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
<table>
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<th>APPLICATION NUMBER</th>
<th>FILING OR 371(C) DATE</th>
<th>FIRST NAMED APPLICANT</th>
<th>ATTY. DOCKET NO./TITLE</th>
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<td>11/289,650</td>
<td>11/30/2005</td>
<td>Yung-Lyul Lee</td>
<td>076980.0102</td>
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**POWER OF ATTORNEY NOTICE**

CONFIRMATION NO. 5922

Date Mailed: 09/12/2014

**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- The Power of Attorney to you in this application has been revoked by the assignee who has intervened as provided by 37 CFR 3.71.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).

/ytdebbie/

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

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

I hereby appoint:

☑ Practitioners associated with the Customer Number: 02292

☐ OR

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

<table>
<thead>
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</table>

as attorney(s) or agent(s) to represent the undersigned before the United States Patent and Trademark Office (USPTO) in connection with any and all patent applications assigned 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: 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/IBS/96 or equivalent) is required to be filed in each application in which this form is used. The statement under 37 CFR 3.73(b) may be completed by one of the practitioners appointed in this form if the appointed practitioner is authorized to act on behalf of the assignee, and must identify the application in which this Power of Attorney is to be filed.

SIGNATURE of Assignee of Record

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

Signature: [Signature]
Date: 29, May 2014
Name: Yongbin, LEE
Telephone: +82 31 776 5243
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 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.
**Electronic Acknowledgement Receipt**

| EFS ID: | 20077323 |
| Application Number: | 11289650 |
| International Application Number: |  |
| Confirmation Number: | 5922 |
| Title of Invention: | MOTION ESTIMATION AND COMPENSATION METHOD AND DEVICE ADAPTIVE TO CHANGE IN ILLUMINATION |
| First Named Inventor/Applicant Name: | Yung-Lyul Lee |
| Customer Number: | 24735 |
| Filer: | Esther Hyeri Chong/Jody Mazzarese |
| Filer Authorized By: | Esther Hyeri Chong |
| Attorney Docket Number: | 076980.0102 |
| Receipt Date: | 08-SEP-2014 |
| Filing Date: | 30-NOV-2005 |
| Time Stamp: | 17:09:50 |
| Application Type: | Utility under 35 USC 111(a) |

**Payment information:**

| Submitted with Payment | no |

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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.
TRANSMITTAL FORM

(to be used for all correspondence after initial filing)

Application Number: 11/289,650
Filing Date: November 30, 2005
First Named Inventor: Yung-Lyu Lee et al.
Art Unit: 2825
Examiner Name: D. Popovici
Attorney Docket Number: 5200-0126PUS1

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
  - Reply to Missing Parts under 37 CFR 1.52 or 1.53
- Drawing(s)
- Licensing-related Papers
- Petition
- Petition to Convert to a Provisional Application
- Power of Attorney, Revocation of Correspondence Address
- Terminal Disclaimer
- Request for Refund
- CD, Number of CD(s)
- Landscape Table on CD
- 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

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

Firm Name: Birch, Stewart, Kolasch & Birch, LLP
Signature: [Signature]
Printed name: Esther H. Chong
Date: SEP 08 2014
Reg. No.: 40953

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 data shown below:

Signature:
Typed or printed name: [Signature]
Date: [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.: 7,924,923 Filed/Issue Date: April 12, 2011
Titled: MOTION ESTIMATION AND COMPENSATION METHOD AND DEVICE ADAPTIVE TO CHANGE IN ILLUMINATION

HUMAX HOLDINGS CO., LTD. [Name of Assignee], a CORPORATION [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 0814, 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 03555 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: SEP 08 2014

Esther H. Chong, Reg. No. 40963
Printed or Typed Name: Attorney of Record: Title:

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.
APPLICATION NO. | ISSUE DATE | PATENT NO. | ATTORNEY DOCKET NO. | CONFIRMATION NO.
--- | --- | --- | --- | ---
11/289,650 | 04/12/2011 | 7924923 | 076980.0102 | 5922

2475 | 7590 | 03/23/2011

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 1471 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;
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 applicable. 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)

2473
7990
1206/2010

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

APPLICATION NO.
11/289,650

FILING DATE
11/30/2005

FIRST NAMED INVENTOR
Yung-lyul Lee

ATTORNEY DOCKET NO.
0769/0102

CONFIRMATION NO.
5922

TITLE OF INVENTION: MOTION ESTIMATION AND COMPENSATION METHOD AND DEVICE ADAPTIVE TO CHANGE IN ILLUMINATION

APPL. TYPE
nonprovisional

SMALL ENTITY
NO

ISSUE FEE DUE
$1510

PUBLICATION FEE DUE
$300

PREV. PAID ISSUE FEE
$0

TOTAL FEE(S) DUE
$1810

DATE DUE
03/07/2011

EXAMINER
PoPOVICI, DOV
2625

ART UNIT
375-240160

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 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 patent 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 an assignment.

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

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

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

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

4b. Payment of Fee(s): (Please first reapply any previously paid issue fee shown above)
   - A check is enclosed.
   - Payment by credit card. Form PTO-2088 is attached.
   - The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment, to Deposit Account Number 02-0375. (enclose an extra copy of this form).

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

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

Authorized Signature __/James B. Arpin/

Typed or printed name ____________________________________________
James B. Arpin

Date __/March 4, 2011/

Registration No. __/33,470/

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

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

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

OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE.
**Electronic Patent Application Fee Transmittal**

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

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<td><strong>Title of Invention:</strong></td>
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| **First Named Inventor/Applicant Name:** | Yung-Lyul Lee |
| **Customer Number:** | 24735 |
| **Filer:** | JAMES B ARPIN |
| **Filer Authorized By:** | |
| **Attorney Docket Number:** | 076980.0102 |
| **Receipt Date:** | 04-MAR-2011 |
| **Filing Date:** | 30-NOV-2005 |
| **Time Stamp:** | 17:43:50 |
| **Application Type:** | Utility under 35 USC 111(a) |

## Payment information:

| **Submitted with Payment:** | yes |
| **Payment Type:** | Deposit Account |
| **Payment was successfully received in RAM:** | $1816 |
| **RAM confirmation Number:** | 4240 |
| **Deposit Account:** | 020375 |
| **Authorized User:** | |

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**Total Files Size (in bytes):** 184929

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.
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 6, 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 4, 2011

By

James B. Arpin
Registration No. 33,470

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

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

Courtesy Reminder for Application Serial No: 11/289,650
Attorney Docket No: 076980.0102
Customer Number: 24735
Date of Electronic Notification: 12/06/2010

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

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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://sportal.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.
BAKER BOTTS LLP
C/O INTELLECTUAL PROPERTY DEPARTMENT
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Please verify that these email addresses are correct.

To view your correspondence online or update your email addresses, please visit us anytime at https://sportal.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.
BAKER BOTTLS LLP  
C/O INTELLCTUAL PROPERTY DEPARTMENT  
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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 12/06/2010

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.
11/289,650 11/30/2005 Yung-Lyul Lee 076980.0102 5922

TITLE OF INVENTION: MOTION ESTIMATION AND COMPENSATION METHOD AND DEVICE ADAPTIVE TO CHANGE IN ILLUMINATION

EXAMINER
POPOVICI, DOV

ART UNIT PAPER NUMBER
2625 DATE MAILED: 12/06/2010

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
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  12/06/2010
BAKER BOTTs LLP
C/O INTELLECTUAL PROPERTY DEPARTMENT
THE WARNER, SUITE 1300
1299 PENNSYLVANIA AVE, NW
WASHINGTON, DC 20004-2400

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

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

Depositor's name
(Signature)
(Date)

APPLICATION NO.  11/289,650
FILING DATE  11/30/2005
FIRST NAMED INVENTOR  Yung-Lyul Lee
ATTORNEY DOCKET NO.  076980.0102
CONFIRMATION NO.  5922

TITLE OF INVENTION: MOTION ESTIMATION AND COMPENSATION METHOD AND DEVICE ADAPTIVE TO CHANGE IN ILLUMINATION

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EXAMINER  POPOVICI, D.O.V. 2625
ART UNIT  375-240160
CLASS-SUBCLASS

1. Change of correspondence address or indication of “Fee Address” (37 CFR 1.363).
   ☑ Change of correspondence address (Change of Correspondence Address Form PTOSB/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,
      (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 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

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

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

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

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

Authorized Signature
Date

Typed or printed name
Registration No.

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

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

PTOL-85 (Rev. 08/07) Approved for use through 08/31/2010.  OMB 0931-0039  U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment to date is 1178 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 1178 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.
--- 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 amendments filed on 09/23/2010 and 11/24/2010.

2. ☒ The allowed claim(s) is/are 1, 3-6, 8-14, 16-21 and 23-25, renumbered as claims 1-21.

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 20101130
7. ☒ Examiner’s Amendment/Comment
8. ☐ Examiner’s Statement of Reasons for Allowance
9. ☐ Other ______.

/Dov Popovici/  
Primary Examiner, Art Unit 2625
Examiner-Initiated Interview Summary

Application No.  
11/289,650

Applicant(s)  
LEE ET AL.

Examiner  
Dov Popovici

Art Unit  
2625

All Participants:  
(1) Dov Popovici.
(2) James Arpin (Reg. No. 33,470).

Status of Application: Response to Non-Final

Date of Interview: 30 November 2010  
Time: 9:46 A.M.

Type of Interview:  
✓ Telephonic
☐ Video Conference
☐ Personal (Copy given to: ☐ Applicant ☐ Applicant’s representative)

Exhibit Shown or Demonstrated:  ☐ Yes ☒ No
If Yes, provide a brief description: .

Part I.

Rejection(s) discussed:
None

Claims discussed:
1, 4, 6, 9, 11, 17, 19 and 24

Prior art documents discussed:
None

Part II.

SUBSTANCE OF INTERVIEW DESCRIBING THE GENERAL NATURE OF WHAT WAS DISCUSSED:
See Continuation Sheet

Part III.

✓ It is not necessary for applicant to provide a separate record of the substance of the interview, since the interview directly resulted in the allowance of the application. The examiner will provide a written summary of the substance of the interview in the Notice of Allowability.

☐ It is not necessary for applicant to provide a separate record of the substance of the interview, since the interview did not result in resolution of all issues. A brief summary by the examiner appears in Part II above.

/Dov Popovici/  
Primary Examiner, Art Unit 2625

(Applicant/Applicant’s Representative Signature – if appropriate)
Continuation of Substance of Interview including description of the general nature of what was discussed: On 11/23/2010, an amendment was discussed and agreed to. Claims 1, 4, 6, 9, 11, 17, 19 and 24 are amended for clarity purpose and in order to overcome lack of antecedent basis issues. Applicant will file the amendment. On 11/30/2010, an examiner's amendment was discussed and agreed to.
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 B. Arpin (Reg. No. 33,470) on 11/30/2010.

The application has been amended as follows:

In the claims:

In claim 9, line 2, change “the least SAD” to --a least SAD--.

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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### NONE

(Primary Examiner)  
/Dov Popovici/  
Primary Examiner, Art Unit 2625  
(Date): 11/30/2010

### Total Claims Allowed:

21

O.G. Print Claim(s): 5  
O.G. Print Figure: 2A

U.S. Patent and Trademark Office  
Part of Paper No. 20101130
**Search Notes**

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/Dov Popovici/  
Primary Examiner, Art Unit 2625
SUPPLEMENTAL RESPONSIVE AMENDMENT UNDER 37 C.F.R. § 1.111(a)(2)

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

Sir:

In response to the Office Action, of which the U.S. Patent and Trademark Office ("PTO") notified Applicants on June 23, 2010, and supplementing Applicants’ Responsive Amendment filed on September 23, 2010, Applicants respectfully request that the Examiner reconsider the above-captioned patent application in view of the following:

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

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

Request for Reconsideration begins on page 11 of this paper.

Remarks and Conclusion begin on page 12 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:

Provided are a motion estimation device and method adaptive to change in illumination. The motion estimation method includes the steps of: generating a current frame pattern block and a reference frame pattern block for a reference frame block; calculating the sum of absolute differences (SAD) for candidate pattern blocks and determining the candidate pattern block corresponding to the SAD satisfying a predetermined condition among the calculated [[SADs]] SAD as a motion vector; encoding the current frame block, and adding flag information indicating the addition of a mean pixel value applied to the encoded current frame block and identification information on the encoding mode as header information corresponding to the encoded current frame block.
Amendments to the Claims:
This listing of claims will replace all prior versions and listings of the claims in the above-captioned patent application:

Claim 1. (Currently Amended) A motion estimation method adaptive to change in illumination, comprising the steps of:

(a) generating a current frame pattern block for a current frame block and a reference frame pattern block for a reference frame block;

(b) calculating the sum of absolute differences (SAD) for candidate pattern blocks corresponding to the current frame pattern block among [[the]] reference frame pattern blocks and determining [[the]] each candidate pattern block corresponding to the SAD satisfying a predetermined condition among the calculated [[SADs]] SAD as a motion vector;

(c) encoding the current frame block, by generating a residual signal using a difference signal between the candidate pattern block corresponding to the motion vector and the current frame pattern block then performing discrete cosine transform and quantization to the residual signal with a predetermined encoding mode; and

(d) adding flag information indicating the addition of a mean pixel value applied to the encoded current frame block and identification information on the encoding mode as header information corresponding to the encoded current frame block;

wherein the addition of a mean pixel value to be applied to the current frame block is identified by the flag information,

wherein step (a) includes the steps of:

calculating a mean brightness value of the current frame block and a mean brightness value of the reference frame block; and

generating the current frame pattern block by subtracting the mean brightness value of the current frame block from brightness values of the current frame block and generating the reference frame pattern blocks by subtracting the mean brightness value of the reference frame block from brightness values of the reference frame block.

Claim 2. (Canceled).
Claim 3. (Original) The motion estimation method according to claim 1, further comprising encoding the mean pixel value of the current frame block.

Claim 4. (Currently Amended) The motion estimation method according to claim 1, wherein the SAD satisfying the predetermined condition indicates [[the]] a least SAD and the SAD is calculated by the following equation:

\[
\text{NewSAD} (x, y) = \sum_{i=0}^{U-1} \sum_{j=0}^{V-1} \left[ |f(i, j) - M_{curr}| - |r(i + x, j + y) - M_{ref}| \right]
\]

where \( M_{curr} \) denotes the mean pixel value of the current frame block, \( M_{ref} \) denotes the mean pixel value of the candidate pattern blocks, \( f(i,j) \) denotes a pixel value at a coordinate \((i,j)\) of the current frame, \( r(i,j) \) denotes a pixel value of a coordinate \((i,j)\) of the reference frame, \( U \) and \( V \) denote the sizes of blocks used for matching the blocks, and \((x,y)\) denotes the motion vector.

Claim 5. (Original) The motion estimation method according to claim 1, wherein the residual signal is calculated by the following equation:

\[
\text{NewR} (i, j) = \left[ f(i, j) - M_{curr} \right] - \left[ r(i + MV_x, j + MV_y) - M_{ref} \right]
\]

\[
= f(i,j) - r(i + MV_x, j + MV_y) - M_{curr} + M_{ref}
\]

where \( \text{NewR} \) denotes the residual signal, \( M_{curr} \) denotes the mean pixel value of the current frame block, \( M_{ref} \) denotes the mean pixel value of the candidate pattern blocks, \( f(i,j) \) denotes a pixel value at a coordinate \((i,j)\) of the current frame, \( r(i,j) \) denotes a pixel value of a coordinate \((i,j)\) of the reference frame, \( U \) and \( V \) denote the sizes of blocks used for matching the blocks, and \((x,y)\) denotes the motion vector.

