIC OF;
Chung-Ku Lee, Inchon, KOREA, REPUBLIC OF;

IR103 (Rev. 10/09)
**PART B - FEE(S) TRANSMITTAL**

Complete and send this form, together with applicable fee(s), to: 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
12/16/2010

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

**APPLICATION NO.** 11/289,649 **FILING DATE** 11/30/2005 **FIRST NAMED INVENTOR** Yung-Lyul Lee **ATTORNEY DOCKET NO.** 076980.0104 **CONFIRMATION NO.** 5884

**TITLE OF INVENTION:** IMAGE DOWN-SAMPLING TRANSCODING METHOD AND DEVICE

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1. Change of correspondence address or indication of “Fee Address” (37 CFR 1.362).
   - Change of correspondence address (or Change of Correspondence Address Form PTO/SB/122) attached.
   - “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 recordation as set forth in 37 CFR 3.11. Completion of this form is **NOT** a substitute for filing as assignment.

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

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

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

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

4b. Payment of Fee(s): (Please first reapply any previously paid issue fee shown above)
   - [X] Payment by check enclosed.
   - [X] Payment by credit card. Form PTO-2038 is attached.
   - [X] The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment, to Deposit Account Number 020579 (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/
   James B. Arpin

   **Date** 2011-03-16
   **Registration No.** 33470

This collection of information is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by which the public 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.

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Filed as Large Entity

### Utility under 35 USC 111(a) Filing Fees

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<th><strong>First Named Inventor/Applicant Name:</strong></th>
<th>Yung-Lyul Lee</th>
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<td><strong>Customer Number:</strong></td>
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<tr>
<td><strong>Filer:</strong></td>
<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.

**Total Files Size (in bytes):** 211952
IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:  
Yung-Lyul LEE et al.  

Application No.: 11/289,649  

Filed: November 30, 2005  

For: IMAGE DOWN-SAMPLING TRANSCODING METHOD AND DEVICE  

Examiner: Dov POPOVICI  

Group Art Unit: 2625  

Confirmation No. 5884  

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 December 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: March 16, 2011

By: /James B. Arpin/
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
Courtesy Reminder for
Application Serial No: 11/289,649
Attorney Docket No: 076980.0104
Customer Number: 24735
Date of Electronic Notification: 12/16/2010

This is a courtesy reminder that new correspondence is available for this application. The official date of notification of the outgoing correspondence will be indicated on the form PTOL-90 accompanying the correspondence.

An email notification regarding the correspondence was sent to the following email address(es) associated with your customer number:

darlene.hoskins@bakerbotts.com
oneka.davis@bakerbotts.com
usptocorrespondence@bakerbotts.com

Please verify that these email addresses are correct.

To view your correspondence online or update your email addresses, please visit us anytime at https://sporal.uspto.gov/secure/myportal/privatepair. If you have any questions, please email the Electronic Business Center (EBC) at EBC@uspto.gov or call 1-866-217-9197.
NOTICE OF ALLOWANCE AND FEE(S) DUE

24735 7590 12/16/2010

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

EXAMINER
POPOVICI, DOV
ART UNIT 2625
DATE MAILED: 12/16/2010
PAPER NUMBER

APPLICATION NO.  FILING DATE  FIRST NAMED INVENTOR  ATTORNEY DOCKET NO.  CONFIRMATION NO.
11/289,649  11/30/2005  Yung-Lyul Lee  076980.0104  5884

TITLE OF INVENTION: IMAGE DOWN-SAMPLING TRANSCODING METHOD AND DEVICE

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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.
**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  

**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  
12/16/2010

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

**APPLICATION NO.**  
**FILING DATE**  
**FIRST NAMED INVENTOR**  
**ATTORNEY DOCKET NO.**  
**CONFIRMATION NO.**

11/289,649  
11/30/2005  
Yung-Lyul Lee  
076980.0104  
5884

**TITLE OF INVENTION:** IMAGE DOWN-SAMPLING TRANSCODING METHOD AND DEVICE

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**EXAMINER**  
POPOVICI, DOV  
2625  
375-240120

**ART UNIT**  
CLASS-SUBCLASS

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

- Change of correspondence address (or Change of Correspondence Address Form PT/SB/122) attached.
- "Fee Address" indication (or "Fee Address" Indication form PTOSB/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, the names 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.
   2. 2
   3. 3

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

   (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.
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 1259 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 1259 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

Application No. 11/289,649
Applicant(s) LEE ET AL.
Examiner Dov Popovici
Art Unit 2625

-- 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 on 10/12/2010.

2. ☒ The allowed claim(s) is/are 1-3 and 5-33, renumbered as claims 1-32.

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 Draftsperson'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/SB/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 20101210
7. ☒ Examiner's Amendment/Comment
8. ☒ Examiner's Statement of Reasons for Allowance
9. ☐ Other ______.

/Dov Popovici/
Primary Examiner, Art Unit 2625
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<tr>
<td>(1) <strong>Dov Popovici.</strong></td>
<td>(3) ____</td>
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<tr>
<td>(2) <strong>James Arpin (Reg. No. 33,470).</strong></td>
<td>(4) ____</td>
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**Date of Interview:** 10 December 2010  
**Time:** 5:49 P.M.

**Type of Interview:**  
- [x] Telephonic  
- [ ] Video Conference  
- [ ] Personal (Copy given to: [ ] Applicant [ ] Applicant’s representative)

**Exhibit Shown or Demonstrated:**  
- [ ] Yes  
- [x] No  
If Yes, provide a brief description:  

**Part I.**  
Rejection(s) discussed:

Claims discussed:  
6, 9, 18

Prior art documents discussed:

**Part II.**  
SUBSTANCE OF INTERVIEW DESCRIBING THE GENERAL NATURE OF WHAT WAS DISCUSSED:  
An examiner's amendment was discussed and agreed to on 12/09/2010 and 12/10/2010 (see attached examiner's amendment for more specific details).

**Part III.**  
- [x] 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.

/Dov Popovici/  
Primary Examiner, Art Unit 2625

(Applicant/Applicant’s Representative Signature – if appropriate)
EXAMINER’S AMENDMENT

An 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 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

Authorization for this examiner’s amendment was given in a telephone interview with James Arpin (Reg. No. 33,470) on 12/09/2010 and 12/10/2010.

The application has been amended as follows:

In the claims:

In claim 6, line 2, change “4” to --1--.

In claim 9, line 5, change “‖ 1” to --± 1--.

In claim 18, line 10, change "in." to --in--.

REASONS FOR ALLOWANCE

The following is an examiner’s statement of reasons for allowance:

The closest prior art of record, namely, Lee (US 2005/0135486 A1) does not disclose, teach or suggest, wherein the block mode in step (a) is determined, at least in part, by the use of an SAD comparison method for macro blocks, when the first macro block includes some intra blocks, as recited in independent claim 1.

The closest prior art of record, namely, Lee (US 2005/0135486 A1) does not disclose, teach or suggest, wherein the predetermined condition comprises that any one
of the candidate block modes is determined as the block mode by the use of a SAD comparison method of macro blocks included in the first macro block, when two or less intra macro blocks are included in the first macro block, as claimed in independent claim 10.

The closest prior art of record, namely, Lee (US 2005/0135486 A1) does not disclose, teach or suggest, wherein the first conversion unit determines the block mode, at least in part, by the use of an SAD comparison method for macro blocks, when the first macro block includes some intra macro blocks, as recited in independent claim 18.

The closest prior art of record, namely, Lee (US 2005/0135486 A1) does not disclose, teach or suggest, wherein the predetermined condition comprises that any one of the candidate block modes is determined as the block mode by the use of a SAD comparison method of macro blocks included in the first macro block, when two or less intra macro blocks are included in the first macro block, as claimed in independent claim 22.

Furthermore, independent claims 1, 10, 18 and 22 are found to be allowable over the closest prior art of record for the reasons stated in applicant remarks filed on 10/12/2010.

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

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Dov Popovici whose telephone number is 571-272-4083. The examiner can normally be reached on Monday-Thursday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner’s supervisor, Edward Coles can be reached on 571-272-7402. 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.

/Dov Popovici/
Primary Examiner, Art Unit 2625
**Index of Claims**

*1128964*

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**Search Notes**

**11289649**

**Application/Control No.**
11289649

**Applicant(s)/Patent Under Reexamination**
LEE ET AL.

**Examiner**
Dov Popovici

**Art Unit**
2625

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## SEARCH NOTES

- **Search Notes**
  - East Search - See attached East Search History - (S1 to S135) - text search with the search area listed above, text search in the US-PGPUB, USPAT and UPAD databases and within the claims and with the search area listed below (Interference Search), and Inventor Name Search
  - Date: 12/08/2010 and 12/09/2010
  - Examiner: D.P.
- **Inventor Name Search**
  - Date: 12/09/2010
  - Examiner: D.P.
- **Consulted with Andy Rao and Young Lee in class 375**
  - Date: 6/29/2010
  - Examiner: D.P.

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## INTERFERENCE SEARCH

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/U/Dov Popovici/
Primary Examiner, Art Unit 2625
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(Primary Examiner)  (Date)  
/Dov Popovici/
Primary Examiner, Art Unit 2625

O.G. Print Claim(s)  O.G. Print Figure
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U.S. Patent and Trademark Office  Part of Paper No. 20101210
RESPONSIVE AMENDMENT UNDER 37 C.F.R. § 1.111

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Sir:

In response to the Office Action, of which the U.S. Patent and Trademark Office ("PTO") notified Applicants on July 12, 2010, please reconsider the above-captioned patent application in view of the amendments and arguments, as follows:

Amendments to the Abstract of the Disclosure begin on page 2 of this paper.

Amendments to the Specification begin on page 3 of this paper.

Amendments to the Claims are reflected in the listing of claims which begins on page 5 of this paper.

Request for Reconsideration begins on page 15 of this paper.

Remarks begin on page 16 of this paper.

Conclusion begins on page 20 of this paper.
Amendments to the Abstract of the Disclosure:

Please replace the Abstract of the Disclosure with the following amended Abstract of the Disclosure:

**ABSTRACT**

Methods and devices are provided for downsampling an image from H.264 to MPEG-4 at a high speed. The image down-sampling transcoding method for converting a first macro block having a first format into a second macro block having a second format includes: (a) determining a block mode of the second macro block and converting the first macro block into the second macro block with the determined block mode, when the number of intra macro blocks included in the first macro block satisfies a first condition; (b) determining a block mode of the second macro block and converting the first macro block into the second macro block with the determined block mode, when the number for inter macro blocks included in the first macro block satisfies a second condition; and (c) re-adjusting a motion vector of the second macro block, after the conversion of the first macro block into the second macro block is finished.
Amendments to the Specification:

Please replace the paragraph at Page 5, Line 25, through Page 6, Line 6, with the following amended paragraph:

The re-adjustment of the motion vector may be performed using the following equation:

\[ MV_{i,j} = \left( \sum_{k=0}^{3} \sum_{l=0}^{3} \frac{mv_{m,n,k,l}}{\sum_{k=0}^{3} \sum_{l=0}^{3} l} \right) \gg 2, \quad i, j = 0,1 \]

where m and n denote coordinate values in the axis of the abscissa and the axis of ordinate in an 8x8 mode block which is an intermediate macro block and k and l denote coordinate values in the axis of the abscissa and the axis of ordinate in a 4x4 mode block corresponding to the (m,n)-th macro block in 2x2 macro blocks.

Please replace the paragraph at Page 10, Lines 1-7, with the following amended paragraph:

Generally, the simplest method for converting macro blocks (MB) in an H.264 frame into macro blocks in an MPEG-4 frame is a cascaded pixel-domain transcoding method of decompressing the compressed H.264 frame to be input and then compressing again the decompressed frame in accordance with MPEG-4. However, however, in such a method, since a motion estimation process of all the macro blocks in the whole frame is performed by an MPEG-4 encoder, real-time transmission by a transcoder can be hindered due to a large amount of calculation.

Please replace the paragraph at Page 16, Lines 11-14, with the following amended paragraph:

As shown in Fig. 4, when the 2x2 macro blocks in H.264 are input (S410), the 2x2 MB type in H.264 is converted into a 1x1 MB type in accordance with the conditions (S420S415) and then the down-sampling is performed by the use of the average filter (S430S420).
Please replace the paragraph at Page 20, Lines 1-5, with the following amended paragraph:

As can be seen from Table 2 and Fig. 6, in the transcoding method according to the invention, only the MPEG-4 block modes having a relatively high frequency at the time of converting the macro blocks having a predetermined size from H.264 to MPEG-4 can be considered. At this time, the features of the 2x2 macro blocks in H.264 can be used.

Please replace the paragraph at Page 21, Lines 15-18, with the following amended paragraph:

In addition, the transcoder for converting a macro block from H.264 to MPEG-4 can permit the use of images compressed in accordance with H.264, which is a new standard for compressing a moving picture, without replacing devices employing an existing MPEG-4 codec.
Amendments to the Claims
This listing of the claims replaces all prior versions and listings of the claims in the above-captioned patent application.

Listing of Claims:
Claim 1. (Currently Amended) An image down-sampling transcoding method for converting a first macro block having a first format into a second macro block having a second format, the image down-sampling transcoding method comprising:

(a) determine a block mode of the second macro block having a CxD size (where C and D are natural numbers) and converting the first macro block into the second macro block with the determined block mode, when the number of intra macro blocks included in the first macro block having a AxB size (where A and B are natural numbers) satisfies a first condition;

(b) determining a block mode of the second macro block and converting the first macro block into the second macro block with the determined block mode, when the number for inter macro blocks included in the first macro block satisfies a second condition; and

(c) re-adjusting a motion vector of the second macro block, after the conversion of the first macro block into the second macro block is finished,

wherein the block mode in step (a) is determined, at least in part, by the use of an SAD comparison method for macro blocks, when the first macro block includes some intra blocks.

Claim 2. (Original) The image down-sampling transcoding method according to claim 1, wherein the first macro block is converted into the second macro block with the determined block mode while being down-sampled by the use of an average filter.

Claim 3. (Previously Presented) The image down-sampling transcoding method according to claim 1, wherein step (a) includes converting the first macro block into one intra macro block, when the first macro block includes only the intra macro blocks.

Claim 4. (Canceled).
Claim 5. (Previously Presented) The image down-sampling transcoding method according to claim 1, wherein step (b) includes:

converting the first macro block into the second macro block with the inter mode when the number of inter macro blocks is greater than or equal to a predetermined number or when a difference value between the motion vectors is calculated and the difference value is less than or equal to a predetermined value; and

determining the block mode by the use of an SAD comparison method of macro blocks and converting the first block into the second block with the determined block mode in the other cases.

Claim 6. (Previously Presented) The image down-sampling transcoding method according to claim 4, wherein the SAD comparison method includes:

calculating SADs between two inter macro blocks and determining the least inter SAD; and

converting the first macro block into the second macro block with the block mode corresponding to the least SAD by comparing the least inter SAD with the predetermined intra SAD.

Claim 7. (Currently Amended) The image down-sampling transcoding method according to claim 6, wherein a mean pixel value of a macro block is calculated by the following expression:

\[ MB_{\text{mean}} = \sum_{i=0}^{15} \sum_{j=0}^{15} \text{org}_{i,j} \]

where \( \text{org}_{i,j} \) denotes pixel values of 16x16 pixels in a macro block and \( MB_{\text{mean}} \) denotes the mean pixel value of a macro block, and

wherein the intra SAD is calculated by the following expression:

\[ SAD_{\text{INTRA}} = \sum_{i=0}^{15} \sum_{j=0}^{15} \text{org}_{i,j} - MB_{\text{mean}} \]

wherein the intra SAD is calculated by the following expression.
Claim 8.  (Original) The image down-sampling transcoding method according to claim 1, wherein the re-adjustment of the motion vector is performed by the use of the following expression:

$$ MV_{i,j} = \left( \frac{\sum_{k=0}^{3} \sum_{l=0}^{3} m_{m,n,k,l}}{\sum_{k=0}^{3} \sum_{l=0}^{3} l} \right) > 2, \quad i, j = 0, 1 $$

where m and n denote coordinate values in the axis of abscissa and the axis of ordinate in an 8x8 mode block which is an intermediate macro block and k and l denote coordinate values in the axis of abscissa and the axis of ordinate in a 4x4 mode block corresponding to the (m,n)-th macro block in 2x2 macro blocks.

Claim 9.  (Currently Amended) The image down-sampling transcoding method according to claim 1, wherein step (e) includes:

searching for an integer pixel motion vector in ±3 neighboring pixels about an integer pixel motion vector; and

searching for a half pixel motion vector in ±1 neighboring pixels about the searched integer pixel motion vector.

Claim 10.  (Currently Amended) An image down-sampling transcoding method for converting a first macro block having a first format into a second macro block having a second format, the image down-sampling transcoding method comprising:

determining any one of candidate block modes having the second format, which is determined in accordance with a predetermined condition by types of macro blocks included in the first macro block having a predetermined size, as a block mode of the second macro block and converting the first macro block into the second macro block with the determined block mode; and

re-adjusting a motion vector of the second macro block, after the conversion of the first macro block into the second macro block is finished,

wherein the predetermined condition comprises that any one of the candidate block modes is determined as the block mode by the use of a SAD comparison method of macro blocks.
included in the first macro block, when two or less intra macro blocks are included in the first macro block.

Claim 11.  (Original) The image down-sampling transcoding method according to claim 10, wherein the predetermined condition is that one intra macro block having the second format is determined as the block mode when three or more intra macro blocks are included in the first macro block.

Claim 12.  (Currently Amended) The image down-sampling transcoding method according to claim 10, wherein the predetermined condition is that anyone of the candidate block modes is determined as the block mode by the use of a SAD comparison method of macro blocks included in the first macro block, when two or less intra macro blocks are included in the first macro block, and

wherein the candidate block modes include one or more of a skip mode, an inter 16x16 mode, and an inter 8x8 mode.

Claim 13.  (Currently Amended) The image down-sampling transcoding method according to claim 10, wherein the predetermined condition [[is]] comprises that any one of the candidate block modes is determined as the block mode by the use of a SAD comparison method of macro blocks, when only inter macro blocks are included in the first macro block and two or less macro blocks in the inter 16x16 mode are included in the inter macro blocks, and

wherein the candidate block modes include one or more of a skip mode, an inter 16x16 mode, and an inter 8x8 mode.
Claim 14. (Currently Amended) The image down-sampling transcoding method according to claim 12 [[or 13]], wherein when a difference between the motion vectors in the respective macro blocks is calculated and the difference is less than or equal to a predetermined threshold value, any one of the inter 16x 16 mode and the skip mode is determined as the block mode and in the other cases, the inter 8x8 mode is determined as the block mode.

Claim 15. (Currently Amended) The image down-sampling transcoding method according to claim 12 [[or 13]], wherein any one of the candidate block modes is a block mode having the least SAD value.

Claim 16. (Currently Amended) The image down-sampling transcoding method according to claim 12, wherein a mean pixel value of a macro block is calculated by the following expression:

\[ MB_{\text{mean}} = \sum_{i=0}^{15} \sum_{j=0}^{15} \text{org}_{i,j} \]

where \( \text{org}_{i,j} \) denotes pixel values of 16x 16 pixels in a macro block and \( MB_{\text{mean}} \) denotes the mean pixel value of a macro block, and

wherein the intra SAD is calculated by the following expression[[.]]:

\[ SAD_{\text{INTRA}} = \sum_{i=0}^{15} \sum_{j=0}^{15} \text{org}_{i,j} - MB_{\text{mean}}^2 \]

Claim 17. (Original) The image down-sampling transcoding method according to claim 10, wherein the re-adjustment of the motion vector is performed, by the use of the following expression:

\[ MV_{i,j} = \left( \frac{\sum_{k=0}^{3} \sum_{l=0}^{3} \text{mv}_{m,n,k,l}}{\sum_{i=0}^{3} \sum_{j=0}^{3} l} \right) >> 2 \]

where \( m \) and \( n \) denote coordinate values in the axis of abscissa and the axis of ordinate in an 8x8 mode block which is an intermediate macro block and \( k \) and \( l \) denote coordinate values in the
axis of abscissa and the axis of ordinate in a 4x4 mode block corresponding to the (m,n)-th macro block in 2x2 macro blocks.

Claim 18. (Currently Amended) An image down-sampling transcoding device for converting a first macro block having a first format into a second macro block having a second format, the image down-sampling transcoding device comprising:

a first conversion unit determining a block mode of the second macro block and converting the first macro block into the second macro block with the determined block mode, when the number of intra macro blocks included in [[.]] the first macro block satisfies a first condition;

a second conversion unit determining a block mode of the second macro block and converting the first macro block into the second macro block with the determined block mode, when the number for inter macro blocks included in the first macro block satisfies a second condition; and

a motion vector re-adjusting unit re-adjusting a motion vector of the second macro block, after the conversion of the first macro block into the second macro block is finished,

wherein the first conversion unit determines the block mode, at least in part, by the use of an SAD comparison method for macro blocks, when the first macro block includes some intra macro blocks.

Claim 19. (Currently Amended) The image down-sampling transcoding device according to claim 18, wherein the first conversion unit:

converts the first macro block into one intra macro block, when the first macro block includes only the intra macro blocks; and

determines the block mode by the use of an SAD comparison method for macro blocks, when the first macro block includes some intramacro blocks.

Claim 20. (Original) The image down-sampling transcoding device according to claim 18, wherein the second conversion unit:

converts the first macro block into the second macro block with the inter mode, when the number of inter macro blocks is greater than or equal to a predetermined number or when a
difference value between the motion vectors is calculated and the difference value is less than or equal to a predetermined value; and

determines the block mode by the use of an SAD comparison method of macro blocks and converts the first block into the second block with the determined block mode in the other cases.

Claim 21. (Original) The image down-sampling transcoding device according to claim 20, wherein the SAD comparison method includes: calculating SADs between two inter macro blocks and determining the least inter SAD; and converting the first macro block into the second macro block with the block mode corresponding to the least SAD by comparing the least inter SAD with the predetermined intra SAD.

Claim 22. (Currently Amended) An image down-sampling transcoding device for converting a first macro block having a first format into a second macro block having a second format, the image down-sampling transcoding device comprising:

a conversion unit determining anyone of candidate block modes having the second format, which is determined in accordance with a predetermined condition by types of macro blocks included in the first macro block having a predetermined size, as a block mode of the second macro block and converting the first macro block into the second macro block with the determined block mode; and

a motion vector re-adjusting unit re-adjusting a motion vector of the second macro block, after the conversion of the first macro block into the second macro block is finished,

wherein the predetermined condition comprises that any one of the candidate block modes is determined as the block mode by the use of a SAD comparison method of macro blocks included in the first macro block, when two or less intra macro blocks are included in the first macro block.

Claim 23. (Currently Amended) The image down-sampling transcoding device according to claim 22, wherein the predetermined condition [[is]] comprises that one intra macro block having the second format is determined as the block mode when three or more intra macro blocks are included in the first macro block.
Claim 24.  (Currently Amended) The image down-sampling transcoding device according to claim 22, wherein the predetermined condition is that anyone of the candidate block modes is determined as the block mode by the use of a SAD comparison method of macro blocks included in the first macro block, when two or less intra macro blocks are included in the first macro block, and

wherein the candidate block modes include one or more of a skip mode, an inter 16x16 mode, and an inter \([SxS]\) 8x8 mode.

Claim 25.  (Currently Amended) The image down-sampling transcoding device according to claim 22, wherein the predetermined condition \([is]\) comprises that anyone any one of the candidate block modes is determined as the block mode by the use of a SAD comparison method of macro blocks, when only inter macro blocks are included in the first macro block and two or less macro blocks in the inter 16x16 mode are included in the inter macro blocks, and

wherein the candidate block modes include one or more of a skip mode, an inter 16x16 mode,\([-and]\) and an inter 8x8 mode.

Claim 26.  (Currently Amended) The image down-sampling transcoding device according to claim 24, wherein the conversion unit calculates a difference, between the motion vectors in the respective macro blocks, determines anyone any one of the inter 16x16 mode and the skip mode as the block mode when the difference is less than or equal to a predetermined threshold value, and in the other cases, determines the inter \([SxS]\) 8x8 mode as the block mode.

Claim 27.  (Currently Amended) The image down-sampling transcoding device according to claim 24, wherein a mean pixel value of a macro block is calculated by the following expression:

\[
MB_{\text{mean}} = \sum_{i=0}^{15} \sum_{j=0}^{15} \text{org}_{i,j}
\]

where \text{org}_{ij} denotes pixel values of 16x 16 pixels in a macro block and \(MB_{\text{mean}}\) denotes the mean pixel value of a macro block, and

wherein the intra SAD is calculated by the following expression:\([.\]):
\[ SAD_{\text{INTRA}} = \sum_{i=0}^{15} \sum_{j=0}^{15} \text{org}_{i,j} - MB_{\text{mean}}^2 \]

Claim 28. (Original) The image down-sampling transcoding device according to claim 22, wherein the re-adjustment of the motion vector is performed by the use of the following expression:

\[ MV_{i,j} = \left( \sum_{k=0}^{3} \sum_{l=0}^{3} MV_{m,n,k,l} \right) \sum_{k=0}^{3} \sum_{l=0}^{3} l \gg 2, \quad i,j = 0,1 \]

where \( m \) and \( n \) denote coordinate values in the axis of abscissa and the axis of ordinate in an 8x8 mode block which is an intermediate macro block and \( k \) and \( l \) denote coordinate values in the axis of abscissa and the axis of ordinate in a 4x4 mode block corresponding to the \((m,n)\)-th macro block in 2x2 macro blocks.

Claim 29. (Previously Presented) The image down-sampling transcoding method according to claim 5, wherein the SAD comparison method includes:

- calculating SADs between two inter macro blocks and determining the least inter SAD;
- and
- converting the first macro block into the second macro block with the block mode corresponding to the least SAD by comparing the least inter SAD with the predetermined intra SAD.

Claim 30. (Previously Presented) The image down-sampling transcoding method according to claim 29, wherein a mean pixel value of a macro block is calculated by the following expression:

\[ MB_{\text{mean}} = \sum_{i=0}^{15} \sum_{j=0}^{15} \text{org}_{i,j} \]

where \( \text{org}_{ij} \) denotes pixel values of 16x16 pixels in a macro block and \( MB_{\text{mean}} \) denotes the mean pixel value of a macro block, and

wherein the intra SAD is calculated by the following expression:
\[
SAD_{\text{INTRA}} = \sum_{i=0}^{15} \sum_{j=0}^{15} |v_{i,j} - MB_{\text{mean}}|.
\]

Claim 31. (Previously Presented) The image down-sampling transcoding method according to claim 13, wherein when a difference between the motion vectors in the respective macro blocks is calculated and the difference is less than or equal to a predetermined threshold value, any one of the inter 16x 16 mode and the skip mode is determined as the block mode and in the other cases, the inter 8x8 mode is determined as the block mode.

Claim 32. (Previously Presented) The image down-sampling transcoding method according to claim 13, wherein any one of the candidate block modes is a block mode having the least SAD value.

Claim 33. (Currently Amended) The image down-sampling transcoding device according to claim 25, wherein the conversion unit calculates a difference[[]] between the motion vectors in the respective macro blocks, determines anyone any one of the inter 16x 16 mode and the skip mode as the block mode when the difference is less than or equal to a predetermined threshold value, and in the other cases, determines the inter [[SxS]] 8x8 mode as the block mode.
Request for Reconsideration

Claims 1-33 are pending in this application. Applicants are amending claims 1, 10, 18, and 22 to incorporate subject matter of claims 4, 12, 19, and 24, respectively. Applicants are amending claims 7, 12, 14-16, 18-21, 23-27, and 33 for consistency with the claims from which they depend and to correct certain informalities. Applicants also are cancelling claim 4, without prejudice or disclaimer. Further, Applicants are amending the specification and the Abstract of the Disclosure to correct certain informalities. No new matter is added by these amendments, and these amendments are supported fully by the disclosure, as originally filed. E.g., Appl’n, Claims 4, 12, 19, and 24 (Original). Applicants respectfully request that the Examiner enter these amendments and reconsider the above-captioned patent application in view of these amendments and the following remarks.
Remarks

1. Objections and Rejections.


2. Objections to the Specification.

As noted above, the Office Action objects to the specification and to the length of the Abstract of Disclosure. Office Action, Page 2, Lines 3-14. Applicants are amending the specification to correct certain informalities, as proposed by the Office Action. Further, Applicants are amending the Abstract of the Disclosure so that the length of the Abstract of the Disclosure does not exceed the limit of 150 words. Therefore, Applicants respectfully request that the Examiner withdraw the objections to the specification and to the Abstract of the Disclosure, at least for these reasons.

3. Objections to the Claims.

As noted above, the Office Action objects to claims 7, 18-21, 24-27, and 33 for certain informalities. Office Action, Page 3, Lines 5-22. Applicants are amending these claims to correct these informalities, as suggested by the Examiner. Therefore, Applicants respectfully request that the Examiner withdraw the objections to claims 7, 18-21, 24-27, and 33, at least for this reason.
4. **Anticipation Rejections.**

As noted above, the Office Action rejects claims 1, 3-5, 10-15, 18-20, 22-26, and 31-33 as allegedly anticipated by Lee.¹ “A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference.” MPEP 2131. Applicants respectfully traverse.

a. **Claims 1, 10, 18, and 22.**

Lee describes a transcoding method and apparatus for transforming a first coded video format into a second coded video format. Lee, Abstract. In particular, Lee describes transforming one or more blocks in the first video format into one or more blocks of the second video format, where the block mode of the second video format is determined based on the block mode (or modes) of the first video format. Lee, Paras. [0041-0048]; **Figs. 3A-F.** Nevertheless, Lee does not disclose determining a block mode of the second video format based on a Sum of Absolute Differences (SAD).

Accordingly, Applicants are amending independent claims 1, 10, 18, and 22 to describe, in part, that the block mode of the second macro block is determined, at least in part, “by the use of an SAD comparison method for macro blocks, when the first macro block includes some intra macro blocks.” Similarly, amended claims 10 and 22 describe, in part, that “the predetermined condition comprises that any one of the candidate block modes is determined as the block mode by the use of a SAD comparison method of macro blocks included in the first macro block, when two or less intra macro blocks are included in the first macro block.” As noted above, Lee does not disclose using a SAD comparison method. Thus, the Office Action fails to demonstrate that Lee discloses each and every element of claims 1, 10, 18, and 20. Therefore, Applicants respectfully request that the Examiner withdraw the anticipation rejections of claims 1, 10-15, 18, and 22-26, at least for this reason.

b. **Claims 3-5, 11-15, 19, 20, 23-26, and 31-33.**

Claims 3-5 depend from claim 1; claims 11-15, 31, and 32 depend from claim 10; claims 19 and 20 depend from claim 18; and claims 23-26 and 33 depend from claim 22.

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¹ Applicants are cancelling claim 4, without prejudice or disclaimer, thereby rendering the rejection to that claim moot.
Therefore, Applicant respectfully requests that the Examiner withdraw the anticipation rejections of claims 3-5, 11-15, 19, 20, 23-26, and 31-33, at least for this reason.

5. **Obviousness Rejections.**

    Claim 2 depends from independent claim 1. “If an independent claim is nonobvious under 35 U.S.C. 103, then any claim depending therefrom is nonobvious.” MPEP 2143.03 (citations omitted). For the reasons set forth above, Applicants maintain that claim 1, as amended, is distinguishable over the cited references. Therefore, Applicants respectfully request that the Examiner also withdraw the obviousness rejection of claim 2, at least for this reason.

6. **Allowable Subject Matter.**

    As noted above, the Examiner indicates that claims 6-9, 16, 17, 21, and 27-30 contain allowable subject matter and would be allowable if rewritten in independent form, including all of the limitations of the base claim and any intervening claims. Office Action, Page 10, Lines 12-14. Nevertheless, the Office Action objects to claims 6-9, 16, 17, 21, and 27-30 as being dependent on a rejected base claim. **Id.** Claims 6-9, 29, and 30 depend, directly or indirectly, from independent claim 1 and incorporate all of the elements of claim 1. Claims 16 and 17 as amended, depend from independent claim 10 and incorporate all of the elements of claim 10. Claim 21 as amended, depends from independent claim 18 and incorporates all of the elements of claim 18. Claims 27 and 28 as amended, depend from independent claim 22 and incorporate all of the elements of claim 22. Applicants maintain that amended claims 1, 10, 18, and 22 are distinguishable over the cited references. Therefore, Applicants respectfully request that the Examiner withdraw the objections to claims 6-9, 16, 17, 21, and 27-30, at least for this reason.