Claim 6. (Currently Amended) A motion estimation device comprising:

a pattern block generating unit generating a current frame pattern block of a current frame block and reference frame pattern blocks of a reference frame block;

a motion vector determining unit calculating the sum of absolute differences (SAD) of candidate pattern blocks corresponding to the current frame pattern block among the reference frame pattern blocks and determining [[the]] each candidate pattern block corresponding to the
SAD satisfying a predetermined condition among the calculated \([\text{SADs}]\) SAD as a motion vector;

a motion compensation unit generating a residual signal using a difference signal between the candidate pattern block corresponding to the motion vector and the current frame pattern block; and

an adding unit adding flag information indicating the addition of a mean pixel value applied to \([\text{the}]\) an encoded current frame block and identification information on \([\text{the}]\) an encoding mode as header information corresponding to the encoded current frame block;

wherein the addition of a mean pixel value to be applied to the current frame block is identified by the flag information,

wherein the pattern block generating unit:

calculates a mean brightness value of the current frame block and a mean brightness value of the reference frame block;

generates the current frame pattern block by subtracting the mean brightness value of the current frame block from brightness values of the current frame block; and

generates the reference frame pattern blocks by subtracting the mean brightness value of the reference frame block from brightness values of the reference frame block.

Claim 7. (Canceled).

Claim 8. (Original) The motion estimation device according to claim 6, further comprising a unit carrying out discrete cosine transform and quantization to the residual signal.

Claim 9. (Currently Amended) The motion estimation device according to claim 6, wherein the SAD satisfying the predetermined condition indicates the least SAD and the motion vector determining unit calculates the SAD with the following equation:

\[
\text{NewSAD} \ (x, y) = \sum_{i=0}^{U-1} \sum_{j=0}^{V-1} \left[ f(i, j) - M_{\text{curr}} \right] - \left[ r(i + x, j + y) - M_{\text{ref}} \right]
\]

where \(M_{\text{curr}}\) denotes the mean pixel value of the current frame block, \(M_{\text{ref}}\) denotes the mean pixel value of the candidate pattern blocks, \(f(i,j)\) denotes a pixel value at a coordinate (i,j) of the
current frame, \( r(i,j) \) denotes a pixel value of a coordinate \((i,j)\) of the reference frame, \( U \) and \( V \) denote the sizes of blocks used for matching the blocks, and \((x,y)\) denotes the motion vector.

Claim 10.  (Original)  The motion estimation device according to claim 6, wherein the motion compensation unit calculates the residual signal with the following equation:

\[
NewR (i, j) = [ f(i, j) - M_{curr} ] - [ r(i + MV_x, j + MV_y) - M_{ref} ]
\]

\[= f(i, j) - r(i + MV_x, j + MV_y) - M_{curr} + M_{ref}\]

where \( NewR \) denotes the residual signal, \( M_{curr} \) denotes the mean pixel value of the current frame block, \( M_{ref} \) denotes the mean pixel value of the candidate pattern blocks, \( f(i,j) \) denotes a pixel value at a coordinate \((i,j)\) of the current frame, \( r(i,j) \) denotes a pixel value of a coordinate \((i,j)\) of the reference frame, \( U \) and \( V \) denote the sizes of blocks used for matching the blocks, and \((x,y)\) denotes the motion vector.

Claim 11.  (Currently Amended) A motion estimation method comprising the steps of:

(a) generating a current frame pattern block for a current frame block and a reference frame pattern block for a reference frame block;

(b) calculating the sum of absolute differences ([[SADs]] SAD) for candidate pattern blocks corresponding to the current frame pattern block among [[the]] reference frame pattern blocks and determining [[the]] each candidate pattern block corresponding to the SAD satisfying a predetermined condition among the calculated [[SADs]] SAD as a motion vector;

(c) encoding the current frame block, by generating a residual signal using a difference signal between the candidate pattern block corresponding to the motion vector and the current frame pattern block then performing discrete cosine transform and quantization to the residual signal with a predetermined encoding mode; and

(d) adding flag information indicating whether a mean pixel value of the encoded current frame block is included and identification information on the encoding mode to the encoded current frame block as header information,

wherein whether the mean pixel value of the current frame block is included is identified by the flag information,

wherein step (a) includes the steps of:
calculating a mean brightness value of the current frame block and a mean brightness value of the reference frame block; and
generating the current frame pattern block by subtracting the mean brightness value of the current frame block from brightness values of the current frame block and generating the reference frame pattern blocks by subtracting the mean brightness value of the reference frame block from brightness values of the reference frame block.

Claim 12. (Original) The motion estimation method according to claim 11, wherein the current frame block is set to at least one type of 16×16, 16×8, 8×16, 8×8, 8×4, 4×8, and 4×4.

Claim 13. (Original) The motion estimation method according to claim 11, wherein when the flag information indicates that the mean pixel value is not included, a mean value of mean pixel values corresponding to n blocks surrounding the current frame block is used as the mean pixel value of the current frame block.

Claim 14. (Original) The motion estimation method according to claim 11, wherein when the flag information does not contain the mean pixel value and the header information further contains additional information indicating that the mean pixel value corresponding to any block among the blocks surrounding the current frame block should be used, a mean pixel value of the block corresponding to the additional information is used as the mean pixel value of the current frame block.

Claim 15. (Canceled).

Claim 16. (Original) The motion estimation method according to claim 11, further comprising the step of encoding the mean pixel value of the current frame block.

Claim 17. (Currently Amended) The motion estimation method according to claim 11, wherein the SAD satisfying the predetermined condition indicates [[the]] a least SAD and the SAD is calculated by the following equation:
\[ \text{NewSAD} \ (x, y) = \sum_{i=0}^{U-1} \sum_{j=0}^{V-1} \left| f(i, j) - M_{\text{curr}} \right| - \left| r(i + x, j + y) - M_{\text{ref}} \right| \]

where \( M_{\text{curr}} \) denotes the mean pixel value of the current frame block, \( M_{\text{ref}} \) denotes the mean pixel value of the candidate pattern blocks, \( f(i,j) \) denotes a pixel value at a coordinate \((i,j)\) of the current frame, \( r(i+x,j+y) \) denotes a pixel value of a coordinate \((i+x,j+y)\) of the reference frame, \( U \) and \( V \) denote the sizes of blocks used for matching the blocks, and \((x,y)\) denotes the motion vector.

Claim 18.  (Original) The motion estimation method according to claim 11, wherein the residual signal is calculated by the following equation:

\[ \text{NewR} \ (i, j) = \left[ f(i, j) - M_{\text{curr}} \right] - \left[ r(i + MV_x, j + MV_y) - M_{\text{ref}} \right] \]

\[ = f(i, j) - r(i + MV_x, j + MV_y) - M_{\text{curr}} + M_{\text{ref}} \]

where \( \text{NewR} \) denotes the residual signal, \( M_{\text{curr}} \) denotes the mean pixel value of the current frame block, \( M_{\text{ref}} \) denotes the mean pixel value of the candidate pattern blocks, \( f(i,j) \) denotes a pixel value at a coordinate \((i,j)\) of the current frame, \( r(i,j) \) denotes a pixel value of a coordinate \((i,j)\) of the reference frame, \( U \) and \( V \) denote the sizes of blocks used for matching the blocks, and \((x,y)\) denotes the motion vector.

Claim 19.  (Currently Amended) A motion estimation device comprising:

- a pattern block generating unit generating a current frame pattern block for a current frame block and reference frame pattern blocks for a reference frame block;
- a motion vector determining unit calculating the sum of absolute differences (SAD) for candidate pattern blocks corresponding to the current frame pattern block among the reference frame pattern blocks and determining [[the]] each candidate pattern block corresponding to the SAD satisfying a predetermined condition among the calculated [[SADs]] SAD as a motion vector;
- a motion compensation unit generating a residual signal using a difference signal between the candidate pattern block corresponding to the motion vector and the current frame pattern block; and
an adding unit adding flag information indicating whether a mean pixel value of the encoded current frame block is included and identification information on an encoding mode to the encoded current frame block as header information, wherein whether the mean pixel value of the current frame block is included is identified by the flag information, wherein the pattern block generating unit: calculates a mean brightness value of the current frame block and a mean brightness value of the reference frame block; generates the current frame pattern block by subtracting the mean brightness value of the current frame block from brightness values of the current frame block; and generates the reference frame pattern blocks by subtracting the mean brightness value of the reference frame block from brightness values of the reference frame block.

Claim 20. (Original) The motion estimation device according to claim 19, wherein when the flag information indicates that the mean pixel value is not included, a mean value of mean pixel values corresponding to n blocks surrounding the current frame block is used as the mean pixel value of the current frame block.

Claim 21. (Original) The motion estimation device according to claim 19, wherein when the flag information does not contain the mean pixel value and the header information further contains additional information indicating that the mean pixel value corresponding to any block among the blocks surrounding the current frame block should be used, a mean pixel value of the block corresponding to the additional information is used as the mean pixel value of the current frame block.

Claim 22. (Canceled).

Claim 23. (Original) The motion estimation device according to claim 19, further comprising a unit carrying out discrete cosine transform and quantization to the residual signal.
Claim 24.  (Currently Amended) The motion estimation device according to claim 19, wherein the SAD satisfying the predetermined condition indicates [[the]] a least SAD and the motion vector determining unit calculates the SAD with the following equation:

\[
\text{NewSAD} \ (x, y) = \sum_{i=0}^{U-1} \sum_{j=0}^{V-1} \left\lfloor f(i, j) - M_{\text{curr}} \right\rfloor - \left\lfloor r(i + x, j + y) - M_{\text{ref}} \right\rfloor
\]

where \(M_{\text{curr}}\) denotes the mean pixel value of the current frame block, \(M_{\text{ref}}\) denotes the mean pixel value of the candidate pattern blocks, \(f(i,j)\) denotes a pixel value at a coordinate \((i,j)\) of the current frame, \(r(i+x,j+y)\) denotes a pixel value of a coordinate \((i+x,j+y)\) of the reference frame, \(U\) and \(V\) denote the sizes of blocks used for matching the blocks, and \((x,y)\) denotes the motion vector.

Claim 25.  (Original) The motion estimation device according to claim 19, wherein the motion compensation unit calculates the residual signal with the following equation:

\[
\text{NewR} \ (i, j) = [f(i, j) - M_{\text{curr}}] - [r(i + MV_x, j + MV_y) - M_{\text{ref}}] = f(i, j) - r(i + MV_x, j + MV_y) - M_{\text{curr}} + M_{\text{ref}}
\]

where \(\text{NewR}\) denotes the residual signal, \(M_{\text{curr}}\) denotes the mean pixel value of the current frame block, \(M_{\text{ref}}\) denotes the mean pixel value of the candidate pattern blocks, \(f(i,j)\) denotes a pixel value at a coordinate \((i,j)\) of the current frame, \(r(i,j)\) denotes a pixel value of a coordinate \((i,j)\) of the reference frame, \(U\) and \(V\) denote the sizes of blocks used for matching the blocks, and \((x,y)\) denotes the motion vector.
Request for Reconsideration:

Claims 1, 3-6, 8-14, 16-21, and 23-25 are pending in this application. Applicants are amending the Abstract of the Disclosure to correct a typographical error and are amending claims 1, 4, 6, 9, 11, 17, 19, and 24 to correct certain typographical errors and to ensure proper antecedent basis for the claim terms. No new matter is added by these amendments, and these amendments are supported by the specification, as originally filed. E.g., Appl'n Claims 1, 4, 6, 9, 11, 17, 19, and 24 (as originally filed). Moreover, these amendments do not narrow the scope of the amended claims. Therefore, Applicants respectfully request that the Examiner reconsider the application in view of the foregoing amendments and the following remarks, in addition to the amendments and remarks presented in Applicants' Responsive Amendment of September 23, 2010.
Remarks:

On November 23, 2010, Examiner Popovici telephoned Applicants’ representative, James B. Arpin, and identified (1) certain typographical errors in the Abstract of the Disclosure and in claims 1, 6, 11, and 19 and (2) certain terms allegedly lacking proper antecedent basis in claims 1, 4, 6, 9, 11, 17, 19, and 24. Applicants respectfully submit that the foregoing amendments are consistent with possible amendments to correct these typographical errors and to provide proper antecedent basis for the claim terms, discussed during that telephone conversation. Accordingly, Applicants respectfully request that the Examiner enter this Supplemental Amendment, in accordance with 37 C.F.R. § 1.111(a)(2)(i)(B), and reconsider the above-captioned patent application in view of the foregoing amendments, and further in view of the amendments and remarks presented in the Responsive Amendment, which Applicants submitted on September 23, 2010.

Conclusion:

Applicants respectfully submits 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’ representative, we would welcome the opportunity to do so.

Applicants believes that, because the previously-filed Responsive Amendment was fully responsive to the outstanding objections and rejections and because Applicants are making these further amendments at the suggestion of the Examiner, no fees are due as a result of the filing of this Supplemental Amendment. 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 Deposit Account No. 02-0375.

Respectfully submitted,

BAKER BOTTS L.L.P.

Dated: November 24, 2010

By:

James B. Arpin
Registration No. 33470

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(202) 639-7700 (telephone)
(202) 639-7890 (facsimile)

JBA/djw
## Electronic Acknowledgement Receipt

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<td><strong>First Named Inventor/Applicant Name:</strong></td>
<td>Yung-Lyul Lee</td>
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**Warnings:**

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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/O/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.
## PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 11/289,650  
Filing Date: 11/30/2005  
To be Mailed: 

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

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

Legal Instrument Examiner: 
TINA J. BARDEN/

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.
IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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

Application No.: 11/289,650 ) Examiner: Dov POPOVICI

Filed: November 30, 2005 ) Group Art Unit: 2613

For: MOTION ESTIMATION AND COMPENSATION METHOD AND DEVICE ADAPTIVE TO CHANGE IN ILLUMINATION )

CONFIRMATION NO. 5922

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

MAIL STOP AMENDMENT
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Sir:

In response to the Office Action, of which the U.S. Patent and Trademark Office ("PTO") notified Applicant on June 23, 2010, Applicants respectfully request that the Examiner reconsider the above-captioned patent application in view of the following:

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

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

Request for Reconsideration begins on page 11 of this paper.

Remarks begin on page 12 of this paper.

Conclusion begins on page 13 of this paper.
Amendments to the Specification:

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

Provided are a motion estimation device and method adaptive to change in illumination. The motion estimation method includes the steps of: generating a current frame pattern block for a current frame block and a reference frame pattern block for a reference frame block; calculating the sum of absolute differences (SAD) for candidate pattern blocks corresponding to the current frame pattern block among the reference frame pattern blocks and determining the candidate pattern block corresponding to the SAD satisfying a predetermined condition among the calculated SADs as a motion vector; encoding the current frame block, by generating a residual signal using a difference signal between the candidate pattern block corresponding to the motion vector and the current frame pattern block then performing discrete cosine transform and quantization to the residual signal with a predetermined encoding mode; and adding flag information indicating the addition of a mean pixel value applied to the encoded current frame block and identification information on the encoding mode as header information corresponding to the encoded current frame block. By omitting insertion of a mean pixel value for some fields, it is possible to minimize the amount of bit streams transmitted to a decoder.
Amendments to the Claims:

This listing of claims will replace all prior versions and listings of the claims in the above-captioned patent application:

Claim 1. (Currently Amended) A motion estimation method adaptive to change in illumination, comprising the steps of:

(a) generating a current frame pattern block for a current frame block and a reference frame pattern block for a reference frame block;

(b) calculating the sum of absolute differences (SAD) for candidate pattern blocks corresponding to the current frame pattern block among the reference frame pattern blocks and determining the candidate pattern block corresponding to the SAD satisfying a predetermined condition among the calculated SADs as a motion vector;

(c) encoding the current frame block, by generating a residual signal using a difference signal between the candidate pattern block corresponding to the motion vector and the current frame pattern block then performing discrete cosine transform and quantization to the residual signal with a predetermined encoding mode; and

(d) adding flag information indicating the addition of a mean pixel value applied to the encoded current frame block and identification information on the encoding mode as header information corresponding to the encoded current frame block;

wherein the addition of a mean pixel value to be applied to the current frame block is identified by the flag information,

wherein step (a) includes the steps of:

calculating a mean brightness value of the current frame block and a mean brightness value of the reference frame block; and

generating the current frame pattern block by subtracting the mean brightness value of the current frame block from brightness values of the current frame block and generating the reference frame pattern blocks by subtracting the mean brightness value of the reference frame block from brightness values of the reference frame block.