7. **Request for Interview.**

    Applicants respectfully request that the Examiner agree to conduct a telephone interview with Applicants’ representatives prior to the issuance of a further Office Action in the above-captioned patent application. Applicants propose scheduling the interview for 1:00 PM on November 17, 2010, so that the Examiner may have sufficient time to consider Applicants’ amendments and remarks. If the Examiner is unavailable to conduct an interview at the proposed
time or date, Applicants respectfully request that the Examiner propose an alternative time or date.
Conclusion:

Applicants maintain 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 12, 2010        By: /Aaron Perez-Daple/
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JBA/APD/CMC
**Electronic Acknowledgement Receipt**

| **EFS ID:** | 8612636 |
| **Application Number:** | 11289649 |
| **International Application Number:** | 
| **Confirmation Number:** | 5884 |
| **Title of Invention:** | Image down-sampling transcoding method and device |
| **First Named Inventor/Applicant Name:** | Yung-Lyul Lee |
| **Customer Number:** | 24735 |
| **Filer:** | Aaron Christopher Perez-Daple |
| **Filer Authorized By:** | 
| **Attorney Docket Number:** | 076980.0104 |
| **Receipt Date:** | 12-OCT-2010 |
| **Filing Date:** | 30-NOV-2005 |
| **Time Stamp:** | 19:55:50 |
| **Application Type:** | Utility under 35 USC 111(a) |

**Payment information:**

- Submitted with Payment: no

**File Listing:**

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**Warnings:**

**Information:**

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/O/A/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/R0/105) 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.
### PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

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TOTAL CLAIMS
(37 CFR 1.16(u))

TOTAL INDENTED CLAIMS
(37 CFR 1.16(n))

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).

MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))

* If the difference in column 1 is less than zero, enter "0" in column 2.

### APPLICATION AS AMENDED – PART II

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

TOTAL ADD'L FEE OR TOTAL ADD'L FEE 0

### LEGAL INSTRUMENT EXAMINER

ZURIAISH WORK ZENEVE

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.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.
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<td>Yung-Lyul Lee</td>
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24735  
BAKER BOTTS LLP  
C/O INTELLECTUAL PROPERTY DEPARTMENT  
THE WARNER, SUITE 1300  
1299 PENNSYLVANIA AVE, NW  
WASHINGTON, DC 20004-2400

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. 11/289,649
Applicant(s) LEE ET AL.

Examiner Dov Popovici
Art Unit 2625

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 13 March 2006.
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) 1-33 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) 1-5, 10-15, 18-20, 22-26 and 31-33 is/are rejected.
7)☐ Claim(s) 6-9, 16-17, 21, 27-28 and 29-30 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 30 November 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 02/16/2007.
4)☐ Interview Summary (PTO-413)
   Paper No(s)/Mail Date ______.
5)☐ Notice of Informal Patent Application
6)☐ Other: ______.
DETAILED ACTION

Specification

The disclosure is objected to because of the following informalities:

On page 5, line 26, “followingequation:” should be --following equation:--.

On page 10, line 4, “however” should be --However--.

On page 16, line 13, “(S420)” should be --(S415)--.

On page 16, line 14, “(S430)” should be --(S420)--.

On page 20, line 3, “H,264” should be --H.264--.

On page 21, line 18, after “codec”, insert --.--.

Appropriate correction is required.

The abstract of the disclosure is objected to because the abstract exceed 150 words in length, since the space provided for the abstract on the computer tape used by the printer is limited. The abstract contains 153 words in length which is over the range of 50-150 words.

Correction is required. See MPEP § 608.01(b).

Applicant is reminded of the proper language and format for an abstract of the disclosure.

The abstract should be in narrative form and generally limited to a single paragraph on a separate sheet within the range of 50 to 150 words. It is important that the abstract not exceed 150 words in length since the space provided for the abstract on the computer tape used by the printer is limited. The form and legal phraseology often used in patent claims, such as "means" and "said," should be avoided. The abstract should describe the disclosure sufficiently to assist readers in deciding whether there is a need for consulting the full patent text for details.
The language should be clear and concise and should not repeat information given in the title. It should avoid using phrases which can be implied, such as, "The disclosure concerns," "The disclosure defined by this invention," "The disclosure describes," etc.

**Claim Objections**

Claims 7, 18-21, 24-27 and 33 are objected to because of the following informalities:

In claim 7, line 8, the claimed recitation of “wherein the intra SAD is calculated by the following expression” should be recited or located before line 7, where the expression “SAD intra” is defined. In other words, line 8 should be shifted and relocated before line 7, in order for the recitation “the following expression” to be pointing to SAD intra.

In claim 18, line 10, after “included in”, delete ".".

In claim 19, line 6, "intramacro" should be --intra macro--.

In claim 24, line 7, “SXS mode” should be --8X8 mode--.

In claim 25, line 7, “-and” should be --and--.

In claim 26, line 2, after “difference”, delete ".".

In claim 26, line 5, “SXS mode” should be --8X8 mode--.

In claim 33, line 2, after “difference”, delete ".".

In claim 33, line 5, “SXS mode” should be --8X8 mode--.

Claims 19-21, 26-27 and 33 are objected to because they are dependent on objected to claims 18, 24 and 25 above.
Appropriate correction is required.

**Claim Rejections - 35 USC § 102**

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

Claims 1, 3-5, 10-15, 18-20, 22-26 and 31-33 are rejected under 35 U.S.C. 102(e) as being anticipated by Lee (US 2005/0135486 A1).

The applied reference has a common inventor with the instant application. Based upon the earlier effective U.S. filing date of the reference, it constitutes prior art under 35 U.S.C. 102(e). This rejection under 35 U.S.C. 102(e) might be overcome either by a showing under 37 CFR 1.132 that any invention disclosed but not claimed in the reference was derived from the inventor of this application and is thus not the invention “by another,” or by an appropriate showing under 37 CFR 1.131.

As to claim 1, Lee discloses an image down-sampling transcoding method for converting (i.e., transforming) a first macro block (macroblock of H.264 video) having a first format into a second macro block (MPEG-4 macroblock) having a second format, the image down-sampling transcoding method comprising: (a) determine a block mode (see figure 4) of the second macro block (MPEG-4 macroblock) having a CxD size
(where C and D are natural numbers) and converting the first macro block (macroblock of H.264 video) into the second macro block (MPEG-4 macroblock) with the determined block mode, when the number of intra macro blocks (see figure 3A, 3E, 4 and see paragraphs 0041 and 0045) included in the first macro block having a AxB size (where A and B are natural numbers) satisfies a first condition; (see paragraphs 0010, 0012, 0014, 0041, 0042, 0049); (b) determining a block mode of the second macro block (see figure 4 and see paragraphs 0010, 0012, 0014, 0041, 0042, 0049) and converting (i.e., transforming) the first macro block (H.264 macroblock) into the second macro block (MPEG-4 macroblock) with the determined block mode (see figure 4, and see paragraphs 0010, 0012, 0014, 0041, 0042, 0049), when the number for inter macro blocks (see figures 3B, 3C, 3D, 3E, 3F, 4 and see paragraphs 0042, 0043, 0044, 0046, and 0047 i.e., inter 16x16 mode, inter-8x8 mode) included in the first macro block satisfies a second condition; and (c) re-adjusting a motion vector (see figure 4, S430 and S440) of the second macro block, after the conversion of the first macro block into the second macro block is finished.

As to claim 3, Lee discloses wherein (a) includes converting the first macro block (H.264 macroblock) into one intra macro block (see paragraphs 0041, 0045 and 0049 and see figures 3A and 3E), when the first macro block (H.264 macroblock) includes only the intra macro blocks (see paragraphs 0041 and 0045).

As to claim 4, Lee discloses wherein (a) includes determining the block mode by the use of an SAD comparison method (see figure 4, and see paragraph 0049) for
macro blocks, when the first macro block includes some intra blocks (see paragraphs 0041, 0045 and 0049 and see figures 3A and 3E.

As to claim 5, Lee discloses wherein (b) includes: converting the first macro block (H.264 macroblock) into the second macro block (MPEG-4 macroblock) with the inter mode (see figures 3B, 3C, 3D, 3E, 3F, 4 and see paragraphs 0042, 0043, 0044, 0046, and 0047 i.e., inter 16x16 mode, inter-8x8 mode) when the number of inter macro blocks is greater than or equal to a predetermined number or when a difference value between the motion vectors is calculated and the difference value is less than or equal to a predetermined value; and determining the block mode (see figure 4 and paragraph 0049) by the use of an SAD comparison method of macro blocks and converting the first block into the second block with the determined block mode in the other cases (see figures 3B, 3C, 3D, 3E, 3F, 4 and see paragraphs 0042, 0043, 0044, 0046, and 0047 i.e., inter 16x16 mode, inter-8x8 mode).

As to claim 10, Lee discloses an image down-sampling transcoding method for converting a first macro block (macroblock of H.264 video) having a first format into a second macro block (MPEG-4 macroblock) having a second format, the image down-sampling transcoding method comprising: determining any one of candidate block modes (see figure 4) having the second format, which is determined in accordance with a predetermined condition by types of macro blocks included in the first macro block having a predetermined size, as a block mode of the second macro block and converting the first macro block into the second macro block with the determined block mode (see figures 3A-3F and 4, and paragraphs 0010, 0012, 0014, 0041, 0042, 0049);
and re-adjusting a motion vector (see figure 4, S430 and S440) of the second macro block, after the conversion of the first macro block into the second macro block is finished.

As to claim 11, Lee discloses wherein the predetermined condition is that one intra macro block having the second format is determined as the block mode when three or more intra macro blocks are included in the first macro block (see figures 3A-3F and see paragraphs 0045-0046).

As to claim 12, Lee discloses wherein the predetermined condition is that anyone of the candidate block modes is determined as the block mode by the use of a SAD comparison method of macro blocks included in the first macro block, when two or less intra macro blocks are included in the first macro block (see figure 4), and wherein the candidate block modes include one or more of a skip mode (see paragraph 0047), an inter 16x16 mode (see paragraph 0042), and an inter 8x8 mode (see paragraph 0046).

As to claim 13, Lee discloses wherein the predetermined condition is that any one of the candidate block modes is determined as the block mode by the use of a SAD comparison method of macro blocks (see figure 4), when only inter macro blocks (see para. 0042) are included in the first macro block and two or less macro blocks in the inter 16x16 mode are included in the inter macro blocks, and wherein the candidate block modes include one or more of a skip mode (see para. 0047), an inter 16x16 mode (see para. 0042), and an inter 8x8 mode (see para. 0046).

As to claim 14, Lee discloses wherein when a difference between the motion vectors in the respective macro blocks is calculated (see figures 3A-3F and 4) and the
difference is less than or equal to a predetermined threshold value, any one of the inter
16x16 mode (para. 0042 and 0049) and the skip mode (para. 0047) is determined as
the block mode and in the other cases, the inter 8x8 mode (para. 0046) is determined
as the block mode.

As to claim 15, Lee discloses wherein any one of the candidate block modes is a
block mode having the least SAD value (see figures 3A-3F and 4 and para. 0049, 0042-
0043, 0044, 0046-0047).

As to claim 31, applicant is directed to the remarks and the discussion made in
claim 14 above.

As to claim 32, applicant is directed to the remarks and the discussion made in
claim 15 above.

Claims 18-20 are directed to an image down-sampling transcoding device.
Claims 18-20 are claiming the same and/or similar claim limitations or claim features as
recited in method claims 1, 3-4 and 5. Therefore, claims 18-20 are rejected similarly as
claims 1, 3-4 and 5 above. Applicant is directed to the remarks and the discussion made
in claims 1, 3-4 and 5 above.

Claims 22-26 are directed to an image down-sampling transcoding device.
Claims 22-26 are claiming the same and/or similar claim limitations or claim features as
recited in method claims 10-14. Therefore, claims 22-26 are rejected similarly as claims
10-14 above. Applicant is directed to the remarks and the discussion made in claims 10
to 14 above.
Claim 33 recites the same or similar claim limitations or features, as recited in claim 26 above. Claim 33 is rejected similarly as claim 26 above. Applicant is directed to the remarks and the discussion made in claim 26 above.

**Claim Rejections - 35 USC § 103**

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 negativated by the manner in which the invention was made.

Claim 2 is rejected under 35 U.S.C. 103(a) as being unpatentable over Lee in view of Etoh et al. (US 2005/0063466 A1).

As to claim 2, Lee does not teach wherein the first macro block is converted into the second macro block with the determined block mode while being down-sampled by the use of an average filter.

Etoh et al. (US 2005/0063466 A1) teaches inter prediction mode(s), macroblock in an INTER prediction mode, motion vector is adjusted, macro-blocks constituting the picture by an intra prediction mode, inter prediction mode a method of down-sampling by operating a (1, 2, 1)/4 filter, and down-sampling by 3 tap filters (see paragraphs 0018, 0116, 0165, 0178, 0204, 0280, 0300, 0301, 0352 and 0353).

Therefore, it would have been obvious to a person having ordinary skill in the art at the time the invention was made to have modified Lee wherein the first macro block
is converted into the second macro block with the determined block mode while being down-sampled by the use of an average filter.

It would have been obvious to a person having ordinary skill in the art at the time the invention was made to have modified Lee by the teaching of Etoh et al. wherein the first macro block is converted into the second macro block with the determined block mode while being down-sampled by the use of an average filter, so that the picture is subjected to strong smoothing and so that a picture subjected to strong smoothing in which space resolution is integer pixel accuracy, as taught by Etoh et al. at paragraphs 0300 and 0301, and to provide and improve pixel accuracy, integer pixel accuracy and maintain space resolution of an original picture, as taught by Etoh et al. at paragraphs 0352, 0353 and 0354.

**Allowable Subject Matter**

Claims 6-9, 16-17, 21, 27-28 and 29-30 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

The following is a statement of reasons for the indication of allowable subject matter:

The closest prior art of record, namely, Lee (US 2005/0135486 A1) and/or Etoh et al. (US 2005/0063466 A1), do not disclose, teach or suggest, wherein the SAD comparison method includes: calculating SADs between two inter macro blocks and
determining the least inter SAD; and converting the first macro block into the second macro block with the block mode corresponding to the least SAD by comparing the least inter SAD with the predetermined intra SAD, as recited in dependent claim 6.

Claim 7 is dependent on objected to claim 6 above.

The closest prior art of record, namely, Lee (US 2005/0135486 A1) and/or Etoh et al. (US 2005/0063466 A1), do not disclose, teach or suggest, wherein the re-adjustment of the motion vector is performed by the use of the following expression: (see claim 8, line 4, page 3 of the preliminary amendment filed on 3/13/2006, for the expression or formula $M_{Vi,j} = \sum_{(k=0; 3)}^{(l=0; 3)} mv (m,n, k, l)/ \sum_{(k=0; 3)}^{(l=0; 3)} l \gg 2, i,j=0,1)$ where m and n denote coordinate values in the axis of abscissa and the axis of ordinate in an 8x8 mode block which is an intermediate macro block and k and 1 denote coordinate values in the axis of abscissa and the axis of ordinate in a 4x4 mode block corresponding to the (m,n)-th macro block in 2x2 macro blocks, as claimed in dependent claim 8.

The closest prior art of record, namely, Lee (US 2005/0135486 A1) and/or Etoh et al. (US 2005/0063466 A1), do not disclose, teach or suggest, wherein (c) includes: searching for an integer pixel motion vector in (+ or -) 3 neighboring pixels about an integer pixel motion vector; and searching for a half pixel motion vector in (+ or -) 1
neighboring pixels about the searched integer pixel motion vector, as recited in dependent claim 9.

The closest prior art of record, namely, Lee (US 2005/0135486 A1) and/or Etoh et al. (US 2005/0063466 A1), do not disclose, teach or suggest, wherein the SAD comparison method includes: calculating SADs between two inter macro blocks and determining the least inter SAD; and converting the first macro block into the second macro block with the block mode corresponding to the least SAD by comparing the least inter SAD with the predetermined intra SAD, as claimed in dependent claim 29.

Claim 30 is dependent on objected to dependent claim 29 above.

The closest prior art of record, namely, Lee (US 2005/0135486 A1) and/or Etoh et al. (US 2005/0063466 A1), do not disclose, teach or suggest, wherein a mean pixel value of a macro block is calculated by the following expression:

(see claim 16, line 4, page 5 of the preliminary amendment filed on 3/13/2006, MB mean=$\sum_{i=0}^{15} \sum_{j=0}^{15} \text{org}(i,j)$
where \text{org}(i,j) denotes pixel values of 16x16 pixels in a macro block and \text{MBmean} denotes the mean pixel value of a macro block, and wherein the intra SAD is calculated by the following expression.

SAD intra=$\sum_{i=0}^{15} \sum_{j=0}^{15} |\text{org}(i,j) - \text{MB mean}|$, as recited in claim 16.
The closest prior art of record, namely, Lee (US 2005/0135486 A1) and/or Etoh et al. (US 2005/0063466 A1), do not disclose, teach or suggest, wherein the re-adjustment of the motion vector is performed by the use of the following expression:

(see claim 17, line 4, page 5 of the preliminary amendment filed on 3/13/2006, for the expression or formula

\[
MV_{i,j} = \sum_{k=0}^{3} \sum_{l=0}^{3} (m,n,k,l) \sum_{(k=0)}^{3} \sum_{(l=0)}^{3} (i,j,k,l) \] = 2, \quad i,j = 0,1
\]

where \( m \) and \( n \) denote coordinate values in the axis of abscissa and the axis of ordinate in an 8x8 mode block which is an intermediate macro block and \( k \) and \( l \) denote coordinate values in the axis of abscissa and the axis of ordinate in a 4x4 mode block corresponding to the \((m,n)\)-th macro block in 2x2 macro blocks, as claimed in claim 17.

Claim 21 is similar to claim 6 above. Claim 21 recites claim limitations or claim features which are similar to objected to claim 6 above. Therefore, claim 21 is objected to, as containing allowable subject matter, for the same or similar reason(s) as stated in claim 6 above.

Claim 27-28 are similar to claims 16-17 above. Claims 27-28 recite claim limitations or claim features which are similar to objected to claims 16-17 above. Therefore, claims 27-28 are objected to, as containing allowable subject matter, for the same or similar reason(s) as stated in claims 16-17 above.

**Conclusion**
Any inquiry concerning this communication or earlier communications from the examiner should be directed to Dov Popovici whose telephone number is 571-272-4083. The examiner can normally be reached on Monday-Thursday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner’s supervisor, Edward Coles can be reached on 571-272-7402. 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.

/Dov Popovici/
Primary Examiner, Art Unit 2625
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### Index of Claims

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S9 16 S2 and S5 and S7
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(Not for submission under 37 CFR 1.99)

//D.P./


EXAMINER SIGNATURE

/Dov Popovici/

Date Considered
07/04/2010

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☐ 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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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 inspections 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.
**BIB DATA SHEET**

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**APPLICANTS**
- Yung-Lyul Lee, Seoul, KOREA, REPUBLIC OF;
- Euee-S. Jang, Seoul, KOREA, REPUBLIC OF;
- Chung-Ku Lee, Incheon, KOREA, REPUBLIC OF;

**CONTINUING DATA**

**FOREIGN APPLICATIONS**

**IF REQUIRED, FOREIGN FILING LICENSE GRANTED**
01/05/2006

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**ADDRESS**

BAKER BOTTs LLP
C/O INTELLECTUAL PROPERTY DEPARTMENT
THE WARNER, SUITE 1300
1259 PENNSYLVANIA AVE, NW
WASHINGTON, DC 20004-2400
UNITED STATES

**TITLE**
Image down-sampling transcoding method and device

**FILING FEE RECEIVED**
1980

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

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- ☐ 1.16 Fees (Filing)
- ☐ 1.17 Fees (Processing Ext. of time)
- ☐ 1.18 Fees (Issue)
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Signature  /James B. Arpin/
Name/Print  James B. Arpin
Date (YYYY-MM-DD)  2007-02-16
Registration Number  33470

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A transcoding method, medium, and apparatus for transforming a coded video format into another coded video format. The transcoding method includes decoding a bitstream encoded using a first coding method to output data in a pixel domain and motion vector and macroblock information for each of macroblock of the bitstream, and performing motion compensation using the motion vector and macroblock information to encode the data in the pixel domain using a second coding method.
(19) 대한민국특허정 (KR)
(12) 공개특허공보(A)

(51) Int. Cl. 7
HOAN 7/30

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(43) 공개일자 2005년06월29일

(21) 출원번호 10-2003-0083159
(22) 출원일자 2003년12월18일

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서울 은평구 군자동 98
심성진기주식회사

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(72) 발명자
이영철
서울특별시영등가각동124근동아파트1동704호

권혁균
서울특별시송파구영통동1175-16

(74) 대리인
이영철, 이혜영

상사적용 : 없음

(64) 트랜스코딩 방법 및 장치

요약

항목 1. 영상은 다른 영상 압축 포맷으로 변환하는 트랜스코딩 방법 및 장치가 제시된다. 본 발명
에 따라, 트랜스코딩 방법은 (a) 상성의 제1압축방법으로 압축된 비트 스트림을 디코딩하여 적절 영역의
데이터와 각 프레임별로 불록의 음직임 벡터 정보 및 메크로 불록 정보를 출력하는 단계 및 (b) 상기
비디오 영상의 데이터를 입력받아 상성의 제2압축방법으로 인코딩을 수행하는데 있어, 상기 음직임 벡터 정보와 메
크로 불록 정보를 이용하여 음직임 변동을 수행하는 단계를 포함하는 것으로 한다. 이에 의해,
H.264 표준에 따라 압축된 영상을 MPEG-4 단일기기에서도 실시간으로 재생할 수 있다.

대표도
도 2

본바탕
도 1-1

도면의 필요성 설명

도 1a는 H.264 표준에서 음직임 추정시에 사용되는 불록들을 도시한 도면이다.
도 1b는 MPEG-4 표준에서 음직임 추정시에 사용되는 불록들을 도시한 도면이다.
도 2는 본 발명의 직접 도시한 트랜스코딩 장치의 불록도이다.

도 3a 내지 도 3h는 H.264 표준에 따라 인코딩된 비트스트림의 메크로 불록 부분과 모드와 음직
임 벡터를 MPEG-4에서의 부호화 모드와 음직임 벡터로 변환하는 것을 설명하는 도면이다.

도 4는 본 발명의 트랜스코딩 방법의 플로우차트이다.

도 5a는 Foreman 영상을 H.264로 압축하였을 때와 MPEG-4로 압축하였을 때, 그리고 개스케이드
트랜스코딩을 사용하였을 때와 본 발명의 트랜스코딩방법을 사용하였을 때의 범가산호의 PSNR를 도시한
도면이다.

도 5b는 Mother & Daughter 영상을 H.264로 압축하였을 때와 MPEG-4로 압축하였을 때, 그리고 개
스케이드 트랜스코딩을 사용하였을 때와 본 발명의 트랜스코딩방법을 사용하였을 때의 범가산호의 PSNR를
도시한 도면이다.

문목의 위배적 설명

11-1
해일성의 특성
해일성이 수록하는 가족들 및 그 동반자를 증가시키는
본 방법은 트랜스코딩에 관한 것으로, 보다 상세하게는 압축된 영상들 다른 영상 압축 포맷으로 
변환하는 트랜스코딩 방법 및 장점에 관한 것이다.

해밀턴은 통합기술과 통합기술에 대해 다양한 데이터를 통합기술에 대해 전용할 수 있게 되었다.

버퍼링을 통해 해당 이미지의 데이터를 인코딩하기 위하여 여러 가지 코덱을 데이터 압축 포맷 
생성하고 있으며, 송신측과 수신측의 관리자가 다르게 하여 업데이트의 QoS(Quality of Service)를 고려 
하여 하나의 데이터 포맷을 다른 데이터 포맷으로 변환하는 것이 필요하다. 이를 트랜스코딩 
(transcoding)이라 한다. 예시로 트랜스코딩은 함께 제공(pixel-domain)에서의 트랜스코딩 방법과 주파수 
변환법, 예를 들면 DCT(Discrete Cosine Transform) 제공에서는 트랜스코딩 방법이 있다.

특별 영역에서 트랜스코딩을 하기 위해서는 디코딩과 인코딩을 다시 수행해야 하되, 따라서 
모든 프레임에 있는 모든 화소를 복제하여 동일한 동작과정을 다시 수행해야 한다. 그러므로, 트랜스 
코딩에 시간이 많이 걸리고 트랜스코딩된 영상은 실시간으로 전송하기가 어렵다.

해양의 수요도를 가진 기술적 특성

다시, 본 방법이 이루어진가 하는 기술적 특성은 음악적인 면에서 사용되는 블록타입과 음악적 백 
터를, 트랜스코딩하고자 하는 압축포맷에 맞게 변환하여 효율적으로 트랜스코딩하는 방법 및 장치를 제공 
하는 것이다.

설명의 구성 및 작동

상기 기술적 특성은 본 방법에 따라, (a) 소정의 제1압축방법으로 압축된 비트 스트림을 디코딩 
하여 복원 영상의 데이터와 각 마크로 블록의 음악적 백터 정보 및 마크로 블록 정보를 출력하는 단계; 
(b) 상기 기능중복의 데이터를 입력받아 소정의 제2압축방법으로 인코딩을 수행하는데 있어, 상기 풀 
직렬 별겨 블록 정보 및 마크로 블록 정보를 이용하여 음악적 보상을 수행하는 단계를 포함하는 것을 특성으로 
하는 트랜스코딩 방법에 의해서만 행한다.

또한, 상기 기능적 특성은 (b) 상기 변환방법의 단계의 결과로 생성된 결과를 구성하는 마크로 블록의 
블록 정보 및 음악적 백터 정보를 입력받고, 상기 백터 포맷은 16x16 또는 8x8 블록으로 변환하고, 상기 음악 
적 백터를 16x16 또는 8x8 블록의 음악적 백터로 평가시키는 단계가 포함된다. (c) 상기 변환의 단계를 16x16 또는 8x8 블록의 음악적 백터로 평가시킨 단계를 포함 
하는 것을 특성으로 하는 트랜스코딩 방법에 의해서도 달성한다.

상기 트랜스코딩 방법은, (d) 상기 변환된 음악적 백터 정보의 확대에 미치는 영향에 대한 음악적 
변형을 수행하여 영상의 음악적 백터 정보의 확대 정보의 1/2 확대을 수행하고, 이를 1/2 확대에 
대해 음악적 변형을 수행하여 음악적 백터를 결정하는 단계를 더 포함하는 것이 바람직하다.

한편, 본 방법의 다른 부분에 따르면, 상기 기술적 특성은 소정의 제1압축방법으로 압축된 비트 
스트림을 디코딩하여 복원 영상의 데이터와 각 마크로 블록의 음악적 백터 정보 및 마크로 블록 정보를 
출력하는 방법과, 상기 기능중복의 데이터를 입력받아 소정의 제2압축방법으로 인코딩되어 상기 음악적 
적 백터 정보와 마크로 블록 정보를 이용하여 음악적 보상을 수행하는 인코딩을 포함하는 것을 특성으로 
하는 트랜스코딩 방법에 의해서도 달성한다.

상기 인코딩은 음악적 정보를 포함하여, 상기 음악적 정보는 상기 제1압축방법에 의해 만들어 
진 영상을 구성하고, 상기 음악적 정보를 중심으로 블록타입을 생성하여, 상기 블록타입은 16x16 또는 8x8 블록으로 변환하고, 상기 음악적 백터를 16x16 또는 8x8 블록의 음악적 백터로 평가시 
키는 단계가 바람직하다.

이러한 형식의 도면을 참고하여, 본 방법의 바람직한 실용화에 대해 상세히 설명한다.

본 방법에 따라 트랜스코딩 장치는 적절한 변환 비도이드로 교환율의 영상을 제공하는 새로운 동영상 
압축방법인 H.264/ITU-T Recommendation H.264으로서 MPE-64의 Part 10 Advanced Video Coding 
Baseline profile(SB)에 의해 압축된 영상을 줄을 때 복제해서 사용되는 MPE-4 Simple profile(SP) 포맷 
으로 변환하는 장치이다.

H.264는 64x64 정리전 압축 포맷인 H.261, H.263, MPE-2와 MPE-4 둘의 통합은 상호 연관성을 고려하지 않고 만든 표준이다. 따라서 H.264와 MPE-64는 서로 다른 특성을 가지고 있다. 예를 들어, 
H.264는 4x4 블록단위로 정수 DCT를 수행하는 반면에 MPE-4는 8x8 블록단위로 DCT를 수행한다. 또한 
음직이 보상(Notion Compensation, NC)에서 7/2 가중치 단위의 음직이 예측을 사용하고는 H.264에선 다른 
H.264는 4x4 단위의 음직이 예측을 사용한다. 물론, H.264에서는 7/2 가중치 단위의 음직이 예측을 수행한다. 그러나, 음직이 추정 
(Notion Estimation, NE)에서 사용하는 NC은 NC에 4x4 블록단위로 서로 다른 모드가 보호된 
모드로 변환되어야 한다. 가변성의 부 
호물(NameLength Coding, VLC)에 있어서도 MPE-4는 예측과 마주비( Huffman table)를 사용하지만 
H.264에서는 우리의 가변길이 코드를 사용한다.

도 1은 H.264 표준에서 음직이 추정에 사용되는 블록들로 도시한 도면이다. 
도 1과 같은 도면에서 H.264는 16x16 마크로 블록을 7개의 가변블록으로 나눌 수 있고, 각각의 가변
블록은 움직임 벡터를 가질 수 없다. 즉, 매커트로 블록은 18x16, 8x16, 16x8, 8x8 블록으로 나누어질 수 있으며, 8x8 블록으로 나누어진 매커트로 블록은 다시 4x8, 4x4로 나누어질 수 있다.

도 1b는 MPEF-4 표준에서 움직임 추정시에 사용되는 블록들을 도시한 도면이다.

다 1b를 참조하면, MPEF-4 표준에서 H.264에는 단일 16x16 블록 또는 8x8 블록 27개가 형태의 블록만을 사용한다. 그러나 H.263에 비해 다각형 모양의 움직임 벡터를 사용할 수 있도록 허용한다. 도 1b의 원래의 그림에 나타난 8x8 블록은 MPEF-4 표준을 반영한 것이다. MPEF-4 표준에서 사용할 수 없는 H.264의 블록 타입과 움직임 정보를 어떻게 변환하여 트랜스코딩에 소요되는 시간을 줄일 것인가에 대하여 상세히 설명한다.

복합 영역에서 트랜스코딩을 수행하는 방식으로 캐스케이드 복합 도메인 트랜스코딩(Scalable Pixel-domain Truncoding) 방식이 있다. 캐스케이드 복합 도메인 트랜스코딩 방식은, 입력된 H.264 프레임을 모두 복합하고, 복합된 영상에 대해 MPEF-4 표준에 따라 다각형을 추정하는 방식이다. 모든 프레임에는 모든 메커트로 블록에 대한 움직임 예측 결과가 MPEF-4 부분에서 다시 수행되어야 하기 때문에 시간과 비용이 많이 들어 실시간 인공에 적응하지 않다.

도 2는 본 복합의 핵심 도메인 트랜스코딩 장치의 블록도이다.

본 복합의 트랜스코딩 장치는 복합 도메인 트랜스코딩 사용시간을 줄이 실시간 손실이 가능하도록 하기 위하여 H.264 디코더(210)에서 사용한 블록도 및 움직임 벡터 정보를 MPEF-4 인코더(220)에서 재사용하도록 한다. 트랜스코딩 장치는 H.264 디코더(210)의 MPEF-4 인코더(220)를 구비하여 H.264 비트 스트림을 복합 도메인으로 모두 다각화할 수며, MPEF-4 비트 스트림으로 변환한다.

가변길이 디코더(211)는 H.264 표준에 따라 압축된 비트 스트림(bitstream)을 입력받아 가변길이 디코더(Variable Length Decoding, VLD)를 수행하여, 현재 복합되고 있는 디코트로 트랜스코딩 프로파일 형식, 메커트로 모션 및 움직임 벡터를 출력한다. 프로파일 형식은 1 프로파일, P 프로파일 등의 형식을 나타내고 제어스레드 정보는 메커트로 블록에 사용하여 움직임 추정이 수행되었는지 확인할 수 있다. 움직임 벡터 정보는 H.264 디코더의 움직임 보상부(215)의 MPEF-4 인코더의 움직임 보상부(227)로 전달된다. 메커트로 스트림은 MPEF-4 인코더(220)의 움직임 보상부(227)로 전달된다.

역량화 및 역 VCT 수송부(212)는 가변길이 디코딩된 비트 스트림을 역량화하고 역 VCT를 수행한다. 루프 필터(Loopfilter, 212)는 입력된 저전력복잡성(Low Pass Filter, LPF)으로 블록을 검정을 스모킹(smoothing)하는 기능을 한다. 이들 루프 필터는 MPEF-4 인코더(220)의 입력에 따라 블록을 입력법(213)으로 입력받는 루프 필터 복합기(214)의 출력을 받아 수행한다. 움직임 보상부(215)와는 가변길이 디코더(211)에서 수신한 음성의 움직임 정보를 사용하여 움직임 보상을 수행한다.

MPEF-4 인코더(220)는 직접 도메인으로 변환된 데이터를 입력받은 다음, MPEF-4 인코더(220)의 방식에 따라 VCT 수송부(221), 양자화부(222) 및 가변길이 인코더(222)를 거쳐 MPEF-4 비트 스트림으로 변환된다. MPEF-4 인코더(220)의 출력으로 되는 음성의 보상부(227)는 도 2의 요소와 같이 예측된 비트 스트림이 역량화되어 역량화된 출력으로 변환된다.