Claim 2. (Canceled).
Claim 3. (Original) The motion estimation method according to claim 1, further comprising encoding the mean pixel value of the current frame block.

Claim 4. (Original) The motion estimation method according to claim 1, wherein the SAD satisfying the predetermined condition indicates the least SAD and the SAD is calculated by the following equation:

$$\text{NewSAD} (x, y) = \sum_{i=0}^{U-1} \sum_{j=0}^{V-1} \left| f(i, j) - M_{\text{curr}} \right| - \left| r(i + x, j + y) - M_{\text{ref}} \right|$$

where $M_{\text{curr}}$ denotes the mean pixel value of the current frame block, $M_{\text{ref}}$ denotes the mean pixel value of the candidate pattern blocks, $f(i,j)$ denotes a pixel value at a coordinate $(i,j)$ of the current frame, $r(i,j)$ denotes a pixel value of a coordinate $(i,j)$ of the reference frame, $U$ and $V$ denote the sizes of blocks used for matching the blocks, and $(x,y)$ denotes the motion vector.

Claim 5. (Original) The motion estimation method according to claim 1, wherein the residual signal is calculated by the following equation:

$$\text{NewR} (i, j) = \left[ f(i, j) - M_{\text{curr}} \right] - \left[ r(i + MV_x, j + MV_y) - M_{\text{ref}} \right]$$

$$= f(i,j) - r(i+MV_x,j+MV_y) - M_{\text{curr}} + M_{\text{ref}}$$

where $\text{NewR}$ denotes the residual signal, $M_{\text{curr}}$ denotes the mean pixel value of the current frame block, $M_{\text{ref}}$ denotes the mean pixel value of the candidate pattern blocks, $f(i,j)$ denotes a pixel value at a coordinate $(i,j)$ of the current frame, $r(i,j)$ denotes a pixel value of a coordinate $(i,j)$ of the reference frame, $U$ and $V$ denote the sizes of blocks used for matching the blocks, and $(x,y)$ denotes the motion vector.

Claim 6. (Currently Amended) A motion estimation device comprising:

a pattern block generating unit generating a current frame pattern block of a current frame block and reference frame pattern blocks of a reference frame block;

a motion vector determining unit calculating the sum of absolute differences (SAD) of candidate pattern blocks corresponding to the current frame pattern block among the reference frame pattern blocks and determining the candidate pattern block corresponding to the SAD satisfying a predetermined condition among the calculated SADs as a motion vector;
a motion compensation unit generating a residual signal using a difference signal between
the candidate pattern block corresponding to the motion vector and the current frame pattern
block; and
an adding unit adding flag information indicating the addition of a mean pixel value
applied to the encoded current frame block and identification information on the encoding mode
as header information corresponding to the encoded current frame block;
wherein the addition of a mean pixel value to be applied to the current frame block is
identified by the flag information,
wherein the pattern block generating unit:
calculates a mean brightness value of the current frame block and a mean brightness
value of the reference frame block;
generates the current frame pattern block by subtracting the mean brightness value of the
current frame block from brightness values of the current frame block; and
generates the reference frame pattern blocks by subtracting the mean brightness value of
the reference frame block from brightness values of the reference frame block.

Claim 7. (Canceled).

Claim 8. (Original) The motion estimation device according to claim 6, further comprising a
unit carrying out discrete cosine transform and quantization to the residual signal.

Claim 9. (Original) The motion estimation device according to claim 6, wherein the SAD
satisfying the predetermined condition indicates the least SAD and the motion vector
determining unit calculates the SAD with the following equation:

\[ \text{NewSAD} (x, y) = \sum_{i=0}^{U-1} \sum_{j=0}^{V-1} \left[ f(i, j) - M_{\text{curr}} \right] - \left[ r(i + x, j + y) - M_{\text{ref}} \right] \]

where \( M_{\text{curr}} \) denotes the mean pixel value of the current frame block, \( M_{\text{ref}} \) denotes the mean
pixel value of the candidate pattern blocks, \( f(i,j) \) denotes a pixel value at a coordinate \((i,j)\) of the
current frame, \( r(i,j) \) denotes a pixel value of a coordinate \((i,j)\) of the reference frame, \( U \) and \( V \)
denote the sizes of blocks used for matching the blocks, and \((x,y)\) denotes the motion vector.
Claim 10. (Original) The motion estimation device according to claim 6, wherein the motion compensation unit calculates the residual signal with the following equation:

\[ \text{NewR}(i, j) = [f(i, j) - M_{curr}] - [r(i + MV_x, j + MV_y) - M_{ref}] \]

\[ = f(i, j) - r(i + MV_x, j + MV_y) - M_{curr} + M_{ref} \]

where \( \text{NewR} \) denotes the residual signal, \( M_{curr} \) denotes the mean pixel value of the current frame block, \( M_{ref} \) denotes the mean pixel value of the candidate pattern blocks, \( f(i, j) \) denotes a pixel value at a coordinate \((i, j)\) of the current frame, \( r(i, j) \) denotes a pixel value of a coordinate \((i, j)\) of the reference frame, \( U \) and \( V \) denote the sizes of blocks used for matching the blocks, and \((x, y)\) denotes the motion vector.

Claim 11. (Currently Amended) A motion estimation method comprising the steps of:

(a) generating a current frame pattern block for a current frame block and a reference frame pattern block for a reference frame block;

(b) calculating the sum of absolute differences (SADs) for candidate pattern blocks corresponding to the current frame pattern block among the reference frame pattern blocks and determining the candidate pattern block corresponding to the SAD satisfying a predetermined condition among the calculated SADs as a motion vector;

(c) encoding the current frame block, by generating a residual signal using a difference signal between the candidate pattern block corresponding to the motion vector and the current frame pattern block then performing discrete cosine transform and quantization to the residual signal with a predetermined encoding mode; and

(d) adding flag information indicating whether a mean pixel value of the encoded current frame block is included and identification information on the encoding mode to the encoded current frame block as header information,

wherein whether the mean pixel value of the current frame block is included is identified by the flag information,

wherein step (a) includes the steps of:

calculating a mean brightness value of the current frame block and a mean brightness value of the reference frame block; and

generating the current frame pattern block by subtracting the mean brightness value of the current frame block from brightness values of the current frame block and generating the
reference frame pattern blocks by subtracting the mean brightness value of the reference frame block from brightness values of the reference frame block.

Claim 12. (Original) The motion estimation method according to claim 11, wherein the current frame block is set to at least one type of 16×16, 16×8, 8×16, 8×8, 8×4, 4×8, and 4×4.

Claim 13. (Original) The motion estimation method according to claim 11, wherein when the flag information indicates that the mean pixel value is not included, a mean value of mean pixel values corresponding to n blocks surrounding the current frame block is used as the mean pixel value of the current frame block.

Claim 14. (Original) The motion estimation method according to claim 11, wherein when the flag information does not contain the mean pixel value and the header information further contains additional information indicating that the mean pixel value corresponding to any block among the blocks surrounding the current frame block should be used, a mean pixel value of the block corresponding to the additional information is used as the mean pixel value of the current frame block.

Claim 15. (Canceled).

Claim 16. (Original) The motion estimation method according to claim 11, further comprising the step of encoding the mean pixel value of the current frame block.

Claim 17. (Original) The motion estimation method according to claim 11, wherein the SAD satisfying the predetermined condition indicates the least SAD and the SAD is calculated by the following equation:

\[
\text{NewSAD} \ (x, y) = \sum_{i=0}^{u-1} \sum_{j=0}^{v-1} \left| f(i, j) - M_{\text{cur}} \right| - \left| r(i+x, j+y) - M_{\text{ref}} \right|
\]

where \(M_{\text{cur}}\) denotes the mean pixel value of the current frame block, \(M_{\text{ref}}\) denotes the mean pixel value of the candidate pattern blocks, \(f(i,j)\) denotes a pixel value at a coordinate \((i,j)\) of the current frame, \(r(i+x,j+y)\) denotes a pixel value of a coordinate \((i+x,j+y)\) of the reference frame,
$U$ and $V$ denote the sizes of blocks used for matching the blocks, and $(x,y)$ denotes the motion vector.

Claim 18. (Original) The motion estimation method according to claim 11, wherein the residual signal is calculated by the following equation:

$$NewR(i,j) = [f(i,j) - M_{curr}] - [r(i + MV_x, j + MV_y) - M_{ref}]$$

$$= f(i,j) - r(i + MV_x, j + MV_y) - M_{curr} + M_{ref}$$

where $NewR$ denotes the residual signal, $M_{curr}$ denotes the mean pixel value of the current frame block, $M_{ref}$ denotes the mean pixel value of the candidate pattern blocks, $f(i,j)$ denotes a pixel value at a coordinate $(i,j)$ of the current frame, $r(i,j)$ denotes a pixel value of a coordinate $(i,j)$ of the reference frame, $U$ and $V$ denote the sizes of blocks used for matching the blocks, and $(x,y)$ denotes the motion vector.

Claim 19. (Currently Amended) A motion estimation device comprising:

a pattern block generating unit generating a current frame pattern block for a current frame block and reference frame pattern blocks for a reference frame block;

a motion vector determining unit calculating the sum of absolute differences (SAD) for candidate pattern blocks corresponding to the current frame pattern block among the reference frame pattern blocks and determining the candidate pattern block corresponding to the SAD satisfying a predetermined condition among the calculated SADs as a motion vector;

a motion compensation unit generating a residual signal using a difference signal between the candidate pattern block corresponding to the motion vector and the current frame pattern block; and

an adding unit adding flag information indicating whether a mean pixel value of the encoded current frame block is included and identification information on the encoding mode to the encoded current frame block as header information,

wherein whether the mean pixel value of the current frame block is included is identified by the flag information,

wherein the pattern block generating unit:

calculates a mean brightness value of the current frame block and a mean brightness value of the reference frame block;
generates the current frame pattern block by subtracting the mean brightness value of the
current frame block from brightness values of the current frame block; and

generates the reference frame pattern blocks by subtracting the mean brightness value of
the reference frame block from brightness values of the reference frame block.

Claim 20. (Original) The motion estimation device according to claim 19, wherein when the
flag information indicates that the mean pixel value is not included, a mean value of mean pixel
values corresponding to n blocks surrounding the current frame block is used as the mean pixel
value of the current frame block.

Claim 21. (Original) The motion estimation device according to claim 19, wherein when the
flag information does not contain the mean pixel value and the header information further
contains additional information indicating that the mean pixel value corresponding to any block
among the blocks surrounding the current frame block should be used, a mean pixel value of the
block corresponding to the additional information is used as the mean pixel value of the current
frame block.

Claim 22. (Canceled).

Claim 23. (Original) The motion estimation device according to claim 19, further comprising a
unit carrying out discrete cosine transform and quantization to the residual signal.

Claim 24. (Original) The motion estimation device according to claim 19, wherein the SAD
satisfying the predetermined condition indicates the least SAD and the motion vector
determining unit calculates the SAD with the following equation:

\[ \text{NewSAD} \ (x, y) = \sum_{i=0}^{W-1} \sum_{j=0}^{H-1} \left[ f(i, j) - M_{\text{curr}} \right] - \left[ r(i + x, j + y) - M_{\text{ref}} \right] \]

where \( M_{\text{curr}} \) denotes the mean pixel value of the current frame block, \( M_{\text{ref}} \) denotes the mean
pixel value of the candidate pattern blocks, \( f(i, j) \) denotes a pixel value at a coordinate \( (i, j) \) of the
current frame, \( r(i+x,j+y) \) denotes a pixel value of a coordinate \( (i+x,j+y) \) of the reference frame,
$U$ and $V$ denote the sizes of blocks used for matching the blocks, and $(x,y)$ denotes the motion vector.

Claim 25. (Original) The motion estimation device according to claim 19, wherein the motion compensation unit calculates the residual signal with the following equation:

$$\text{NewR}(i,j) = [f(i,j) - M_{curr}] - [r(i + MV_x, j + MV_y) - M_{ref}]$$

$$= f(i,j) - r(i + MV_x, j + MV_y) - M_{curr} + M_{ref}$$

where $\text{NewR}$ denotes the residual signal, $M_{curr}$ denotes the mean pixel value of the current frame block, $M_{ref}$ denotes the mean pixel value of the candidate pattern blocks, $f(i,j)$ denotes a pixel value at a coordinate $(i,j)$ of the current frame, $r(i,j)$ denotes a pixel value of a coordinate $(i,j)$ of the reference frame, $U$ and $V$ denote the sizes of blocks used for matching the blocks, and $(x,y)$ denotes the motion vector.
Request for Reconsideration:

Claims 1, 3-6, 8-14, 16-21, and 23-25 are pending in this application. Applicants are amending independent claims 1, 6, 11, and 19 to incorporate the subject matter of claims 2, 7, 15, and 22, respectively. Applicants also are canceling claims 5, 7, 15, and 22, without prejudice or disclaimer. No new matter is added by the foregoing amendments, and these amendments are supported fully by the specification. E.g., Appl’n, Claims 5, 7, 15, and 22 (as filed). Applicants respectfully request that the Examiner enter the foregoing amendments and reconsider the above-captioned patent application in view of the foregoing amendments and the following remarks.
Remarks

1. Objections to the Specification.

   The Office Action objects to the length of the Abstract of the Disclosure. Applicants are amending the Abstract of the Disclosure, so that it does not exceed 150 words in length. Therefore, Applicants respectfully request that the Examiner withdraw the objections to the specification.

2. Objections and Rejections.

   Applicants acknowledge with appreciation that the Examiner indicates that claims 2, 4, 5, 7, 9, 10, 13-15, 17, 18, 20-22, 24, and 25 contain allowable subject matter and would be allowable if rewritten in independent form to include the limitations of their base claim and any intervening claims. Nevertheless, claims 1, 3, 6, 8, 11, 12, 16, 19, and 23 stand rejected under 35 U.S.C. § 102(b), as allegedly anticipated by Patent No. US 5,699,474 A to Suzuki et al. Applicants respectfully traverse.

   a. Claims 1, 6, 11, and 19.

      As noted above, the Examiner indicates that claims 2, 7, 15, and 22 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. Applicants are amending independent claims 1, 6, 11, and 19 to incorporate the subject matter of claims 2, 7, 15, and 22, respectively. Therefore, Applicants respectfully requests that the Examiner withdraw the anticipation rejections of amended claims 1, 6, 11, and 19, at least for this reason.

   b. Claims 3-5, 8-10, 12-14, 16-18, 20, 21, and 23-25.

      Claims 3-5 depend from and incorporate each and every elements of amended, independent claim 1; claims 8-10 depend from and incorporate each and every elements of amended, independent claim 6; claims 12-14 and 16-18 depend from and incorporate each and every elements of amended, independent claim 11; and claims 20, 21, and 23-25 depend from and incorporate each and every elements of amended, independent claim 19. For the reasons above, Applicants maintain that claims 1, 6, 11, and 19, as amended, are distinguishable over the
cited references. Therefore, Applicants respectfully request that the Examiner withdraw the objections and rejections of claims 3-5, 8-10, 12-14, 16-18, 20, 21, and 23-25, at least for this reason.

**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 responsive amendment. Nevertheless, in the event of any variance between the fees determined by Applicant 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.

Date: **September 23, 2010**

By: /Aaron Perez-Daple/
Aaron Perez-Daple
Registration No. 57,766

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The Warner, Suite 1300
1299 Pennsylvania Avenue, N.W.
Washington, D.C. 20004-2400
Tel.: (202) 639-7700
Fax: (202) 639-7890

JBA/APD
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- Submitted with Payment: no

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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.
PATENT APPLICATION FEE DETERMINATION RECORD
Substitute for Form PTO-875

Applicant or Docket Number 11/289,650
Filing Date 11/30/2005  □ To be Mailed

APPLICATION AS FILED – PART I

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APPLICATION AS AMENDED – PART II

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Legal Instrument Examiner: LYNNE JOHNSON

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 1-866-PTO-9199 and select option 2.
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. 11/289,650
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 --

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 30 November 2005.

2a) ☐ This action is FINAL.

2b) ☒ This action is non-final.

3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under Ex parte Quayle, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4) ☒ Claim(s) 1-25 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) 1,3,6,8,11,12,16,19 and 23 is/are rejected.

7) ☐ Claim(s) 2,4,5,7,9,10,13-15,17,18,20-22,24 and 25 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


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 Draftsman’s Patent Drawing Review (PTO-948)

3) ☐ Information Disclosure Statement(s) (PTO/SB/08)

   Paper No(s)/Mail Date ______.

4) ☐ Interview Summary (PTO-413)

   Paper No(s)/Mail Date ______.

5) ☐ Notice of Informal Patent Application

6) ☐ Other: ______.
DETAILED ACTION

Specification

The abstract of the disclosure is objected to because the abstract contains 195 words and therefore the abstract has exceeded 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. 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 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 –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.
Claims 1, 3, 6, 8, 11, 12, 16, 19 and 23 are rejected under 35 U.S.C. 102(b) as being anticipated by Suzuki et al. (US 5,699,474).

As to claim 1, Suzuki et al. disclose a motion estimation method (see figure 2) adaptive to change in illumination, comprising the steps of: (a) generating a current frame pattern block for a current frame block and a reference frame pattern block for a reference frame block; (b) calculating the sum of absolute differences (SAD) for candidate pattern blocks corresponding to the current frame pattern block among the reference frame pattern blocks and determining the candidate pattern block corresponding to the SAD satisfying a predetermined condition among the calculated SADs as a motion vector (see column 11, line 61 to column 12, line 2); (c) encoding (see figure 2) the current frame block, by generating a residual signal using a difference signal between the candidate pattern block corresponding to the motion vector and the current frame pattern block then performing discrete cosine transform (DCT 304) and quantization (305) to the residual signal with a predetermined encoding mode; and (d) adding flag information (see column 19, lines 10-11, "Such flag is added to slice header at the time of coding at encoding unit 102" or the adding flag information can read on: address in 316 in figure 2) indicating the addition of a mean pixel value (see col. 12, lines 5-10) applied to the encoded current frame block and identification information on the encoding mode as header information corresponding to the encoded current frame block; wherein the addition of a mean pixel value to be applied to the current frame block is identified by the flag information (see figure 2, col. 11, line 60 to col. 12, line 10 and col. 19, lines 10-11).
As to claim 3, Suzuki et al. discloses encoding the mean pixel value of the current frame block (see col. 11, line 60 to col. 12, line 10 and see figure 2).

As to claim 6, Suzuki et al. discloses a motion estimation device (see figure 2) comprising: a pattern block generating unit generating a current frame pattern block of a current frame block and reference frame pattern blocks of a reference frame block; a motion vector determining unit calculating the sum of absolute differences (SAD) of candidate pattern blocks corresponding to the current frame pattern block among the reference frame pattern blocks and determining the candidate pattern block corresponding to the SAD satisfying a predetermined condition among the calculated SADs as a motion vector (see column 11, line 61 to column 12 line 2); a motion compensation unit (see figure 2) generating a residual signal using a difference signal between the candidate pattern block corresponding to the motion vector and the current frame pattern block; and an adding unit (see column 19, lines 10-11, “Such flag is added to slice header at the time of coding at encoding unit 102” or the adding flag information can read on: address in 316 in figure 2) adding flag information indicating the addition of a mean pixel value (see col. 12, lines 5-10) applied to the encoded current frame block and identification information on the encoding mode as header information corresponding to the encoded current frame block; wherein the addition of a mean pixel value to be applied to the current frame block is identified by the flag information (see figure 2, col. 11, line 60 to col. 12, line 10 and col. 19, lines 10-11).

As to claim 8, Suzuki et al. discloses a unit carrying out discrete cosine transform (DCT 304) and quantization (305) to the residual signal (see figure 2).
As to claim 11, Suzuki et al. discloses a motion estimation method (see figure 2) comprising the steps of: (a) generating a current frame pattern block for a current frame block and a reference frame pattern block for a reference frame block; (b) calculating the sum of absolute differences (SADs) for candidate pattern blocks corresponding to the current frame pattern block among the reference frame pattern blocks and determining the candidate pattern block corresponding to the SAD satisfying a predetermined condition among the calculated SADs as a motion vector (see column 11, line 61 to column 12, line 2); (c) encoding (see figure 2) the current frame block, by generating a residual signal using a difference signal between the candidate pattern block corresponding to the motion vector and the current frame pattern block then performing discrete cosine transform (DCT 304) and quantization (305) to the residual signal with a predetermined encoding mode; and (d) adding flag information (see column 19, lines 10-11, "Such flag is added to slice header at the time of coding at encoding unit 102" or the adding flag information can read on: address in 316 in figure 2) indicating whether a mean pixel value (see column 12, lines 5-10) of the encoded current frame block is included and identification information on the encoding mode to the encoded current frame block as header information, wherein whether the mean pixel value of the current frame block is included is identified by the flag information (see figure 2, col. 11, line 60 to col. 12, line 10 and col. 19, lines 10-11).

As to claim 12, Suzuki et al. discloses wherein the current frame block is set to at least one type of 16x16, 16x8, 8x16, 8x8, 8x4, 4x8, and 4x4 (see column 11, lines 13-
14, i.e., Suzuki et al. discloses at least one type of 16x16, see column 11, lines 13-14, “block format of macro block units of, e.g. 16x16 pixels”).

As to claim 16, Suzuki et al. discloses encoding the mean pixel value of the current frame block (see col. 11, line 60 to col. 12, line 10 and see figure 2).

As to claim 19, Suzuki et al. discloses a motion estimation device (see figure 2) comprising: a pattern block generating unit generating a current frame pattern block for a current frame block and reference frame pattern blocks for a reference frame block; a motion vector determining unit calculating the sum of absolute differences (SAD) for candidate pattern blocks corresponding to the current frame pattern block among the reference frame pattern blocks and determining the candidate pattern block corresponding to the SAD satisfying a predetermined condition among the calculated SADs as a motion vector (see column 11, line 61 to column 12, line 2); a motion compensation unit (see figure 2) generating a residual signal using a difference signal between the candidate pattern block corresponding to the motion vector and the current frame pattern block; and an adding unit (see column 19, lines 10-11, "Such flag is added to slice header at the time of coding at encoding unit 102" or the adding flag information can read on: address in 316 in figure 2) adding flag information indicating whether a mean pixel value (see col. 12, lines 5-10) of the encoded current frame block is included and identification information on the encoding mode to the encoded current frame block as header information, wherein whether the mean pixel value of the current frame block is included is identified by the flag information (see figure 2, see column 11, line 60 to column 12, line 10 and see column 19, lines 10-11).
As to claim 23, Suzuki et al. discloses a unit carrying out discrete cosine transform (DCT 304) and quantization (305) to the residual signal (see figure 2).

**Allowable Subject Matter**

Claims 2, 4-5, 7, 9-10, 13, 14, 15, 17-18, 20, 21, 22, 24 and 25 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, Suzuki et al. (US 5,699,474) does not disclose, teach or suggest, wherein step (a) includes the steps of: calculating a mean brightness value of the current frame block and a mean brightness value of the reference frame block; and generating the current frame pattern block by subtracting the mean brightness value of the current frame block from brightness values of the current frame block and generating the reference frame pattern blocks by subtracting the mean brightness value of the reference frame block from brightness values of the reference frame block, as recited in claim 2.

The closest prior art of record, namely, Suzuki et al. (US 5,699,474) does not disclose, teach or suggest, wherein the SAD satisfying the predetermined condition
indicates the least SAD and the SAD is calculated by the following equation: (see the equation in claim 4, line 10, on page 21, line 10)

\[
\text{NewSAD}(x,y) = \sum_{i=0}^{U-1} \sum_{j=0}^{V-1} |[f(i,j)- M \text{ curr}] - [r(i + x, j + y) - M \text{ ref}]|
\]

where \(M \text{ curr}\) denotes the mean pixel value of the current frame block, \(M \text{ ref}\) denotes the mean pixel value of the candidate pattern blocks, \(f(i,j)\) denotes a pixel value at a coordinate \((i,j)\) of the current frame, \(r(i,j)\) denotes a pixel value of a coordinate \((i,j)\) of the reference frame, \(U\) and \(V\) denote the sizes of blocks used for matching the blocks, and \((x,y)\) denotes the motion vector, as claimed in claim 4.

The closest prior art of record, namely, Suzuki et al. (US 5,699,474) does not disclose, teach or suggest, wherein the residual signal is calculated by the following equation: (see the equation in claim 5, lines 19-20 on page 21, lines 19-20)

\[
\text{NewR}(i,j) = \ [f(i,j) - M \text{ curr}] - [r(i + MVx, j + MVy) - M \text{ ref}] \\
= f(i,j) - r(i+MVx,j+MVy) - M \text{ curr} + M \text{ ref}
\]

where \(\text{NewR}\) denotes the residual signal, \(M \text{ curr}\) denotes the mean pixel value of the current frame block, \(M \text{ ref}\) denotes the mean pixel value of the candidate pattern blocks, \(f(i,j)\) denotes a pixel value at a coordinate \((i,j)\) of the current frame, \(r(i,j)\) denotes a pixel value of a coordinate \((i,j)\) of the reference frame, \(U\) and \(V\) denote the sizes of blocks used for matching the blocks, and \((x,y)\) denotes the motion vector, as recited in claim 5.

Claim 7 recites the same or similar claim limitations as recited in claim 2 above. Therefore, claim 7 is 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. Applicant is directed to the remarks or the
statement of reasons for the indication of allowable subject matter made in claim 2 above.

Claim 9 recites the same or similar claim limitations as recited in claim 4 above. Applicant is directed to the remarks (or the statement of reasons for the indication of allowable subject matter) made in claim 4 above.

Claim 10 recites the same or similar claim limitations as recited in claim 5 above. Applicant is directed to the remarks (or the statement of reasons for the indication of allowable subject matter) made in claim 5 above.

The closest prior art of record, namely, Suzuki et al. (US 5,699,474) does not disclose, teach or suggest, wherein when the flag information indicates that the mean pixel value is not included, a mean value of mean pixel values corresponding to n blocks surrounding the current frame block is used as the mean pixel value of the current frame block, as claimed in claim 13.

The closest prior art of record, namely, Suzuki et al. (US 5,699,474) does not disclose, teach or suggest, wherein when the flag information does not contain the mean pixel value and the header information further contains additional information indicating that the mean pixel value corresponding to any block among the blocks surrounding the current frame block should be used, a mean pixel value of the block corresponding to the additional information is used as the mean pixel value of the current frame block, as recited in claim 14.
Claims 15, 17 and 18 recite the same or similar claim limitation(s) as recited in claims 2, 4 and 5 above. Applicant is directed to the remarks (or the statement of reasons for the indication of allowable subject matter) made in claim 2, 4 and 5 above.

Claim 20 recites the same or similar claim limitations as recited in claim 13 above. Applicant is directed to the remarks (or the statement of reasons for the indication of allowable subject matter) made in claim 13 above.

Claim 21 recites the same or similar claim limitations as recited in claim 14 above. Applicant is directed to the remarks (or the statement of reasons for the indication of allowable subject matter) made in claim 14 above.

Claim 22 recites the same or similar claim limitations as recited in claim 15 above. Applicant is directed to the remarks (or the statement of reasons for the indication of allowable subject matter) made in claim 15 above.

Claims 24 and 25 recite the same or similar claim limitation(s) as recited in claims 4, 5, 9, 10, 17 and 18 above. Applicant is directed to the remarks (or the statement of reasons for the indication of allowable subject matter) made in claim 4, 5, 9, 10, 17 and 18 above.

Concluding

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
**Notice of References Cited**

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U.S. Patent and Trademark Office
PTO-892 (Rev. 01-2001)
### Search Notes

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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**
- **YES**
- **NO**

**FOREIGN APPLICATIONS**
- REPUBLIC OF KOREA 10-2005-0003049 01/14/2005

**IF REQUIRED, FOREIGN FILING LICENSE GRANTED**
- 01/06/2006

**ADDRESS**
- BAKER BOTTS LLP
- C/O INTELLECTUAL PROPERTY DEPARTMENT
- THE WARNER, SUITE 1300
- 1289 PENNSYLVANIA AVE. NW
- WASHINGTON, DC 20004-2400
- UNITED STATES

**TITLE**
- Motion estimation and compensation method and device adaptive to change in illumination

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EAST Search History (Interference)
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6/18/2010 11:16:37 AM
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:  
Yung-Lyul LEE et al.  
Examining Attorney: To Be Assigned  
Application No.: 11/289,650  
Group Art Unit: 2613  
Filed: November 30, 2005  
Confirmation No.: 5922  

For: MOTION ESTIMATION AND COMPENSATION METHOD AND DEVICE ADAPTIVE TO CHANGE IN ILLUMINATION

SUBMISSION OF CERTIFIED COPY OF PRIORITY DOCUMENTS

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

Sir:

Applicants are enclosing certified copies of Korean Patent Application Nos. KR 10-2004-0099398, filed in the Republic of Korea on November 30, 2004, and KR 10-2005-0003949, filed in the Republic of Korea on January 15, 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 submission of these priority documents, please charge such fee to the undersigned's Deposit Account No. 02-0375.

Respectfully submitted,

BAKER BOTTS, L.L.P.

Dated: March 29, 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/djw  
Enclosure  
DC01:440761.1
This is to certify that the following application annexed hereto is a true copy from the records of the Korean Intellectual Property Office.

출원번호: 10-2004-0099398
Application Number

출원년월일: 2004년 11월 30일
Date of Application

출원인: 주식회사 휴맥스
Applicant(s)

2005년 11월 16일

COMMISSIONER

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【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】 10-2004-0099398
【출원일자】 2004.11.30
【심사청구일자】 2004.11.30
【발명의 명칭】 조명 변화에 대한 적응적 응직임 예측 장치 및 방법
【제출원인】
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【접수일자】 2004.11.30
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【보정할 사항】
【보정대상항목】 발명자
【보정방법】 정정
【보정내용】
【발명자】
【성명의 국문표기】 이영렬
【성명의 영문표기】 LEE,Yung-Lyul
【주민등록번호】 611030-1047211
【우편번호】 138-160
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【발명의 영문명칭】 Adaptive motion predictive device for illumination change and method for producing the same

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【수수료】
【기본출원료】 0 면 38,000 원
【가산출원료】 32 면 0 원
【우선권주장료】 0 건 0 원
【심사청구료】 10 항 429,000 원
【합계】 467,000 원
【감면사유】 중소기업
【감면후 수수료】 233,500 원
【첨부서류】 1. 중소기업기본법시행령 제2조에의한 중소기업에 해당함을 증명하는 서류_1통 2. 기타첨부서류 [중소기업기본법]_1통
[요약서]

[요약]

본 발명은 조명 변화에 대한 적응적 움직임 예측 방법 및 장치에 관한 것으로서, 보다 상세하게는 조명변화에 적응적인 움직임 예측(motion estimation) 및 움직임 보상(motion compensation)을 통하여, 효율적으로 영상을 부호화 및 복호화 할 수 있는 방법 및 장치에 관한 것이다. 바람직한 실시예에 의할 때, 움직임 예측 방법은 (a) 현재 프레임 블록에 대한 현재 프레임 패턴 블록 및 참조 프레임 블록에 대한 참조 프레임 패턴 블록을 생성하는 단계; (b) 참조 프레임 패턴 블록 중에 현재 프레임 패턴 블록에 대응하는 후보 패턴 블록에 대한 SAD를 산출하는 단계; (c) 최소의 SAD에 대응하는 후보 패턴 블록을 움직임 벡터로 결정하는 단계; 및 (d) 움직임 벡터에 대응하는 후보 패턴 블록과 현재 프레임 패턴 블록의 차분 신호를 이용하여 잔여 신호를 생성한 후, 잔여 신호에 대한 이산적변환과 양자화를 수행하는 단계를 포함한다.