가변길이 디코더(211)에 입력되어 복합된 비트 스트림의 출력을 음성의 예측 결과를 생성하기 위해 메커트로 내는 블록 타입과 움직임 벡터를 재사용한다. 그러므로 H.264 표준에는 1/4씩 음성의 예측 및 움직임 보상, 7개의 가변길이 그리고 11개의 메커트로 부호화 모드가 있고 때문에 H.264 인코더에서는 이러한 정보를 재사용하기 위하여 복잡한 시각화와 복잡한 처리를 필요로 한다.

도 3는 구성도로, H.264 표준에 따라 인코딩된 비트 스트림의 메커트로 블록과 음성의 벡터가 MPEF-4에서의 눈의 부호화 모드 및 음성의 벡터로 변환하는 것을 설명하는 도면이다.

도 3a는 구성도로, H.264 표준에 따라 인코딩된 비트 스트림의 메커트로 블록과 음성의 벡터로 변환하는 것을 설명하는 도면이다.

도 3b를 참조하면, H.264 메커트로 블록이 인터 16x16 모드이거나 인터 4x4 모드이며 MPEF-4에 서는 인터 모드로 변환된다.

도 3c을 참조하면, H.264 메커트로 블록이 인터 16x16 모드이고 음성의 벡터가 도 3d와 같은 MPEF-4에서 인터 16x16 모드 및 H.264에서 인터 16x16 모드가 존재하기 때문에 도 3d의 변환시에 두 번 반복한다.

메커트로 블록이 인터 16x8 또는 인터 8x16 모드이고 도 3e에 도시된 것과 같은 음성의 벡터가 가려면, 인터 8x8 모드로 변환한다. 그리고 16x8 또는 8x16 블록의 움직임 벡터는 8x8 블록에 나누어 적용한다.

도 3d를 참조하면, H.264 메커트로 블록이 인터 4x8, 4x4, 4x4 레이어, 인터 8x8 모드로 변환된다. H.264 메커트로 블록의 각 블록에서의 음성의 벡터는 MPEF-4에서 2:1 또는 4:1로 변환된다. 즉, H.264에서 장치를 4로 나눈 음성의 벡터는 MPEF-4에서 4로 나눈 움직임 벡터를 하위 메커트로 움직임 벡터에 가까이 위치한다. 움직임 벡터의 움직임 벡터는 8x8 블록에 나뉘어 적용된다. 그러므로 음성의 벡터, 4x8, 4x4, 4x4, 4x4 레이어의 음성의 벡터는 8x8 블록에 나뉘어 적용된다. 이것은 8x8 블록의 움직임 벡터를 8x8 블록에 나뉘어 적용한다.

H.264에서는 인터트로 8x8 블록을 존재한다. 도 3에 도시된 것과 같이 인터 8x8 블록이 존재하는 경우에는 16x16, 4x4, 4x4 각 레이어는 인터트로 8x8 블록으로 변환된다. 그러나 인터트로 8x8 블록이 존재하는 경우에는 인터트로에서 인터트로로 변환한다. 그리고 16x8 또는 8x16 블록의 음성의 벡터는 8x8 블록에 나뉘어 적용된다.
임 백터는 BLock이 아닌 이웃하는 블록의 음직임 백터를 평균하여 MPE-4 8x8 블록의 음직임 백터로 한다. 그러나, 매크로 블록비 1BLock 3개 있는 경우 이 매크로 블록은 Intra 블록으로 변환된다.

또한, 변환된 블록의 width 가 변환된 블록의 width가 16의 배수이면, 변환된 블록의 width는 H.264의 skip 모드의 경우에는 16x16 모드로 변환하고 음직임 백터는 (0, 0)으로 설정한다.

상기한 바와 같이 블록 변환을 수행하고, 블록 변환이 끝난 후에 8x8 블록을 중심으로 음직임 백터를 중심으로 대칭한 4개의 피셀 (neighboring pixel)에 대하여 음직임 백터를 찾는 음직임 백터 추정으로 인터포러테이션 (interpolation) 동작을 수행하고 1/2 화소 및 1/2 화소에 대한 음직임 백터를 더 채택한다. 이렇게 하여 PSNR (Peak Signal-to-Noise Ratio)의 향상을 얻을 수 있다.

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원문: 본 방법은 블록 변환의 향상에 있어서 블록의 크기가 16x16에 해당하는 경우에만 적용이 가능하다. 단, 변환된 블록의 width가 16의 배수이면 변환된 블록의 width는 H.264의 skip 모드의 경우에는 16x16 모드로 변환하고 음직임 백터는 (0, 0)으로 설정한다.

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상기한 바와 같이 블록 변환을 수행하고, 블록 변환이 끝난 후에 8x8 블록을 중심으로 음직임 백터를 중심으로 대칭한 4개의 피셀 (neighboring pixel)에 대하여 음직임 백터를 찾는 음직임 백터 추정으로 인터포러테이션 (interpolation) 동작을 수행하고 1/2 화소 및 1/2 화소에 대한 음직임 백터를 더 채택한다. 이렇게 하여 PSNR (Peak Signal-to-Noise Ratio)의 향상을 얻을 수 있다.

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상기한 바와 같이 블록 변환을 수행하고, 블록 변환 후에 8x8 블록을 중심으로 음직임 백터를 중심으로 대칭한 4개의 피셀 (neighboring pixel)에 대하여 음직임 백터를 찾는 음직임 백터 추정으로 인터포러테이션 (interpolation) 동작을 수행하고 1/2 화소 및 1/2 화소에 대한 음직임 백터를 더 채택한다. 이렇게 하여 PSNR (Peak Signal-to-Noise Ratio)의 향상을 얻을 수 있다.
검색한 범위: 전문 분야에 따르면, H.264 표준에 따라 일반적인 영상은 MPEG-4 단말기에서도 실시간으로 재생할 수 있다. 즉, 동영상의 MPEG-4 단말기를 교체하지 않고도 새로운 표준인 H.264 표준에 따라 만들어진 영상을 재생할 수 있어 자원의 낭비를 막을 수 있다.

경구의 정의

경구항 1

(a) 소정의 암호전송방법으로 일반화된 비디오 코드링을 다각방향하여 각 영역의 데이터를 각 매트로 불록의 음직임 벡터 정보 및 매트로 불록 정보를 출력하는 단계; 및

(b) 상기 입력방향의 데이터를 입력방향 상정의 제2암호전송방법으로 암호화를 수행하는데 있어, 상기 음직임 벡터 정보와 매트로 불록 정보를 이용하여 음직임 보상을 수행하는 단계를 포함하는 것을 특징으로 하는 트랜스코딩 방법.

경구항 2

제4항에 있어서, 상기 (b) 단계는

상기 제1암호전송방법에 의한 만들어진 영상을 구성하는 매트로 불록의 불록 모드 정보와 음직임 벡터 정보를 포함하는 단계; 및

경구항 3

제2항에 있어서, 상기 소정의 제1입력방식은 H.264 표준에 따른 암호전송방법이며, 상기 제3입력방식은 MPEG-4 표준에 따른 암호전송방법을 특징으로 하는 트랜스코딩 방법.

경구항 4

(a) 소정의 암호전송방법에 의해 만들어진 영상을 구성하는 매트로 불록의 불록 모드 정보와 음직임 벡터 정보를 입력하는 단계; 및

(b) 상기 불록 모드를 16x16 또는 8x8 불록 모드로 변환하는 단계; 및

경구항 5

제2항에 있어서, 상기 음직임 벡터를 16x16 또는 8x8 불록의 음직임 벡터로 재정리하는 단계를 포함하는 것을 특징으로 하는 트랜스코딩 방법.

경구항 6

제3항에 있어서, 상기 소정의 암호전송방법은 H.264 표준에 따른 암호전송방법을 특징으로 하는 트랜스코딩 방법.

경구항 7

제4항에 있어서 상기 (b) 단계는

상기 불록 모드를 인트라 16x16 모드, 인터 16x16 모드, 인터 8x8 모드 중 어느 하나로 결정하는 것을 특징으로 하는 트랜스코딩 방법.

경구항 8

제3항에 있어서, 상기 (b) 단계는

상기 불록 모드가 인트라 16x16 모드이며 인트라 4x4 모드이며 인트라 16x16 모드로 변환하는 것을 특징으로 하는 트랜스코딩 방법.

경구항 9

제3항에 있어서, 상기 (b) 단계는

상기 불록 모드가 인터 16x16 모드이며 skip 모드이며 인터 16x16 모드로 변환하는 것을 특징으로 하는 트랜스코딩 방법.

경구항 10

제3항에 있어서, 상기 (b) 단계는

상기 불록 모드가 I/BLCK 3 개를 포함하고 있는 모드이며 인트라 16x16 모드로 변환하는 것을 특
장으로 하는 트랜스코딩 방법.

정확방 11

제목에 있어서, 상기 (b) 단계는
상기 복록 모드가 1개 또는 2개의 IBLOCK를 포함하고 있는 모드이거나 인터 16x8 모드, 인터 8x16 모드 또는 인터 PB 모드이면, 인터 8x8 모드로 변환하는 것을 특정으로 하는 트랜스코딩 방법.

정확방 12

제목에 있어서, 상기 (c) 단계는
음직임 벡터를 정확히 할 8x8 복록에 대응하는 복록에 포함된 음직임 벡터의 평균을 상기 8x8 복록의 음직임 벡터로 대체시키는 것을 특정으로 하는 트랜스코딩 방법.

정확방 13

제목에 있어서, 상기 (c) 단계는
음직임 벡터를 정확히 할 8x8 복록에 대응하는 복록에 IBLOCK 인 경우에는 IBLOCK에 인접한 복록의 음직임 벡터를 평균하여 상기 8x8 복록의 음직임 벡터로 대체시키는 것을 특정으로 하는 트랜스코딩 방법.

정확방 14

소정의 제1알호법방으로 압축된 비트 스트림을 디코딩하여 결포 영역의 데이터와 각 맥크로 복록의 음직임 벡터 정보 및 맥크로 복록 정보를 출력하는 디코더 및

상기 피셀영역의 데이터를 입력 받아 소정의 제2알호법방으로 압축상태할 때 상기 음직임 벡터 정보와 맥크로 복록 정보를 이용하여 음직임 보상을 수행하는 인코더를 포함하는 것을 특정으로 하는 트랜스코딩 장치.

정확방 15

제목에 있어서,
상기 인코더는 음직임 보상부를 포함하며,
상기 음직임 보상부는 상기 제1알호법방에 의해 만들어진 영상을 구성하는 맥크로 복록의 복록 모드 정보와 음직임 벡터 정보를 수신하고, 상기 복록 모드를 16x16 또는 8x8 복록 모드로 변환하고, 상기 음직임 벡터를 16x16 또는 8x8 복록의 음직임 벡터로 대체시키는 것을 특정으로 하는 트랜스코딩 장치.

정확방 16

제목에 있어서, 상기 음직임 보상부는
상기 변환된 음직임 벡터 좌표의 위치에 따라 인코더에 의해 음직임 추정을 수행하여 얻어진 음직임 벡터 좌표의 화소 부분으로 1/2 화소로 만듭니다, 이를 1/2 화소에 대하여 음직임 추정을 수행하 여 음직임 벡터를 결정하는 것을 특정으로 하는 트랜스코딩 장치.

정확방 17

제목에 있어서,
상기 소정의 제1알호법방은 H.264 표준에 따른 알호방법이며, 상기 제2알호법방은 MPEG-4 표준에 따른 알호방법인 것을 특정으로 하는 트랜스코딩 장치.
Forcman (QCIF, 10Hz)

- Y-PSNR

- Bit-rate [Kbps/s]
Mother & Daughter (QCIF, 10Hz)

Y-PSNR

Bits-rate [Kbps/s]
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**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 THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:  

Yung-Lyul LEE et al.  

Examiner: To be assigned

Application No.: 11/289,649  

Group Art Unit: 2613

Filed: November 30, 2005  

Confirmation No.: 5884

For: IMAGE DOWN-SAMPLING  

TRANSCODING METHOD AND DEVICE)  

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Sir:

Applicants are enclosing certified copies of Japanese Patent Application Nos. 10-2004-0099400, filed November 30, 2004, and 10-2005-0107224, filed November 9, 2005. These documents provide a basis for Applicants’ claim for priority. No fee is believed due as a result of this submission. Nevertheless, 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: July 18, 2006

By: James B. Arpin  
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JBA/tt  
Enclosures
This is to certify that the following application annexed hereto is a true copy from the records of the Korean Intellectual Property Office.

출원번호 : 10-2004-0099400
Application Number

출원년월일 : 2004년 11월 30일
Date of Application

출원인 : 주식회사 휴맥스
Applicant(s)

2005년 11월 16일

COMMISSIONER

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Issue Date : 2005.11.16
【서지사항】

【서류명】 서지사항 보정서
【수신처】 특허청장
【제출일자】 2004.12.14
【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】 10-2004-0099400
【출원일자】 2004.11.30
【심사결구일자】 2004.11.30
【발명의 명칭】 영상 축소 트랜스코드 방법 및 장치
【제출원인】
【접수번호】 1-1-2004-0563763-42
【접수일자】 2004.11.30
【보정할 서류】 특허출원서
【보정할 사항】
【보정대상항목】 발명자
【보정방법】 정정
【보정내용】
【발명자】
【성명의 국문표기】 이영렬
【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】 장의선
【성명의 영문표기】 JANG, Euee S.
【주민등록번호】 681220-1481119
【우편번호】 133-791
【주소】 서울 성동구 행당1동 한양대학교 산학빌딩 501호
【국적】 KR

【발명자】
【성명의 국문표기】 이충구
【성명의 영문표기】 LEE, Chung Ku
【주민등록번호】 670224-1155119
【우편번호】 403-011
【주소】 인천 부평구 부평1동 동아아파트 15등 304호
【국적】 KR

【취지】 특허법시행규칙 제13조․희용신안법시행규칙 제8조의 규정에 의하여 위와 같 이 제출합니다. 대리인
이경란 (인)

【수수료】
【보정료】 원
【기타 수수료】 0 원
【합계】 0 원
【첨부서류】 1. 기타첨부서류 [사유서] 1통
【서지사항】

【서류명】 특허출원서
【권리구분】 특허
【수신처】 특허청장
【제출일자】 2004.11.30
【발명의 국문명칭】 영상 축소 트랜스 코딩 방법 및 장치
【발명의 영문명칭】 Method and device for video down-sampling transcoding
【출원인】
【명칭】 (주)휴맥스
【출원인코드】 1-1998-000063-1
【대리인】
【성명】 이경란
【대리인코드】 9-1998-000651-6
【포괄위임등록번호】 2004-073908-7
【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】 장의선
【성명의 영문표기】 JANG, Euee S.
【주민등록번호】 681220-1481119
【우편번호】 133-791
【주소】 서울 성동구 행당1동 한양대학교 산학빌딩 501호
【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
【심사청구】 청구
【취지】 특허법 제42조의 규정에 의한 출원, 특허법 제60조의 규정에 의한 출원심사 를 청구합니다. 대리인
이병람 (인)

【수수료】
【기본출원료】 0 면 38,000 원
【가산출원료】 34 면 0 원
【우선권주창료】 0 건 0 원
【심사청구료】 13 항 525,000 원
【합계】 563,000 원
【감면사유】 중소기업
【감면후 수수료】 281,500 원
【첨부서류】 1. 중소기업기본법시행령 제2조에의한 중소기업에 해당함을 증명하는 서류_1통 2. 기타첨부서류[중소기업기본법]_1통
【요약서】

【요약】

본 발명은 영상 축소 코딩 방법 및 장치에 관한 것으로서, 보다 상세하게는 H.264에서 MPEG-4로 영상 축소를 고속으로 수행하는 방법 및 장치에 관한 것이다. 제1 방식에 따른 제1 메크로블록을 제2 방식에 따른 제2 메크로 블록으로 변환하기 위한 영상 축소 트랜스 코딩 방법은 (a) 제1 메크로블록에 포함된 인트라 메크로블록의 개수가 미리 설정된 제1 조건을 충족하면, 제2 메크로 블록의 블록 모드를 결정하고, 결정된 블록 모드로 변환하는 단계; (b) 제1 메크로블록에 포함된 인터 메크로블록의 개수가 제2 조건을 충족하면, 제2 메크로 블록의 블록 모드를 결정하고, 결정된 블록 모드로 변환하는 단계; 및 (c) 메크로 블록의 변환이 완료되면, 제2 메크로블록에 대한 움직임 벡터 재조정을 수행하는 단계를 포함할 수 있다.

【대표도】

도 3

【색인어】

영상 축소, 트랜스코딩, 메크로블록, 움직임벡터
【명세서】

【발명의 명칭】

영상 축소 트랜스 코딩 방법 및 장치 {Method and device for video down-sampling transcoding}

【도면의 간단한 설명】

<1> 도 1은 본 발명의 바람직한 실시예에 따른 영상 크기 축소 방법을 도시한 도면.

<2> 도 2a 내지 도 2e는 본 발명의 바람직한 실시예에 따른 메크로블록 모드 및
음직임 벡터의 변환 방법을 도시한 도면.

<3> 도 3은 본 발명의 바람직한 실시예에 따른 영상 크기 축소를 위한 트랜스 코
딩 장치의 구성요소 도시한 도면.

<4> 도 4은 본 발명의 바람직한 실시예에 따른 영상 크기 축소 방법을 도시한 순
서도.

<5> 도 5a내지 도 5d는 본 발명의 바람직한 실시예에 따른 영상 크기 축소 방법을 도시한 도면.

<6> <도면의 주요부분에 대한 부호의 설명>

<7> 300 : 트랜스코딩 장치

36-4
310 : 제1 변환부
320 : 제2 변환부
330 : 벡터 제조정부

【발명의 상세한 설명】

【발명의 목적】

【발명이 속하는 기술분야 및 그 분야의 종래기술】

본 발명은 영상 축소 코딩 방법 및 장치에 관한 것으로서, 보다 상세하게는 H.264에서 MPEG-4로 영상 축소를 고속으로 수행하는 방법 및 장치에 관한 것이다.

컴퓨터와 네트워크의 발달로 송신측에서 수신측으로 다양한 데이터를 전송할 수 있게 되었다. 이러한 기술 중 네트워크를 통해 대용량의 멀티미디어 데이터를 전송하기 위하여 멀티미디어 표준 압축 형식들이 소개되고 있으며, 송신측과 수신측의 환경을 고려하기 위하여 양측의 QoS(Quality Of Service)를 고려하여 각 환경에 맞게 변환하는 많은 비디오 트랜스코딩 기법이 소개되고 있다. 이러한 종래 기술에 따른 비디오 트랜스코딩 기법은 크게 pixel-domain에서의 트랜스코딩 방법과 DCT domain에서의 트랜스코딩 방법으로 분류된다.

영상의 화질적인 측면에서 가장 좋은 트랜스코딩 방법은 입력된 영상의 비트스트림(bitstream)을 복호화하고, 복호화된 영상을 다시 부호화 하는 직접 화소 영역 트랜스코딩(Cascaded Pixel-domain Transcoding)방법이다. 그러나 이러한 종래
기술은 부호화를 한번 더 수행하기 때문에 복잡도가 높아지는 문제점이 있다. 따라서, 종래 기술에 의할 때, 영상의 화질을 만족시키면서, 복잡도를 개선할 수 있는 효율적인 트랜스코딩 방법이 존재하지 아니한다.

【발명이 이루고자 하는 기술적 과제】

따라서 본 발명은 상기의 제반 문제점을 해결하기 위하여 안출한 것으로서, 메크로블록의 정보를 재사용하여 화질을 만족시키면서 복잡도를 감소시킬 수 있는 영상 축소 트랜스코딩 방법 및 장치를 제공함에 그 목적이 있다. 즉 본 발명은 복잡도를 줄이기 위해서 H.264 복호화기에서 사용한 각각의 MB(Macro block)의 정보를 재사용할 수 있는 트랜스코딩 기법을 제시한다.

【발명의 구성】

상술한 목적으로 달성하기 위하여 본 발명의 제1절에 따르면, H.264에서 MPEG-4로 영상 축소를 고속으로 수행하는 방법을 제공할 수 있다.

바람직한 실시예에 의할 때, 영상 축소 트랜스 코딩 방법은 (a) 제1 매크로 블록에 포함된 인트라 매크로블록의 개수가 미리 설정된 제1 조건을 충족하면, 제2 매크로 블록의 블록 모드를 결정하고, 상기 결정된 블록 모드로 변환하는 단계;
(b) 상기 제1 매크로블록에 포함된 인터 매크로블록의 개수가 제2 조건을 충족하면, 상기 제2 매크로 블록의 블록 모드를 결정하고, 상기 결정된 블록 모드로 변환하는 단계; 및 (c) 상기 매크로 블록의 변화가 완료되면, 상기 제2 매크로 블록에 대한 움직임 벡터 재조정을 수행하는 단계를 포함한다. 여기서, 평균 필터를 이용하여 다른 샘플링을 하면서, 상기 결정된 블록 모드로 변환할 수 있다.

그리고 상기 (a) 단계는 상기 제1 매크로블록이 모두 인트라 매크로 블록인 경우, 한 개의 인트라 매크로블록으로 변환하는 단계를 포함한다. 그리고 상기 (a) 단계는 상기 매크로블록의 일부가 인트라 매크로 블록인 경우, 상기 매크로블록의 SAD 비교 방식을 이용하여 블록 모드를 결정하는 단계를 포함한다.

또한, 상기 (b) 단계는 상기 인터 매크로블록의 개수가 미리 설정된 개수 이상인 경우 및 움직임 벡터간의 차분값을 산출한 후, 상기 차분값이 미리 설정된 이상인 경우는 인터 모드로 변환하고, 그 외의 경우는 상기 매크로블록의 SAD 비교 방식을 이용하여 블록 모드를 결정하고, 상기 결정된 블록모드로 변환한다.
여기서, 상기 SAD 비교 방식은 미리 설정된 두 개의 인터 블록의 SAD를 산출하고, 최소 인터 SAD를 결정하는 단계; 상기 최소 인터 SAD를 미리 설정된 인트라 블록의 인트라 SAD와 비교하여, 최소의 SAD에 상응하는 블록 모드로 변환하는 단계를 포함한다.

그리고 상기 (c) 단계는 정수단위 움직임 벡터를 중심으로 그 주위의 정수단위 ±3개의 이웃 화소(neighbor pixel)에 대하여 정수단위 움직임 벡터를 검색하는 단계; 및 상기 검색한 정수단위 움직임 벡터주변의 1/2 화소 단위의 ±1개의 이웃 화소에 대한 움직임 벡터를 검색하는 단계를 포함한다.

상술한 목적을 달성하기 위하여 본 발명의 제2축면에 따르면, H.264에서 MPEG-4로 영상 축소를 고속으로 수행하는 장치를 제공할 수 있다.

바람직한 실시예에 의할 때, 영상 축소 트랜스 코딩 장치는 제1 메크로블록에 포함된 인트라 메크로블록의 개수가 미리 설정된 제1 조건을 충족하면, 제2 메크로 블록의 블록 모드를 결정하고, 상기 결정된 블록 모드로 변환하는 제1 변환부; 상기 제1 메크로블록에 포함된 인터 메크로블록의 개수가 제2 조건을 충족하면, 상기 제2 메크로 블록의 블록 모드를 결정하고, 상기 결정된 블록 모드로 변환하는 제2 변환부; 및 상기 메크로 블록의 변환이 완료되면, 상기 제2 메크로블록에 대한 움직임 벡터 재조정을 수행하는 움직임 벡터 재조정부를 포함한다.

여기서, 상기 제1 변환부는 상기 제1 메크로블록이 모두 인트라 메크로 블록인 경우, 한 개의 인트라 메크로블록으로 변환하고, 상기 메크로블록의 일부가 인
트라 메크로 블록의 경우, 상기 메크로블록의 SAD 비교 방식을 이용하여 블록 모드를 결정할 수 있다.

그리고 상기 제2·변환부는 상기 인터 메크로블록의 개수가 미리 설정된 개수 이상인 경우 및 움직임 벡터간의 차분값을 산출한 후, 상기 차분값이 미리 설정된 이하인 경우는 인터 모드로 변환하고, 그 외의 경우는 상기 메크로블록의 SAD 비교 방식을 이용하여 블록 모드를 결정하고, 상기 결정된 블록모드로 변환한다.

이하, 첨부한 도면들을 참조하여 본 발명에 따른 영상 축소 트랜스코딩 방법 및 장치의 바람직한 실시예를 상세히 설명하기로 하며, 첨부 도면을 참조하여 설명함에 있어 도면 부호에 상관없이 동일하거나 대응하는 구성 요소는 동일한 참조번호를 부여하고 이에 대한 중복되는 설명은 생략하기로 한다.

일반적으로 H.264의 프레임내의 MB(메크로블록)을 MPEG-4프레임내의 MB으로 변환하는 가장 간단한 방법은 입력으로 들어오는 압축된 H.264 프레임을 모두 복원한 후, MPEG-4에서 복원된 영상을 다시 압축하는 직접 화소 영역 트랜스코딩 방식이다. 하지만 상기 방법은 모든 프레임에 있는 모든 MB에 대한 움직임 예측 과정이 MPEG-4보호기에서 수행되므로, 많은 계산량으로 인하여 트랜스코더(transcoder)에서의 실시간 전송에 문제가 될 수 있다.

본 발명은 이러한 문제를 해결하기 위해서 움직임 예측 과정을 수행하지 않으면서 실시간 전송에 적합하도록 하기 위하여, H.264 보호기에서 사용한 블록모드 및 움직임 벡터 정보를 MPEG-4보호기에서 재사용하도록 구성된다. 본 발명의 실제
예에 따라 H.264로 압축된 Bitstream은 가변장 부호화(VLD, Variable Length Decoding)를 수행하는 과정에서 현재 복원되고 있는 프레임 형식과 MB의 정보와 움직임 벡터에 대한 정보를 파악한다. 여기서, 복원된 Bitstream의 프레임 형식이 P 프레임(Predictive frame)이면 MB내에 있는 블록 타입과 움직임 벡터를 재사용하여 MPEG-4부호기에서 많은 시간을 소모하는 움직임 예측 과정을 생략 할 수 있다.

이하, 도 1 및 도 2a 내지 도 2e에서는 H.264 BP에서 MPEG-4 SP로 변환 시 Pixel 도메인에서 블록타입 간 변환 및 움직임 벡터 조정을 이용한 트랜스코딩방법을 설명한다. 그리고 도 3에서는 구체적인 트랜스 코딩 방법을 설명하고, 도 5에서는 트랜스 코딩 장치의 구성을 설명하기로 한다. 마지막으로 도 5a 내지 도 5d에서는 H.264 BP를 MPEG-4 SP로 화소 영역 트랜스코딩 방식으로 트랜스코딩 했을 때의 실험결과를 설명하기로 한다.

영상 축소 트랜스 코딩의 절차

이하, 도 1에서는 본 발명의 바람직한 실시예에 따른 영상 축소 방법을 설명하기로 한다. 도 1을 참조하면, 평균 필터(average filter)를 이용한 영상 크기 축소 방법(down sampling)이 도시되어 있다.

4개의 MB 타입을 1개의 MB 타입으로의 변환하는 경우, 종래 기술에 의할 때, H.264(SP) 부호화기를 통과한 CIF 크기의 영상을 다시 QCIF 크기의 영상으로 변화하는 동안, 원 영상 (source image)은 두 번의 영상의 변환과정(encoding,
down-sampling)을 통과하면서 화질조화가 발생하게 된다.

본 발명의 실시예에 따르면, H.264 복호기에서 복원된 CIF영상에서 4개의
16x16 MB(macro block)는 MPEG-4복호기에서 부호화할 1개의 16x16 MB로 축소되어
QCIF 영상으로 변환된다. 본 발명에 의할 때, CIF 영상을 QCIF 영상으로 축소시킬 때,
4개의 화소값을 평균 필터링(average filtering)하여 1개의 화소값으로
sampling하는 방법 그리고 4개의 화소값 중 1개의 화소값 만을 취하는
sub-sampling 방법 중 평균 필터(average filter)를 이용하여 영상을 축소 시키는
방법을 사용한다. 이는 sub-sampling 기법을 이용하여 영상을 축소시키면 시간 복
잡도 면에서 약간의 이득은 제공하나, 영상의 화질 저하가 현저히 나타나기 때문에
평균 필터(average filter)를 이용하였다. 그리고 본 발명에서는 계산 복잡도가 낮
은 DCT(Discrete Cosine Transform) 영역에서의 트랜스코딩 방법을 제안하지 않고
화소 영역에서의 트랜스코딩 방법을 사용한다. 이는 H.264의 비선형(non-linear)
loop filter 때문에 DCT 영역에서의 트랜스코딩을 하기 위해서 loop filtering된
영상을 다시 DCT한 후, DCT영역에서 트랜스코딩을 하며, 4x4 integer DCT와 8x8
DCT간의 변환식을 도출하여야 하므로 계산량이 많아지기 때문이다.

H.264에서는 1/4화소 ME(Motion Estimation, 움직임 예측) 및 MC(Motion
Compensation, 움직임 보상), 7개의 가변블록(인터(Inter) 16x16, 인터(Inter)
16x8, 인터(Inter) 8x16, 인터(Inter) 8x8, 인터(Inter) 8x4, 인터(Inter) 4x8, 그
리고 인터(Inter) 4x4) 그리고 10개의 블록 모드(Skip, 인트라(Intra) 16x16, 인트라
(Intra) 4x4, 인터(Inter) 16x16, 인터(Inter) 16x8, 인터(Inter) 8x16,
인터(Inter) 8x8, 인터(Inter) 8x4, 인터(Inter) 4x8, 그리고 인터(Inter) 4x4 모드를 사용하나, MPEG-4는 인트라(Intra) 16x16, 인터(Inter) 16x16, 인터(Inter) 8x8 그리고 skip 모드를 지원하기 때문에, 본 발명에서는 MPEG-4에서 이런 정보들을 재사용하기 위해서는 블록형태 변환을 수행하도록 구성된다.

도 2a 내지 도 2e는 본 발명의 바람직한 실시예에 따른 H.264 4개의 MB모드 및 움직임 벡터를 MPEG-4 MB모드 및 움직임 벡터로 변환하는 방법이 도시되어 있다.

이하, 복원된 H.264 비트스트림의 2x2 MB들의 형태(MB mode)를 MPEG-4에서 재사용할 수 있는 하나의 MB 형태로 변환해 주는 복수개의 실시예를 참조하여, H.264 BP에서 MPEG-4 SP로 변환시 Pixel 도메인에서 블록타입 간 변환 및 움직임 벡터 조정을 이용한 트랜스코딩방법을 설명한다.

도 2a에 따른 H.264내의 모든 Skip 모드는 H.264내의 2x2 MB들을 MPEG-4내의 한 개의 MB으로 변환하기 위한 전처리 단계를 나타내며, 도 2a와 같이 H.264내의 인터(Inter)16x16 모드로 변환 시킨다.

도 2b를 참조하면, H.264의 2x2 MB들이 모두 인트라(Intra) 모드16x16, 인트라(Intra)4x4인 MB들로만 구성되어 있으면, 한 개의 인트라(Intra)16x16 MB으로 변환하고 평균 필터(average filter)를 이용하여 영상 축소를 한다.

도 2c는 2x2 MB들이 2개 또는 3개의 인트라(Intra) 모드 MB들로 구성되어 있
는 경우, MPEG-4 부호기에서 인터(Inter)16x16, 인터(Inter)8x8 그리고
인트라(Intra) 16x16 모드 중 어떤 모드로 변환해주는 기준이 불명확한 경우이다.
이런 경우, 종래 기술에 따라, MPEG-4 내에 있는 특정한 하나의 모드(인터(Inter)16x16, 인터(Inter)8x8 또는 인트라(Intra)16x16 모드)로 변환 하였을
경우 화질이 떨어지게 되고 부호화된 비트량이 증가하는 현상이 나타난다. 그래서
본 발표는 MPEG-4 부호기내에서 인터(Inter)16x16 블록의 SAD(Sum of Absolute
Difference, 절대값 누적차)값(SAD-128)과 4개의 인터(Inter)8x8 블록 각각의 SAD
값들의 합을 비교해서 최소 SAD값을 가지는 모드를 선택하고, 선택된 인터(Inter)
모드 SAD값과 하기의 수학식1 및 수학식 2에 따라 산출된 인트라(Intra) 모드 SAD
값을 비교해서 최소 SAD값을 가지는 모드를 최종적으로 선택하도록 구성된다.