[대표도]

도 1

[색인어]

예측 부호화, 움직임 예측, 움직임 보상, SAD, 조명
【명세서】

【발명의 명칭】
조명 변화에 대한 적응적 움직임 예측 장치 및 방법(Adaptive motion predictive device for illumination change and method for producing the same)

【도면의 간단한 설명】

1. 도 1은 본 발명의 바람직한 실시예에 따른 움직임 예측 방법을 설명한 순서 도.

2. 도 2a는 본 발명의 바람직한 실시예에 따른 부호화 장치의 구성을 나타낸 도면.

3. 도 2b는 본 발명의 바람직한 실시예에 따른 복호화 장치의 구성을 나타낸 도면.

4. 도 3a 및 3b는 본 발명의 바람직한 제1 실시예에 따른 실험 결과를 나타낸 그래프.

5. 도 4a 및 4b는 본 발명의 바람직한 제2 실시예에 따른 실험 결과를 나타낸 그래프.

6. 도 5a 및 5b는 본 발명의 바람직한 제3 실시예에 따른 실험 결과를 나타낸 그래프.
<7>  <도면의 주요부분에 대한 부호의 설명>

<8>  210 : 현재 프레임의 회도 평균값 산출부

<9>  220 : 참조 프레임의 회도 평균값 산출부

<10> 230 : 움직임 예측부

<11> 231 : 현재 프레임의 패턴 블록화부

<12> 233 : 참조 프레임의 패턴 블록화부

<13> 235 : 움직임 벡터 결정부

<14> 240 : 움직임 추정부

【발명의 상세한 설명】

【발명의 목적】

【발명이 속하는 기술분야 및 그 분야의 종래기술】

본 발명은 조명 변화에 대한 적응적 움직임 예측 방법 및 장치에 관한 것으로, 보다 상세하게는 조명변화에 적응적인 움직임 예측(motion estimation) 및 움직임 보상(motion compensation)을 통하여, 효율적으로 영상을 부호화 및 복호화 할 수 있는 방법 및 장치에 관한 것이다.

종래 기술에 의할 때, ITU-T와 ISO/IEC에서는 영상의 부호화 효율성을 향상시키는 과정에서, H.26x 시리즈와 MPEG x 시리즈를 발표하였다. 그리고 2003년도에는 H.264(MPEG 4 part 10 Advanced Video Coding)를 완성시키면서 많은 비트를
잘감할 수 있게 되었다. 이러한 비디오 부호화 표준이 발전하면서 블록 기반 움직임 예측(BMVE : block matching motion estimation)에 관한 연구도 많았는데, 대부분의 방법은 현재 프레임(frame)의 블록과 참조 프레임의 후보 블록의 SAD(sum of absolute differences)들을 구하여 가장 작은 SAD(Sum of Absolute Difference)를 보이는 참조 프레임의 후보 블록의 위치를 현재 프레임의 블록의 움직임 벡터(motion vector)로 결정하도록 구성된다.

그리고 그 후보 블록과 현재 프레임의 블록간의 차분신호(residual)들을 이산여험변환(DCT : discrete cosine transform)과 양자화(quantization)를 하여 움직임 벡터와 같이 가변장 부호화(VLC : variable length coding)를 수행한다. 여기서, 움직임 벡터를 찾는다는 것은 현재 프레임과 참조 프레임의 시간적 중복성(temporal redundancy)을 제거하여 획득하는 것이므로, 상당한 부호화 효율을 가져왔으나 다음과 같은 문제점이 있다.

즉, 영상 내에 장면변화(scene change) 또는 조명이 서서히 어두워지거나 밝아지거나 또는 감박거리이 있는 경우, 종래 기술에 따른 블록간의 SAD를 계산하여 최소의 SAD를 찾아 차분신호를 부호화하면 부호화에 사용되는 비트가 많이 필요하여, 압축률이 급격히 저하되는 문제점이 있다.

一般적으로 장면변화가 있으면 변화된 그 프레임은 화면내 부호화(intra)를 하는 것이 움직임 예측과 움직임 보상(motion compensation)을 하는 것보다 더욱 효과적이다. 그 이유는 참조 프레임의 탑색 영역 내 어느 곳에서도 현재 프레임의 블록의 패턴을 찾아볼 수 없기 때문이다. 마찬가지로, 조명의 변화나 감박거리에서
또 같은 방법으로 움직임 예측을 하여 차분신호를 부호화하게 되면 유사한 결과가 나온다. 그래서 이 경우에서도 화면내 부호화를 하는 경우가 많다. 하지만 이 경우 장면변화는 없었으므로, 참조 프레임에서 현재 프레임의 블록과 비슷한 패턴을 가진 블록을 찾을 수 있으나, 그 블록과 현재 프레임의 블록의 차분을 부호화하더라도 많은 비트를 필요로 하는 문제점이 발생한다.

【발명이 이루고자 하는 기술적 과제】

따라서 본 발명은 상기의 제반 문제점을 해결하기 위하여 안설한 것으로서, 조명변화에 적응적인 움직임 예측(motion estimation) 및 움직임 보상(motion compensation)을 통하여, 효율적으로 영상을 부호화 및 복호화할 수 있는 방법 및 장치에 관한 것이다.

또한, 본 발명의 다른 목적은 조명 변화에 대하여 화면내 부호화를 수행하지 아니하고, 효율적으로 압축을 수행할 수 있는 방법 및 장치를 제공함에 있다.

또한, 본 발명의 또 다른 목적은 실제 환경에서 주변 조명변화에 강한 크랙을 제공함에 있으며, 그 외의 다른 본 발명의 목적들은 이하에 서술되는 바람직한 실시예를 통하여 보다 명확해질 것이다.

【발명의 구성】

상술한 목적을 달성하기 위하여 본 발명의 제1측면에 따르면, 조명 변화에
대한 적응적 움직임 예측 방법을 제공할 수 있다.

바람직한 실시예에 의할 때, 상기 움직임 예측 방법은 (a) 현재 프레임 블록에 대한 현재 프레임 패턴 블록 및 참조 프레임 블록에 대한 참조 프레임 패턴 블록을 생성하는 단계; (b) 상기 참조 프레임 패턴 블록 중에 상기 현재 프레임 패턴 블록에 대응하는 후보 패턴 블록에 대한 SAD를 산출하는 단계; (c) 최소의 SAD에 대응하는 후보 패턴 블록을 움직임 벡터로 결정하는 단계; 및 (d) 상기 움직임 벡터에 대응하는 후보 패턴 블록과 상기 현재 프레임 패턴 블록의 차분 신호를 이용하여 잔여 신호를 생성한 후, 상기 잔여 신호에 대한 이산여현변환과 양자화를 수행하는 단계를 포함한다.

또한, 상기 (a) 단계는 상기 현재 프레임 블록의 휘도 성분 평균값 및 상기 참조 프레임 블록의 휘도 성분 평균값을 산출하는 단계; 및 상기 현재 프레임 블록의 휘도 성분에서 상기 현재 프레임 블록의 휘도 성분 평균값을 차분하여 현재 프레임 패턴 블록을 생성하고, 상기 참조 프레임 블록의 휘도 성분에서 상기 참조 프레임 블록의 휘도 성분 평균값을 차분하여 참조 프레임 패턴 블록을 생성하는 단계를 포함한다.

그리고 상기 (d) 단계는 상기 현재 프레임 블록의 화소 평균값에 대한 이산여현변환과 양자화를 수행하는 단계를 포함한다.

여기서, 상기 SAD는 하기 수학식에 의하여 산출되며,
<28> \[ \text{NewSAD}(x, y) = \sum_{i=0}^{S-1} \sum_{j=0}^{T-1} |(f(i, j) - M_{\text{curr}}) - (r(i+x, j+y) - M_{\text{ref}})| \]

<29> 상기 \( M_{\text{curr}} \)은 현재 프레임 블록의 화소 평균값, 상기 \( M_{\text{ref}} \)는 상기 후보 패턴 블록의 화소 평균값, 상기 \( f(i, j) \)는 현재 프레임의 \( i, j \) 좌표에서 화소값, 상기 \( r(i, j) \)는 참조 프레임의 \( i, j \) 좌표에서 화소값, 상기 \( S \) 및 상기 \( T \)는 블록매칭시 사용하는 블록의 크기, 상기 \( (x, y) \)는 움직임벡터를 지칭한다.

<30> 또한, 상기 (d) 단계에서 상기 잔여 신호는 하기 수학식에 의하여 산출되며,

\[ \text{NewR}(i, j) = (f(i, j) - M_{\text{curr}}) - (r(i+x, j+y) - M_{\text{ref}}) \]

\[ = f(i, j) - r(i+x, j+y) - M_{\text{curr}} + M_{\text{ref}} \]

<33> 상기 \( \text{NewR} \)은 상기 잔여 신호, 값, 상기 \( M_{\text{ref}} \)는 상기 후보 패턴 블록의 화소 평균값, 상기 \( f(i, j) \)는 현재 프레임의 \( i, j \) 좌표에서 화소값, 상기 \( r(i, j) \)는 참조 프레임의 \( i, j \) 좌표에서 화소값, 상기 \( S \) 및 상기 \( T \)는 블록매칭시 사용하는 블록의 크기, 상기 \( (x, y) \)는 움직임벡터를 지칭한다.

<34> 상술한 목적을 달성하기 위하여 본 발명의 제 2측면에 따르면, 조명 변화에 대한 적응적 움직임 예측 장치를 제공할 수 있다.

<35> 바람직한 실용예에 의할 때, 상기 움직임 예측 장치는 현재 프레임 블록에 대한 현재 프레임 패턴 블록 및 참조 프레임 블록에 대한 참조 프레임 패턴 블록을
생성하기 위한 패턴 블록 생성부: 상기 참조 프레임 패턴 블록 중에 상기 현재 프레임 패턴 블록에 대응하는 후보 패턴 블록에 대한 SAD를 산출하고, 최소의 SAD에 대응하는 후보 패턴 블록을 움직임 벡터로 결정하기 위한 움직임 벡터 결정부; 및 상기 움직임 벡터에 대응하는 후보 패턴 블록과 상기 현재 프레임 패턴 블록의 차분 신호를 이용하여 잔여 신호를 생성하기 위한 움직임 보상부를 포함한다.

여기서, 상기 패턴 블록 생성부는 상기 현재 프레임 블록의 휘도 성분 평균 값 및 상기 참조 프레임 블록의 휘도 성분 평균값을 산출하고, 상기 현재 프레임 블록의 휘도 성분에서 상기 현재 프레임 블록의 휘도 성분 평균값을 차분하여 현재 프레임 패턴 블록을 생성하고, 상기 참조 프레임 블록의 휘도 성분에서 상기 참조 프레임 블록의 휘도 성분 평균값을 차분하여 참조 프레임 패턴 블록을 생성한다.

또한, 상기 잔여 신호에 대한 이산여현변환과 양자화를 수행하는 수단을 더 포함한다.

이하, 참조한 도면들을 참조하여 본 발명에 따른 조명 변화에 대한 적응적 움직임 예측 장치 및 방법의 바람직한 실시예를 상세히 설명하기로 하며, 참조 도면을 참조하여 설명함에 있어 도면 부호에 상관없이 동일하거나 대응하는 구성 요소는 동일한 참조번호를 부여하고 이에 대한 중복되는 설명은 생략하기로 한다.

적응적 움직임 예측 장치 및 방법의 동작
도 1은 본 발명의 바람직한 실시예에 따른 적응적 움직임 예측 방법의 동작 순서를 도시한 도면이다.

본 발명에 의한 적응적 움직임 예측 방법에 의하면, 영상에서 조명이 변화하거나 감백거리라는 경우 이를 인식하여, 화면내 부호화를 하지 않고 패턴이 가장 비슷한 블록을 검색하여 부호화하도록 구성된다.

즉, 본 발명은 조명이 변화하면서 블록의 휘도성분의 값이 전체적으로 올라가거나 내려가는 것에 충만하여, 현재 블록의 휘도성분 평균값을 구하고, 각 휘도성분값과 구한 평균값을 차분하여 새로운 패턴 블록(pattern block)을 생성하고, 참조 프레임에서도 같은 과정을 통해 참조 패턴 블록을 생성한다.

본 발명은 이와 같이 생성된 현재 패턴 블록과 참조 패턴 블록 사이에서 움직임 예측을 수행하여 부호화하는 방법(이하 패턴부호화라 칭함)이다. 본 발명에 따르면, 동일한 비트율에서 객관적 화질(PSNR)은 0.1dB~0.3dB이상의 향상이 되는 결과를 제공하며, 실제 환경에서 주변 조명변화에 강한 코덱을 제공할 수 있다.

이하, 도 1을 참조하여 본 발명에 따른 동작 순서를 설명하면 다음과 같다.
먼저, 단계 S100에서 감백거리 등과 같은 조명 변화가 발생하면 이를 인식하고, 통상의 화면내 부호화를 수행하지 아니하고, 본 발명에 따른 움직임 예측에 따른 패턴 부호화 방법을 수행하도록 인식한다.

단계 S110에서 참조 프레임의 블록 중에 현재 프레임의 블록과 가장 비슷한 패턴을 가진 후보 블록을 검색하기 위하여, 현재 프레임의 블록에 있는 휘도성분의
평균값을 구하여 그 평균값을 각 휘도성분에서 빠주어 현재 프레임 블록의 패턴 블록을 만든다. 그리고 참조 프레임의 블록들도 같은 과정을 통하여 참조 프레임 블록의 패턴 블록을 만든다.

현재 프레임의 블록과 참조 프레임의 블록들의 패턴 블록이 모두 완성되면, 단계 S120에서 패턴 블록끼리의 SAD를 구하고, 최소의 SAD를 보이는 후보 패턴 블록이 최종 움직임 벡터가 된다.

이후, 부호화 효율을 높이기 위하여, 앞에서 산출한 패턴 블록을 사용하게 된다. 즉, 단계 S130에서 최종 움직임 벡터가 가리키는 후보 블록의 패턴 블록과 현재 프레임 블록의 패턴 블록의 차분 신호(이하, 간여 신호라 칭함)를 이산여현변환과 양자화를 수행하여, 많은 비트를 사용하지 않고도 부호화할 수 있다. 여기서, 화소 평균값도 함께 부호화하도록 구성할 수 있다.

그리고 단계 S140에서복호화를 위하여, 함께 부호화된 현재 프레임의 블록의 화소 평균값을 정부하여, 복호화 장치로 전송할 수 있다. 여기서, 상기 화소 평균값은 종래 코딩 방식 또는 향후 개발될 코딩 방식에 따라 부호화하여 전송할 수 있다.

이러한 방법으로 기존에는 화면내 부호화가 불가피했던 블록들을 움직임 예측을 통해 부호화를 하기 때문에 부호화 효율의 향상을 가져올 수 있다.

구체적인 부호화 방법

34-12
이하, 도 2a 및 도 2b를 참조하여 본 발명에 따른 후보화를 위한 구체적인 방법을 설명하기로 한다. 도 2a는 본 발명의 바람직한 실시예에 따른 후보화 장치의 구성품을 도시한 도면이고, 도 2b는 본 발명의 바람직한 실시예에 따른 복호화 장치의 구성품을 도시한 도면이다.

도 2a는 본 발명의 바람직한 실시예에 따른 후보화 장치의 블록 다이어그램을 도시한 도면이다.

본 발명에 따른 후보화 장치는 현재 프레임의 휘도 평균값 산출부(210), 참조 프레임의 휘도 평균값 산출부(220), 움직임 예측부(230) 및 움직임 추정부(240)를 포함한다.

움직임 예측부(230)는 참조 프레임의 블록 중에 현재 프레임의 블록과 가장 비슷한 패턴을 가진 후보 블록을 검색하기 위하여, 현재 프레임의 휘도 평균값 산출부(210)에서 산출한 휘도성분의 평균 값을 구하여 그 평균값을 현재 프레임의 각 휘도성분에서 떨어져 현재 프레임 블록의 패턴 블록을 생성하기 위한 현재 프레임의 패턴 블록화부(231) 및 참조 프레임의 블록들도 같은 과정을 통하여 참조 프레임 블록의 패턴 블록을 생성하기 위한 참조 프레임의 패턴 블록화부(233)를 포함한다.

움직임 벡터 결정부(235)는 현재 프레임의 블록과 참조 프레임의 블록들의 패턴 블록이 모두 완성되면, 패턴 블록거리의 SAD를 구하고, 최소의 SAD를 보이는 후보 패턴 블록을 최종 움직임 벡터를 결정하는 기능을 수행한다.
여기서, 움직임 벡터 결정부(235)의 SAD는 중래 방식과는 상이하게, 블록 패턴의 효율성을 위하여 새로운 수식으로 산출된다.

중래 기술에 따른 최적의 움직임 벡터를 구하기 위한 SAD는 다음과 수학식 1을 이용하여 산출되며, SAD가 가장 작은 후보 블록을 최적의 움직임 벡터로 결정하도록 구성된다.

【수학식 1】

\[
S-1 \sum_{i=0}^{T-1} \sum_{j=0}^{T-1} | f(i,j) - r(i+x, j+y) |
\]

여기서, \( f(i,j) \)는 현재 프레임의 \( i,j \) 좌표에서 확소값, \( r(i,j) \)는 참조 프레임의 \( i,j \) 좌표에서 확소값, \( S \)와 \( T \)는 블록매칭시 사용하는 블록의 크기를 나타낸다. 또한 수학식 1에서 \( (x,y) \)는 움직임벡터를 나타낸다.

반면, 본 발명에 의할 때, 조명 변화로 인한 현재 블록과 후보 블록 간의 오차를 최소화하기 위하여 조명 변화에 영향을 받지 않는 객체의 형태, 즉 패턴을 추출하여야 하는데, 그 방법으로 하기 수학식 2와 같이 각 블록에서 얻어진 평균값을 각 블록에 차분하여 패턴 블록을 생성할 수 있다.

【수학식 2】

\[
\sum_{i=0}^{S-1} \sum_{j=0}^{T-1} | f(i,j) - M_{curr} - r(i+x, j+y) - M_{ref} |
\]

여기서, \( M_{curr} \)과 \( M_{ref} \)는 각각 현재 블록과 참조 프레임의 후보 블록의 확소
평균값을 의미한다.

움직임 보상부(240)는 기존과는 상이한 움직임 보상 산식을 이용하여 움직임 보상을 수행할 수 있다. 움직임 보상부(240)는 잔여 신호를 부호화하기 위해 상기 수학식 2에 의하여 산출한 SAD 계산식으로 획득한 참조 블록을 이용한다. 하기 수학식 3과 같이, 현재 블록과 참조 블록의 각 화소값에 각각의 화소 평균값을 차분하여 움직임 보상을 수행할 수 있다.

【수학식 3】

\[
\text{NewR}(i,j) = f(i,j) - \frac{M_{\text{curr}}}{(r(i+, j+ MV_x) + MV_y) - M_{\text{ref}}}
\]

여기서, NewR은 화소 평균값을 차분한 잔여 신호 (residual signal)를 의미한다. 위와 같이, 각 블록의 평균값으로 차분함으로써 잔여 신호의 평균을 0에 가깝도록 조정하여 조명 변환에 인해 떨어진 압축 효율을 높일 수 있다.

상기 잔여신호(NewR)은 이상현현변환 (DCT)과 양자화 (Quantization)를 거쳐 부호화된 잔여신호(NewR')가 되고, 최종적으로 Entropy Coding과정을 통해 부호화 과정을 마치게 된다.

도 2b는 본 발명의 바람직한 실시예에 따른 부호화 장치의 블록 다이어그램을 도시한 도면이다.
역으로 복호화 과정에서는 상기 부호화된 잔여신호(NewR')는 역량자화 (inverse quantization)와 역이산여현변환(inverse DCT)을 통해 부호된 잔여신호 (NewR'')가 되고 이를 통해 복원(reconstruction)을 수행하게 된다. 하지만, 복호 기에서 복원을 수행하기 위해선 반드시 현재 복호화 중인 블록의 화소 평균값이 필요하다. 그렇기 때문에 현재 블록의 화소 평균값(Mcurr)에 대한 추가적인 정보가 Syntax에 추가되어야 하며, 바람직한 실시에 의할 때, 상기 값을 8bits 고정 길이 코드(8bits fixed length code)로 표시할 수 있다.

복호화 장치의 움직임 보상부(250)는 참조 프레임의 휘도 평균값 산출부 (260)에서 산출한 휘도 평균값과 부호화 장치에서 수신한 움직임 벡터. 현재 블록의 휘도 평균값을 이용하여, 상기 복원된 잔여신호(NewR'')에 대한 복호화를 수행할 수 있다.

결과적으로 역량자화와 역이산여현변환 이후의 복원 과정은 하기의 수학식 4와 같이 나타낼 수 있다.

【수학식 4】

\[ f'(i, j) = r(i + x, j + y) + M_{curr} + M_{ref} \]

여기서, \( f'(i, j) \)는 복호화된 현재 프레임의 \( i, j \) 좌표에서 화소값, \( r(i, j) \)는 참조 프레임의 \( i, j \) 좌표에서 화소값, \((x, y)\)는 움직임 벡터를 지칭한다. 즉, 복원된 잔여신호(NewR'')에 움직임 벡터를 고려한 참조프레임의 화소값을 더한 후, 현재 블록의 화소 평균값을 더하고, 참조 프레임의 후보 블록의 화소 평균값을 빼면, 현
재 프레임의 $i,j$ 좌표에서 화소 값을 산출하여 복호할 수 있다.

여기서, 본 발명에 따른 조명 변화에 적응적인 움직임 예측 방법은 H.264을
포함하는 종래 모든 부호화 및 복호화 방식 뿐만 아니라, 향후 개발될 모든 부호화
및 복호화 방식에 적용할 수 있다. 실시간에 의한 때, 소정의 부호화 방식에 본 발
명이 적용되는 경우, 부호화 모드는 기존 부호화 모드의 두 배가 된다. 이는, 기존
방식에 따른 각 부호화 모드에 대응하여 화소 평균값을 이용한 부호화 모드가 각각
생성되기 때문이다. 따라서, 본 발명을 적용하는 경우, 상기 부호화 모드를 식별하
기 위한 식별자를 플래그 필드 등에 표시하는 단계가 더 추가될 수 있다.

실험 결과

본 발명에 따른 움직임 예측 부호화 방법의 실험 결과를 도면에 도시된 그래
프를 참조하여 설명하기로 한다.

본 논문의 실험은 H.264의 참조부호화기인 JM(joint model)8.2을 이용하여
실행하였으며 16x16 블록 모드만 사용한 경우와 가변 크기 블록(Variable block
size)의 모든 블록 모드(16x16, 16x8, 8x16, 8x8, 8x4, 4x8, 4x4)를 사용한 경우의
움직임 예측 및 보상을 수행하였다. 실험이 사용된 영상은 QVGA(Objects1, Flamenco1)영상, CIF(Paris, Mobile and Calendar), QCIF(Foreman, Container)영상
이다. 여기서, CIF, QCIF영상은 H.264의 실험 권고 영상이고, QVGA영상은 현재
ISO/IEC MPEG에서 EE(exploration experiment)단계에 있는 3DAV(3 Dimensions
audio video)를 연구하고 있는 KDDI corp.에서 만든 실험 영상으로 Objects1영상은

34-17
조명이 감백거림을 반복하고 있으며, Flamencol영상은 조명이 밝아졌다 어두워지는 것을 반복하는 영상이다. 그리고 모든 실험 영상은 300프레임을 갖는 영상으로 첫 프레임만 화면내 부호화를 하고 나머지 프레임은 예측 부호화를 하였다(IPPPP...). 그리고 모든 실험에는 미리 설정된 올 왜곡 최적화 기술을 사용하였다. 제안된 방법은 JM8.2에 구현되어 있는 전체 영역 탐색 기법으로 움직임 예측한 결과의 PSNR(peak signal to noise ratio)과 비교하였다.

도 3a 및 3b를 참조하면, 본 발명에 따른 움직임 예측 방법과 동래 기술에 따른 방법으로 움직임 예측을 수행한 결과에 올 왜곡 평균이 도시되어 있다. 여기서, 가로축은 비트율을 나타내고 세로축은 PSNR을 나타낸다. 도 3a를 참조하면, 16x16 블록 모드만 사용한 경우 비트율이 450kbps일 때 PSNR을 비교하면, 기존의 방법으로 움직임 예측을 한 것에 비해 본 발명에 따른 움직임 예측을 한 경우 0.3dB이상의 화질 향상을 보였다. 마찬가지로, 도 3b 내지 도 5b 역시 비슷한 경향을 나타내고 있다.

기억히, 가변 크기 블록 모드를 사용한 경우에는 16x16모드만 사용한 경우에 비해 약간 작은 성능 향상을 보이는데, 이는 가변 크기 블록을 이용함으로 인해 간여 신호가 어미 축소되었기 때문이라 예상된다.

상술한 바와 같이, 본 발명은 블록들의 평균값으로 패턴 블록을 만들어서 이 패턴 블록을 이용하여 움직임 예측을 하고 패턴 블록간의 차분신호를 부호화하는 기법으로, 조명변화에 적응적으로 움직임 예측하는 기법을 제안하여 부호화 효율의 향상을 보였다. 또한, 실험에 사용한 Objects1이나 Flamencol과 같은 조명의 변화
가 있는 영상에서는 효율적인 비트의 감소를 가져오게 되고, 그 외의 경우에도 비트 감소를 제공하였다.

【발명의 효과】

상술한 바와 같이 본 발명은 조명변화에 적응적인 움직임 예측(motion estimation) 및 움직임 보상(motion compensation)을 통하여, 효율적으로 영상을 부호화 및 복호화할 수 있는 효과가 있다.

또한, 본 발명은 조명 변화에 대하여 화면내 부호화를 수행하지 아니하고, 효율적으로 압축을 수행할 수 있는 효과도 있다.

또한, 본 발명은 실제 환경에서 주변 조명변화에 강한 코덱을 제공할 수 있는 효과도 있다.

상기에서는 본 발명의 바람직한 실시예를 참조하여 설명하였지만, 해당 기술 분야에서 통상의 지식을 가진 자라면 하기의 특허청구의 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】

움직임 예측 방법에 있어서,

(a) 현재 프레임 블록에 대한 현재 프레임 패턴 블록 및 참조 프레임 블록에
대한 참조 프레임 패턴 블록을 생성하는 단계;

(b) 상기 참조 프레임 패턴 블록 중에 상기 현재 프레임 패턴 블록에 대응하
는 후보 패턴 블록에 대한 SAD를 산출하고, 상기 산출된 SAD 중 미리 설정된 조건
에 대응하는 SAD에 대응하는 후보 패턴 블록을 움직임 벡터로 결정하는 단계; 및

(c) 상기 움직임 벡터에 대응하는 후보 패턴 블록과 상기 현재 프레임 패턴
블록의 차분 신호를 이용하여 잔여 신호를 생성한 후, 상기 잔여 신호에 대하여 미
리 설정된 부호화 모드에 따라 이상여현변환과 양자화를 수행하여, 상기 현재 프레
임 블록을 부호화하는 단계;

(d) 부호화된 현재 프레임 블록의 화소 평균값 및 상기 부호화 모드에 대한
식별 정보를 상기 부호화된 현재 프레임 블록에 첨부하는 단계.

을 포함하는 조명 변화에 적응적인 움직임 예측 방법.

【청구항 2】

제1항에 있어서,

상기 (a) 단계는
상기 현재 프레임 블록의 화도 성분 평균값 및 상기 참조 프레임 블록의 화도 성분 평균값을 산출하는 단계; 및

상기 현재 프레임 블록의 화도 성분에서 상기 현재 프레임 블록의 화도 성분 평균값을 차분하여 현재 프레임 패턴 블록을 생성하고, 상기 참조 프레임 블록의 화도 성분에서 상기 참조 프레임 블록의 화도 성분 평균값을 차분하여 참조 프레임 패턴 블록을 생성하는 단계

를 포함하는 것을 조명 변화에 적응적인 움직임 예측 방법.

【청구항 3】

제1항에 있어서,

상기 현재 프레임 블록의 화도 평균값을 부호화하는 단계가 더 포함되는 것을 조명 변화에 적응적인 움직임 예측 방법.

【청구항 4】

제1항에 있어서,

상기 미리 설정된 조건에 대응하는 SAD는 최소의 SAD를 지칭하고, 상기 SAD는 하기 수학식에 의하여 산출되며,

\[
\text{NewSAD}(x, y) = \sum_{i=0}^{S-1} \sum_{j=0}^{T-1} | (f(i, j) - \tilde{M}_{curr}) - (r(i+x, j+y) - \tilde{M}_{ref}) |
\]
여기서, 상기 \( M_{curr} \)은 현재 프레임 블록의 화소 평균값, 상기 \( M_{ref} \)는 상기 후보 패턴 블록의 화소 평균값, 상기 \( f(i, j) \)는 현재 프레임의 \( i,j \) 좌표에서 화소값, 상기 \( r(i, j) \)는 참조 프레임의 \( i,j \) 좌표에서 화소값; 상기 \( S \) 및 상기 \( T \)는 블록 매칭시 사용하는 블록의 크기, 상기 \( (x, y) \)는 움직임 벡터를 지칭하는 것을 특징으로 하는 움직임 예측 방법.

【청구항 5】

제1항에 있어서,

상기 잔여 신호는 하기 수학식에 의하여 산출되며,

\[
\text{NewR}(i, j) = \{ f(i, j) - M_{curr} \} - \{ r(i, j) - (x, y) \} - M_{ref}
\]

여기서, 상기 \( \text{NewR} \)은 상기 잔여 신호, 상기 \( M_{curr} \)은 현재 프레임 블록의 화소 평균값, 상기 \( M_{ref} \)는 상기 후보 블록의 화소 평균값, 상기 \( f(i, j) \)는 현재 프레임의 \( i,j \) 좌표에서 화소값, 상기 \( r(i, j) \)는 참조 프레임의 \( i,j \) 좌표에서 화소값, 상기 \( S \) 및 상기 \( T \)는 블록매칭시 사용하는 블록의 크기, 상기 \( (x, y) \)는 움직임 벡터를 지칭하는 것을 특징으로 하는 움직임 예측 방법.

【청구항 6】

움직임 예측 장치에 있어서,

현재 프레임 블록에 대한 현재 프레임 패턴 블록 및 참조 프레임 블록에 대
한 참조 프레임 패턴 블록을 생성하기 위한 패턴 블록 생성부;

상기 참조 프레임 패턴 블록 중에 상기 현재 프레임 패턴 블록에 대응하는 후보 패턴 블록에 대한 SAD를 산출하고, 상기 산출된 SAD 중 미리 설정된 조건에 대응하는 SAD에 대응하는 후보 패턴 블록을 움직임 벡터로 결정하기 위한 움직임 벡터 결정부;

상기 움직임 벡터에 대응하는 후보 패턴 블록과 상기 현재 프레임 패턴 블록의 차분 신호를 이용하여 잔여 신호를 생성하기 위한 움직임 보상부; 및

부호화된 현재 프레임 블록의 화소 평균값 및 상기 부호화 모드에 대한 식별 정보를 상기 부호화된 현재 프레임 블록에 첨부하는 수단

을 포함하는 조명 변화에 적응적인 움직임 예측 장치.