【수학식 1】

\[
MB_{mean} = \sum_{i=0}^{15} \sum_{j=0}^{15} \text{org}_{i,j} \\
SAD_{intra} = \sum_{i=0}^{15} \sum_{j=0}^{15} |\text{org}_{i,j} - MB_{mean}| 
\]
【수학식 2】

\[
MB_{mean} = \sum_{i=0}^{15} \sum_{j=0}^{15} r_{i,j}
\]

\[
SAD_{min} = \sum_{i=0}^{15} \sum_{j=0}^{15} |r_{i,j} - MB_{mean}|
\]

위 식에서 \(r_{i,j}\)는 MB내에 있는 각각의 16x16 화소들의 값이고 \(MB_{mean}\)은 MB내에 있는 화소값들의 평균이다. 이와 같이 과정을 거쳐 선택된 최적의 모드로 변환시킴으로써, 화질적인 측면이나 부호화되는 비트 량 측면을 모두 충족시킬 수 있다.

도 2d를 참조하면, H.264의 2x2 MB들 내에 인터(Inter)16x16 모드가 4개 또는 3개가 있는 경우, MPEG-4 부호기내에서 인터(Inter)16x16 모드로 변환하도록 구성된다. 중대 기술에 의할 때, H.264의 2x2 MB들 내에 인터(Inter)16x16 모드가 4개 또는 3개가 있는 경우 MPEG-4 부호기내의 인터(Inter)16x16 또는 인터(Inter)8x8 모드로 변환이 가능하다. 본 방법에 따르면 인터(Inter)8x8 모드가 아닌 인터(Inter)16x16 모드로 변환한다. 먼저, 2x2 MB내의 각각의 MB의 1/4단위 움직임 벡터의 평균값을 MPEG-4 MB내의 4개의 8x8 블록들의 평균 단위 움직임 벡터로 취한 후, 이렇게 얻은 4개의 8x8 블록 움직임 벡터의 평균값으로 하나의 움직임 벡터를 인터(Inter)16x16 MB에 취함으로써 모드 변환이 이루어지도록 구성된다. 구체적인 산식은 하기 수학식 3과 같다.
【수학식 3】

\[
M_{ij} = \left( \sum_{k=0}^{2} \sum_{n=0}^{2} m_{k,n} + 1 \right) + 2 \quad i, j = 0, 1
\]

여기서, \( m, n \)은 중간 단계인 MB이 취하는 8x8 블록들의 가로축, 세로축 좌표를 가리키고 \( j, k \)는 2x2 MB들 안의 \((m, n)\)번째 MB이 취하는 4x4 블록들의 가로축, 세로축 좌표를 가리킨다.

이와 같이 인터(Inter)8x8 모드가 아닌 인터(Inter)16x16 모드로 변환하는 이유는 H.264에서 MPEG-4로 트랜스코딩 시 foreman 영상에 대해 QP(quantization parameter)를 10으로 고정한 후, 모드 변환에 대한 모든 조건을 동일하게 하고, 도 2d와 같은 조건인 경우, 인터(Inter)8x8 모드로 변환 하면 인터(Inter)16x16 모드로 변환 하였을 때 보다 PSNR이 31.61dB에서 31.69dB로 0.08dB 향상을 가져오나, 부분화된 비트양은 143.2kbps에서 156.8kbps로 증가하는 현상을 보이기 때문에 전체 적인 부분화 효율이 떨어지기 때문이다.

도 2e를 참조하면, H.264의 2x2 MB들이 복잡한 블록모드 즉, 한 개 이상의 인터(Inter)P8x8 모드인 MB들, 한 개 이하의 인트라(Intra) 모드 MB 그리고 이들 외의 인터(Inter) 모드 MB들로 구성되어 있는 경우, 2x2 MB들 내의 각각의 MB들을 MPEG-4내의 8x8 블록으로 변환 시킨다. MPEG-4내의 8x8 블록이 취하는 정수단위 움직임 벡터는 16개의 4x4 블록이 가지고 있는 1/4단위 움직임 벡터의 평균값을 구하고 이 값을 다시 4로 나눔으로써 정수단위 움직임 벡터를 구한다. 산식은 상기
수학식 3과 같다.

도 3은 본 발명의 바람직한 실시예에 따른 트랜스코딩 장치의 구성을 도시한 도면이다.

도 3을 참조하면, 본 발명에 따른 트랜스코딩 장치(300)는 상기 제1 매크로 블록에 포함된 인트라 매크로블록의 개수가 미리 설정된 제1 조건을 충족하면, 상기 제2 매크로 블록의 블록 모드를 결정하고, 상기 결정된 블록 모드로 변환하는 제1 변환부(310), 상기 제1 매크로블록에 포함된 인터 매크로블록의 개수가 제2 조건을 충족하면, 상기 제2 매크로 블록의 블록 모드를 결정하고, 상기 결정된 블록 모드로 변환하는 제2 변환부(320) 및 상기 매크로 블록의 변환이 완료되면, 상기 제2 매크로블록에 대한 음직임 벡터 재조정을 수행하는 음직임 벡터 재조정부(330)를 포함한다.

여기서, 상기 제1 변환부(310)는 상기 제1 매크로블록이 모두 인트라 매크로 블록인 경우, 한 개의 인트라 매크로블록으로 변환하고, 상기 매크로블록의 일부가 인트라 매크로 블록인 경우, 상기 매크로블록의 SAD 비교 방식을 이용하여 블록 모드를 결정한다.

그리고 상기 제2 변환부(320)는 상기 인터 매크로블록의 개수가 미리 설정된 개수 이상인 경우 및 음직임 벡터간의 차분값을 산출한 후, 상기 차분값이 미리 설정된 이하인 경우는 인터 모드로 변환하고, 그 외의 경우는 상기 매크로블록의 SAD 비교 방식을 이용하여 블록 모드를 결정하고, 상기 결정된 블록모드로 변환한다.
보다 상세한 기능은 도 4의 흐름도를 참조하여 설명하기로 한다.

4를 참조하면, 2x2 MB 기반의 H.264 에서 MPEG-4로 트랜스코딩을 수행하는
구체적인 흐름도(flow chart)가 도시되어 있다.

먼저 단계 S410에서, H.264 2x2 MB 형태가 입력되면, 단계 S410에서, 입력된
H.264 2x2 MB 형태를 MPEG-4 1x1 형태로 각 조건에 맞게를 수행 한 후, average 필터를 사용하여 다른 샘플링을 수행한다.

이후, 을 수행한다.

단계 S425에서 H.264의 2x2 MB들 내에 인트라(Intra) 매크로 블록의 개수가
2개 이상인 경우, 단계 S430으로 진행하여, 매크로블록의 개수가 4개인지 여부를
판단하고, 4개가 아니면 단계 S435로 진행하여 인트라(Intra) 방식으로 변환하고,
그 외의 경우에는 단계 S455로 진행한다.

단계 S440에서 H.264의 2x2 MB들 내에 인터(Inter)16x16 모드가 2개 이상인
경우(예를 들면, 4개 또는 3개가 있는 경우), 단계 S450으로 진행하여 인터(Inter)
16x16으로 변환한다. 그리고 단계 S440에서 H.264의 2x2 MB들 내에
인터(Inter)16x16 모드가 2개 이상인 경우, 단계 S445에서 을 미리 설정된 문턱값
(예를 들면, 4)과 비교한다.

상기 차분값이 상기 문턱값보다 작으면 단계 S450에서 단계 S455로 진행하여
SAD 과정을 통한 MB 모드를 결정하게 된다.
여기서, H.264 부호기에서 인터(Inter)8x8, 인터(Inter)8x4, 인터(Inter)4x8 그리고 인터(Inter)4x4 모드처럼 edge로 인하여 결정된 모드를 MPEG-4 부호기에서 사용할 모드를 인터(Inter)8x8 MB모드가 아닌 인터(Inter)16x16 MB모드로 변환 하는 이유는 H.264로 부호화 및 영상 축소과정이 일종의 LPF(Low Pass Filtering)이기 때문이다.

이후, 단계 S460에서 매크로블록의 모드 결정을 종료하고, 단계 S415로 진행하여 다음의 매크로블록을 변환한다. 이와 같이 모드 결정이 종료하면, 단계 S470에서 움직임 벡터 재조정을 수행한다. 즉, 계산된 정수단위 움직임 벡터를 중심으로 그 주위의 정수단위 ±3개의 이웃화소(neighbor pixel)에 대하여 정수단위 움직임 벡터를 찾고, 찾은 정수단위 움직임 벡터주변의 1/2 화소 단위의 ±1개의 이웃화소에 대한 움직임 벡터를 찾아서 움직임 벡터 재조정(refinement)을 수행하여 PSNR(Peak Signal-to-Noise Ratios)의 향상을 얻을 수 있다.

도 5a, 도 5d는 본 발명의 바람직한 실시예에 따른 H.264 BP를 MPEG-4 SP로 화소 영역 트랜스코딩 방식으로 트랜스코딩 했을 때의 실험결과를 설명한 도면이다.

상기 실험은 H.264 BP로 재구성된 JM(Joint Model) Decoder와 MPEG-4의 SP로서 재구성된 MoMuSys -FDIS-V1.0 Encoder를 이용하여 구현한 트랜스코더를 이용하여 수행하였다. 실험은 펜티엄 IV 2.8GHz PC에서 실험 하였고 트랜스코더에서 사용한 Bitstream은 JM Encoder에서 Foreman, News, Paris 그리고 Coast CIF(352x288)
영상은 압축하여 각각 생성된 H.264 Bitstream을 사용하였다. Bitstream 생성에 사용한 각 영상들에 대하여 첫 번째는 I(인트라(Intra)) 프레임 나머지는 모두 P(Predictive) 프레임을 사용하였으며, 30Hz의 프레임 속도로 300장의 시퀀스를 압축하여 실험 하였다.

도 5a의 Coast, 도 5b의 Paris, 도 5c의 News 그리고 도 5d의 Foreman 시퀀스에 대하여, 각각 H.264에서 MPEG-4로 변환시 종래 기술에 따른 직렬 화소 영역 트랜스코딩 방식(510, 520, 530, 540), 본 발명에 따른 변환 방식에 따라 영상 압축 방식(515, 525, 535, 545)간의 차이(Y)신호의 PSNR의 차이를 보여주고 있다. 여기서, 장면변환(scene change)이 있는 도 5d의 foreman 영상을 제외한 모든 영상에서 화질 저하를 거의 보이지 않았음을 뿐 아니라, 도 5a의 Coast영상에서는 최대 0.5dB의 화질이 개선 되었다.

가히의 표 1은 본 발명에 따른 트랜스코딩 방식에 따른 시간적 이득을 나타내고 있다. 각각의 영상마다 약간의 차이는 보이지만 평균적으로 1.72배의 속도향상을 보였고 트랜스코더의 부호기(MPEG-4 encoder)만을 고려할 경우 약 4.1배의 속도 향상을 보임을 알 수 있다.

【표 1】

<table>
<thead>
<tr>
<th>Sequence</th>
<th>Cascade pixel-domain</th>
<th>Proposed Transcoding</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Transcoding</td>
<td></td>
</tr>
<tr>
<td></td>
<td>H.264 decoder time</td>
<td>H.264 decoder time</td>
</tr>
<tr>
<td></td>
<td>MPEG-4 encoder time</td>
<td>MPEG-4 encoder time</td>
</tr>
<tr>
<td></td>
<td>Total time</td>
<td>Total time</td>
</tr>
<tr>
<td>News</td>
<td>34.14</td>
<td>34.14</td>
</tr>
<tr>
<td></td>
<td>52.23</td>
<td>12.1</td>
</tr>
<tr>
<td></td>
<td>86.37</td>
<td>46.24</td>
</tr>
</tbody>
</table>
상술한 바와 같이, 본 발명에 따라 H.264에서 정의된 블록 정보를 MPEG-4에
서 다시 사용하기 위해 정보 변환 방법을 제공할 수 있다. 종래 기술에 따라 시간
적으로 많은 비용 갖는 직렬 화소 영역 트랜스코딩 방식에 비해 H.264에서 이전 움
직업 벡터와 블록정보를 재사용 함으로써 시간적으로 1.8배 정도의 성능향상을 보
이면서 화질영화가 거의 없음을 알 수 있다.

【발명의 효과】

상술한 바와 같이 본 발명은 패크로블록의 정보를 재사용하여 화질을 만족시
키면서 복잡도를 감소시킬 수 있는 영상 축소 트랜스코딩 방법 및 장치를 제공할
수 있다.

또한, 본 발명에 따른 H.264에서 MPEG-4로 변환하는 트랜스코더는 기존의
MPEG-4코덱을 사용했던 장비들을 교체하지 않고도 새로운 동영상 압축 표준인
H.264로 압축된 영상을 사용 가능하게 할 수 있는 효과도 있다.

상기에서는 본 발명의 바람직한 실시예를 참조하여 설명하였지만, 해당 기술
분야에서 통상의 지식을 가진 자라면 하기의 특허 청구의 범위에 기재된 본 발명의
사상 및 영역으로부터 벗어나지 않는 범위 내에서 본 발명을 다양하게 수정 및 변
경시킬 수 있음을 이해할 수 있을 것이다.
【특허청구범위】

【청구항 1】

제1 방식에 따른 제1 매크로블록을 제2 방식에 따른 제2 매크로 블록으로 변환하기 위한 영상 축소 트랜스 코드 방법이 있어서,

(a) 상기 제1 매크로블록에 포함된 인트라 매크로블록의 개수가 미리 설정된 제1 조건을 충족하면, 상기 제2 매크로 블록의 블록 모드를 결정하고, 상기 결정된 블록 모드로 변환하는 단계;

(b) 상기 제1 매크로블록에 포함된 인터 매크로블록의 개수가 제2 조건을 충족하면, 상기 제2 매크로 블록의 블록 모드를 결정하고, 상기 결정된 블록 모드로 변환하는 단계; 및

(c) 상기 매크로 블록의 변환이 완료되면, 상기 제2 매크로블록에 대한 움직임 벡터 재조정을 수행하는 단계

를 포함하는 것을 특징으로 하는 영상 축소 트랜스 코드 방법.

【청구항 2】

제1항에 있어서,

평균 필터를 이용하여 다른 샘플링을 하면서, 상기 결정된 블록 모드로 변환 하는 것을 특징으로 하는 영상 축소 트랜스 코드 방법.
【청구항 3】

제1항에 있어서,

상기 (a) 단계는

상기 제1 매크로블록이 모두 인트라 매크로 블록인 경우, 한 개의 인트라 매크로블록으로 변환하는 단계

를 포함하는 것을 특징으로 하는 영상 축소 트랜스코딩 방법.

【청구항 4】

제1항에 있어서,

상기 (a) 단계는

상기 매크로블록의 일부가 인트라 매크로 블록인 경우, 상기 매크로블록의

SAD 비교 방식을 이용하여 블록 모드를 결정하는 단계

를 포함하는 것을 특징으로 하는 영상 축소 트랜스코딩 방법.

【청구항 5】

제1항에 있어서,

상기 (b) 단계는

상기 인트라 매크로블록의 개수가 미리 설정된 개수 이상인 경우 및 움직임 벡터간의 차분값을 산출한 후, 상기 차분값이 미리 설정된 이하인 경우는 인터 모드.
로 변환하고, 그 외의 경우는 상기 매크로블록의 SAD 비교 방식을 이용하여 블록모드를 결정하고, 상기 결정된 블록모드로 변환하는 단계

를 포함하는 것을 특징으로 하는 영상 축소 트랜스코딩 방법.

【정구항 6】

제4항 및 제5항 중 어느 한 항에 있어서,

상기 SAD 비교 방식은

미리 설정된 두 개의 인터 블록의 SAD를 산출하고, 최소 인터 SAD를 결정하는 단계;

상기 최소 인터 SAD를 미리 설정된 인트라 블록의 인트라 SAD와 비교하여,

최소의 SAD에 상응하는 블록 모드로 변환하는 단계

를 포함하는 것을 특징으로 하는 영상 축소 트랜스코딩 방법.

【정구항 7】

제6항에 있어서,

상기 인트라 SAD는

\[ MB_{mean} = \sum_{i=0}^{15} \sum_{j=0}^{15} |org_{i,j}| \]

\[ SAD_{min} = \sum_{i=0}^{15} \sum_{j=0}^{15} |org_{i,j} - MB_{mean}| \]

수학식에 의하여 매크로블록의 화소값을 평균을
산출하는 단계- 여기서, 상기 \( \text{org}_{ij} \)는 MB내에 있는 각각의 16x16 화소들의 값이고

상기 \( \text{MB}_{\text{mean}} \)은 MB내에 있는 화소값들의 평균을 지칭함-

\[
\text{MB}_{\text{mean}} = \frac{\sum_{i=0}^{15} \sum_{j=0}^{15} \text{org}_{ij}}{16 \times 16}
\]

\[
\text{SAD}_{\text{mean}} = \frac{\sum_{i=0}^{15} \sum_{j=0}^{15} |\text{org}_{ij} - \text{MB}_{\text{mean}}|}{16 \times 16}
\]

수학식에 의하여 상기 인트라 SAD를 산출하는 단계

에 의하여 산출되는 것을 특징으로 하는 영상 축소 트랜스코딩 방법.

【성구항 8】

제5항에 있어서,

\[
\text{MV}_{ij} = \left( \frac{\sum_{k=0}^{3} \sum_{l=0}^{3} \text{mv}_{k,l,ij}}{\sum_{k=0}^{3} \sum_{l=0}^{3} 1} \right)^{2} \gg 2, \ i, j = 0, 1
\]

수학식에 의하여 상기 매크로블록을 변환하며, 여기서, 상기 \( m, n \)은 중간 단계인 MB이 취하는 8x8 블록들의 가로축, 세로축 좌표를 가리키고 상기 \( j, k \)는 2x2 MB들 안의 \((m, n)\)번째 매크로블록에 대응하는 4x4 블록들의 가로축, 세로축 좌표를 지칭하는 것을 특징으로 하는 영상 축소 트랜스코딩 방법.

【성구항 9】

제1항에 있어서,
상기 (c) 단계는
정수단위 움직임 벡터를 중심으로 그 주위의 정수단위 ±3개의 이웃화소 (neighbor pixel)에 대하여 정수단위 움직임 벡터를 검색하는 단계; 및
상기 검색한 정수단위 움직임 벡터주변의 1/2 화소 단위의 ±1개의 이웃 화소에 대한 움직임 벡터를 검색하는 단계
를 포함하는 것을 특징으로 하는 영상 축소 트랜스코딩 방법.

【청구항 10】
제1 방식에 따른 제1 메크로블록을 제2 방식에 따른 제2 메크로 블록으로 변환하기 위한 영상 축소 트랜스 코딩 장치에 있어서,
상기 제1 메크로블록에 포함된 인트라 메크로블록의 개수가 미리 설정된 제1 조건을 충족하면, 상기 제2 메크로 블록의 블록 모드를 결정하고, 상기 결정된 블록 모드로 변환하는 제1 변환부; 및
상기 제1 메크로블록에 포함된 인터 메크로블록의 개수가 제2 조건을 충족하면, 상기 제2 메크로 블록의 블록 모드를 결정하고, 상기 결정된 블록 모드로 변환하는 제2 변환부; 및
상기 메크로 블록의 변환이 완료되면, 상기 제2 메크로블록에 대한 움직임ベクト르 제조성을 수행하는 움직임 벡터 제조정부.
를 포함하는 것을 특징으로 하는 영상 축소 트랜스코딩 방법.

【청구항 11】

제10항에 있어서,

상기 제1 변환부는

상기 제1 매크로블록이 모두 인트라 매크로 블록인 경우, 한 개의 인트라 매크로블록으로 변환하고, 상기 매크로블록의 일부가 인트라 매크로 블록인 경우, 상기 매크로블록의 SAD 비교 방식을 이용하여 블록 모드를 결정하는 것을 특징으로 하는 영상 축소 트랜스코딩 장치.

【청구항 12】

제10항에 있어서,

상기 제2 변환부는

상기 인터 매크로블록의 개수가 미리 설정된 개수 이상인 경우 및 움직일 벡터간의 차분값을 산출한 후, 상기 차분값이 미리 설정된 이하인 경우는 인터 모드로 변환하고, 그 외의 경우에는 상기 매크로블록의 SAD 비교 방식을 이용하여 블록 모드를 결정하고, 상기 결정된 블록모드로 변환하는 것을 특징으로 하는 영상 축소 트랜스코딩 방법.
【청구항 13】

제12항에 있어서,

상기 SAD 비교 방식은

미리 설정된 두 개의 인터 블록의 SAD를 산출하고, 최소 인터 SAD를 결정하고, 상기 최소 인터 SAD를 미리 설정된 인트라 블록의 인트라 SAD와 비교하여, 최소의 SAD에 상응하는 블록 모드로 변환하는 것을 특징으로 하는 영상 축소 트랜스코딩 방법.
【도면】

【도 1】

2x2 MB

16
MB
MB

16
MB

1x1 MB

16

(a+b+c+d)/4

【도 2a】

Skip mode MB conversion in H.264

16
16

Skip mode MB in H.264

16

Inter16x16 MB in H.264
<table>
<thead>
<tr>
<th>16</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>4x4 Intra or 16x16 Intra</td>
<td>4x4 Intra or 16x16 Intra</td>
</tr>
<tr>
<td>4x4 Intra or 16x16 Intra</td>
<td>4x4 Intra or 16x16 Intra</td>
</tr>
</tbody>
</table>

2x2 MB in H.264

**Intra block conversion**

<table>
<thead>
<tr>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
</tr>
</tbody>
</table>

Intra 16x16

One MB in MPEG-4
【도 2d】

16

inter block conversion

8

A

B

C

D

MV average

16

2x2 MB in H.264

One MB in MPEG-4
【도 3】

제1 변환부  310

제2 변환부  320

음직임 벡터 재조정부  330
2x2 MB information in H.264 decoder (MB type, MV)

MB type conversion
Each MB information in 2x2 MB in H.264

Down-sampling using the average filter

The # of Intra MB in 2x2 MB > 2

No

The # of Intra MB in 2x2 MB = 4

Yes

Intra

Calculate SAD

End of 2x2 MB in H.264

Motion of vector REFINEMENT

S410

S415

S420

S425

S430

S435

S440

S445

S450

S455

S460

S470
5c. News (CIF \rightarrow QCIF, 30hz)

5d. Foreman (CIF \rightarrow QCIF, 30hz)
This is to certify that the following application annexed hereto is a true copy from the records of the Korean Intellectual Property Office.

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Application Number

출원 년월일 : 2005년 11월 09일
Date of Application
NOV 09, 2005

출원 인 : 주식회사 휴맥스
Applicant(s)

2005년 11월 16일

COMMISSIONER

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【권리구분】특허
【수신처】특허청장
【제출일자】2005.11.09
【발명의 국문명칭】영상 축소 트랜스 코딩 방법 및 장치
【발명의 영문명칭】Method and device for video down-sampling transcoding
【출원인】
【명칭】주식회사 휴맥스
【출원인코드】1-1998-000063-1
【대리인】
【성명】이경란
【대리인코드】9-1998-000651-6
【포괄위임등록번호】2004-073908-7
【발명자】
【성명】이영렬
【성명의 영문표기】LEE, YUNG-LYUL
【주민등록번호】611030-1047211
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【발명자】
【성명】장의선
【성명의 영문표기】JANG, EUYEE S.
【주민등록번호】681220-1481119
【우편번호】133-791
【주소】서울 서동구 행당1동 한양대학교 산학빌딩 501호
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56-1
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【국적】 KR

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【출원국명】 KR
【출원종류】 특허
【출원번호】 10-2004-0099400
【출원일자】 2004.11.30
【증명서류】 청부

【심사청구】 청구

【취지】 특허법 제42조의 규정에 의한 출원, 특허법 제60조의 규정에 의한 출원심사를 청구합니다. 대리인
이경란 (인)

【수수료】
【기본출원료】 0 면 38,000 원
【가산출원료】 53 면 0 원
【우선권주장료】 1 건 20,000 원
【심사청구료】 28 항 1,005,000 원
【합계】 1,063,000 원
【요약서】

【요약】

본 발명은 영상 축소 코딩 방법 및 장치에 관한 것으로서, 보다 상세하게는 H.264에서 MPEG-4로 영상 축소를 고속으로 수행하는 방법 및 장치에 관한 것이다.

제1 방식에 따른 제1 메크로블록을 제2 방식에 따른 제2 메크로블록으로 변환하기 위한 영상 축소 트랜스 코딩 방법은 (a) 제1 메크로블록에 포함된 인트라 메크로블록의 개수가 미리 설정된 제1 조건을 충족하면, 제2 메크로블록의 블록 모드를 결정하고, 결정된 블록 모드로 변환하는 단계; (b) 제1 메크로블록에 포함된 인터 메크로블록의 개수가 제2 조건을 충족하면, 제2 메크로블록의 블록 모드를 결정하고, 결정된 블록 모드로 변환하는 단계; 및 (c) 메크로블록의 변환이 완료되면, 제2 메크로블록에 대한 움직임 벡터 재조정을 수행하는 단계를 포함할 수 있다.

【대표도】

도-3

【색인어】

영상 축소, 트랜스코딩, 메크로블록, 움직임벡터
【명세서】

【발명의 명칭】

영상 축소 트랜스 코딩 방법 및 장치 {Method and device for video down-sampling transcoding}

【도면의 간단한 설명】

1. 도 1은 본 발명의 바람직한 실시예에 따른 영상 크기 축소 방법을 도시한 도면.

2. 도 2a 내지 2e는 본 발명의 바람직한 실시예에 따른 메크로블록 모드 및 움직임 벡터의 변환 방법을 도시한 도면.

3. 도 3은 본 발명의 바람직한 실시예에 따른 영상 크기 축소를 위한 트랜스 코딩 장치의 구성을 도시한 도면.

4. 도 4은 본 발명의 바람직한 실시예에 따른 영상 크기 축소 방법을 도시한 순서도.

5. 도 5a 내지 5d는 본 발명의 바람직한 실시예에 따른 영상 크기 축소 방법을 도시한 도면.

6. 도 6a 내지 6d는 본 발명의 바람직한 다른 실시예에 따른 메크로블록 모드 및 움직임 벡터의 변환 방법을 도시한 도면.

7. <도면의 주요부분에 대한 부호의 설명>
<8> 300 : 트랜스코딩 장치

<9> 310 : 제1 변환부

<10> 320 : 제2 변환부

<11> 330 : 벡터 재조정부

【발명의 상세한 설명】

【발명의 목적】

【발명이 속하는 기술분야 및 그 분야의 종류기술】

본 발명은 영상 축소 코딩 방법 및 장치에 관한 것으로서, 보다 상세하게는 H.264에서 MPEG-4로 영상 축소를 고속으로 수행하는 방법 및 장치에 관한 것이다.

컴퓨터와 네트워크의 발달로 송신측에서 수신측으로 다양한 데이터를 전송할 수 있게 되었다. 이러한 기술 중 네트워크를 통해 대용량의 멀티미디어 데이터를 전송하기 위하여 멀티미디어 표준 압축 형식들이 소개되고 있으며, 송신측과 수신측의 환경을 고려하기 위하여 양측의 QoS(Quality Of Service)를 고려하여 각 환경에 맞게 변환하는 많은 비디오 트랜스코딩 기법이 소개되고 있다. 이러한 종류 기술에 따른 비디오 트랜스코딩 기법은 크게 픽셀 도메인(pixel domain)에서의 트랜스코딩 방법과 DCT 도메인(domain)에서의 트랜스코딩 방법으로 분류된다.

영상의 화질적인 측면에서 가장 좋은 트랜스코딩 방법은 입력된 영상의 비트스트림(bitstream)을 복호화하고, 복호화된 영상을 다시 부호화 하는 직렬 화소 영
역 트랜스코딩(Cascaded Pixel-domain Transcoding)방법이다. 그러나 이러한 종래 기술은 부호화를 한번 더 수행하기 때문에 복잡도가 높아지는 문제점이 있다. 따라서, 종래 기술에 의할 때, 영상의 화질을 만족시키면서, 복잡도를 개선할 수 있는 효율적인 트랜스코딩 방법이 존재하지 아니한다.

【발명이 이루고자 하는 기술적 과제】

따라서 본 발명은 상기의 제반 문제점을 해결하기 위하여 안출한 것으로서, 매크로블록의 정보를 재사용하여 화질을 만족시키면서 복잡도를 감소시킬 수 있는 영상 축소 트랜스코딩 방법 및 장치를 제공함에 그 목적이 있다. 즉 본 발명은 복잡도를 줄이기 위해서 H.264 부호화기에서 사용한 각각의 매크로블록(MB, Macro block)의 정보를 재사용할 수 있는 트랜스 코딩 기법을 제시한다.

【발명의 구성】

상술한 목적을 달성하기 위하여 본 발명의 제1측면에 따르면, H.264에서 MPEG-4로 영상 촉소를 고속으로 수행하는 방법을 제공할 수 있다.

본 발명의 바람직한 일 실시예에 따르면, 제1 방식에 따른 제1 매크로블록을 제2 방식에 따른 제2 매크로블록으로 변환하기 위한 영상 촉소 트랜스 코딩 방법에 있어서, (a) A(자연수)xB(자연수) 크기의 상기 제1 매크로블록에 포함된 인트라 매크로블록의 개수가 미리 설정된 제1 조건을 충족하면, C(자연수)xD(자연수) 크기의 상기 제2 매크로블록의 블록 모드를 결정하고, 상기 결정된 블록 모드로 변환하는 단계; (b) 상기 제1 매크로블록에 포함된 인터 매크로블록의 개수가 제2 조건을 충족하면, 상기 제2 매크로블록의 블록 모드를 결정하고, 상기 결정된 블록 모드로 변환하는 단계; 및 (c) 상기 제1 매크로블록의 변환이 완료되면, 상기 제2 매크로블록에 대한 움직임 벡터 재조정을 수행하는 단계를 포함하는 것을 특징으로 하는 영상 촉소 트랜스 코딩 방법이 제공된다.

상기 영상 촉소 트랜스 코딩 방법은 평균 필터를 이용하여 다운 샘플링을 하면서, 상기 결정된 블록 모드로 변환할 수 있다.

상기 (a) 단계는 상기 제1 매크로블록이 모두 인트라 매크로블록인 경우, 한 개의 인트라 매크로블록으로 변환하는 단계를 포함할 수 있다.

상기 (a) 단계는 상기 매크로블록의 일부가 인트라 매크로블록인 경우, 상기
매크로블록의 SAD 비교 방식을 이용하여 블록 모드를 결정하는 단계를 포함할 수 있다.

상기 (b) 단계는 상기 인터 매크로블록의 개수가 미리 설정된 개수 이상인이 경우 및 움직임 벡터간의 차분값을 산출한 후, 상기 차분값이 미리 설정된 이하인 경우는 인터 모드로 변환하고, 그 외의 경우는 상기 매크로블록의 SAD 비교 방식을 이용하여 블록 모드를 결정하고, 상기 결정된 블록모드로 변환하는 단계를 포함할 수 있다.

상기 SAD 비교 방식은 미리 설정된 두 개의 인터 블록의 SAD를 산출하고, 최소 인터 SAD로 결정하는 단계; 및 상기 최소 인터 SAD를 미리 설정된 인트라 블록의 인트라 SAD와 비교하여, 최소의 SAD에 상응하는 블록 모드로 변환하는 단계를 포함할 수 있다.

상기 인트라 SAD는 수학식 $MB_{mean} = \sum_{i=0}^{15} \sum_{j=0}^{15} |org_{ij}|$에 의하여 매크로블록의 화소값 평균이 산출되고 여기서, 상기 $org_{ij}$는 MB내에 있는 각각의 16x16 화소들의 값이고 상기 $MB_{mean}$은 MB내에 있는 화소값들의 평균을 지칭함-, 수학식

$SAD_{intra} = \sum_{i=0}^{15} \sum_{j=0}^{15} |org_{ij} - MB_{mean}|$에 의해 상기 인트라 SAD가 산출되는 것을 특정으로 한다.

상기 움직임 벡터 제조정은 수학식 $MB_{ij} = \left( \frac{\sum_{k=0}^{15} \sum_{l=0}^{15} m_{kl} \times n_{kl}}{\sum_{k=0}^{15} \sum_{l=0}^{15} 1} + 2 \right) >> 2$, $i,j = 0,1$에 의하여

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수행되며, 여기서, 상기 m, n은 중간 단계인 MB이 위하는 8x8 블록들의 가로축, 세로축 좌표를 가리키고 상기 k, l은 2x2 MB들 안의 (m, n)번째 매크로블록에 대응하는 4x4 블록들의 가로축, 세로축 좌표를 지칭하는 것을 특징으로 한다.

상기 (c) 단계는 정수단위 움직임 벡터를 중심으로 그 주위의 정수단위 ±3 개의 이웃 화소(neighbor pixel)에 대하여 정수단위 움직임 벡터를 검색하는 단계; 및 상기 검색한 정수단위 움직임 벡터주변의 1/2 화소 단위의 ±1개의 이웃 화소에 대한 움직임 벡터를 검색하는 단계를 포함할 수 있다.