【청구항 7】

제6항에 있어서,

상기 패턴 블록 생성부는

상기 현재 프레임 블록의 휘도 성분 평균값 및 상기 참조 프레임 블록의 휘도 성분 평균값을 산출하고, 상기 현재 프레임 블록의 휘도 성분에서 상기 현재 프레임 블록의 휘도 성분 평균값과 차분하여 현재 프레임 패턴 블록을 생성하고, 상기 참조 프레임 블록의 휘도 성분에서 상기 참조 프레임 블록의 휘도 성분 평균값을 차분하여 참조 프레임 패턴 블록을 생성하는 것을 조명 변화에 적응적인 움직임
예측 장치.

【청구항 8】

제6항에 있어서,

장기 잔여 신호에 대한 이상여현변환과 양자화를 수행하는 수단을 더 포함하는 것을 조명 변화에 적응적인 움직임 예측 장치.

【청구항 9】

제6항에 있어서,

장기 미리 설정된 조건에 대응하는 SAD는 최소의 SAD를 지칭하고, 장기 움직임 벡터 결정부는 하기 수학식에 의하여 장기 SAD를 산출하며,

\[
NewSAD(x, y) = \sum_{i=0}^{S-1} \sum_{j=0}^{T-1} | f(i, j) - \frac{M_{curr}}{(r(i+x, j+y) - M_{ref})} |
\]

여기서, 장기 Mcurr은 현재 프레임 블록의 화소 평균값, 장기 Mref는 장기 후보 패턴 블록의 화소 평균값, 장기 f(i, j)는 현재 프레임의 i, j 좌표에서 화소값, 장기 r(i, j)는 참조 프레임의 i, j 좌표에서 화소값, 장기 S 및 장기 T는 블록 매칭시 사용하는 블록의 크기, 장기 (x, y)는 움직임벡터를 지칭하는 것을 특정으로 하는 움직임 예측 장치.
【청구항 10】

제6항에 있어서,

상기 움직임 보상부는 하기 수학식에 의하여 상기 잔여 신호를 산출하며,

여기서, 상기 NewR은 상기 잔여 신호, 상기 Mcurr은 현재 프레임 블록의 화소 평균값, 상기 Mref는 상기 후보 패턴 블록의 화소 평균값, 상기 f(i, j)는 현재 프레임의 i,j 좌표에서 화소값, 상기 r(i,j)는 참조 프레임의 i,j 좌표에서 화소값, 상기 S 및 상기 T는 블록매칭시 사용하는 블록의 크기, 상기 (x,y)는 움직임벡터를 지정하는 것을 특정으로 하는 움직임 예측 장치.
Objects1 (QVGA, 10Hz)

![Graph showing PSNR vs Bitrates for different encoding methods.]

- JM82
- Proposed ME

- JM82 using VBS
- Proposed ME using VBS
【도 3b】

Flamenco1(QVGA, 10Hz)

- JMB2
- Proposed ME

Bitrates(kbps)

PSNR(dB)

39
38.8
38.6
38.4
38.2
38

135
145
155
165

- JMB2 using VBS
- Proposed ME using VBS

Bitrates(kbps)

PSNR(dB)

39.7
39.5
39.3
39.1
38.9
38.7
Mobile & Calendar (CIF, 10Hz)

- JMB2
- Proposed ME

PSNR (dB) vs Bitrates (kbps)

JMB2 using VBS
Proposed ME using VBS

PSNR (dB) vs Bitrates (kbps)
【도 5b】

Foreman(QCIF, 10Hz)

- JMB2
- Proposed ME

- JMB2 using VBS
- Proposed ME using VBS
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출원 번호 : 10-2005-0003949
Application Number

출원 년월일 : 2005년 01월 14일
Date of Application

출원 인 : 주식회사 휴맥스
Applicant(s)

2005년 11월 16일

COMMISSIONER

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【서류명】  특허출원서
【권리구분】  특허
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【제출일자】  2005.01.14
【발명의 국문명칭】  조명 변화에 대한 적응적 움직임 예측/보상 장치 및 방법
【발명의 영문명칭】  Adaptive motion estimation/compensation device for illumination change and method thereof
【출원인】
【명칭】  (주)휴맥스
【출원인코드】  1-1998-000063-1
【대리인】
【성명】  이경란
【대리인코드】  9-1998-000651-6
【포괄위임등록번호】  2004-073908-7
【발명자】
【성명의 국문표기】  이영렬
【성명의 영문표기】  LEE, Yung-Lyu
【주민등록번호】  611030-1047211
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【취지】 특허법 제42조의 규정에 의하여 위와 같이 출원합니다. 대 리인 이경

【수수료】
| [기본출원료] | 0 면 | 38,000 원 |
| [가산출원료] | 40 면 | 0 원 |
| [우선권주장료] | 0 건 | 0 원 |
| [심사청구료] | 0 항 | 0 원 |
| [합계] | 38,000 원 |
| [감면사유] | 중소기업 |
| [감면후 수수료] | 19,000 원 |

【첨부서류】 1. 중소기업기본법 시행령 제2조에 의한 중소기업에 해당함을 증명하는 서류_1동 2. 기타첨부서류 [중소기업기본법]_1동

42-2
【요약서】

【요약】

본 발명은 조명 변화에 대한 적응적 움직임 예측/보상 장치 및 방법에 관한 것이다. 본 발명에 따른 상기 움직임 예측 방법은 현재 프레임 패턴 블록 및 참조 프레임 패턴 블록을 생성하는 단계; (b) 참조 프레임 패턴 블록 중에서 현재 프레임 패턴 블록에 대응하는 후보 패턴 블록에 대한 SAD를 산출하고, 미리 설정된 조건에 대응하는 SAD에 대응하는 후보 패턴 블록을 움직임 벡터로 결정하는 단계; (c) 움직임 벡터에 대응하는 후보 패턴 블록과 현재 프레임 패턴 블록의 차분 신호를 이용하여 잔여 신호를 생성한 후, 미리 설정된 부호화 모드에 따라 이산여현변환과 양자화를 수행하여, 현재 프레임 블록을 부호화하는 단계; 및 (d) 부호화된 현재 프레임 블록에 적용되는 화소 평균값 포함 여부를 나타내는 플래그 정보 및 상기 부호화 모드에 대한 식별 정보를 상기 부호화된 현재 프레임 블록에 상응하는 헤더 정보로 첨부하는 단계를 포함하여 구성된다. 따라서, 본 발명에 의하여 임의의 필드에 대해서는 화소 평균값의 삽입을 생략함으로써 복호화를 위해 복호화기로 전송되는 비트스트림의 전송량을 최소화할 수 있다.

【대표도】

도 1
【색인어】

예측 부호화, 움직임 예측, 움직임 보상, SAD, 조명
【명세서】

【발명의 명칭】
조명 변화에 대한 적응적 움직임 예측/보상 장치 및 방법(Adaptive motion estimation/compenensation device for illumination change and method thereof)

【도면의 간단한 설명】

1. 도 1은 본 발명의 바람직한 실시예에 따른 적응적 움직임 예측 방법의 동작 순서를 도시한 도면.

2. 도 2a는 본 발명의 바람직한 일 실시예에 따른 부호화 장치의 구성을 도시한 도면.

3. 도 2b는 본 발명의 바람직한 일 실시예에 따른 임의의 불록에 대한 좌표 평균값 산입을 생략하기 위한 방법을 나타낸 도면.

4. 도 2c는 본 발명의 바람직한 일 실시예에 따른 부호화 장치의 구성을 도시한 도면.

5. 도 3a 및 5b는 본 발명에 따른 움직임 예측 방법과 종래 기술에 따른 방법으로 움직임 예측을 수행한 결과에 의한 율-왜곡 곡선을 도시한 도면.

6. <도면의 주요 부분에 대한 부호의 설명>

7. 210: 현재 프레임의 화도 평균값 산출부
220: 참조 프레임의 회도 평균값 산출부

230: 움직임 예측부

231: 현재 프레임의 패턴 복록화부

233: 참조 프레임의 패턴 복록화부

235: 움직임 벡터 결정부

240: 움직임 추정부

【발명의 상세한 설명】

【발명의 목적】

【발명이 속하는 기술분야 및 그 분야의 종래기술】

본 발명은 조명 변화에 대한 적응적 움직임 예측 방법 및 장치에 관한 것으로, 보다 상세하게는 조명 변화에 적응적인 움직임 예측(ME: motion estimation) 및 움직임 보상(MC: motion compensation)을 통하여 효율적으로 영상 을 부호화 및 복호화할 수 있는 방법 및 장치에 관한 것이다.

종래 기술에 의할 때, ITU-T와 ISO/IEC에서는 영상의 부호화 효율성을 향상시키는 과정에서, H.26x 시리즈와 MPEG-x 시리즈를 발표하였다. 그리고 2003년도에는 H.264(MPEG-4 part 10 Advanced Video Coding)를 완성시키면서 많은 비트를 절감할 수 있게 되었다. 이러한 비디오 부호화 표준이 발전하면서 블록 기반 움직임 예측(BMME: block matching motion estimation)에 관한 연구도 많았으며, 이를 위
한 대부분의 방법은 현재 프레임(current frame)의 블록과 참조 프레임(reference frame)의 후보 블록의 절대값 차의 합(SAD : sum of absolute differences - 이하 "SAD"라 함)들을 구하여 가장 작은 SAD를 보이는 참조 프레임의 후보 블록의 위치를 현재 프레임의 블록의 움직임 벡터(motion vector)로 결정하도록 구성된다.

그리고 그 후보 블록과 현재 프레임의 블록간의 차분 신호(residual)들을 이산여행변환(DCT : discrete cosine transform)과 양자화(quantization)를 하여 움직임 벡터와 같이 가변장 부호화(VLC : variable length coding)를 수행한다. 여기서, 움직임 벡터를 찾는다는 것은 현재 프레임과 참조 프레임의 시간적 중복성(temporal redundancy)을 제거하여 획득하는 것이므로, 상당한 부호화 효율을 가져왔으나 다음과 같은 문제점이 있다.

다시금 비디오 코딩(multi-view video coding)시 동일한 시간 축에서 다른 카메라를 통해 입력된 프레임들(inter-views) 간에 혹은 연속된 시간축에서 동일한 카메라를 통해 입력되는 프레임들(same-views)간에 조도(illumination)가 변경되는 경우(예를 들어, 영상 내에 장면변화(scene change) 또는 조명이 서서히 어두워지거나 밝아지거나 또는 감각거리가 있는 경우), 종래 기술에 의하여 블록간의 SAD를 계산하여 최소의 SAD를 찾아 차분신호를 부호화하면 부호화에 사용되는 비트가 많이 필요하여, 압축률이 급격히 저하되는 문제점이 있었다.

일반적으로 장면변화가 있으면 변화된 그 프레임은 화면내 부호화(intra)를 하는 것이 움직임 예측(motion estimation)과 움직임 보상(motion compensation)을 하는 것보다 더욱 효과적이다. 그 이유는 참조 프레임의 탐색 영역 내 어느 곳에서
도 현재 프레임의 블록의 패턴을 찾아볼 수 없기 때문이다. 마찬가지로, 조명의 변
화나 검박거림에서도 같은 방법으로 움직임 예측을 하여 차분신호를 부호화하게 되면
유사한 결과가 나온다. 그래서 이 경우에서도 화면내 부호화를 하는 경우가 많
다. 하지만 이 경우 장면변화는 없었으므로, 참조 프레임에서 현재 프레임의 블록
과 비슷한 패턴을 가진 블록을 찾을 수 있으나, 그 블록과 현재 프레임의 블록의
차분을 부호화하더라도 많은 비트를 필요로 하는 문제점이 발생한다.

【발명이 이루고자 하는 기술적 과제】

따라서 본 발명은 상기의 제반 문제점을 해결하기 위하여 안술한 것으로서,
조명변화에 적응적인 움직임 예측(ME : Motion Estimation) 및 움직임 보상(MC :
Motion Compensation)을 통하여 보다 효율적으로 영상을 부호화 및 복호화할 수 있
는 조명 변화에 대한 적응적 움직임 예측/보상 장치 및 방법을 제공하기 위한 것이
다.

본 발명의 다른 목적은 임의의 필드에 대해서는 화소 평균값의 산입을 생략
함으로써 부호화를 위해 부호화기로 전송되는 비트스트림의 전송량을 최소화할 수
있는 조명 변화에 대한 적응적 움직임 예측/보상 장치 및 방법을 제공하기 위한 것
이다.

또한, 본 발명의 또 다른 목적은 조명 변화에 대하여 화면내 부호화(intra)
를 수행하지 아니하고 효율적으로 압축을 수행할 수 있는 조명 변화에 대한 적응적
움직임 예측/보상 장치 및 방법을 제공하기 위한 것이다.

또한, 본 발명의 또 다른 목적은 실제 환경에서 주변 조명 변화에 강한 코덱을 제공함에 있으며, 그 외의 다른 본 발명의 목적들은 이하에 서술되는 바람직한 실시예를 통하여 보다 명확해질 것이다.

【발명의 구성】

상술한 목적을 달성하기 위하여 본 발명의 제 1측면에 따르면, 조명 변화에 대한 적응적 움직임 예측 방법을 제공할 수 있다.

바람직한 일 실시예에 의할 때, 상기 움직임 예측 방법은 (a) 현재 프레임 블록에 대한 현재 프레임 패턴 블록 및 참조 프레임 블록에 대한 참조 프레임 패턴 블록을 생성하는 단계; (b) 상기 참조 프레임 패턴 블록 중에 상기 현재 프레임 패턴 블록에 대응하는 후보 패턴 블록에 대한 SAD를 산출하고, 상기 산출된 SAD 중 미리 설정된 조건에 대응하는 SAD에 대응하는 후보 패턴 블록을 움직임 벡터로 결정하는 단계; (c) 상기 움직임 벡터에 대응하는 후보 패턴 블록과 상기 현재 프레임 패턴 블록의 차분 신호를 이용하여 잔여 신호를 생성한 후, 상기 잔여 신호에 대하여 미리 설정된 부호화 모드에 따라 이산화현변환과 양자화를 수행하여, 상기 현재 프레임 블록을 부호화하는 단계; 및 (d) 부호화된 현재 프레임 블록에 적용되는 화소 평균값 포함 여부를 나타내는 플래그 정보 및 상기 부호화 모드에 대한 식별 정보를 상기 부호화된 현재 프레임 블록에 상응하는 헤더 정보로 함께하는 단계.
을 포함하여 구성된다. 이때, 상기 플래그 정보에 의해 상기 현재 프레임 블록에 적용될 화소 평균값 포함 여부가 식별되는 것을 특정으로 한다.

또한, 상기 현재 프레임 블록은 16x16, 16x8, 8x16, 8x8, 8x4, 4x8 또는 4x4 중 적어도 어느 하나의 형태로 설정될 수 있다.

그리고, 상기 플래그 정보가 화소 평균값을 포함하지 않음을 표시하는 경우, 상기 현재 프레임 블록에 적용되는 화소 평균값은 주변에 위치하는 블록들 중 n개의 블록에 상응하는 화소 평균값들의 평균값이 이용될 수 있다.

또한, 상기 플래그 정보가 화소 평균값을 포함하지 않고, 상기 헤더 정보가 주변에 위치하는 블록들 중 임의의 블록에 상응하는 화소 평균값을 이용하도록 지시하는 부가 정보를 더 포함하는 경우, 상기 현재 프레임 블록에 적용되는 화소 평균값은 상기 부가 정보에 상응하는 블록의 화소 평균값이 이용될 수 있다.

또한, 상기 움직임 예측 방법의 상기 (a) 단계는 상기 현재 프레임 블록의 휘도 성분 평균값 및 상기 참조 프레임 블록의 휘도 성분 평균값을 산출하는 단계; 및 상기 현재 프레임 블록의 휘도 성분에서 상기 현재 프레임 블록의 휘도 성분 평균값을 차분하여 현재 프레임 패턴 블록을 생성하고, 상기 참조 프레임 블록의 휘도 성분에서 상기 참조 프레임 블록의 휘도 성분 평균값을 차분하여 참조 프레임 패턴 블록을 생성하는 단계를 포함할 수 있다.