본 발명의 바람직한 다른 실시예에 따르면, 제1 방식에 따른 제1 매크로블록을 제2 방식에 따른 제2 매크로블록으로 변환하기 위한 영상 축소 트랜스 코딩 방법에 있어서, 미리 지정된 크기의 상기 제1 매크로블록에 포함된 매크로블록들의 유형에 의해 미리 설정된 조건에 의해 결정되는 상기 제2 방식에 따른 후보 블록 모드 중 어느 하나를 상기 제2 매크로블록의 블록 모드로 결정하고, 상기 결정된 블록 모드로 변환하는 단계; 및 상기 제1 매크로블록의 변환이 완료되면, 상기 제2 매크로블록에 대한 움직임 벡터 재조정을 수행하는 단계를 포함하는 것을 특징으로 하는 영상 축소 트랜스 코딩 방법이 제공된다.

상기 미리 설정된 조건은 상기 제1 매크로블록에 셋 이상의 인트라 매크로블록이 포함된 경우 상기 제2 방식에 따른 한 개의 인트라 매크로블록으로 블록 모드를 결정하는 것일 수 있다.

상기 미리 설정된 조건은 상기 제1 매크로블록에 둘 이하의 인트라 매크로블록이 포함된 경우, 상기 제1 매크로블록에 포함된 각 매크로블록의 SAD(Sum of
Absolute Difference) 비교 방식을 이용하여 상기 후보 블록 모드 중 어느 하나로 결정하는 것일 수 있다. 여기서, 상기 후보 블록 모드는 스킵(SKIP) 모드, 인터(Inter)-16x16 모드, 인터 8x8 모드 중 하나 이상을 포함할 수 있다.

상기 미리 설정된 조건은 상기 제1 메크로블록이 인터 메크로블록들로만 구성되고, 상기 인터 메크로블록들 중 둘 이하의 인터 16x16 메크로블록이 포함된 경우, 각 인터 메크로블록의 SAD(Sum of Absolute Difference) 비교 방식을 이용하여 상기 후보 블록 모드 중 어느 하나로 결정하는 것일 수 있다. 여기서, 상기 후보 블록 모드는 스킵(SKIP) 모드, 인터(Inter) 16x16 모드, 인터 8x8 모드 중 하나 이상을 포함할 수 있다.

각 메크로블록의 움직임 벡터간의 차분값을 산출한 후, 상기 차분값이 미리 설정된 봉투값이하인 경우 상기 인터 16x16 모드 또는 상기 스킵 모드 중 어느 하나로 결정하되, 그렇지 않은 경우에는 상기 인터 8x8 모드로 결정할 수 있다.

상기 후보 블록 모드 중 결정된 어느 하나는 상기 SAD 비교 방식에 의해 최소의 SAD 값을 가지는 블록 모드인 것을 특징으로 한다.

상기 인트라 메크로블록의 SAD는, 수학식

\[ MB_{\text{mean}} = \sum_{i=0}^{15} \sum_{j=0}^{15} \text{org}_{ij} \]

에 의해 메크로블록의 화소값 평균이 산출되고-여기서, 상기 org_{ij}는 MB내에 있는 각각의 16x16 화소들의 값이고 상기 MB_{\text{mean}}은 MB내에 있는 화소값들의 평균을 지정함-, 수학식

\[ \text{SAD}_{\text{INTRA}} = \sum_{i=0}^{15} \sum_{j=0}^{15} |\text{org}_{ij} - MB_{\text{mean}}| \]

에 의해 상기 인트라 메크로블록의 SAD
가 촬출되는 것을 특징으로 한다.

게시

\[
M_{ij} = \left( \frac{\sum_{k=0}^{1-d} \sum_{l=0}^{1-d} m_{k,l}}{\sum_{k=0}^{1-d} \sum_{l=0}^{1-d} \sum_{i=0}^{1} \sum_{j=0}^{1} \sum_{k=0}^{1-d} \sum_{l=0}^{1-d} 1} + 2 \right) \geq 2 \quad i, j = 0, 1
\]

상기 움직임 벡터 재조정은 수학식 를 이용하여 수행되며, 상기 \(m, n\)은 중간 단계인 MB가 취하는 8x8 블록들의 가로축, 세로축 좌표를 가리키고 상기 \(k, l\)은 2x2 MB들 안의 \((m, n)\)번째 마크로블록에 대응하는 4x4 블록들의 가로축, 세로축 좌표를 지칭하는 것을 특징으로 한다.

상술후 목적을 달성하기 위하여 본 발명의 제2축면에 따르면, H.264에서 MPEG-4로 영상 축소를 고속으로 수행하는 장치를 제공할 수 있다.

본 발명의 바람직한 일 실시예에 따르면, 제1 방식에 따른 제1 마크로블록을 제2 방식에 따른 제2 마크로블록으로 변환하기 위한 영상 축소 트랜스 코딩 장치에 있어서, 상기 제1 마크로블록에 포함된 인트라 마크로블록의 개수가 미리 설정된 제1 조건을 충족하면, 상기 제2 마크로블록의 블록 모드를 결정하고, 상기 결정된 블록 모드로 변환하는 제1 변환부; 상기 제1 마크로블록에 포함된 인터 마크로블록의 개수가 제2 조건을 충족하면, 상기 제2 마크로블록의 블록 모드를 결정하고, 상기 결정된 블록 모드로 변환하는 제2 변환부; 및 상기 제1 마크로블록의 변화가 완료되면, 상기 제2 마크로블록에 대한 움직임 벡터 재조정을 수행하는 움직임 벡터 재조정부를 포함하는 것을 특징으로 하는 영상 축소 트랜스 코딩 장치가 제공된다.

상기 제1 변환부는 상기 제1 마크로블록이 모두 인트라 마크로블록인 경우,
한 개의 인트라 매크로블록으로 변환하고, 상기 매크로블록의 일부가 인트라 매크로블록인 경우, 상기 매크로블록의 SAD 비교 방식을 이용하여 블록 모드를 결정할 수 있다.

상기 제2 변환부는 상기 인터 매크로블록의 개수가 미리 설정된 개수 이상인 경우 및 움직임 벡터간의 차분값을 산출한 후, 상기 차분값이 미리 설정된 이하인 경우에는 인터 모드로 변환하고, 그 외의 경우에는 상기 매크로블록의 SAD 비교 방식을 이용하여 블록 모드를 결정하고, 상기 결정된 블록모드로 변환할 수 있다.

상기 SAD 비교 방식은 미리 설정된 두 개의 인터 블록의 SAD를 산출하고, 최소 인터 SAD를 결정하고, 상기 최소 인터 SAD를 미리 설정된 인트라 블록의 인트라 SAD와 비교하여, 최소의 SAD에 상응하는 블록 모드로 변환하는 것을 특징으로 한다.

본 발명의 바람직한 다른 실시예에 따르면, 제1 방식에 따른 제1 매크로블록을 제2 방식에 따른 제2 매크로블록으로 변환하기 위한 영상 축소 트랜스 코딩 장치에 있어서, 미리 저장된 크기의 상기 제1 매크로블록에 포함된 매크로블록들의 유형에 의해 미리 설정된 조건에 의해 결정되는 상기 제2 방식에 따른 후보 블록 모드 중 어느 하나를 상기 제2 매크로블록의 블록 모드로 결정하고, 상기 결정된 블록 모드로 변환하는 변환부; 및 상기 제1 매크로블록의 변환이 완료되면, 상기 제2 매크로블록에 대한 움직임 벡터 제조정을 수행하는 움직임 벡터 제조정부를 포함하는 것을 특징으로 하는 영상 축소 트랜스 코딩 장치가 제공된다.

상기 미리 설정된 조건은 상기 제1 매크로블록에 셋 이상의 인트라 매크로블록에 한 상호 연결됨과 동시에 일치하는 경우로서, 상기 각 매크로블록의 장소 위치가 상호 연결되는 조건을 만족하는 매크로블록이 들어있는 경우.
록이 포함된 경우 상기 제2 방식에 따른 한 개의 인트라 매크로블록으로 블록 모드를 결정하는 것이 있을 수 있다.

상기 미리 설정된 조건은 상기 제1 매크로블록에 들어가야 하는 인트라 매크로블록이 포함된 경우, 상기 제1 매크로블록에 포함된 각 매크로블록의 SAD(Sum of Absolute Difference) 비교 방식을 이용하여 상기 후보 블록 모드 중 어느 하나로 결정하는 것일 수 있다. 여기서, 상기 후보 블록 모드는 스킵(SKIP) 모드, 인터(Inter) 16x16 모드, 인터 8x8 모드 중 하나 이상을 포함할 수 있다.

상기 미리 설정된 조건은 상기 제1 매크로블록이 인트라 매크로블록들로만 구성되며, 상기 인터 매크로블록들이 들어가야 하는 인터 16x16 매크로블록이 포함될 경우, 각 인터 매크로블록의 SAD(Sum of Absolute Difference) 비교 방식을 이용하여 상기 후보 블록 모드 중 어느 하나로 결정하는 것이 될 수 있다. 여기서, 상기 후보 블록 모드는 스킵(SKIP) 모드, 인터(Inter) 16x16 모드, 인터 8x8 모드 중 하나 이상을 포함할 수 있다.

상기 변환부는 각 매크로블록의 움직임 벡터간의 차분값을 산출한 후, 상기 차분값이 미리 설정된 문턱값이하인 경우 상기 인터 16x16 모드 또는 상기 스킵 모드 중 어느 하나로 결정되며, 그렇지 않은 경우에는 상기 인터 8x8 모드로 결정하는 것을 특별으로 한다.

상기 인트라 매크로블록의 SAD는, 수학식 \[ \text{MB}_{\text{mean}} = \frac{15}{13} \sum_{i=0}^{15} \sum_{j=0}^{15} \text{org}_{ij} \] 에 의하여 매크로블록의 화소값 평균이 산출되고, 여기서, 상기 org_{ij}는 MB내에 있는 각각의
16x16 흑소들의 값이고 상기 \( \text{MB}_{\text{mean}} \)은 MB내에 있는 흑소값들의 평균을 지칭함, 수학식
\[
\text{\( \frac{\text{SAD}_{\text{INTRA}} = \sum_{i=0}^{15} \sum_{j=0}^{15} |\text{org}_{i,j} - \text{MB}_{\text{mean}}| \)}\]
ung에 의해 상기 인트라 메크로블록의 SAD가 산출되는 것을 특정으로 한다.

\[
\text{\( \text{MB}_{i,j} = \left( \frac{\sum_{k=0,1} \sum_{l=0,1} \text{MB}_{m,n,kl} + 2}{\sum_{k=0,1} \sum_{l=0,1} 1} \right) \gg 2, i, j = 0,1 \)}
\]<46>

상기 움직임 벡터 제조정은 수학식을 이용하여 수행되며, 상기 \( m, n \)은 중간 단계인 MB이 취하는 8x8 블록들의 가로축, 세로축 좌표를 가리키고 상기 \( k, l \)은 2x2 MB들 안의 \((m, n)\)번째 메크로블록에 대응하는 4x4 블록들의 가로축, 세로축 좌표를 지칭하는 것을 특정으로 한다.

이하, 첨부한 도면들을 참조하여 본 발명에 따른 영상 축소 트랜스코딩 방법 및 장치의 바람직한 실시예를 상세히 설명하기로 하며, 첨부 도면을 참조하여 설명함에 있어 도면 부호에 상관없이 동일하나, 상세한 구성 요소는 동일한 참조변호를 부여하고 이에 대한 종목되는 설명은 생략하기로 한다.

일반적으로 H.264의 프레임내의 MB(메크로블록)을 MPEG-4 프레임내의 MB으로 변환하는 가장 간단한 방법은 염력으로 들어오는 압축된 H.264 프레임을 모두 복원한 후, MPEG-4에서 복원된 영상을 다시 압축하는 직접 화소 영역 트랜스코딩 방식이다. 하지만 상기 방법은 모든 프레임에 있는 모든 MB에 대한 움직임 예측 과정이 MPEG-4 부호기에서 수행되므로, 많은 계산량으로 인하여 트랜스코더(transcoder)에

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서의 실시간 전송에 문제가 될 수 있다.

본 발명은 이러한 문제를 해결하기 위해서 움직임 예측 과정을 수행하지 않으면서 실시간 전송에 적합하도록 하기 위하여, H.264 복호기에서 사용한 블록모드 및 움직임 벡터 정보를 MPEG-4부호기에서 재사용하도록 구성된다. 본 발명의 실시간 예측에 따라 H.264로 압축된 비트스트림(Bitstream)의 가변장 부호화(VLD, Variable Length Decoding)를 수행하는 과정에서 현재 복원되고 있는 프레임 형식과 MB의 정보, 움직임 벡터에 대한 정보를 파악한다. 여기서, 복원된 비트스트림의 프레임 형식이 P프레임(Predictive frame)이면 MB내에 있는 블록 타입과 움직임 벡터를 재사용하여 MPEG-4부호기에서 많은 시간을 소모하는 움직임 예측 과정을 생략할 수 있다.

상술한 바와 같이, 본 발명에 따른 트랜스코딩 장치는 H.264 복호기(decoder) 및 MPEG4 부호기(encoder)를 포함할 수 있고, H.264 복호기에서 파악된 정보들은 MPEG4 부호기로 제공될 수 있다. 본 발명에 따른 트랜스코딩 장치는 비트스트림을 수신 장치로 전송하기 위한 미디어 게이트웨이 서버 등에 구비될 수 있다.

이하에서는 본 발명에 따른 트랜스코딩 장치에서 수행되는 트랜스코딩 방법의 중심으로 설명하기로 한다. 당업자는 이하의 설명을 통해 본 발명에 따른 트랜스코딩 장치의 구성 및 동작을 용이하게 이해할 수 있을 것이다.

이하, 도 1 및 도 2a 내지 도 2e를 참조하여 H.264 BP(Baseline profile)에
서 MPEG-4 SP(Simple profile)로 변환 시 픽셀(Pixel) 도메인에서 블록타입 간 변환 및 움직임 벡터 조정을 이용한 트랜스코딩방법을 설명한다. 그리고 도 3을 참조하여 트랜스코딩 장치의 구성을 설명하고, 도 4를 참조하여 구체적인 트랜스코딩 방법을 설명하기로 한다. 또한, 도 5a 내지 도 5d를 참조하여 H.264 BP를 MPEG-4 SP로 화소 영역 트랜스코딩 방식으로 트랜스코딩 했을 때의 실험결과를 설명하기로 한다. 마지막으로, 도 6a 내지 도 6d를 참조하여 통계학적 방법에 의해 블록타입 간 변환 및 움직임 벡터 조정을 이용한 트랜스코딩이 신속하게 수행하는 방법을 설명한다.

<53>
영상 축소 트랜스 코딩의 절차

<54>
도 1에는 본 발명의 바람직한 실시예에 따른 영상 축소 방법으로서, 평균 필터(average filter)를 이용한 영상 크기 축소 방법(down sampling)이 도시되어 있다.

<55>
예를 들어, 4개의 MB 타입을 1개의 MB 타입으로의 변환하는 경우, 중래 기술에 의할 때, H.264(SP) 부호화기를 통과한 CIF 크기의 영상을 다시 QCIF 크기의 영상으로 변환하는 동안, 원 영상(source image)은 두 번의 영상의 변환과정(encoding, down-sampling)을 거치면서 화질열화가 발생된다.

<56>
본 발명의 실시예에 따르면, H.264 부호기에에서 복원된 CIF영상에서 4개의 16x16 MB(macro block)는 MPEG-4부호기에서 부호화할 1개의 16x16 MB로 축소되어 QCIF 영상으로 변환된다. 본 발명에 의할 때, CIF 영상을 QCIF 영상으로 축소시키
기 위하여, 4개의 화소값을 평균 필터링(average filtering)하여 1개의 화소값으로 sampling하는 방법, 그리고 4개의 화소값 중 1개의 화소값만을 취하는 sub-sampling 방법 중 평균 필터(average filter)를 이용하여 영상을 축소시키는 방법이 사용된다. 이는 sub-sampling 기법을 이용하여 영상을 축소시키면 시간 복잡도 측면에서 약간의 이득은 제공하나, 영상의 화질 저하가 현저히 나타나기 때문에 평균 필터(average filter)를 이용하였다. 그리고 본 발명에서는 계산 복잡도가 낮은 DCT(Discrete Cosine Transform) 영역에서의 트랜스코딩 방법을 제안하지 않고 픽셀 도메인(pixel domain)에서의 트랜스코딩 방법을 사용한다. 이는 H.264의 비선형 루프 필터(non-linear loop filter) 때문에 DCT 영역에서의 트랜스코딩을 하기 위해서 loop filtering된 영상을 다시 DCT한 후, DCT영역에서 트랜스코딩을 하며, 4x4 integer DCT와 8x8 DCT간의 변환식을 도출하여야 하므로 계산량이 많아지기 때문이다.

H.264에서는 1/4화소 ME(Motion Estimation, 움직임 예측) 및 MC(Motion Compensation, 움직임 보상), 7개의 가변블록(即, 인터(Inter) 16x16, 인터(Inter) 16x8, 인터(Inter) 8x16, 인터(Inter) 8x8, 인터(Inter) 8x4, 인터(Inter) 4x8, 그리고 인터(Inter) 4x4) 및 10개의 블록 모드(즉, Skip, 인트라(Intra) 16x16, 인트라(Intra) 4x4, 인터(Inter) 16x16, 인터(Inter) 16x8, 인터(Inter) 8x16, 인터(Inter) 8x8, 인터(Inter) 8x4, 인터(Inter) 4x8 및 인터(Inter) 4x4 모드)를 사용한다. MPEG-4는 인트라(Intra) 16x16, 인터(Inter) 16x16, 인터(Inter) 8x8 그리고 skip 모드를 지원하기 때문에, 본 발명에서는 MPEG-4에서 이런 정보들을 재사용하
기 위해 블록형태 변환을 수행하도록 구성된다.

도 2a 내지 도 2e에는 본 발명의 바람직한 실시예에 따른 H.264 4개의 MB모드 및 움직임 벡터를 MPEG-4 MB 모드 및 움직임 벡터로 변환하는 방법이 도시되어 있다.

이하, 복원된 H.264 비트스트림의 2x2 MB들의 형태(MB mode)를 MPEG-4에서 재사용할 수 있는 하나의 MB 형태로 변환하는 다양한 실시예를 참조하여, H.264 BP에서 MPEG-4 SP로 변환시 픽셀 도메인(Pixel domain)에서 블록타입 간 변환 및 움직임 벡터 조정을 이용한 트랜스코딩방법을 설명한다.

도 2a에 따른 H.264내의 모든 Skip 모드는 H.264내의 2x2 MB들을 MPEG-4내의 한 개의 MB으로 변환하기 위한 전처리 단계를 나타내며, 도 2a와 같이 H.264내의 인터(Inter)16x16 모드로 변환시킨다.

도 2b와 같이 H.264의 2x2 MB들이 모두 인트라(Intra) 16x16 또는 인트라(Intra)4x4인 MB들로만 구성되어 있으며, 한 개의 인트라(Intra) 16x16 MB으로 변환하고 평균 필터(average filter)를 이용하여 영상 향상한다.

도 2c와 같이 H.264의 2x2 MB들 중 2개 또는 3개 MB들만이 인트라(Intra) 모드 MB들로 구성된 경우, MPEG-4 부호기에서 인터(Inter)16x16, 인터(Inter)8x8 그리고 인트라(Intra) 16x16 모드 중 어떤 모드로 변환할 것인지 기준이 불명확한 경우이다.
이런 경우, 종래 기술에 따라, MPEG-4 내에 있는 특정한 하나의 모드(인터(Inter) 16x16, 인터(Inter) 8x8 또는 인트라(Intra) 16x16 모드)로 변환 하였을 경우 화질이 떨어지게 되고 부호화된 비트량이 증가하는 현상이 나타난다.

그래서 본 발명은 MPEG-4 부호기내에서 인터(Inter) 16x16 블록의 SAD(Sum of Absolute Difference, 절대값 누적치)값(SAD-128)과 4개의 인터(Inter) 8x8 블록 각각의 SAD값들의 합을 비교해서 최소 SAD값을 가지는 모드를 선택한다. 이어서, 선택된 인터(Inter) 모드 SAD값과 하기의 수학식1 및 수학식2에 의해 산출된 인트라(Intra) 모드 SAD값을 비교해서 최소 SAD값을 가지는 모드를 최종적으로 선택하도록 구성된다.

【수학식 1】

\[ MB_{\text{mean}} = \sum_{i=0}^{15} \sum_{j=0}^{15} \text{org}_{ij} \]

【수학식 2】

\[ \text{SAD}_{\text{INTRA}} = \sum_{i=0}^{15} \sum_{j=0}^{15} | \text{org}_{ij} - MB_{\text{mean}} | \]

위 식에서 \( \text{org}_{ij} \)는 MB내에 있는 각각의 16x16 화소들의 값이고 \( MB_{\text{mean}} \)는 MB내에 있는 화소값들의 평균이다. 이와 같이 과정을 거쳐 선택된 최적의 모드로 변환.
시킴으로써, 화질적인 측면이나 보호화되는 비트 향 측면을 모두 충족시킬 수 있다.

도 2d와 같이, H.264의 2x2 MB들 내에 인터(Inter) 16x16 모드인 MB가 4개 또는 3개가 있는 경우, MPEG-4 보호기능에서 인터(Inter)16x16 모드로 변환하도록 구성된다. 중래 기술에 의할 때, H.264의 2x2 MB들 내에 인터(Inter)16x16 모드인 MB가 4개 또는 3개가 있는 경우 MPEG-4 보호기내의 인터(Inter) 16x16 또는 인터(Inter) 8x8 모드로 변환이 가능하나, 본 발명에 따르면 인터(Inter)8x8 모드가 아닌 인터(Inter)16x16 모드로 변환한다. 먼저, 2x2 MB내의 각각의 MB의 1/4단위 움직임 벡터의 평균값을 MPEG-4 MB내의 4개의 8x8 블록들의 정수 단위 움직임 벡터로 취한 후, 이렇게 얻은 4개의 8x8 블록 움직임 벡터의 평균값으로 하나의 움직임 벡터를 인터(Inter) 16x16 MB에 취함으로써 모든 변환이 이루어지도록 구성된다. 정수 단위 움직임 벡터를 구하기 위한 구체적인 산출식은 하기 수학식 3과 같다.

【수학식 3】

\[ MV_{ij} = \left( \frac{\sum_{k=0}^{2} \sum_{l=0}^{2} mv_{m,n,k,l}}{\sum_{k=0}^{1} \sum_{l=0}^{1} 1} \right) \geq 2, \quad i, j = 0, 1 \]

여기서, \( m, n \)은 중간 단계인 MB이 취하는 8x8 블록들의 가로축, 세로축 좌표를 가지키고 \( k, l \)은 2x2 MB들 안의 \((m, n)\)번째 MB이 취하는 4x4 블록들의 가로축, 세로축 좌표를 가지킨다.
이와 같이 인터(Inter) 8x8 모드가 아닌 인터(Inter) 16x16 모드로 변환하는 이유는 H.264에서 MPEG-4로 트랜스코딩 시 foreman 영상에 대해 QP(quantization parameter)를 10으로 고정한 후, 모드 변환에 대한 모든 조건을 동일하게 하고, 도 2d와 같은 조건인 경우, 인터(Inter) 8x8 모드로 변환하면 인터(Inter) 16x16 모드로 변환 하였을 때 보다 PSNR이 31.61dB에서 31.69dB로 0.08dB 향상을 가져오나, 부호화된 비트양은 143.2kbps에서 156.8kbps로 증가하는 현상을 보이기 때문에 전 제적이 부호화 효율이 떨어지기 때문이다.

도 2e를 참조하면, H.264의 2x2 MB들이 복잡한 블록모드 즉, 한 개 이상의 인터(Inter) P8x8 모드인 MB들, 한 개 이하의 인트라(Intra) 모드 MB 및 이들 외의 인터(Inter) 모드 MB들로 구성되어 있는 경우, 2x2 MB들 내의 각각의 MB를 MPEG-4내의 8x8 블록으로 변환한다. MPEG-4내의 8x8 블록이 취하는 정수단위 움직임 벡터는 16개의 4x4 블록이 가지고 있는 1/4단위 움직임 벡터의 평균값을 구하고 이 값을 다시 4로 나눠서 정수단위의 움직임 벡터를 구한다. 산출식은 상기 수학적 3과 같다.

도 3은 본 발명의 바람직한 실시예에 따른 트랜스코딩 장치의 구성을 도시한 도면이다.

도 3을 참조하면, 본 발명에 따른 트랜스코딩 장치(300)는 제1 변환부(310), 제2 변환부(320) 및 움직임 벡터 재조정부(330)를 포함한다.
제1 변환부(310)는 제1 메크로블록에 포함된 인트라(Intra) 메크로블록의 개수가 미리 설정된 제1 조건을 충족하면, 제2 메크로블록의 블록 모드를 결정하고, 결정된 블록 모드로 변환한다. 예를 들어, 제1 변환부(310)는 제1 메크로블록이 모두 인트라 메크로블록인 경우 한 개의 인트라 메크로블록으로 변환하고(도 2b 참조), 상기 메크로블록의 일부가 인트라 메크로블록인 경우, 메크로블록의 SAD 비교 방식을 이용하여 블록 모드를 결정(도 2c 참조)한다.

제2 변환부(320)는 제1 메크로블록에 포함된 인터(Inter) 메크로블록의 개수가 제2 조건을 충족하면, 제2 메크로블록의 블록 모드를 결정하고, 결정된 블록 모드로 변환한다. 예를 들어, 제2 변환부(320)는 상기 인터 메크로블록의 개수가 미리 설정된 개수 이상인 경우 및 움직임 벡터간의 차분값을 산출한 후, 차분값이 미리 설정된 이하인 경우는 인터 모드로 변환하고, 그 외의 경우는 메크로블록의 SAD 비교 방식을 이용하여 블록 모드를 결정하고, 상기 결정된 블록모드로 변환한다. 보다 상세한 기능은 도 4의 흐름도를 참조하여 설명하기로 한다.

움직임 벡터 재조정부(330)는 제2 메크로블록에 대한 움직임 벡터 재조정을 수행한다.

도 4에는, 2x2 MB 기반의 H.264에서 MPEG-4로 트랜스코딩을 수행하는 구체적인 흐름도(flow chart)가 도시되어 있다.

도 4에 도시된 바와 같이, H.264 2x2 MB 형태가 입력되면(단계 S410), 입력
H.264 2x2 MB 형태를 MPEG-4 1x1 MB 형태로 각 조건에 맞게 변환을 수행(단계 S420)한 후, average 필터를 사용하여 다운 샘플링을 수행한다(단계 S430).

이후, MPEG4 블록 형태를 위한 모드 결정을 수행한다.

단계 S425에서 H.264의 2x2 MB를 내에 인트라(Intra) 매크로블록의 개수가 2개 초과인 경우, 단계 S430으로 진행하여, 매크로블록의 개수가 4개인지 여부를 판단하고, 4개가 아니면 단계 S435로 진행하여 인트라(Intra) 방식으로 변환하고, 그 외의 경우에는 단계 S455로 진행한다.

그러나, 단계 S425에서 H.264의 2x2 MB를 내에 인트라(Intra) 매크로블록의 개수가 2개 이하인 경우, 단계 S440으로 진행한다. 단계 S440에서 H.264의 2x2 MB들 내에 인터(Inter) 16x16 모드가 2개 초과인 경우(예를 들어, 4개 또는 3개가 있는 경우), 단계 S445로 진행하여 인터(Inter) 16x16으로 변환한다. 그러나, 단계 S440에서 H.264의 2x2 MB들 내에 인터(Inter) 16x16 모드가 2개 이하인 경우, 단계 S450에서 모든 정수단위 움직임 벡터간의 차분값을 미리 설정된 문턱값(예를 들면 4)과 비교한다.

차분값이 문턱값 이상이면 단계 S450에서 단계 S455로 진행하여 SAD 과정을 통한 MB 모드를 결정하게 된다. 그러나, 차분값이 미리 설정된 문턱값 미만이면 단계 S445로 진행하여 인터 16x16으로 변환한다.

여기서, H.264 부호기에서 인터(Inter) 8x8, 인터(Inter) 8x4, 인터(Inter) 4x8 그리고 인터(Inter) 4x4 모드처럼 edge로 인하여 결정된 모드를 MPEG-4 부호기에서 사용할 모드를 인터(Inter) 8x8 MB모드가 아닌 인터(Inter) 16x16 MB모드
로 변환하는 이유는 H.264로 부호화 및 영상 축소과정이 일종의 LPF(Low Pass Filtering)이기 때문이다.

이후, 단계 S460에서 매크로블록의 모드 결정을 종료하고, 단계 S415로 진행하여 다음 매크로블록의 변환을 개시한다.

상술한 과정에 의하면 모드 결정이 완료되면, 단계 S470에서 움직임 벡터 제조점을 수행한다. 즉, 계산된 정수단위 움직임 벡터를 중심으로 그 주위의 정수단위 ±3개의 이웃화소(neighbor pixel)에 대하여 정수단위 움직임 벡터를 찾고, 찾은 정수단위 움직임 벡터주변의 1/2 화소 단위의 ±1개의 이웃화소에 대한 움직임 벡터를 찾으며 움직임 벡터 제조점(refinement)을 수행하여 PSNR(Peak Signal-to-Noise Ratios)의 향상을 얻을 수 있다.

도 5a 내지 도 5d는 본 발명의 바람직한 실시예에 따른 H.264 BP를 MPEG-4 SP로 화소 영역 트렌스코딩 방식으로 트랜스코딩했을 때의 실험결과를 설명한 도면이다.

상기 실험은 H.264 BP로 재구성된 JM(Joint Model) 부호기(Decoder)와 MPEG-4의 SP로서 재구성된 MoMuSys-3DIS-V1.0 부호기(Encoder)를 이용하여 구성한 트랜스코더를 이용하여 수행하였다. 실험은 펌티엄 IV 2.8GHz PC에서 수행되었고, JM 부호기에서 Foreman, News, Paris 그리고 Coast CIF(352x288)영상의 압축하여 각각 생성된 H.264 비트스트림이 사용되었다. 비트스트림 생성에 사용된 각 영상들에 대하여 첫 번째 프레임만 I(인트라(Intra)) 프레임을 사용하였고, 나머지는 모두
P(Predictive) 프레임을 사용하였으며, 30Hz의 프레임 율로 300장의 시퀀스를 압축하여 실험하였다.

도 5a의 Coast, 도 5b의 Paris, 도 5c의 News 그리고 도 5d의 Foreman 시퀀스에 대하여, 각각 H.264에서 MPEG-4로 변환시 종래 기술과 다른 적립 화소 영역 트랜스코딩 방식(510, 520, 530, 540), 본 발명에 따른 변환 방식에 따라 영상 압축 방식(515, 525, 535, 545)간의 밝기(Y)신호의 PSNR의 차이를 보여주고 있다. 여기서, 장면변환(scene change)이 있는 도 5d의 foreman 영상을 제외한 모든 영상에서 화질 저하를 거의 보이지 않았을 뿐 아니라, 도 5a의 Coast영상에서는 최대 0.5dB의 화질이 개선되었다.

하기의 표 1은 본 발명에 따른 트랜스코딩 방식에 따른 시간적 이득을 나타내고 있다. 각각의 영상마다 약간의 차이는 보이지만 평균적으로 1.72배의 속도향상을 보였고 트랜스코더의 부호기(MPEG-4 encoder)만을 고려하면 약 4.1배의 속도향상을 보임을 알 수 있다.

【표 1】

<table>
<thead>
<tr>
<th>Sequence</th>
<th>Cascade pixel-domain Transcoding</th>
<th>Proposed Transcoding</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>H.264 decoder</td>
<td>MPEG-4 encoder</td>
</tr>
<tr>
<td></td>
<td>time</td>
<td>time</td>
</tr>
<tr>
<td>News</td>
<td>34.14</td>
<td>52.23</td>
</tr>
<tr>
<td>Paris</td>
<td>37.2</td>
<td>52.18</td>
</tr>
<tr>
<td>Coast</td>
<td>51.48</td>
<td>53.54</td>
</tr>
<tr>
<td>Foreman</td>
<td>49.54</td>
<td>53.49</td>
</tr>
</tbody>
</table>

상술한 바와 같이, 본 발명에 따라 H.264에서 정의된 블록 정보를 MPEG-4에
서 다시 사용하기 위해 정보 변환 방법을 제공할 수 있다. 종래 기술에 따라 시간적으론 많은 비용 갖는 직렬 화소 영역 트랜스코딩 방식에 비해 H.264에서 이전 움직임 벡터와 블록정보를 재사용함으로써 시간적으로 1.8배 정도의 성능향상을 보이면서 화질영화가 거의 없음을 알 수 있다.

이제까지, 본 발명에 따른 H.264 BP(Baseline profile)에서 MPEG4 SP(Simple profile)로 변환방법을 설명하였다. 또한, H.264에서 정의된 블록 모드를 MPEG4에서 정의된 블록 모드로 변환함에 있어, MPEG4에서 정의된 모든 블록 모드를 고려하는 방법을 중심으로 설명하였다.

그러나, 통계적으로 검토한 결과 H.264의 2x2 MB를 MPEG4의 1x1 MB로 변환함에 있어, H.264의 2x2 MB의 특징을 고려하면 최소한의 MPEG4 블록모드만을 고려할 수 있어 화질 영화가 거의 없으면서도 신속하게 트랜스코딩이 가능함을 발견하였다.

하기 표 2는 통계적으로 검토된 H.264의 2x2 MB의 특성에 따른 MPEG4 블록모드로의 변환 변도를 나타내고, 도 6a 내지 도 6b는 통계학적 방법을 고려한 메크로블록 모드 및 움직임 벡터의 변환 과정이 예시되어 있다.
<table>
<thead>
<tr>
<th>MB modes of the MPEG-4 2x 2 MB modes of the H.264</th>
<th>INTRA</th>
<th>SKIP</th>
<th>INTER 16 η16</th>
<th>INTER 8 η8</th>
<th>Total</th>
<th>비고</th>
</tr>
</thead>
<tbody>
<tr>
<td>two Inter16* 16, two blocks smaller than Inter16* 8 or Inter8* 16</td>
<td>0.20%</td>
<td>13.53%</td>
<td>3.48%</td>
<td>1.88%</td>
<td>19.09%</td>
<td>도 6a 참조</td>
</tr>
<tr>
<td>one Inter16* 16, three blocks smaller than Inter16* 8 or Inter8* 16</td>
<td>0.22%</td>
<td>13.91%</td>
<td>2.16%</td>
<td>3.21%</td>
<td>19.49%</td>
<td></td>
</tr>
<tr>
<td>four blocks smaller than Inter16* 8 or Inter8* 16</td>
<td>0.14%</td>
<td>8.55%</td>
<td>0.86%</td>
<td>3.25%</td>
<td>12.79%</td>
<td></td>
</tr>
<tr>
<td>four Inter16* 16</td>
<td>0.26%</td>
<td>3.48%</td>
<td>25.94%</td>
<td>0.09%</td>
<td>29.77%</td>
<td>도 6b 참조</td>
</tr>
<tr>
<td>three Inter16* 16, one block smaller than Inter16* 8 or Inter8* 16</td>
<td>0.13%</td>
<td>8.01%</td>
<td>5.75%</td>
<td>0.47%</td>
<td>14.35%</td>
<td></td>
</tr>
<tr>
<td>one intra, three Inter Fig. 5(c)</td>
<td>0.03%</td>
<td>1.15%</td>
<td>0.32%</td>
<td>1.26%</td>
<td>2.76%</td>
<td>도 6c 참조</td>
</tr>
<tr>
<td>two intra, two Inter Fig. 5(c)</td>
<td>0.02%</td>
<td>0.37%</td>
<td>0.10%</td>
<td>0.65%</td>
<td>1.14%</td>
<td></td>
</tr>
<tr>
<td>three intra, one Inter Fig. 5(d)</td>
<td>0.00%</td>
<td>0.10%</td>
<td>0.04%</td>
<td>0.16%</td>
<td>0.31%</td>
<td>도 6d 참조</td>
</tr>
<tr>
<td>four intra Fig. 5(d)</td>
<td>0.05%</td>
<td>0.09%</td>
<td>0.01%</td>
<td>0.14%</td>
<td>0.29%</td>
<td></td>
</tr>
<tr>
<td>Total Number</td>
<td>1.04%</td>
<td>49.19%</td>
<td>38.65%</td>
<td>11.11%</td>
<td>100.00%</td>
<td></td>
</tr>
</tbody>
</table>

상술한 표 2 및 도 6에서 보여지는 바와 같이, 본 발명에 따른 트랜스코딩 방법은 미리 지정된 크기의 MB를 H.264로부터 MPEG4로 변환시 빈도가 상대적으로

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높은 MPEG4의 블록 모드만을 고려할 수 있다. 이때, H.264의 2x2 MB가 가지는 특성
이 이용될 수 있다.

예를 들어, H.264의 2x2 MB의 2개의 매크로블록이 인터 16x16 매크로블록이
고, 나머지 2개의 매크로블록이 인터 16x8 또는 인터 8x16 매크로블록보다 작은 블
록인 경우 도 6a와 같이 MPEG4의 인터 16x16 블록모드, 스마 모드 또는 인터 8x8
블록 모드만이 변환시 고려되도록 할 수 있다. 해당 블록 모드들은 표 2를 참조할
때 상대적으로 큰 변도를 가짐을 알 수 있다. 또한, 도시된 바와 같이 MPEG4의 인
터 16x16 블록모드 또는 스마 모드 중 하나로 선택할 것인지 아니면 인터 8x8 블록
모드로 선택할 것인지는 1/4 픽셀 단위의 모션벡터의 각 차분값(Difference)가 분
택값(예를 들어 9) 미만인지 여부로 1차적으로 결정될 수 있다.

다만, H.264의 2x2 MB의 3개 이상의 매크로블록이 인트라 매크로블록인 경우
표 2에서 가장 높은 변환 변도를 가지는 MPEG4의 블록모드는 인터 8x8 블록모드이
다. 그러니, 그 변도가 매우 낮은 값(즉, 0.14% 또는 0.16%)을 나타내므로 이는 무
시될 수 있으며 도 6d에 도시된 바와 같이 MPEG4의 블록모드를 인트라 블록모드로
결정할 수 있다.

【발명의 효과】

상술한 바와 같이 본 발명은 매크로블록의 정보를 계산하여 화질을 만족시
키면서 복잡도를 감소시킬 수 있는 영상 축소 트랜스코딩 방법 및 장치를 제공할
또한, 본 발명에 따른 H.264에서 MPEG-4로 변환하는 트랜스코디는 기존의 MPEG-4코덱을 사용했던 장비들을 교체하지 않고도 새로운 동영상 압축 표준인 H.264로 압축된 영상을 사용 가능하게 할 수 있는 효과도 있다.

상기에서는 본 발명의 바람직한 실시예를 참조하여 설명하였지만, 해당 기술 분야에서 동영상 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】

제1 방식에 따른 제1 매크로블록을 제2 방식에 따른 제2 매크로블록으로 변환하기 위한 영상 축소 트랜스 코딩 방법에 있어서,

(a) \( A(\text{자연수}) \times B(\text{자연수}) \) 크기의 상기 제1 매크로블록에 포함된 인트라 매크로블록의 개수가 미리 설정된 제1 조건을 충족하면, \( C(\text{자연수}) \times D(\text{자연수}) \) 크기의 상기 제2 매크로블록의 블록 모드를 결정하고, 상기 결정된 블록 모드로 변환하는 단계;

(b) 상기 제1 매크로블록에 포함된 인터 매크로블록의 개수가 제2 조건을 충족하면, 상기 제2 매크로블록의 블록 모드를 결정하고, 상기 결정된 블록 모드로 변환하는 단계; 및

(c) 상기 제1 매크로블록의 변환이 완료되면, 상기 제2 매크로블록에 대한 움직임 벡터 제조정을 수행하는 단계를 포함하는 단계를 포함하는 것을 특징으로 하는 영상 축소 트랜스 코딩 방법.

【청구항 2】

제1항에 있어서,

평균 필터를 이용하여 다음 샘플링을 하면서, 상기 결정된 블록 모드로 변환하는 것을 특징으로 하는 영상 축소 트랜스 코딩 방법.
【청구항 3】

제1항에 있어서,

상기 (a) 단계는

상기 제1 매크로블록이 모두 인트라 매크로블록인 경우, 한 개의 인트라 매크로블록으로 변환하는 단계를 포함하는 것을 특징으로 하는 영상 축소 트랜스코딩 방법.

【청구항 4】

제1항에 있어서,

상기 (a) 단계는

상기 매크로블록의 일부가 인트라 매크로블록인 경우, 상기 매크로블록의 SAD 비교 방식을 이용하여 블록 모드를 결정하는 단계를 포함하는 것을 특징으로 하는 영상 축소 트랜스코딩 방법.

【청구항 5】

제1항에 있어서,

상기 (b) 단계는

상기 인터 매크로블록의 개수가 미리 설정된 개수 이상인 경우 및 움직임 백
터간의 차분값을 산출한 후, 상기 차분값이 미리 설정된 이하인 경우는 인터 모드로 변환하고, 그 외의 경우는 상기 매크로블록의 SAD 비교 방식을 이용하여 블록모드를 결정하고, 상기 결정된 블록모드로 변환하는 단계를 포함하는 것을 특정으로 하는 영상 축소 트랜스코딩 방법.

【청구항 6】

제4항 또는 제5항에 있어서,

상기 SAD 비교 방식은

미리 설정된 두 개의 인터 블록의 SAD를 산출하고, 최소 인터 SAD를 결정하는 단계; 및

상기 최소 인터 SAD를 미리 설정된 인트라 블록의 인트라 SAD와 비교하여, 최소의 SAD에 상응하는 블록 모드로 변환하는 단계를 포함하는 것을 특정으로 하는 영상 축소 트랜스코딩 방법.

【청구항 7】

제6항에 있어서,

상기 인트라 SAD는

\[ MB_{\text{mean}} = \frac{\sum_{i=0}^{n} \sum_{j=0}^{m} \text{org}_{ij}}{a \times b} \]

수학식에 의하여 매크로블록의 화소값 평균이 산
출하고 여기서, 상기 \( \text{org}_{ij} \)는 MB내에 있는 각각의 16x16 화소들의 값이고 상기 \( \text{MB}_{\text{mean}} \)은 MB내에 있는 화소값들의 평균을 지칭함.

수학식 \[ \text{SAD}_{\text{intra}} = \sum_{i=0}^{15} \sum_{j=0}^{15} | \text{org}_{ij} - \text{MB}_{\text{mean}} | \] 에 의해, 상기 인트라 SAD가 산출되는 것을 특징으로 하는 영상 축소 트랜스코딩 방법.

【청구항 8】

제1항에 있어서,

\[ M_{r,j} = \left( \frac{\sum_{k=0}^{3} \sum_{l=0}^{3} \text{MB}_{r,l} \cdot \text{MV}_{n,m,k,l}^{j} \right)^{2} + 2 \right] \gg 2 \quad i, j = 0, 1

상기 움직임 벡터 재조정은 수학식에 의하여 수행되며, 여기서, 상기 \( m, n \)은 중간 단계인 MB가 취하는 8x8 블록들의 가로축, 세로축 좌표를 가리키고 상기 \( k, l \)은 2x2 MB들 안의 \((m, n)\)번째 매크로블록에 대응하는 4x4 블록들의 가로축, 세로축 좌표를 지칭하는 것을 특징으로 하는 영상 축소 트랜스코딩 방법.

【청구항 9】

제1항에 있어서,

상기 \( (c) \) 단계는

정수단위 움직임 벡터를 중심으로 그 주위의 정수단위 \pm 3개의 이웃 화소
(neighbor pixel)에 대하여 정수단위 움직임 벡터를 검색하는 단계; 및

상기 검색한 정수단위 움직임 벡터주변의 1/2 화소 단위의 ±1개의 이웃 화소에 대한 움직임 벡터를 검색하는 단계를 포함하는 것을 특징으로 하는 영상 축소 트랜스코딩 방법.

【청구항 10】

제1 방식에 따른 제1 메크로블록을 제2 방식에 따른 제2 메크로블록으로 변환하기 위한 영상 축소 트랜스 코딩 방법에 있어서.

미리 지정된 크기의 상기 제1 메크로블록에 포함된 메크로블록들의 유형에 의해 미리 설정된 조건에 의해 결정되는 상기 제2 방식에 따른 후보 블록 모드 중 어느 하나를 상기 제2 메크로블록의 블록 모드로 결정하고, 상기 결정된 블록 모드로 변환하는 단계; 및

상기 제1 메크로블록의 변환이 완료되면, 상기 제2 메크로블록에 대한 움직임 벡터 재조정을 수행하는 단계를 포함하는 것을 특징으로 하는 영상 축소 트랜스 코딩 방법.

【청구항 11】

제10항에 있어서,

상기 미리 설정된 조건은 상기 제1 메크로블록에 셋 이상의 인트라 메크로블
록이 포함된 경우 상기 제2 방식에 따른 한 개의 인트라 매크로블록으로 블록 모드를 결정하는 것을 특징으로 하는 영상 축소 트랜스코딩 방법.

【청구항 12】

제10항에 있어서,

상기 미리 설정된 조건은 상기 제1 매크로블록에 들 이하의 인트라 매크로블록이 포함된 경우, 상기 제1 매크로블록에 포함된 각 매크로블록의 SAD(Sum of Absolute Difference) 비교 방식을 이용하여 상기 후보 블록 모드 중 어느 하나로 결정하되,

상기 후보 블록 모드는 스킵(SKIP) 모드, 인터(Inter) 16x16 모드, 인터 8x8 모드 중 하나 이상을 포함하는 것을 특징으로 하는 영상 축소 트랜스코딩 방법.

【청구항 13】

제10항에 있어서,

상기 미리 설정된 조건은 상기 제1 매크로블록이 인터 매크로블록들로만 구성되고, 상기 인터 매크로블록들 중 들 이하의 인터 16x16 매크로블록이 포함된 경우, 각 인터 매크로블록의 SAD(Sum of Absolute Difference) 비교 방식을 이용하여 상기 후보 블록 모드 중 어느 하나로 결정하되,

상기 후보 블록 모드는 스킵(SKIP) 모드, 인터(Inter) 16x16 모드, 인터 8x8 모드
모드 중 하나 이상을 포함하는 것을 특징으로 하는 영상 축소 트랜스코딩 방법.

【청구항 14】

제12항 또는 제13항에 있어서,

각 메크로블록의 움직임 벡터간의 차분값을 산출한 후, 상기 차분값이 미리 설정된 문턱값이하인 경우 상기 인터 16x16 모드 또는 상기 스킵 모드 중 어느 하나로 결정하되, 그렇지 않은 경우에는 상기 인터 8x8 모드로 결정하는 것을 특징으로 하는 영상 축소 트랜스코딩 방법.

【청구항 15】

제12항 또는 제13항에 있어서,

상기 후보 블록 모드 중 결정된 어느 하나는 상기 SAD 비교 방식에 의해 최소의 SAD 값을 가지는 블록 모드의 것을 특징으로 하는 영상 축소 트랜스코딩 방법.

【청구항 16】

제12항에 있어서,

상기 인트라 메크로블록의 SAD는,
수학식 \( \text{MB}_{\text{mean}} = \sum_{i=0}^{255} \sum_{j=0}^{255} \text{org}_{ij} \) 에 의하여 마크로블록의 화소값 평균이 산출되고, 여기서, 상기 \( \text{org}_{ij} \)는 MB내에 있는 각각의 16x16 화소들의 값이고 상기 \( \text{MB}_{\text{mean}} \)은 MB내에 있는 화소값들의 평균을 지칭함.

수학식 \( \text{SAD}_{\text{INTRA}} = \sum_{i=0}^{255} \sum_{j=0}^{255} | \text{org}_{ij} - \text{MB}_{\text{mean}} | \) 에 의해 상기 인트라 마크로블록의 SAD가 산출되는 것을 특징으로 하는 영상 축소 트랜스코딩 방법.

【청구항 17】

제10항에 있어서,

\[
\text{MB}_{ij} = \left( \frac{\sum_{k=0}^{8} \sum_{l=0}^{8} m_{k,l,ij} + 2}{\sum_{k=0}^{8} \sum_{l=0}^{8} 1} \right) \gg 2, i,j=0,1
\]

상기 움직임 벡터 제조정은 수학식을 이용하여 수행되며, 상기 \( m, n \)은 중간 단계인 MB이 취하는 8x8 블록들의 가로축, 세로축 좌표를 가리키고 상기 \( k, l \)은 2x2 MB들 안의 \( (m, n) \)번째 마크로블록에 대응하는 4x4 블록들의 가로축, 세로축 좌표를 지칭하는 것을 특징으로 하는 영상 축소 트랜스코딩 방법.

【청구항 18】

제1 방식에 따른 제1 마크로블록을 제2 방식에 따른 제2 마크로블록으로 변
환하기 위한 영상 축소 트랜스 코딩 장치에 있어서,

상기 제1 매크로블록에 포함된 인트라 매크로블록의 개수가 미리 설정된 제1 조건을 충족하면, 상기 제2 매크로블록의 블록 모드를 결정하고, 상기 결정된 블록 모드로 변환하는 제1 변환부;

상기 제1 매크로블록에 포함된 인터 매크로블록의 개수가 제2 조건을 충족하면, 상기 제2 매크로블록의 블록 모드를 결정하고, 상기 결정된 블록 모드로 변환하는 제2 변환부; 및

상기 제1 매크로블록의 변환이 완료되면, 상기 제2 매크로블록에 대한 움직임 벡터 재조정을 수행하는 움직임 벡터 재조정부를 포함하는 것을 특징으로 하는 영상 축소 트랜스 코딩 장치.

【청구항 19】

제18항에 있어서,

상기 제1 변환부는

상기 제1 매크로블록이 모두 인트라 매크로블록인 경우, 한 개의 인트라 매크로블록으로 변환하고, 상기 매크로블록의 일부가 인트라 매크로블록인 경우, 상기 매크로블록의 SAD 비교 방식을 이용하여 블록 모드를 결정하는 것을 특징으로 하는 영상 축소 트랜스코딩 장치.
【청구항 20】

제18항에 있어서,

상기 제2 변환부는

상기 인터 매크로블록의 개수가 미리 설정된 개수 이상인 경우 및 움직임 벡터간의 차분값을 산출한 후, 상기 차분값이 미리 설정된 이하인 경우는 인터 모드로 변환하고, 그 외의 경우는 상기 매크로블록의 SAD 비교 방식을 이용하여 블록모드를 결정하고, 상기 결정된 블록모드로 변환하는 것을 특징으로 하는 영상 축소 트랜스코딩 장치.

【청구항 21】

제20항에 있어서,

상기 SAD 비교 방식은

미리 설정된 두 개의 인터 블록의 SAD를 산출하고, 최소 인터 SAD를 결정하고, 상기 최소 인터 SAD를 미리 설정된 인트라 블록의 인트라 SAD와 비교하여, 최소의 SAD에 상응하는 블록 모드로 변환하는 것을 특징으로 하는 영상 축소 트랜스코딩 장치.

【청구항 22】

제1 방식에 따른 제1 매크로블록을 제2 방식에 따른 제2 매크로블록으로 변

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환하기 위한 영상 축소 트랜스 코딩 장치에 있어서,

미리 지정된 크기의 상기 제1 매크로블록에 포함된 매크로블록들의 유형에 의해 미리 설정된 조건에 의해 결정되는 상기 제2 방식에 따른 후보 블록 모드 중 어느 하나를 상기 제2 매크로블록의 블록 모드로 결정하고, 상기 결정된 블록 모드로 변환하는 변환부; 및

상기 제1 매크로블록의 변환이 완료되면, 상기 제2 매크로블록에 대한 움직임 벡터 제조정을 수행하는 움직임 벡터 제조정부를 포함하는 것을 특정으로 하는 영상 축소 트랜스 코딩 장치.

【청구항 23】

제22항에 있어서,

상기 미리 설정된 조건은 상기 제1 매크로블록에 셋 이상의 인트라 매크로블록이 포함된 경우 상기 제2 방식에 따른 한 개의 인트라 매크로블록으로 블록 모드를 결정하는 것을 특정으로 하는 영상 축소 트랜스 코딩 장치.

【청구항 24】

제22항에 있어서,

상기 미리 설정된 조건은 상기 제1 매크로블록에 둘 이상의 인트라 매크로블록이 포함된 경우, 상기 제1 매크로블록에 포함된 각 매크로블록의 SAD(Sum of
Absolute Difference) 비교 방식을 이용하여 상기 후보 블록 모드 중 어느 하나로 결정하되,

상기 후보 블록 모드는 스킵(SKIP) 모드, 인터(Inter) 16x16 모드, 인터 8x8 모드 중 하나 이상을 포함하는 것을 특징으로 하는 영상 축소 트랜스코딩 장치.

【청구항 25】

제22항에 있어서,

상기 미리 설정된 조건은 상기 제1 메크로블록이 인터 메크로블록들로만 구성되고, 상기 인터 메크로블록들 중 독 이하의 인터 16x16 메크로블록이 포함된 경우, 각 인터 메크로블록의 SAD(Sum of Absolute Difference) 비교 방식을 이용하여 상기 후보 블록 모드 중 어느 하나로 결정하되,

상기 후보 블록 모드는 스킵(SKIP) 모드, 인터(Inter) 16x16 모드, 인터 8x8 모드 중 하나 이상을 포함하는 것을 특징으로 하는 영상 축소 트랜스코딩 장치.

【청구항 26】

제24항 또는 제25항에 있어서,

상기 변환부는 각 메크로블록의 움직임 벡터간의 차분값을 산출한 후, 상기 차분값이 미리 설정된 문턱값이하인 경우 상기 인터 16x16 모드 또는 상기 스킵 모드 중 어느 하나로 결정하되, 그렇지 않은 경우에는 상기 인터 8x8 모드로 결정하

56-41
는 것을 특징으로 하는 영상 축소 트랜스코딩 장치.

【청구항 27】

제24항에 있어서,

상기 인트라 메크로블록의 SAD는,

수학식 \( MB_{\text{mean}} = \sum_{i=0}^{15} \sum_{j=0}^{15} \text{org}_{i,j} \) 이 의해 메크로블록의 화소값 평균이 산출되고 여기서, 상기 \( \text{org}_{i,j} \)는 MB 내에 있는 각각의 16x16 화소들의 값이고 상기 MB_{\text{mean}}은 MB 내에 있는 화소값들의 평균을 지칭함.

\( SAD_{\text{INTRA}} = \sum_{i=0}^{15} \sum_{j=0}^{15} | \text{org}_{i,j} - MB_{\text{mean}} | \) 이 의해 상기 인트라 메크로블록의 SAD가 산출되는 것을 특징으로 하는 영상 축소 트랜스코딩 장치.

【청구항 28】

제22항에 있어서,

\( MR_{i,j} = \left( \frac{\sum_{k=0}^{3} \sum_{l=0}^{3} \text{mv}_{i,j} \cdot k \cdot l}{\sum_{k=0}^{3} \sum_{l=0}^{3} k \cdot l} + 2 \right) \gg 2 \quad i,j=0,1 \)

상기 움직임 벡터 제조정은 수학식을 이용하여 수행되며, 상기 \( m, n \)은 중간 단계인 MB가 취하는 8x8 블록들의 가로축, 세로축 좌표를 가리키고 상기 \( k, l \)은 2x2 MB들 안의 \( (m, n) \)번째 메크로블록에 대응하는
4x4 블록들의 가로축, 세로축 좌표를 지칭하는 것을 특징으로 하는 영상 축소 트랜스코딩 장치.
【도면】

【도 1】

2x2 MB

MB

MB

MB

MB

1x1 MB

(a+b+c+d)/4

【도 2a】

Skip mode MB conversion in H.264

Inter 16x16 MB conversion in H.264
【도 2b】

<table>
<thead>
<tr>
<th>16</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>4x4 Intra or 16x16 Intra</td>
<td>4x4 Intra or 16x16 Intra</td>
</tr>
<tr>
<td>4x4 Intra or 16x16 Intra</td>
<td>4x4 Intra or 16x16 Intra</td>
</tr>
</tbody>
</table>

2x2 MB in H.264

Intra block conversion

16

Intra 16x16

One MB in MPEG-4
[도 2c]
【도 2d】

Inter block conversion

2x2 MB in H.264

One MB in MPEG-4
【도 3】

300

제1 변환부

제2 변환부

음직임 벡터 재조정부
【도 4】

1. 2x2 MB information in H.264 decoder (MB type, MV) → S410
2. MB type conversion Each MB information in 2x2 MB in H.264 → S415
3. Down-sampling using the average filter → S420
4. The # of Intra MB in 2x2 MB > 2
   - Yes → S430
   - No → S435
     - Intra → S455
     - No → S460
5. The # of Intra MB in 2x2 MB != 4
   - Yes → S440
   - No → S445
8. Each value of MV difference < Threshold(4)
   - Yes → INTER 16x16
   - No → S450
7. The # of Inter 16x16 MB in 2x2 MB > 2
   - Yes → INTER 16x16
   - No → S450
6. Calculate SAD
5. End of 2x2 MB in H.264
4. Motion of vector: REFINEMENT → S470
【도 5a】

Coast(CIF ⇒ QCIF, 30hz)

【도 5b】

Paris(CIF ⇒ QCIF, 30hz)
【도 5c】

News(CIF ⇒ QCIF, 30hz)

- Cascade
- Proposed

【도 5d】

Foreman(CIF ⇒ QCIF, 30hz)

- Cascade
- Proposed
【도 6a】

2x2 MB in H.264

Intermediate MB

One MB in MPEG-4

Inter8x8

when Each Difference of a, b, c, d

or

Inter16x16

when Each Difference of a, b, c, d

otherwise

SKIP

Calculate each difference of a, b, c, d

Inter8x8 conversions

56-53
【도 6b】

2x2 MB in H.264

Direct block conversion

Inter 16x16

or

One MB in MPEG-4
<table>
<thead>
<tr>
<th>16.</th>
<th>any Inter</th>
<th>Intra16×16 or Intra4×4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intra16×16 or Intra4×4</td>
<td>Intra16×16 or Intra4×4</td>
<td></td>
</tr>
</tbody>
</table>

2x2 MB in H.264

Direct block conversion

One MB in MPEG-4

INTRA
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 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 10 of this paper.
**Amendments to the Claims:**

This listing of claims will replace all prior versions, and listings, of claims in the applications:

**Listing of Claims:**

Claim 1. (Original) An image down-sampling transcoding method for converting a first macro block having a first format into a second macro block having a second format, the image down-sampling transcoding method comprising:

   (a) determine a block mode of the second macro block having a CxD size (where C and D are natural numbers) and converting the first macro block into the second macro block with the determined block mode, when the number of intra macro blocks included in the first macro block having a AxB size (where A and B are natural numbers) satisfies a first condition;

   (b) determining a block mode of the second macro block and converting the first macro block into the second macro block with the determined block mode, when the number for inter macro blocks included in the first macro block satisfies a second condition; and

   (c) re-adjusting a motion vector of the second macro block, after the conversion of the first macro block into the second macro block is finished.

Claim 2. (Original) The image down-sampling transcoding method according to claim 1, wherein the first macro block is converted into the second macro block with the determined block mode while being down-sampled by the use of an average filter.

Claim 3. (Original) The image down-sampling transcoding method according to claim 1, wherein (a) includes converting the first macro block into one intra macro block, when the first macro block includes only the intra macro blocks.

Claim 4. (Original) The image down-sampling transcoding method according to claim 1, wherein (a) includes determining the block mode by the use of an SAD comparison method for macro blocks, when the first macro block includes some intra blocks.

Claim 5. (Original) The image down-sampling transcoding method according to claim 1, wherein (b) includes:

   converting the first macro block into the second macro block with the inter mode when the number of inter macro blocks is greater than or equal to a predetermined number or when a difference value between the motion vectors is calculated and the difference value is less than or equal to a predetermined value; and

   determining the block mode by the use of an SAD comparison method of macro blocks and converting the first block into the second block with the determined block mode in the other cases.
Claim 6. (Currently Amended) The image down-sampling transcoding method according to claim 4 [[or 5]], wherein the SAD comparison method includes:

- calculating SADs between two inter macro blocks and determining the least inter SAD; and
- converting the first macro block into the second macro block with the block mode corresponding to the least SAD by comparing the least inter SAD with the predetermined intra SAD.

Claim 7. (Original) The image down-sampling transcoding method according to claim 6, wherein a mean pixel value of a macro block is calculated by the following expression:

\[ MB_{\text{mean}} = \sum_{i=0}^{15} \sum_{j=0}^{15} \text{org}_{i,j} \]

where \( \text{org}_{i,j} \) denotes pixel values of 16x16 pixels in a macro block and \( MB_{\text{mean}} \) denotes the mean pixel value of a macro block, and

\[ SAD_{\text{INTRA}} = \sum_{i=0}^{15} \sum_{j=0}^{15} \left| \text{org}_{i,j} - MB_{\text{mean}} \right| \]

wherein the intra SAD is calculated by the following expression.

Claim 8. (Original) The image down-sampling transcoding method according to claim 1, wherein the re-adjustment of the motion vector is performed by the use of the following expression:

\[ MV_{i,j} = \left( \frac{\sum_{k=0}^{3} \sum_{l=0}^{3} mv_{m,p,k,l}}{\sum_{k=0}^{3} \sum_{l=0}^{3} l} \right) >> 2, \quad i,j = 0,1 \]

where \( m \) and \( n \) denote coordinate values in the axis of abscissa and the axis of ordinate in an 8x8 mode block which is an intermediate macro block and \( k \) and \( l \) denote coordinate values in the axis of abscissa and the axis of ordinate in a 4x4 mode block corresponding to the \((m,n)\)-th macro block in 2x2 macro blocks.
Claim 9. (Original) The image down-sampling transcoding method according to claim 1, wherein (c) includes:

searching for an integer pixel motion vector in \( \pm 3 \) neighboring pixels about an integer pixel motion vector; and

searching for a half pixel motion vector in \( \pm 1 \) neighboring pixels about the searched integer pixel motion vector.

Claim 10. (Original) An image down-sampling transcoding method for converting a first macro block having a first format into a second macro block having a second format, the image down-sampling transcoding method comprising:

determining any one of candidate block modes having the second format, which is determined in accordance with a predetermined condition by types of macro blocks included in the first macro block having a predetermined size, as a block mode of the second macro block and converting the first macro block into the second macro block with the determined block mode; and

re-adjusting a motion vector of the second macro block, after the conversion of the first macro block into the second macro block is finished.

Claim 11. (Original) The image down-sampling transcoding method according to claim 10, wherein the predetermined condition is that one intra macro block having the second format is determined as the block mode when three or more intra macro blocks are included in the first macro block.

Claim 12. (Original) The image down-sampling transcoding method according to claim 10, wherein the predetermined condition is that anyone of the candidate block modes is determined as the block mode by the use of a SAD comparison method of macro blocks included in the first macro block, when two or less intra macro blocks are included in the first macro block, and

wherein the candidate block modes include one or more of a skip mode, an inter 16x16 mode, and an inter 8x8 mode.

Claim 13. (Original) The image down-sampling transcoding method according to claim 10, wherein the predetermined condition is that any one of the candidate block modes is determined as the block mode by the use of a SAD comparison method of macro blocks, when only inter macro blocks are included in the first macro block and two or less macro blocks in the inter 16x16 mode are included in the inter macro blocks, and

wherein the candidate block modes include one or more of a skip mode, an inter 16x16 mode, and an inter 8x8 mode.
Claim 14. (Currently Amended) The image down-sampling transcoding method according to claim 12 [[or 13]], wherein when a difference between the motion vectors in the respective macro blocks is calculated and the difference is less than or equal to a predetermined threshold value, any one of the inter 16x 16 mode and the skip mode is determined as the block mode and in the other cases, the inter 8x8 mode is determined as the block mode.

Claim 15. (Currently Amended) The image down-sampling transcoding method according to claim 12 [[or 13]], wherein any one of the candidate block modes is a block mode having the least SAD value.

Claim 16. (Original) The image down-sampling transcoding method according to claim 12, wherein a mean pixel value of a macro block is calculated by the following expression:

\[ MB_{\text{mean}} = \sum_{i=0}^{15} \sum_{j=0}^{15} \text{org}_{i,j} \]

where \( \text{org}_{i,j} \) denotes pixel values of 16x16 pixels in a macro block and \( MB_{\text{mean}} \) denotes the mean pixel value of a macro block, and

wherein the intra SAD is calculated by the following expression.

\[ SAD_{\text{INTRA}} = \sum_{i=0}^{15} \sum_{j=0}^{15} |\text{org}_{i,j} - MB_{\text{mean}}| \]

Claim 17. (Original) The image down-sampling transcoding method according to claim 10, wherein the re-adjustment of the motion vector is performed by the use of the following expression:

\[ MV_{i,j} = \left( \frac{\sum_{k=0}^{3} \sum_{l=0}^{3} m_{k,n,k,l}}{\sum_{k=0}^{3} \sum_{l=0}^{3}} \right) \gg 2, \quad i,j = 0,1 \]

where \( m \) and \( n \) denote coordinate values in the axis of abscissa and the axis of ordinate in an 8x8 mode block which is an intermediate macro block and \( k \) and \( l \) denote coordinate values in the axis of abscissa and the axis of ordinate in a 4x4 mode block corresponding to the \( (m,n) \)-th macro block in 2x2 macro blocks.
Claim 18.  (Original)  An image down-sampling transcoding device for converting a first macro block having a first format into a second macro block having a second format, the image down-sampling transcoding device comprising:

a first conversion unit determining a block mode of the second macro block and converting the first macro block into the second macro block with the determined block mode, when the number of intra macro blocks included in the first macro block satisfies a first condition;

a second conversion unit determining a block mode of the second macro block and converting the first macro block into the second macro block with the determined block mode, when the number for inter macro blocks included in the first macro block satisfies a second condition; and

a motion vector re-adjusting unit re-adjusting a motion vector of the second macro block, after the conversion of the first macro block into the second macro block is finished.

Claim 19.  (Original)  The image down-sampling transcoding device according to claim 18, wherein the first conversion unit:

converts the first macro block into one intra macro block, when the first macro block includes only the intra macro blocks; and

determines the block mode by the use of an SAD comparison method for macro blocks, when the first macro block includes some intramacro blocks.

Claim 20.  (Original)  The image down-sampling transcoding device according to claim 18, wherein the second conversion unit:

converts the first macro block into the second macro block with the inter mode, when the number of inter macro blocks is greater than or equal to a predetermined number or when a difference value between the motion vectors is calculated and the difference value is less than or equal to a predetermined value; and

determines the block mode by the use of an SAD comparison method of macro blocks and converts the first block into the second block with the determined block mode in the other cases.
Claim 21. (Original) The image down-sampling transcoding device according to claim 20, wherein the SAD comparison method includes:
calculating SADs between two inter macro blocks and determining the least inter SAD; and
converting the first macro block into the second macro block with the block mode corresponding to the least SAD by comparing the least inter SAD with the predetermined intra SAD.

Claim 22. (Original) An image down-sampling transcoding device for converting a first macro block having a first format into a second macro block having a second format, the image down-sampling transcoding device comprising:

a conversion unit determining anyone of candidate block modes having the second format, which is determined in accordance with a predetermined condition by types of macro blocks included in the first macro block having a predetermined size, as a block mode of the second macro block and converting the first macro block into the second macro block with the determined block mode; and

a motion vector re-adjusting unit re-adjusting a motion vector of the second macro block, after the conversion of the first macro block into the second macro block is finished.

Claim 23. (Original) The image down-sampling transcoding device according to claim 22, wherein the predetermined condition is that one intra macro block having the second format is determined as the block mode when three or more intra macro blocks are included in the first macro block.

Claim 24. (Original) The image down-sampling transcoding device according to claim 22, wherein the predetermined condition is that anyone of the candidate block modes is determined as the block mode by the use of a SAD comparison method of macro blocks included in the first macro block, when two or less intra macro blocks are included in the first macro block, and

wherein the candidate block modes include one or more of a skip mode, an inter 16x16 mode, and an inter SxS mode.

Claim 25. (Original) The image down-sampling transcoding device according to claim 22, wherein the predetermined condition is that anyone of the candidate block modes is determined as the block mode by the use of a SAD comparison method of macro blocks, when only inter macro blocks are included in the first macro block and two or less macro blocks in the inter 16x16 mode are included in the inter macro blocks, and

wherein the candidate block modes include one or more of a skip mode, an inter 16x16 mode, and an inter 8x8 mode.
Claim 26. (Currently Amended) The image down-sampling transcoding device according to claim 24 [[or 25]], wherein the conversion unit calculates a difference between the motion vectors in the respective macro blocks, determines anyone of the inter 16x16 mode and the skip mode as the block mode when the difference is less than or equal to a predetermined threshold value, and in the other cases, determines the inter SxS mode as the block mode.

Claim 27. (Original) The image down-sampling transcoding device according to claim 24, wherein a mean pixel value of a macro block is calculated by the following expression:

\[ MB_{\text{mean}} = \sum_{i=0}^{15} \sum_{j=0}^{15} \text{org}_{i,j} \]

where \( \text{org}_{i,j} \) denotes pixel values of 16x16 pixels in a macro block and \( MB_{\text{mean}} \) denotes the mean pixel value of a macro block, and

wherein the intra SAD is calculated by the following expression.

\[ SAD_{\text{INTRA}} = \sum_{i=0}^{15} \sum_{j=0}^{15} |\text{org}_{i,j} - MB_{\text{mean}}| \]

Claim 28. (Original) The image down-sampling transcoding device according to claim 22, wherein the re-adjustment of the motion vector is performed by the use of the following expression:

\[ MV_{i,j} = \left( \frac{\sum_{k=0}^{3} \sum_{l=0}^{3} \text{mv}_{m,n,k,l}}{\sum_{k=0}^{3} \sum_{l=0}^{3} l} \right) \gg 2, \quad i,j = 0,1 \]

where \( m \) and \( n \) denote coordinate values in the axis of abscissa and the axis of ordinate in an 8x8 mode block which is an intermediate macro block and \( k \) and \( l \) denote coordinate values in the axis of abscissa and the axis of ordinate in a 4x4 mode block corresponding to the \( (m,n) \)-th macro block in 2x2 macro blocks.
Claim 29. (New) The image down-sampling transcoding method according to claim 5, wherein the SAD comparison method includes:

- calculating SADs between two inter macro blocks and determining the least inter SAD; and
- converting the first macro block into the second macro block with the block mode corresponding to the least SAD by comparing the least inter SAD with the predetermined intra SAD.

Claim 30. (New) The image down-sampling transcoding method according to claim 29, wherein a mean pixel value of a macro block is calculated by the following expression:

\[ MB_{\text{mean}} = \sum_{i=0}^{15} \sum_{j=0}^{15} \text{org}_{i,j} \]

where \( \text{org}_{i,j} \) denotes pixel values of 16x16 pixels in a macro block and \( MB_{\text{mean}} \) denotes the mean pixel value of a macro block, and

wherein the intra SAD is calculated by the following expression:

\[ SAD_{\text{intra}} = \sum_{i=0}^{15} \sum_{j=0}^{15} |\text{org}_{i,j} - MB_{\text{mean}}| \]

Claim 31. (New) The image down-sampling transcoding method according to claim 13, wherein when a difference between the motion vectors in the respective macro blocks is calculated and the difference is less than or equal to a predetermined threshold value, any one of the inter 16x16 mode and the skip mode is determined as the block mode and in the other cases, the inter 8x8 mode is determined as the block mode.

Claim 32. (New) The image down-sampling transcoding method according to claim 13, wherein any one of the candidate block modes is a block mode having the least SAD value.

Claim 33. (New) The image down-sampling transcoding device according to claim 25, wherein the conversion unit calculates a difference between the motion vectors in the respective macro blocks, determines anyone of the inter 16x16 mode and the skip mode as the block mode when the difference is less than or equal to a predetermined threshold value, and in the other cases, determines the inter SxS mode as the block mode.
Remarks:

Applicants are amending claims 6, 14, 15, and 26, so that these claims are not in multiple dependent form. Further, Applicant is adding new claims 29-33 to capture the subject matter removed by the amendments to claims 6, 14, 15, and 26. The purpose of these amendments is to reduce the fees associated with the filing of this application, without narrowing the scope of the claims of this application. No new matter is added by these amendments, and these amendments are fully supported by the specification. Applicants respectfully request entry of these amendments. Based on the claims remaining after entry of this Preliminary Amendment, no multiple dependent claim fee is due, but fees for thirteen (13) excess total claims and one (1) excess independent claim are due. 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: March 10, 2006

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
RESPONSE TO NOTICE TO FILE MISSING PARTS

MAIL STOP MISSING PARTS
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U.S. Patent and Trademark Office
Customer Service Window
Randolph Building
401 Dulany Street
Alexandria, VA 22314

Sir:

In response to the attached Notice to File Missing Parts of Nonprovisional Application (NTFMP) mailed January 11, 2006, by the U.S. Patent and Trademark Office (PTO), Applicants are enclosing an executed Declaration for Patent Application, and a Preliminary Amendment, and are requesting the PTO to recalculate the excess claim fees in view of the Preliminary Amendment and to charge the filing, search and examination fees; excess claim fees, and the late filing surcharge to the undersigned’s deposit account.

Specifically Applicants respectfully request that the PTO charge the amount of $1,980.00 to cover the filing fee ($1000.00), additional claims ($850), and the late filing surcharge ($130.00) to the undersigned’s Deposit Account No. 02-0375. In the event of any variance between the fees determined by Applicants and those determined by the U.S. Patent
and Trademark Office, please also charge or credit any such variance to the undersigned’s Deposit Account No. 02-0375.

Respectfully submitted,

BAKER BOTTS, L.L.P.

By:

James B. Arpin
Registration No. 33,470

Dated: March 10, 2006

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JBA/dh

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 $1110 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 $2240 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 $1110
  - $200 for 1 independent claims over 3.
  - $550 for 11 total claims over 20.
  - $360 for multiple dependent claim surcharge.

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
☑ Application No. 11/289,649 filed on November 30, 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;

If 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: Yung-Lyul Lee
Signature: [Signature]
Citizen of: Korea

Inventor two: Euee-S Jang
Signature: [Signature]
Citizen of: Korea

Inventor three: Chung-Ku Lee
Signature: [Signature]
Citizen of: Korea

Inventor four: __________________________
Signature: [Signature]
Citizen of: ______________________________

☐ Additional inventors are being named on additional form(s) attached hereto.
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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.

Total Files Size (in bytes): 662672
**PATENT APPLICATION FEE DETERMINATION RECORD**

**Column 1** | **Column 2**
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**FOR** | **NUMBER FILLED**
**TOTAL CLAIMS** (37 CFR 1.16(e)) | **NUMBER EXTRA**
**INDEPENDENT CLAIMS** (37 CFR 1.16(e)) | minus 20
**MULTIPLE DEPENDENT CLAIM PRESENT** (37 CFR 1.16(e))

*If the difference in column 1 is less than zero, enter '0' in column 2.*

**CLAIMS AS AMENDED - PART II**

**Column 1** | **Column 2** | **Column 3**
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**CLAIMS REMAINING AFTER AMENDMENT** | **HIGHEST NUMBER PREVIOUSLY PAID FOR** | **PRESENT EXTRA**
**TOTAL** (37 CFR 1.46(b)) | Minus **"** | **___**
**INDEPENDENT** (37 CFR 1.46(b)) | 4 | Minus **""** | **___**

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

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*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. 172 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.

If you need assistance in completing the form, call 1-800-TTI-999 and select option 3.
POWER OF ATTORNEY OR
AUTHORIZATION OF AGENT

I hereby appoint:

☑ Practitioners at Customer Number 24735

☐ Practitioner(s) named below:

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as my/our attorney(s) or agent(s) to prosecute the application identified above, and to transact all business in the United States Patent and Trademark Office connected therewith.

Please change the correspondence address for the above-identified application to:

☐ The above-mentioned Customer Number.

☐ Practitioners at Customer Number

Place Customer Number Bar Code Label here

☐ Firm or Individual Name

Address

City State Zip

Country

Telephone Fax

I am the:

☐ Applicant/Inventor.

☑ Assignee of record of the entire interest. See 37 CFR 3.71. Statement under 37 CFR 3.73(b) is enclosed. (Form PTO/SB/96).

SIGNATURE of Applicant or Assignee of Record

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<td>on behalf of Humax Co., Ltd.</td>
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NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below*.

☐ "Total of forms are submitted"
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| Total Files Size (in bytes): | 425062 |

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**
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of: )
Yung-Lyul LEE et al . ) Examiner: To Be Assigned
Application No.: 11/289,649 ) Group Art Unit: 2613
Filed: November 30, 2005 ) Confirmation No. 5884
For: IMAGE DOWN-SAMPLING TRANS-CODING METHOD AND DEVICE )

SUBMISSION OF POWER OF ATTORNEY
AND STATEMENT UNDER 37 C.F.R. § 3.73 (b)

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

Sir:

Applicants are submitting herewith an executed Power of Attorney for the above-captioned patent application. This Power of Attorney does not change the correspondence address for the application, which should remain the address associated with Customer Number 24735. Applicants also are submitting a Statement Under 37 C.F.R. 3.73 (b).

No fee is believed due as a result of this submission. However, if a fee is due
upon the filing of this Power of Attorney, please charge the undersigned’s Deposit Account
No. 02-0375.

Respectfully submitted,

BAKER BOTTs, L.L.P.

Dated: March 9, 2006

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
Tel: (202) 639-7700
Fax: (202) 639-7890

JBA/dh

Enclosures
STATEMENT UNDER 37 CFR 3.73(b)

Applicant/Patent Owner: Yung-Lyu Lee et al.

Application No./Patent No./Control No.: 11/288,649 Filed/Issue Date: November 30, 2005

Entitled: Image Down-Sampling Transcoding Method And Device

Humax Co., Ltd., a Korea

(Name of Assignee) (Type of Assignee: corporation, partnership, university, government agency, etc.)

states that it is:

1. [ ] the assignee of the entire right, title, and interest; or
2. [ ] an assignee of less than the entire right, title and interest

(The extent (by percentage) of its ownership interest is ________ %)

in the patent application/patent identified above by virtue of either:

A. [x] 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 a true copy of the original assignment 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: ___________________________ To: ___________________________

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

2. 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.

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.

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 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] March 02, 2006

[Printed or Typed Name] on behalf of [Title]

[Date] 3-31-690-6192

[Telephone Number]

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 1.11 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.
Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) 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 2908. 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.
ASSIGNMENT

WHEREAS, WE, Yung-Lyul Lee, Euee-S Jang, and Chung-Ku Lee, citizens of the Republic of Korea, have invented certain new and useful improvements in:

IMAGE DOWN-SAMPLING TRANSCODING METHOD AND DEVICE

as described in an application for United States Letters Patent filed on November 30, 2005, and accorded Application No. 11/289,649;

AND, WHEREAS, Humax Co., Ltd, a corporation organized under the laws of the Republic of Korea, located at Humax Venture Tower 271-2, Seohyeon-dong, Bundang-gu, Seongnam-si Gyeonggi-do 463-050, Republic of Korea, (hereinafter "ASSIGNEE"), is desirous of acquiring certain rights thereunder;

NOW, THEREFORE, in consideration of the sum of One Dollar ($1.00) or the equivalent thereof, and other good and valuable consideration, receipt of which is hereby acknowledged, we do hereby sell, assign, and transfer unto said ASSIGNEE, its successors, assigns, and legal representatives, our entire right, title, and interest in and throughout the United States of America (including its territories and dependencies) in and to said improvements; said United States patent application; any other United States applications, including provisional, divisional, renewal, substitute, continuation, reexamination, and reissue applications, based in whole or in part on said United States application or in whole or in part on said improvements; and in and to any and all Letters Patent, including extensions thereof, which have been or may be granted on any of the aforesaid applications or on said improvements or any parts thereof;

AND WE hereby agree for ourselves and our heirs, executors, and administrators to execute without further consideration any further documents and instruments which may be necessary, lawful, and proper in the prosecution of said above-referenced application or in the preparation or prosecution of any continuing, substitute, divisional, renewal, reexamination, or reissue application or in any amendments, extensions or interference proceedings, that may be necessary to secure to ASSIGNEE its interest and title in and to said improvements or any parts thereof, and in and to said several application or patents, or any of them;

AND WE hereby covenant for ourselves and our legal representatives, and agree with said ASSIGNEE, its successors and assigns, that we have granted no right or license to make, use, sell, or offer to sell said improvements, to anyone except said ASSIGNEE, that prior to the execution of this deed, our right, title, and interest in said improvements had not been otherwise encumbered, and that we have not and will not execute any instrument in conflict therewith;

AND WE do hereby authorize and request the Director of the United States Patent and Trademark Office to issue any and all Letters Patent which may be granted upon

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)
said United States application or applications, or upon said improvements or any parts thereof when granted, to said ASSIGNEE.

IN WITNESS WHEREOF, we have hereunto set our hands and seals.

Feb. 27, 2006
Date
Yung-Lyul Lee

WITNESSES:

Feb. 27, 2006
Date
Kwak Eun Kyung

Feb. 27, 2006
Euee-S Jang

Date

WITNESSES:

Feb. 27, 2006
Date
Kwak Eun Kyung

Feb. 27, 2006
Chung-Ku Lee

Date

WITNESSES:

DC01:434800.1

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)

2 of 2
### 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 **$1110** 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 **$2240** 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 $1110
  • $200 for 1 independent claims over 3.
  • $550 for 11 total claims over 20.
  • $360 for multiple dependent claim surcharge.

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.

D. S.
Office of Initial Patent Examination (571) 272-4000, or 1-800-PTO-9199, or 1-800-972-6382
PART 3 - OFFICE COPY
November 30, 2005

UTILITY PATENT APPLICATION TRANSMITTAL

Attorney Docket Number: 076980.0104
First Named Inventor: Yung-Lyul LEE et al.
Title: Image Down-Sampling Transcoding Method And Device

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: 31 (Including Abstract)

<table>
<thead>
<tr>
<th>Claims Filed</th>
<th>Basic Fee Claims</th>
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<th>Rate (Large Entity)</th>
<th>Rate (Small Entity)</th>
<th>Amount</th>
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<tr>
<td>TOTAL FILING FEE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. ☒ Drawings - Total Sheets: 15 (Fig(s). 1-6D)
4. Oath or Declaration - Total Pages: 1
   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.

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:
    and 10-2005-0107224, filed November 9, 2005

    □ 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:

☐ Please add as power of attorney:

19. Please address all correspondence to: 24735

20. ☐ A check in the amount of $1,600.00 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.

☐ The Commissioner is hereby authorized to charge any variance between the amount enclosed and the Patent Office charges to Deposit Account No. 02-0375.

Respectfully submitted,

By:

James B. Arpin
Registration No 33,470

JBA/dh

Enclosures
November 30, 2005

UTILITY PATENT APPLICATION TRANSMITTAL

Attorney Docket Number: 076980.0104
First Named Inventor: Yung-Lyul LEE et al.
Title: Image Down-Sampling Transcoding Method And Device

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

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<tr>
<td>BASIC FEE</td>
</tr>
<tr>
<td>TOTAL FILING FEE</td>
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</tbody>
</table>

3. ☒ Drawings - Total Sheets: 15 (Fig(s). 1-6D)

4. Oath or Declaration - Total Pages: 1

   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.

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)

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   b. □ Paper Copy (identical to computer copy)
   c. □ Statement verifying identity of above copies

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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 _______________________

DC01:431691.1
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:
  □ Please add as power of attorney:

19. Please address all correspondence to: 24735

20. □ A check in the amount of $1,600.00 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.
  □ The Commissioner is hereby authorized to charge any variance between the amount enclosed and the Patent Office charges to Deposit Account No. 02-0375.

Respectfully submitted,

By:

James B. Arpin
Registration No 33,470

JBA/dh

Enclosures
IMAGE DOWN-SAMPLING TRANSCODING METHOD AND DEVICE

BACKGROUND OF THE INVENTION

5 1. Field of the Invention

The present invention relates to an image down-sampling coding method and
device, more particularly to a method and device for performing an image down-
sampling process from H.264 to MPEG-4 at a high speed.

10 2. Description of Related Art

Thanks to the development of computers and networks, a variety of data can be
transmitted from a transmission party to a reception party. There have been
multimedia standard compression formats developed for transmitting large-capacity
multimedia data through networks. Various video transcoding methods of performing
conversion processes suitable for circumstances of the transmission party and the
reception party by considering QoS (Quality of Service) of both parties have been
introduced. Such video coding methods are roughly divided into a transcoding method
in a pixel domain and a transcoding method in a DCT (Discrete Cosine Transform)
domain.

15 The best transcoding method in view of image quality is a cascaded pixel-
domain transcoding method of decoding input bit streams of images and encoding the
decoded images again. However, since the encoding process is performed once more,
such a conventional method has a problem with the increase in complexity. Therefore,
an efficient transcoding method which can improve the complexity while maintaining
the image quality is required.

SUMMARY OF THE INVENTION

1
The present invention is contrived to solve the above-mentioned problems. An objective of the present invention is to provide an image down-sampling transcoding method and device which can reduce complexity while maintaining the image quality by re-using information on macro blocks. That is, the present invention provides a transcoding method which re-uses information on macro blocks used in an H.264 decoder so as to reduce the complexity.

Another objective of the invention is to provide a transcoding method and device for smooth communication by reducing an image bit stream having a CIF (Common Intermediate Format) size, which is encoded by an H.264 (ITU-T Recommendation H.264 and ISO/IEC MPEG-4 Part 10 Advanced Video Coding) BP (Baseline Profile) encoder, into a half in image size in a pixel domain and converting the image bit stream into an MPEG-4 SP (Simple Profile) image bit stream having a QCIF (Quarter Common Intermediate Format) size. Other objectives of the invention will become apparent through preferred embodiments to be described later.

According to a first aspect of the present invention, there is provided a method of performing an image down-sampling process from H.264 to MPEG-4 at a high speed.

According to a preferred embodiment of the invention, there is provided an image down-sampling transcoding method for converting a first macro block having a first format into a second macro block having a second format, the image down-sampling transcoding method comprising the steps of: (a) determining a block mode of the second macro block having a C×D size (where C and D are natural numbers) and converting the first macro block into the second macro block with the determined block mode, when the number of intra macro blocks included in the first macro block having a A×B size (where A and B are natural numbers) satisfies a first condition; (b) determining a block mode of the second macro block and converting the first macro block into the second macro block with the determined block mode, when the number of inter macro blocks included in the first macro block satisfies a second condition; and
(c) re-adjusting a motion vector of the second macro block, after the conversion of the first macro block into the second macro block is finished.

The first macro block may be converted into the second macro block with the determined block mode while being down-sampled using an average filter.

In the image down-sampling transcoding method, step (a) may include converting the first macro block into one intra macro block, when the first macro block includes only the intra macro blocks.

Here, step (a) may include determining the block mode using an SAD comparison method for macro blocks, when the first macro block includes some intra macro blocks.

In the image down-sampling transcoding method, step (b) may include: converting the first macro block into the second macro block with the inter mode when the number of inter macro blocks is greater than or equal to a predetermined number or when a difference value between the motion vectors is calculated and the difference value is less than or equal to a predetermined value; and determining the block mode using an SAD comparison method of macro blocks and converting the first block into the second block with the determined block mode in the other cases.

The SAD comparison method may include the steps of: calculating SADs between two inter macro blocks and determining the least inter SAD; and converting the first macro block into the second macro block with the block mode corresponding to the least SAD by comparing the least inter SAD with the predetermined intra SAD.

A mean pixel value of a macro block may be calculated by the following equation:

\[ MB_{\text{mean}} = \sum_{i=0}^{15} \sum_{j=0}^{15} \text{org}_{i,j} \]

where \( \text{org}_{i,j} \) denotes pixel values of 16x16 pixels in a macro block, and \( MB_{\text{mean}} \) denotes the mean pixel value of a macro block. Here, the intra SAD may be calculated by the following equation.
\[ SAD_{INTRA} = \sum_{i=0}^{15} \sum_{j=0}^{15} \, |og_{i,j} - MB_{mean}| \]

The re-adjustment of the motion vector may be performed using the following equation:

\[
MV_{i,j} = \left( \frac{\sum_{k=0}^{3} \sum_{l=0}^{3} \, mv_{m,n,k,l}}{\sum_{k=0}^{3} \sum_{l=0}^{3} \, l} \right) \gg 2, \quad i, j = 0 \ldots 1 \]

where \(m\) and \(n\) denote coordinate values in the axis of abscissa and the axis of ordinate in an 8×8 mode block which is an intermediate macro block, and \(k\) and \(l\) denote coordinate values in the axis of abscissa and the axis of ordinate in a 4×4 mode block corresponding to the \((m,n)\)-th macro block in 2×2 macro blocks.

In the image down-sampling transcoding method, (c) may include the steps of: searching for an integer pixel motion vector in ±3 neighboring pixels about an integer pixel motion vector; and searching for a half pixel motion vector in ±1 neighboring pixels about the searched integer pixel motion vector.

According to another preferred embodiment of the invention, there is provided an image down-sampling transcoding method for converting a first macro block having a first format into a second macro block having a second format, the image down-sampling transcoding method comprising the steps of: determining any one of the candidate block modes having the second format, which is determined in accordance with a predetermined condition by types of macro blocks included in the first macro block having a predetermined size, as a block mode of the second macro block and converting the first macro block into the second macro block with the determined block mode; and re-adjusting a motion vector of the second macro block, after the conversion of the first macro block into the second macro block is finished.

In the image down-sampling transcoding method, the predetermined condition may be such that one intra macro block having the second format is determined as the block mode when three or more intra macro blocks are included in the first macro block.
Furthermore, the predetermined condition may be such that any one of the candidate block modes is determined as the block mode using a SAD comparison method of macro blocks included in the first macro block, when two or less intra macro blocks are included in the first macro block. Here, the candidate block modes may include one or more of a skip mode, an inter 16×16 mode, and an inter 8×8 mode.

Alternatively, The predetermined condition may be such that any one of the candidate block modes is determined as the block mode using a SAD comparison method of macro blocks, when only inter macro blocks are included in the first macro block and two or less macro blocks in the inter 16×16 mode are included in the inter macro blocks. Here, the candidate block modes may include one or more of a skip mode, an inter 16×16 mode, and an inter 8×8 mode.

When a difference between the motion vectors in the respective macro blocks is calculated and the difference is less than or equal to a predetermined threshold value, any one of the inter 16×16 mode and the skip mode may be determined as the block mode and in the other cases, the inter 8×8 mode may be determined as the block mode.

Here, any one of the candidate block modes may be a block mode having the least SAD value.

A mean pixel value of a macro block may be calculated by the following equation:

\[ MB_{mean} = \sum_{i=0}^{15} \sum_{j=0}^{15} o_{i,j} \]

where \( o_{i,j} \) denotes pixel values of 16×16 pixels in a macro block and \( MB_{mean} \) denotes the mean pixel value of a macro block. The intra SAD may be calculated by the following equation:

\[ SAD_{INTRA} = \sum_{i=0}^{15} \sum_{j=0}^{15} |o_{i,j} - MB_{mean}| \]

The re-adjustment of the motion vector may be performed using the following equation:
\[ MV_{i,j} = \left( \frac{\sum_{k=0}^{3} \sum_{l=0}^{3} mv_{m,n,k,l}}{\sum_{k=0}^{3} \sum_{l=0}^{3} I} \right) \gg 2 \] 

where \( m \) and \( n \) denote coordinate values in the axis of abscissa and the axis of ordinate in an 8x8 mode block which is an intermediate macro block and \( k \) and \( l \) denote coordinate values in the axis of abscissa and the axis of ordinate in a 4x4 mode block corresponding to the \((m,n)\)-th macro block in 2x2 macro blocks.

According to another aspect of the invention, there is provided a device for down-sampling an image from H.264 to MPEG-4 at a high speed.

That is, according to a preferred embodiment of the invention, there is provided an image down-sampling transcoding device for converting a first macro block having a first format into a second macro block having a second format, the image down-sampling transcoding device comprising: a first conversion unit determining a block mode of the second macro block and converting the first macro block into the second macro block with the determined block mode, when the number of intra macro blocks included in the first macro block satisfies a first condition; a second conversion unit determining a block mode of the second macro block and converting the first macro block into the second macro block with the determined block mode, when the number for inter macro blocks included in the first macro block satisfies a second condition; and a motion vector re-adjusting unit re-adjusting a motion vector of the second macro block, after the conversion of the first macro block into the second macro block is finished.

The first conversion unit may convert the first macro block into one intra macro block, when the first macro block includes only the intra macro blocks and may determine the block mode using an SAD comparison method for macro blocks, when the first macro block includes some intra macro blocks.

The second conversion unit may convert the first macro block into the second macro block with the inter mode, when the number of inter macro blocks is greater than
or equal to a predetermined number or when a difference value between the motion vectors is calculated and the difference value is less than or equal to a predetermined value and may determine the block mode using an SAD comparison method of macro blocks and converts the first block into the second block with the determined block mode in the other cases.

The SAD comparison method is characterized by: calculating SADs between two inter macro blocks and determining the least inter SAD; and converting the first macro block into the second macro block with the block mode corresponding to the least SAD by comparing the least inter SAD with the predetermined intra SAD.

According to another preferred embodiment of the invention, there is provided an image down-sampling transcoding device for converting a first macro block having a first format into a second macro block having a second format, the image down-sampling transcoding device comprising: a conversion unit determining any one of candidate block modes having the second format, which is determined in accordance with a predetermined condition by types of macro blocks included in the first macro block having a predetermined size, as a block mode of the second macro block and converting the first macro block into the second macro block with the determined block mode; and a motion vector re-adjusting unit re-adjusting a motion vector of the second macro block, after the conversion of the first macro block into the second macro block is finished.

The predetermined condition may be such that one intra macro block having the second format is determined as the block mode when three or more intra macro blocks are included in the first macro block.

The predetermined condition may be such that any one of the candidate block modes is determined as the block mode using a SAD comparison method of macro blocks included in the first macro block, when two or less intra macro blocks are included in the first macro block. Here, the candidate block modes may include one or
more of a skip mode, an inter 16×16 mode, and an inter 8×8 mode.

Alternatively, the predetermined condition may be such that any one of the candidate block modes is determined as the block mode using a SAD comparison method of macro blocks, when only inter macro blocks are included in the first macro block and two or less macro blocks in the inter 16×16 mode are included in the inter macro blocks. Here, the candidate block modes may include one or more of a skip mode, an inter 16×16 mode, and an inter 8×8 mode.

The conversion unit may calculate a difference between the motion vectors in the respective macro blocks, may determine any one of the inter 16×16 mode and the skip mode as the block mode when the difference is less than or equal to a predetermined threshold value, and in the other cases, may determine the inter 8×8 mode as the block mode.

A mean pixel value of a macro block may be calculated by the following equation:

\[ MB_{\text{mean}} = \sum_{i=0}^{15} \sum_{j=0}^{15} \text{org}_{i,j} \]

where \( \text{org}_{i,j} \) denotes pixel values of 16×16 pixels in a macro block and \( MB_{\text{mean}} \) denotes the mean pixel value of a macro block. Here, the intra SAD may be calculated by the following equation:

\[ \text{SAD}_{\text{INTRA}} = \sum_{i=0}^{15} \sum_{j=0}^{15} |\text{org}_{i,j} - MB_{\text{mean}}| \]

The re-adjustment of the motion vector may be performed using the following equation:

\[ MV_{i,j} = \left( \frac{\sum_{i=0}^{3} \sum_{j=0}^{3} MV_{m,n;i,j} \cdot l}{\sum_{k=0}^{3} \sum_{l=0}^{3} l} \right) \gg 2, \quad i,j = 0,1 \]

where \( m \) and \( n \) denote coordinate values in the axis of abscissa and the axis of ordinate in an 8×8 mode block which is an intermediate macro block, and \( k \) and \( l \) denote coordinate values in the axis of abscissa and the axis of ordinate in a 4×4 mode block block.
corresponding to the \((m,n)\)-th macro block in 2x2 macro blocks.

**BRIEF DESCRIPTION OF THE DRAWINGS**

The above and other features and advantages of the present invention will become more apparent by describing in detail preferred embodiments thereof with reference to the attached drawings in which:

Fig. 1 is a diagram illustrating an image down-sampling method according to a preferred embodiment of the invention;

Figs. 2A to 2D are diagrams illustrating a conversion method of macro block modes and motion vectors according to a preferred embodiment of the invention;

Fig. 3 is a block diagram illustrating a configuration of a transcoding device for down-sampling an image according to a preferred embodiment of the invention;

Fig. 4 is a flow diagram illustrating an image down-sampling method according to a preferred embodiment of the invention;

Figs. 5A to 5D are graphs illustrating an image down-sampling method according to a preferred embodiment of the invention; and

Figs. 6A to 6D are diagrams illustrating a conversion method of macro block modes and motion vectors according to another preferred embodiment of the invention.

**DETAILED DESCRIPTION OF THE EMBODIMENTS**

Hereinafter, image down-sampling transcoding method and device according to exemplary embodiments of the present invention will be described in detail with reference to the attached drawings such that the 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.
Generally, the simplest method for converting macro blocks (MB) in an H.264 frame into macro blocks in an MPEG-4 frame is a cascaded pixel-domain transcoding method of decompressing the compressed H.264 frame to be input and then compressing again the decompressed frame in accordance with MPEG-4. However, in such a method, since a motion estimation process of all the macro blocks in the whole frame is performed by an MPEG-4 encoder, real-time transmission by a transcoder can be hindered due to a large amount of calculation.

In the invention, block modes and motion vector data used in the H.264 decoder are re-used by the MPEG-4 encoder so as to perform the real-time transmission without performing the motion estimation process. According to an embodiment of the invention, a format, macro block data, and motion vector data of a current frame are extracted in the course of performing a variable length decoding (VLD) process of a bit stream compressed in accordance with H.264. Here, when the decompressed bit stream has a P (Predictive) frame format, the motion estimation process for which the MPEG-4 encoder requires much time can be omitted by reusing the block types and the motion vectors of the macro blocks.

As described above, a transcoding device according to the invention can include the H.264 decoder and the MPEG-4 encoder and the data extracted by the H.264 decoder can be supplied to the MPEG-4 encoder. The transcoding device according to the invention can be provided in a media gateway server and the like for transmitting bit streams to a reception unit.

Hereinafter, a transcoding method performed by the transcoding device according to the invention will be mainly described. Configurations and operations of the transcoding device according to the invention can be easily understood by those skilled in the art through the following description.

Now, a transcoding method employing conversion between block types in a pixel domain and adjustment of motion vectors at the time of conversion of H.264 BP
(Baseline Profile) into MPEG-4 SP (Simple Profile) will be described with reference to Fig. 1 and Figs. 2A to 2E. Then, the configuration of the transcoding device will be described with reference to Fig. 3 and a specific transcoding method will be then described with reference to Fig. 4. Results of a test of transcoding the H.264 BP into the MPEG-4 SP by the use of a pixel-domain transcoding method will be described with reference to Figs. 5A to 5D. Finally, a method of rapidly performing a transcoding process using the conversion between block types and the adjustment of motion vectors through the use of a statistical technique will be described with reference to Figs. 6A to 6D.

Procedure of Image Down-sampling Transcoding

An image down-sampling method using an average filter as an image down-sampling method according to an exemplary embodiment of the invention is shown in Fig. 1.

For example, when a four-MB (Macro Block) type is converted into a one-MB type, a source image conventionally undergoes two image conversion processes in the course of converting an image having a CIF (Common Intermediate Format) size, which has passed through the H.264 (SP) encoder, into an image having a QCIF (Quarter Common Intermediate Format) size, thereby causing deterioration in image quality.

However, according to an embodiment of the invention, four 16×16 macro blocks in a CIF image decompressed by the H.264 decoder are down-sampled into one 16×16 macro block, which is a QCIF image, to be encoded by the MPEG-4 encoder. According to the invention, among a method of sampling one pixel value among four pixel values by the use of the average filter and a sub-sampling method of selecting only one pixel value among four pixel values, the method of down-sampling an image by the use of the average filter is used to down-sample the CIF image into the QCIF image. When an image is down-sampled using the sub-sampling method, it is slightly
advantageous in view of temporal complexity, but deterioration in image quality occurs remarkably. Accordingly, the method of down-sampling by the use of the average filter is used. The invention uses the transcoding method in the pixel domain, instead of the transcoding method in the DCT domain having low complexity of calculation.

Since an H.264 non-linear loop filter is used in the transcoding method in the DCT domain, a loop-filtered image should be subjected again to the DCT process and then the transcoding process in the DCT domain and a conversion relation between a 4×4 integer DCT and an 8×8 DCT should be derived. Accordingly, the amount of calculation increases.

H.264 uses 1/4 pixel motion estimation and motion compensation, seven variable blocks (for example, inter 16×16, inter 16×8, inter 8×16, inter 8×8, inter 8×4, inter 4×8, and inter 4×4), and ten block modes (for example, skip, intra 16×16, intra 4×4, inter 16×16, inter 16×8, inter 8×16, inter 8×8, inter 8×4, inter 4×8, and inter 4×4). However, since MPEG-4 supports an intra 16×16 mode, an inter 16×16 mode, an inter 8×8 mode, and a skip mode, conversion between block types is performed to reuse such data in MPEG-4 in the invention.

A method of converting four macro block modes and motion vectors in H.264 into a macro block mode and motion vectors in MPEG-4 according to an exemplary embodiment of the invention is shown in Figs. 2A to 2E.

Now, a transcoding method using the conversion between block types and the adjustment of motion vectors in the pixel domain at the time of conversion of H.264 BP into MPEG-4 SP will be described with reference to a variety of embodiments of converting 2×2 macro blocks of the decompressed H.264 bit stream into one macro block which can be reused in MPEG-4.

In Fig. 2A, the skip mode in H.264 indicates a pre-processing step for converting 2×2 macro blocks in H.264 into one macro block in MPEG-4 and serves to convert the macro blocks with the inter 16×16 mode in H.264.
As in Fig. 2B, when the 2×2 macro blocks in H.264 includes only macro blocks having the intra 16×16 mode or the intra 4×4 mode, the 2×2 macro blocks is converted into one macro block having the intra 16×16 mode and an image is down-sampled by the use of the average filter.

As in Fig. 2C, when two or three macro blocks among the 2×2 macro blocks in H.264 are intra mode macro blocks, it is not clear which mode among the inter 16×16 mode, the inter 8×8 mode, and the intra 16×16 mode the MPEG-4 encoder should use.

In this case, as in the related art, when the conversion is performed with any specific mode (the inter 16×16 mode, the inter 8×8 mode, or the intra 16×16 mode) in MPEG-4, the image quality deteriorates and the amount of encoded bits increases.

Accordingly, in the invention, a block mode having the least SAD (Sum of Absolute Difference) value is selected by comparing the SAD value of the macro block with the inter 16×16 mode with the sum of the SAD values of four macro blocks in the inter 8×8 mode in the MPEG-4 encoder. Subsequently, by comparing the SAD value of the selected inter mode with the SAD value of the intra mode calculated by Expression 1 and Expression 2 described below, the block mode having the least SAD value is finally selected.

Expression 1

\[ MB_{mean} = \sum_{i=0}^{15} \sum_{j=0}^{15} |o_{g_{i,j}} - MB_{mean}| \]

Expression 2

\[ SAD_{INTRA} = \sum_{i=0}^{15} \sum_{j=0}^{15} |o_{g_{i,j}} - MB_{mean}| \]

Here, \( o_{g_{i,j}} \) denotes pixel values of 16×16 pixels in a macro block and \( MB_{mean} \) denotes a mean value of the pixel values in the macro block. By performing the conversion with the optimal mode, the requirement for image quality and the requirement for the amount of encoded bits can both be satisfied.
As in Fig. 2D, when the 2×2 macro blocks in H.264 include four or three macro blocks in the inter 16×16 mode, the MPEG-4 encoder performs the conversion with the inter 16×16 mode. Conventionally, when four or three macro blocks in the inter 16×16 mode are included in the 2×2 macro blocks in H.264, the MPEG-4 encoder can perform the conversion with the inter 16×16 mode or the inter 8×8. However, in the invention, the conversion is performed with the inter 16×16 mode, not the inter 8×8 mode. By first acquiring the averages of 1/4 pixel motion vectors of the respective 2×2 macro blocks as integer pixel motion vectors of the four macro blocks in the 8×8 mode in MPEG-4 and then acquiring the average of the acquired integer pixel motion vectors as a motion vector of one macro block in the inter 16×16 mode, the mode conversion is performed. A specific equation for acquiring the integer pixel motion vectors is expressed as Expression 3 described below.

Expression 3

\[
MV_{i,j} = \left( \frac{\sum_{k=0}^{3} \sum_{l=0}^{3} mv_{m,k,l,j}}{\sum_{k=0}^{3} \sum_{l=0}^{3} l} \right) \gg 2, \quad i, j = 0, 1
\]

Here, m and n denote coordinate values in the axis of abscissa and the axis of ordinate in the 8×8 mode block which is an intermediate macro block and k and l denote coordinate values in the axis of abscissa and the axis of ordinate in the 8×8 mode block which is the (m,n)-th macro block in the 2×2 macro blocks.

The reason for performing the conversion with the inter 16×16 mode instead of the inter 8×8 mode is as follows. It is supposed that a quantization parameter is set to 10 with respect to a foreman image at the time of transcoding from H.264 to MPEG-4 and all the conditions are set to the same for all the conversions. Then, when the conversion is performed with the inter 8×8 mode under the condition shown in Fig. 2D, the PSNR is enhanced by 0.08dB from 31.61dB to 31.69dB in comparison with the conversion with the inter 16×16 mode. However, since the amount of encoded bits
increases from 143.2 kps to 156.8 kps, the whole encoding efficiency decreases.

Referring to Fig. 2E, when the 2×2 macro blocks has complex block modes, that is, one or more macro blocks in the inter 8×8 mode, one or less macro block in the intra mode, and macro blocks in other inter modes, the respective macro blocks of the 2×2 macro blocks are converted into the macro blocks in the inter 8×8 mode in MPEG-4. The integer pixel motion vectors of the macro blocks in the inter 8×8 mode in MPEG-4 are acquired by calculating the average of the 1/4 pixel motion vectors of sixteen blocks in the 4×4 mode and dividing the average by 4. The calculating equation is equal to Expression 3.

Fig. 3 is a block diagram illustrating a configuration of a transcoding device according to an exemplary embodiment of the invention.

Referring to Fig. 3, the transcoding device 300 according to the invention includes a first conversion unit 310, a second conversion unit 320, and a motion vector adjusting unit 330.

When the number of intra macro blocks included in a first macro block satisfies a first condition, the first conversion unit 310 determines a block mode of a second macro block and converts the first macro block into the second macro block with the determined block mode. For example, the first conversion unit 310 converts the intra macro blocks into one intra macro block (see Fig. 2B) when the first macro block includes only the intra macro blocks and determines the block mode by the use of the SAD comparison method of a macro block (see Fig. 2C) when the first macro block includes some intra macro blocks.

When the number of inter macro blocks included in the first macro block satisfies a second condition, the second conversion unit 320 determines the block mode of the second macro block and converts the first macro block into the second macro block with the determined block mode. For example, the second conversion unit 320 converts the first macro block into the second macro block with the inter mode when the
number of inter macro blocks is greater than or equal to a predetermined number or when a difference value between the motion vectors is calculated and the difference value is less than or equal to a predetermined value, and determines the block mode by the use of the SAD comparison method of macro blocks and converts the first block into the second block with the determined block mode in the other cases. More specific functions will be described in detail with reference to Fig. 4.

The motion vector adjusting unit 330 re-adjusts the motion vectors of the second macro block.

Fig. 4 is a flow diagram illustrating a procedure of performing the transcoding of 2×2 macro blocks from H.264 to MPEG-4.

As shown in Fig. 4, when the 2×2 macro blocks in H.264 are input (S410), the 2×2 MB type in H.264 is converted into a 1×1 MB type in accordance with the conditions (S420) and then the down-sampling is performed by the use of the average filter (S430).

Thereafter, a block mode in MPEG-4 is determined.

In S425, when the number of intra macro blocks included in the 2×2 macro blocks in H.264 is greater than 2, it is determined in S430 whether the number of macro blocks is 4. When the number of macro blocks is not 4, the conversion with an intra mode is performed in S435 and in the other case, S455 is performed.

On the other hand, when it is determined in S425 that the number of intra macro blocks included in the 2×2 macro blocks in H.264 is less than or equal to 2, S440 is performed. When it is determined in S440 that the number of macro blocks in the inter 16×16 mode included in the 2×2 macro blocks in H.264 is greater than 2 (for example, when the number is 4 or 3), the conversion with the inter 16×16 mode is performed in S445. On the contrary, when it is determined in S440 that the number of macro blocks in the inter 16×16 included in the 2×2 macro blocks in H.264 is less than or equal to 2, the difference values between all the integer pixel motion vectors are
compared with a predetermined threshold value (for example, 4) in S450.

When the difference values are greater than or equal to the threshold value, the MB mode is determined by the use of the SAD process in S455. However, when the difference values are less than the threshold value, the conversion with the inter 16×16 mode is performed in S445.

Here, the reason for performing the conversion with the inter 16×16 mode instead of the inter 8×8 mode as the block mode to be used in the MPEG-4 encoder, like the inter 8×8 mode, the inter 8×4 mode, and the inter 4×4 mode in the H.264, is that the encoding and the image down-sampling in H.264 are a kind of low pass filtering (LPF).

Thereafter, the determination of the macro block mode is finished in S460 and then the conversion of a macro block is started in S415.

In this way, when the determination of the block mode is finished, the re-adjustment of a motion vector is performed in S470. That is, by searching for an integer pixel motion vector in ±3 neighboring pixels about a calculated integer pixel motion vector and searching for a half pixel motion vector in ±1 neighboring pixels about the searched integer pixel motion vector, the re-adjustment of a motion vector is performed, thereby obtaining enhancement in PSNR (Peak Signal-to-Noise Ratio).

Figs. 5A to 5D are graphs illustrating results of a test of transcoding the H.264 BP to the MPEG-4 SP by the using the pixel-domain transcoding method according to an exemplary embodiment of the invention.

The test was performed using a transcoder including a JM (Joint Model) decoder reconstructed with the H.264 BP and a MoMuSys-FDIS-V1.0 encoder reconstructed with the MPEG-4 SP. The test was performed with a Pentium IV 2.8 GHz PC. H.264 bit streams generated by compressing Foreman, News, Paris, and Coast CIF (352×288) images was used in the JM encoder. In the respective images used for generation of the bit streams, an I (Intra) frame was used for only the first frame, a P (Predictive) frame was used for all the other frames, and 300 sequences were
compressed for the test with a frame rate of 30 Hz.

Figs. 5A to 5B show PSNR differences in brightness values Y between the cascaded pixel-domain transcoding method according to the related art (510, 520, 530, and 540) and the image down-sampling transcoding method according to the invention (515, 525, 535, and 545) at the time of conversion of Coast, Paris, News, and Foreman image sequences from H.264 to MPEG-4. Here, all the motion images other than the Foreman image of Fig. 5D having the scene change do not exhibit deterioration in image quality and the enhancement in image quality by 0.5dB in maximum is obtained in the Coast image of Fig. 5A.

Table 1 shows temporal gains in the transcoding method according to the invention. The speed-up effect of about 1.72 times is obtained averagely, slightly different depending upon the images. Considering only the MPEG-4 encoder, the speed-up effect of about 4.1 times is obtained.

<table>
<thead>
<tr>
<th>Sequence</th>
<th>Cascade Pixel-domain Transcoding</th>
<th>Proposed Transcoding</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>H.264 decoder time</td>
<td>MPEG-4 encoder time</td>
</tr>
<tr>
<td>News</td>
<td>34.14</td>
<td>52.23</td>
</tr>
<tr>
<td>Paris</td>
<td>37.2</td>
<td>52.18</td>
</tr>
<tr>
<td>Coast</td>
<td>51.48</td>
<td>53.54</td>
</tr>
<tr>
<td>Foreman</td>
<td>49.54</td>
<td>53.49</td>
</tr>
</tbody>
</table>

As described above, the information conversion method for reusing block information defined in H.264 is provided. By reusing the previous motion vectors and the block information in H.264, enhancement in performance of about 1.8 times is obtained and the deterioration in image quality little occurs, in comparison with the
conventional cascaded pixel-domain transcoding method requiring much time.

Hitherto, the method of converting the H.264 BP into the MPEG-4 SP according to the invention has been described. In converting the block mode defined in H.264 into the block mode defined in MPEG-4, all the block modes defined in MPEG-4 are considered.

However, from the point of statistical view, only the least MPEG-4 block modes can be used by considering the features of the 2×2 macro blocks in H.264 in converting the 2×2 macro blocks in H.264 into a 1×1 macro block. Accordingly, it is possible to rapidly perform the transcoding without the deterioration of image quality.

Table 2 statistically shows conversion frequencies to the MPEG-4 block modes in consideration of the features of the 2×2 macro blocks in H.264. Figs. 6A to 6D show a conversion process of macro blocks and motion vectors in consideration of the statistical method.

<table>
<thead>
<tr>
<th>Table 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>MB modes of MPEG-4</td>
</tr>
<tr>
<td>2×2 MB modes of H.264</td>
</tr>
<tr>
<td>two Inter 16×16, two blocks smaller than Inter 16×8 or Inter 8×16</td>
</tr>
<tr>
<td>one Inter 16×16, three blocks smaller than Inter 16×8 or Inter 8×16</td>
</tr>
<tr>
<td>INTRA</td>
</tr>
<tr>
<td>0.20%</td>
</tr>
<tr>
<td>0.22%</td>
</tr>
<tr>
<td>Description</td>
</tr>
<tr>
<td>-------------</td>
</tr>
<tr>
<td>four blocks smaller than Inter 16×8 or Inter 8×16</td>
</tr>
<tr>
<td>four Inter 16×16</td>
</tr>
<tr>
<td>three Inter 16×16, one block smaller than Inter 8×8 or Inter 8×16</td>
</tr>
<tr>
<td>one Intra, three Inter</td>
</tr>
<tr>
<td>two Intra, two Inter</td>
</tr>
<tr>
<td>three Intra, one Inter</td>
</tr>
<tr>
<td>four Intra</td>
</tr>
<tr>
<td>Total Number</td>
</tr>
</tbody>
</table>

As can be seen from Table 2 and Fig. 6, in the transcoding method according to the invention, only the MPEG-4 block modes having a relatively high frequency at the time of converting the macro blocks having a predetermined size from H.264 to MPEG-4 can be considered. At this time, the features of the 2×2 macro blocks in H.264 can be used.

For example, when the 2×2 macro blocks in H.264 include two macro blocks in the inter 16×16 mode and the other two macro blocks have a smaller mode than the inter 16×8 mode or the inter 8×16 mode, only the inter 16×16 mode, the skip mode, or the inter 8×8 mode in MPEG-4 can be considered for the conversion as shown in Fig. 6A.
It can be seen from Table 2 that the corresponding block modes have relatively high frequencies. As described above, it can be determined as follows whether one of the inter 16×16 mode and the skip mode in MPEG-4 should be selected or the inter 8×8 mode should be selected. That is, it can be primarily determined on the basis whether the difference values between the 1/4 pixel motion vectors is less than a threshold value (for example, 9).

When the 2×2 macro blocks in H.264 include three or more intra macro blocks, the MPEG-4 block mode having the highest conversion frequency in Table 2 is the inter 8×8 block mode. However, since the very low value in frequency (that is, 0.14% or 0.16%) can be neglected, the intra block mode can be determined as the MPEG-4 block mode as shown in Fig. 6D.

According to the invention described above, it is possible to provide the image down-sampling transcoding method and device which can reduce the complexity while maintaining the image quality by re-using the information on the macro blocks.

In addition, the transcoder for converting a macro block from H.264 to MPEG-4 can permit the use of images compressed in accordance with H.264, which is a new standard for compressing a moving picture, without replacing devices employing an existing MPEG-4 codec.

Although the exemplary embodiments of the present invention have been described, the present invention is not limited to the embodiments, but it can be understood by those skilled in the art that the invention may be modified in various forms without departing from the spirit and scope of the appended claims.
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WHAT IS CLAIMED IS:

1. An image down-sampling transcoding method for converting a first macro block having a first format into a second macro block having a second format, the image down-sampling transcoding method comprising:

   (a) determining a block mode of the second macro block having a C×D size (where C and D are natural numbers) and converting the first macro block into the second macro block with the determined block mode, when the number of intra macro blocks included in the first macro block having a A×B size (where A and B are natural numbers) satisfies a first condition;

   (b) determining a block mode of the second macro block and converting the first macro block into the second macro block with the determined block mode, when the number for inter macro blocks included in the first macro block satisfies a second condition; and

   (c) re-adjusting a motion vector of the second macro block, after the conversion of the first macro block into the second macro block is finished.

2. The image down-sampling transcoding method according to claim 1, wherein the first macro block is converted into the second macro block with the determined block mode while being down-sampled by the use of an average filter.

3. The image down-sampling transcoding method according to claim 1, wherein (a) includes converting the first macro block into one intra macro block, when the first macro block includes only the intra macro blocks.

4. The image down-sampling transcoding method according to claim 1, wherein (a) includes determining the block mode by the use of an SAD comparison
method for macro blocks, when the first macro block includes some intra macro blocks.

5. The image down-sampling transcoding method according to claim 1, wherein (b) includes:

converting the first macro block into the second macro block with the inter mode when the number of inter macro blocks is greater than or equal to a predetermined number or when a difference value between the motion vectors is calculated and the difference value is less than or equal to a predetermined value; and
determining the block mode by the use of an SAD comparison method of macro blocks and converting the first block into the second block with the determined block mode in the other cases.

6. The image down-sampling transcoding method according to claim 4 or 5, wherein the SAD comparison method includes:

calculating SADs between two inter macro blocks and determining the least inter SAD; and

converting the first macro block into the second macro block with the block mode corresponding to the least SAD by comparing the least inter SAD with the predetermined intra SAD.

7. The image down-sampling transcoding method according to claim 6, wherein a mean pixel value of a macro block is calculated by the following expression:

\[ MB_{\text{mean}} = \sum_{i=0}^{15} \sum_{j=0}^{15} \text{org}_{i,j} \]

where \( \text{org}_{i,j} \) denotes pixel values of 16×16 pixels in a macro block and \( MB_{\text{mean}} \) denotes the mean pixel value of a macro block, and

wherein the intra SAD is calculated by the following expression.

\[ SAD_{\text{INTRA}} = \sum_{i=0}^{15} \sum_{j=0}^{15} |\text{org}_{i,j} - MB_{\text{mean}}| \]
8. The image down-sampling transcoding method according to claim 1, wherein the re-adjustment of the motion vector is performed by the use of the following expression:

\[
MV_{i,j} = \left( \frac{\sum_{k=0}^{3} \sum_{l=0}^{3} mv_{m,n,k,l}}{\sum_{k=0}^{3} \sum_{l=0}^{3} l} \right) >> 2, \quad i, j = 0,1
\]

where \( m \) and \( n \) denote coordinate values in the axis of abscissa and the axis of ordinate in an \( 8 \times 8 \) mode block which is an intermediate macro block and \( k \) and \( l \) denote coordinate values in the axis of abscissa and the axis of ordinate in a \( 4 \times 4 \) mode block corresponding to the \((m,n)\)-th macro block in \( 2 \times 2 \) macro blocks.

9. The image down-sampling transcoding method according to claim 1, wherein (c) includes:

- searching for an integer pixel motion vector in \( \pm 3 \) neighboring pixels about an integer pixel motion vector, and

- searching for a half pixel motion vector in \( \pm 1 \) neighboring pixels about the searched integer pixel motion vector.

10. An image down-sampling transcoding method for converting a first macro block having a first format into a second macro block having a second format, the image down-sampling transcoding method comprising:

- determining any one of candidate block modes having the second format, which is determined in accordance with a predetermined condition by types of macro blocks included in the first macro block having a predetermined size, as a block mode of the second macro block and converting the first macro block into the second macro block with the determined block mode; and
re-adjusting a motion vector of the second macro block, after the conversion of
the first macro block into the second macro block is finished.

11. The image down-sampling transcoding method according to claim 10,
wherein the predetermined condition is that one intra macro block having the second
format is determined as the block mode when three or more intra macro blocks are
included in the first macro block.

12. The image down-sampling transcoding method according to claim 10,
wherein the predetermined condition is that any one of the candidate block modes is
determined as the block mode by the use of a SAD comparison method of macro blocks
included in the first macro block, when two or less intra macro blocks are included in
the first macro block, and

wherein the candidate block modes include one or more of a skip mode, an inter
16×16 mode, and an inter 8×8 mode.

13. The image down-sampling transcoding method according to claim 10,
wherein the predetermined condition is that any one of the candidate block modes is
determined as the block mode by the use of a SAD comparison method of macro blocks,
when only inter macro blocks are included in the first macro block and two or less
macro blocks in the inter 16×16 mode are included in the inter macro blocks, and

wherein the candidate block modes include one or more of a skip mode, an inter
16×16 mode, and an inter 8×8 mode.

14. The image down-sampling transcoding method according to claim 12
or 13, wherein when a difference between the motion vectors in the respective macro
blocks is calculated and the difference is less than or equal to a predetermined threshold

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value, any one of the inter 16×16 mode and the skip mode is determined as the block mode and in the other cases, the inter 8×8 mode is determined as the block mode.

15. The image down-sampling transcoding method according to claim 12 or 13, wherein any one of the candidate block modes is a block mode having the least SAD value.

16. The image down-sampling transcoding method according to claim 12, wherein a mean pixel value of a macro block is calculated by the following expression:

\[ MB_{\text{mean}} = \sum_{i=0}^{15} \sum_{j=0}^{15} \text{org}_{i,j} \]

where \( \text{org}_{i,j} \) denotes pixel values of 16×16 pixels in a macro block and \( MB_{\text{mean}} \) denotes the mean pixel value of a macro block, and

wherein the intra SAD is calculated by the following expression.

\[ SAD_{\text{INTRA}} = \sum_{i=0}^{15} \sum_{j=0}^{15} |\text{org}_{i,j} - MB_{\text{mean}}| \]

17. The image down-sampling transcoding method according to claim 10, wherein the re-adjustment of the motion vector is performed by the use of the following expression:

\[ MV_{i,j} = \left( \sum_{k=0}^{3} \sum_{l=0}^{3} MV_{m,n,k,l} \right) \quad >> 2, \quad i, j = 0,1 \]

where \( m \) and \( n \) denote coordinate values in the axis of abscissa and the axis of ordinate in an 8×8 mode block which is an intermediate macro block and \( k \) and \( l \) denote coordinate values in the axis of abscissa and the axis of ordinate in a 4×4 mode block corresponding to the \((m,n)\)-th macro block in 2×2 macro blocks.

18. An image down-sampling transcoding device for converting a first
macro block having a first format into a second macro block having a second format, the image down-sampling transcoding device comprising:

a first conversion unit determining a block mode of the second macro block and converting the first macro block into the second macro block with the determined block mode, when the number of intra macro blocks included in the first macro block satisfies a first condition;

a second conversion unit determining a block mode of the second macro block and converting the first macro block into the second macro block with the determined block mode, when the number for inter macro blocks included in the first macro block satisfies a second condition; and

a motion vector re-adjusting unit re-adjusting a motion vector of the second macro block, after the conversion of the first macro block into the second macro block is finished.

19. The image down-sampling transcoding device according to claim 18, wherein the first conversion unit:

converts the first macro block into one intra macro block, when the first macro block includes only the intra macro blocks; and

determines the block mode by the use of an SAD comparison method for macro blocks, when the first macro block includes some intra macro blocks.

20. The image down-sampling transcoding device according to claim 18, wherein the second conversion unit:

converts the first macro block into the second macro block with the inter mode, when the number of inter macro blocks is greater than or equal to a predetermined number or when a difference value between the motion vectors is calculated and the difference value is less than or equal to a predetermined value; and

27
determines the block mode by the use of an SAD comparison method of macro blocks and converts the first block into the second block with the determined block mode in the other cases.

21. The image down-sampling transcoding device according to claim 20, wherein the SAD comparison method includes:

- calculating SADs between two inter macro blocks and determining the least inter SAD; and
- converting the first macro block into the second macro block with the block mode corresponding to the least SAD by comparing the least inter SAD with the predetermined intra SAD.

22. An image down-sampling transcoding device for converting a first macro block having a first format into a second macro block having a second format, the image down-sampling transcoding device comprising:

- a conversion unit determining any one of candidate block modes having the second format, which is determined in accordance with a predetermined condition by types of macro blocks included in the first macro block having a predetermined size, as a block mode of the second macro block and converting the first macro block into the second macro block with the determined block mode; and
- a motion vector re-adjusting unit re-adjusting a motion vector of the second macro block, after the conversion of the first macro block into the second macro block is finished.

23. The image down-sampling transcoding device according to claim 22, wherein the predetermined condition is that one intra macro block having the second format is determined as the block mode when three or more intra macro blocks are
included in the first macro block.

24. The image down-sampling transcoding device according to claim 22, wherein the predetermined condition is that any one of the candidate block modes is determined as the block mode by the use of a SAD comparison method of macro blocks included in the first macro block, when two or less intra macro blocks are included in the first macro block, and

wherein the candidate block modes include one or more of a skip mode, an inter 16×16 mode, and an inter 8×8 mode.

25. The image down-sampling transcoding device according to claim 22, wherein the predetermined condition is that any one of the candidate block modes is determined as the block mode by the use of a SAD comparison method of macro blocks, when only inter macro blocks are included in the first macro block and two or less macro blocks in the inter 16×16 mode are included in the inter macro blocks, and

wherein the candidate block modes include one or more of a skip mode, an inter 16×16 mode, and an inter 8×8 mode.

26. The image down-sampling transcoding device according to claim 24 or 25, wherein the conversion unit calculates a difference between the motion vectors in the respective macro blocks, determines any one of the inter 16×16 mode and the skip mode as the block mode when the difference is less than or equal to a predetermined threshold value, and in the other cases, determines the inter 8×8 mode as the block mode.

27. The image down-sampling transcoding device according to claim 24, wherein a mean pixel value of a macro block is calculated by the following expression:
\[
MB_{\text{mean}} = \sum_{i=0}^{15} \sum_{j=0}^{15} \text{org}_{i,j},
\]

where \( \text{org}_{i,j} \) denotes pixel values of 16\times16 pixels in a macro block and \( MB_{\text{mean}} \) denotes the mean pixel value of a macro block, and

wherein the intra SAD is calculated by the following expression.

\[
SAD_{\text{INTRA}} = \sum_{i=0}^{15} \sum_{j=0}^{15} | \text{org}_{i,j} - MB_{\text{mean}} |
\]

28. The image down-sampling transcoding device according to claim 22, wherein the re-adjustment of the motion vector is performed by the use of the following expression:

\[
MV_{i,j} = \left( \frac{\sum_{k=0}^{1} \sum_{l=0}^{1} MV_{m,n,k,l}}{\sum_{k=0}^{1} \sum_{l=0}^{1} l} \right) \gg 2, \quad i, j = 0, 1
\]

where \( m \) and \( n \) denote coordinate values in the axis of abscissa and the axis of ordinate in an 8\times8 mode block which is an intermediate macro block and \( k \) and \( l \) denote coordinate values in the axis of abscissa and the axis of ordinate in a 4\times4 mode block corresponding to the \((m,n)\)-th macro block in 2\times2 macro blocks.
ABSTRACT OF DISCLOSURE

Provided are method and device for down-sampling an image from H.264 to MPEG-4 at a high speed. The image down-sampling transcoding method for converting a first macro block having a first format into a second macro block having a second format includes: (a) determining a block mode of the second macro block and converting the first macro block into the second macro block with the determined block mode, when the number of intra macro blocks included in the first macro block satisfies a first condition; (b) determining a block mode of the second macro block and converting the first macro block into the second macro block with the determined block mode, when the number for inter macro blocks included in the first macro block satisfies a second condition; and (c) re-adjusting a motion vector of the second macro block, after the conversion of the first macro block into the second macro block is finished.
FIG. 2A

Skip mode MB conversion in H.264

Inter 16x16 MB in H.264

FIG. 2B

2x2 MB in H.264

4x4 Intra or 16x16 Intra
4x4 Intra or 16x16 Intra

Intra block conversion

One MB in MPEG-4
**FIG. 2E**

![Diagram showing block conversion and motion vectors (MV) for 2x2 blocks in H.264 and decision process for Ultimately motion estimation in MPEG-4.](image)
300

- FIRST CONVERSION UNIT 310
- SECOND CONVERSION UNIT 320
- MOTION VECTOR RE-ADJUSTING UNIT 330
2x2 MB information in H.264 decoder (MB type, MV) S410

MB type conversion
Each MB information in 2x2 MB in H.264 S415

Down-sampling using the average filter S420

The # of Intra MB in 2x2 MB > 2 S425

No

Yes S430

The # of Intra MB in 2x2 MB = 4 S435

No

Intra S440

Yes S445

Each value of MV difference < Threshold(4) S450

No

Calculate SAD S455

Yes

INTER 16x16

End of 2x2 MB in H.264 S460

Motion of vector REFINEMENT S470
FIG. 5B

Paris(CIF ⇒ QCIF, 30hz)

PSNR (dB)

Bitrate (kbit/s)

- - - Cascade
- - - - Proposed
FIG. 5C

Press (CIF -> QCIF, 30hz)

PSNR (dB)

Bitrate (kbit/s)

Cascade
Proposed
FIG. 6A

16

16

8

8

8

8

2x2 MB in H.264

Intermediate MB

\[ u_{m16,8}, u_{m16,16} \]

\[ u_{m8,16}, u_{m8,8} \]

| Interblock conversion |

\[ \text{Calculate each difference of } u_{m8} \]

\[ \text{when } | \text{Each Difference of } u_{m8} | < 9 \]

\[ \text{otherwise} \]

Inter16x16

or

SKIP

One MB in MPEG-4
13/15
FIG. 68

2x2 MB in H.264

One MB in MPEG-4
FIG. 6C

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2x2 MB in IE.264

Intermediate MB

inter16×16

Calculates good difference before mb.

when [Each Difference of /m1/ < /y/]

otherwise

inter8×8

One MB in MPEG-4
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<td>Intra16×16 or Intra4×4</td>
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</table>
| 2x2 MB in H.264 | One MB in MPEG-4 

**FIG. 6D**
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.

FULL NAME OF INVENTOR(S)

<table>
<thead>
<tr>
<th>Inventor one:</th>
<th>Yung-Lyul LEE</th>
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<tr>
<td>Signature:</td>
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<th>Inventor two:</th>
<th>Euee-S. JANG</th>
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<th>Inventor three:</th>
<th>Chung-Ku LEE</th>
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| Inventor four: | |
|----------------||
| Signature:     | Citizen of: |

[ ] Additional inventors are being named on additional form(s) attached hereto.
Application Data Sheet

Application Information
Application Type:: Regular
Subject Matter:: Utility
Title:: Image Down-Sampling Transcoding Method And Device
Attorney Docket Number:: 076980.0104
Request for Early Publication?:: No
Request for Non-Publication?:: No
Suggested Drawing Figure:: 1
Total Drawing Sheets:: 15
Small Entity:: No

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Representative Information
Domestic Priority Information
Foreign Priority Information

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**PTO/SB/06 (12-04)**
Approved for use through 7/31/2006. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

**PATENT APPLICATION FEE DETERMINATION RECORD**
Substitute for Form PTO-875

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**APPLICATION AS AMENDED — PART II**

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**AMENDMENT B**

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* 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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