또한, 상기 움직임 예측 방법은 상기 현재 프레임 블록의 화소 평균값을 부호화하는 단계를 더 포함할 수 있다.
상기 미리 설정된 조건에 대응하는 SAD는 최소의 SAD를 지칭하고, 상기 SAD는 수학식

$$\text{NewSAD}(x, y) = \sum_{i=0}^{U-1} \sum_{j=0}^{V-1} |f(i, j) - M_{\text{curr}} - [r(i + x, j + y) - M_{\text{ref}}]|$$

에 의하여 산출될 수 있다. 여기서, 상기 M\text{curr}은 현재 프레임 블록의 화소 평균값, 상기 M\text{ref}는 상기 후보 페턴 블록의 화소 평균값, 상기 f(i, j)는 현재 프레임의 (i, j) 좌표에서 화소값, 상기 r(i + x, j + y)는 참조 프레임의 (i + x, j + y) 좌표에서 화소값, 상기 U 및 상기 V는 블록 매칭시 사용하는 블록의 크기, 상기 (x, y)는 움직임벡터를 지칭하는 것을 특징으로 한다.

또한, 상기 잔여 신호는 수학식

$$\text{NewR}(i, j) = \left[ f(i, j) - M_{\text{curr}} \right] - \left[ r(i + M V_x, j + M V_y) - M_{\text{ref}} \right]$$

$$= f(i, j) - r(i + M V_x, j + M V_y) - M_{\text{curr}} + M_{\text{ref}}$$

에 의하여 산출될 수 있다. 여기서, 상기 NewR은 상기 잔여 신호, 상기 M\text{curr}은 현재 프레임 블록의 화소 평균값, 상기 M\text{ref}는 상기 후보 페턴 블록의 화소 평균값, 상기 f(i, j)는 현재 프레임의 (i, j) 좌표에서 화소값, 상기 r(i, j)는 참조 프레임의 (i, j) 좌표에서 화소값, 상기 (x, y)는 움직임벡터를 지칭하는 것을 특징으로 한다.

상술한 목적을 달성하기 위하여 본 발명의 제2측면에 따르면, 조명 변화에 대한 적응적 움직임 예측 장치를 제공할 수 있다.
바람직한 일 실시에 의할 때, 상기 움직임 예측 장치는 현재 프레임 블록에 대한 현재 프레임 패턴 블록 및 참조 프레임 블록에 대한 참조 프레임 패턴 블록을 생성하기 위한 패턴 블록 생성부; 상기 참조 프레임 패턴 블록 중에 상기 현재 프레임 패턴 블록에 대응하는 후보 패턴 블록에 대한 SAD를 산출하고, 상기 산출된 SAD 중 미리 설정된 조건에 대응하는 SAD에 대응하는 후보 패턴 블록을 움직임 벡터로 결정하기 위한 움직임 벡터 결정부; 상기 움직임 벡터에 대응하는 후보 패턴 블록과 상기 현재 프레임 패턴 블록의 차분 신호를 이용하여 잔여 신호를 생성하기 위한 움직임 보상부; 및 부호화된 현재 프레임 블록에 적용되는 화소 평균값 포함 여부를 나타내는 플래그 정보 및 상기 부호화 모드에 대한 식별 정보를 상기 부호화된 현재 프레임 블록에 상응하는 헤더 정보로 첨부하는 수단을 포함하여 구성된다. 여기서, 상기 플래그 정보에 의해 상기 현재 프레임 블록에 적용될 화소 평균값 포함 여부가 식별되는 것을 특징으로 한다.

상기 플래그 정보가 화소 평균값을 포함하지 않음을 표시하는 경우, 상기 현재 프레임 블록에 적용되는 화소 평균값은 주변에 위치하는 블록들 중 n개의 블록에 상응하는 화소 평균값들의 평균값이 이용되는 것을 특징으로 한다.

또한, 상기 플래그 정보가 화소 평균값을 포함하지 않고, 상기 헤더 정보가 주변에 위치하는 블록들 중 임의의 블록에 상응하는 화소 평균값을 이용하도록 지시하는 부가 정보를 더 포함하는 경우, 상기 현재 프레임 블록에 적용되는 화소 평균값은 상기 부가 정보에 상응하는 블록의 화소 평균값이 이용되는 것을 특징으로 한다.
상기 패턴 블록 생성부는 상기 현재 프레임 블록의 휘도 성분 평균값 및 상기 참조 프레임 블록의 휘도 성분 평균값을 산출하고, 상기 현재 프레임 블록의 휘도 성분 평균값을 차분하여 현재 프레임 패턴 블록을 생성하고, 상기 참조 프레임 블록의 휘도 성분에서 상기 참조 프레임 블록의 휘도 성분 평균값을 차분하여 참조 프레임 패턴 블록을 생성하는 것을 특징으로 한다.

또한, 상기 잔여 신호에 대한 이산역현환환과 양자화를 수행하는 수단을 더 포함할 수 있다.

상기 미리 설정된 조건에 대응하는 SAD는 최소의 SAD를 지칭하고, 상기 SAD는 수학식

\[
NewSAD(x,y) = \sum_{i=0}^{U-1} \sum_{j=0}^{V-1} |[f(i,j)-M_{curr}] - [r(i+x,j+y)-M_{ref}]|
\]

의하여 산출될 수 있다. 여기에서, 상기 \(M_{curr}\)은 현재 프레임 블록의 화소 평균값, 상기 \(M_{ref}\)는 상기 후보 패턴 블록의 화소 평균값, 상기 \(f(i,j)\)는 현재 프레임의 \((i,j)\) 좌표에서 화소값, 상기 \(r(i+x,j+y)\)는 참조 프레임의 \((i+x,j+y)\) 좌표에서 화소값, 상기 \(U\) 및 상기 \(V\)는 블록 매칭시 사용하는 블록의 크기, 상기 \((x,y)\)는 움직임벡터를 지칭하는 것을 특징으로 한다.

또한, 상기 잔여 신호는 수학식
$$\text{NewR}(i,j) = [f(i,j)-M_{\text{curr}}]-[r(i+MV_x,j+MV_y)-M_{\text{ref}}]$$

$$= f(i,j)-r(i+MV_x,j+MV_y)-M_{\text{curr}} + M_{\text{ref}}$$

이하, 점북한 도면들을 참조하여 본 발명에 따른 조명 변화에 대한 적응적 움직임 예측/보상 장치 및 방법의 바람직한 실시예를 상세히 설명하기로 하며, 점북 도면을 참조하여 설명함에 있어 도면 부호에 상관없이 동일하거나 대응하는 구성 요소는 동일한 참조번호를 부여하고 이에 대한 중복되는 설명은 생략하기로 한다.

본 발명에 의한 적응적 움직임 예측 방법에 의하면, 영상에서 조명이 변화하거나 감박거리는 경우 이를 인식하여, 화면내 부호화(intra)를 하지 않고 패턴이 가장 비슷한 블록을 검색하여 부호화하도록 구성된다.
즉, 본 발명은 조명이 변화하면서 블록의 회도 성분(Y)의 값이 전체적으로 올라가거나 내려가는 것에 착안하여, 현재 블록의 회도 성분 평균값을 구하고, 각 회도 성분값과 구한 평균값을 차분하여 새로운 패턴 블록(pattern block)을 생성하고, 참조 프레임에서도 같은 과정을 통해 참조 패턴 블록을 생성한다.

본 발명은 이와 같이 생성된 현재 패턴 블록과 참조 패턴 블록 사이에서 움직임 예측을 수행하여 부호화하는 방법(이하 재부호화라 칭함)이다. 본 발명에 따르면, 동일한 비트율에서 객관적 화질(PSNR)은 0.1dB~0.3dB이상의 향상이 되는 결과를 제공하며, 실제 환경에서 주변 조명변화에 강한 코덱을 제공할 수 있다.

이하, 도 1을 참조하여 본 발명에 따른 동작 순서를 설명하면 다음과 같다.

먼저, 단계 S100에서 감지기림 등과 같은 조명 변화가 발생하면 이를 인식하고, 통상의 화면내 부호화를 수행하지 아니하고, 본 발명에 따른 움직임 예측에 따른 패턴 부호화 방법을 수행하도록 인식한다.

단계 S110에서 참조 프레임의 블록 중에 현재 프레임의 블록과 가장 비슷한 패턴을 가진 후보 블록을 검색하기 위하여, 현재 프레임의 블록에 있는 회도 성분(Y)의 평균값을 구하여 그 평균값을 각 회도 성분에서 평균화 하여 현재 프레임 블록의 패턴 블록을 만든다. 그리고 참조 프레임의 블록들도 같은 과정을 통하여 참조 프레임 블록의 패턴 블록을 만든다.

현재 프레임의 블록과 참조 프레임의 블록들의 패턴 블록이 모두 완성되면, 단계 S120에서 패턴 블록끼리의 SAD를 구하고, 최소의 SAD를 보이는 후보 패턴 블록의
록이 최종 음직임 벡터가 된다.

이후, 부호화 효율을 높이기 위하여, 앞서 산출한 패턴 블록이 사용된다. 즉, 단계 S130에서 최종 음직임 벡터가 가리키는 후보 블록의 패턴 블록과 현재 프레임 블록의 패턴 블록의 차분 신호(이하, 잔여 신호라 칭함)를 이산표현변환(DCT : discrete cosine transform)과 양자화(quantization)를 수행하여, 많은 비트를 사용하지 않고도 부호화할 수 있다. 여기서, 화소 평균값도 함께 부호화하도록 구성할 수 있다.

그리고 단계 S140에서 복호화를 위하여, 함께 부호화된 현재 프레임의 블록의 화소 평균값을 첨부하여, 복호화 장치로 전송할 수 있다. 여기서, 상기 화소 평균값은 중대 코딩 방식 또는 향후 개발될 코딩 방식에 따라 부호화하여 전송할 수 있다. 이때, 당해 블록은 16x16, 16x8, 8x16, 8x8, 8x4, 4x8 또는 4x4의 형태로 설정될 수 있으며, 임의의 블록 단위에 대한 화소 평균값의 전송을 생략함으로써 전송되는 비트스트림의 양을 감소시킬 수 있다.

이러한 방법으로 기존에는 화면내 부호화가 불가피했던 블록들을 음직임 예측을 통해 부호화를 하기 때문에 부호화 효율의 향상을 가져올 수 있다.

이하, 도 2a 내지 도 2c를 참조하여 본 발명에 따른 부호화 및 복호화를 위한 구체적인 방법을 설명하기로 한다. 도 2a는 본 발명의 바람직한 일 실시예에 따른 부호화 장치의 구성도도시한 도면이고, 도 2b는 본 발명의 바람직한 일 실시예에 따른 임의의 블록에 대한 화소 평균값 삽입을 생략하기 위한 방법을 나타낸 도.
면이며, 도 2c는 본 발명의 바람직한 일 실시예에 따른 복호화 장치의 구성을 도시한 도면이다.

<53> 도 2a는 본 발명의 바람직한 일 실시예에 따른 부호화 장치의 블록 다이어그램을 도시한 도면이다.

<54> 본 발명에 따른 부호화 장치는 현재 프레임(current frame)의 화소 평균값 산출부(210), 참조 프레임(reference frame)의 화소 평균값 산출부(220), 움직임 예측부(230) 및 움직임 추정부(240)를 포함한다.

<55> 움직임 예측부(230)는 참조 프레임의 블록 중에 현재 프레임의 블록과 가장 비슷한 패턴을 가진 후보 블록을 검색하기 위하여, 화소 평균값 산출부(210)에 의해 산출된 현재 프레임의 화소성분의 평균값을 현재 프레임의 각 화소 성분에서 빠져 주어 현재 프레임 블록의 패턴 블록을 생성하기 위한 현재 프레임의 패턴 블록화부 (231) 및 참조 프레임의 블록들도 같은 과정을 통하여 참조 프레임 블록의 패턴 블록을 생성하기 위한 참조 프레임의 패턴 블록화부(233)를 포함한다.

<56> 이때, 현재 프레임 화소 평균값 산출부(210)는 현재 블록의 화소 평균값을 의미하는 Mcurr을 비트스트림의 헤더 내에 삽입하여 복호기로 전송한다. 이는 복호기에서 복원을 수행하기 위해선 반드시 현재 복호화 중인 블록의 화소 평균값이 필요하기 때문이다. 예를 들어, 비트스트림의 헤더 내에 삽입되는 8비트 정보인 Mcurr은 블록 타입(Macroblock type) 필드 후단에 삽입될 수 있다.

<57> 또한, 이하에서 설명되는 바와 같이 임의의 블록에 대해서는 Mcurr의 삽입을 생략함으로써 전송되는 비트스트림의 양을 최소화할 수도 있다. 이 경우에는 해당

42-17
블록에 적용될 Mcurr을 복호기에서 인식할 수 있도록 하는 1비트의 플래그 정보가 삽입될 수 있으며, 플래그 정보는 블록 타입 필드 후단에 삽입될 수 있다. Mcurr의 삽입을 생각한 경우 복호기에서 플래그 정보를 통해 다른 블록에 상응하는 Mcurr을 이용하여 현재 복호화중인 블록의 Mcurr을 인식하여 적용하는 다양한 방법 중 몇 가지 방법을 예시하면 다음과 같다.

먼저, 플래그 정보가 예를 들어 1로 설정한 블록에 대해서는 Mcurr의 삽입을 생각하여 복호기로 비트스트림을 전송하면, 복호기가 플래그 정보가 1로 설정된 블록(240)에 대해서는 이미 복호화된 주변의 블록의 평균을 이용하도록 함으로써 해당 블록을 복호화할 수 있다. 도 2b에서 플래그 1에 상응하는 블록(240)을 복호화하기 위하여 주변에 위치하며 이미 복호화된 블록들의 Mcurr값들, 예를 들어 Mcurr-1, Mcurr-2 및 Mcurr-3의 평균값을 해당 블록(240)의 Mcurr로 활용할 수 있다. 물론, 평균값 산출을 위한 블록의 수 및 위치는 다양하게 설정될 수 있다.

다음으로, 플래그 정보가 예를 들어 1로 설정한 블록(245)에 대해서는 Mcurr의 삽입을 생각하고 주변에 존재하고 이미 복호화된 블록의 Mcurr을 이용하여 해당 블록을 복호화하도록 하도록 지시하는 1비트의 지시값이 후행하도록 함으로써 비트스트림의 전송량을 감소시킬 수도 있다. 즉, 도 2b에서 플래그 1에 상응하는 블록(245)을 복호화하기 위하여 주변에 위치하며 이미 복호화된 블록들의 Mcurr값들, 예를 들어 Mcurr-1 및 Mcurr-2 중 해당 블록(245)에 대해 산출된 Mcurr간의 차를 산출하여 차이값이 적은 블록의 Mcurr을 이용하도록 하는 방법이다. 예를 들어, Mcurr-1과
해당 블록의 Mcur라간의 차를 d1이라 하고, Mcur-2가 해당 블록의 Mcur라간의 차를 d2라 할때, d1이 적은 경우 Mcur-1을 해당 블록(245)의 Mcur로 이용하도록 하는 부가 정보를 플래그 정보 후단에 삽입할 수 있다. 물론, 차이값 산출을 위한 블록의 범위는 다양하게 설정될 수 있다. 또한 별도의 1비트의 부가 정보가 아닌 상응하는 블록의 8비트 Mcur 자체가 삽입될 수도 있음을 자명하다.

다만, 이하에서는 부호화기에서 복호화기로 Mcur이 전송되는 경우를 중심으로 설명한다.

음직임 벡터 결정부(235)는 현재 프레임의 블록과 참조 프레임의 블록들의 패턴 블록이 모두 완성되면, 패턴 블록거리의 SAD를 구하고, 최소의 SAD를 보이는 후보 패턴 블록을 이용하여 최종 음직임 벡터를 결정하는 기능을 수행한다.

여기서, 음직임 벡터 결정부(235)의 SAD는 종래 방식과는 상이하게, 블록 패턴의 효율성을 위하여 새로운 수식에 의하여 산출된다.

먼저, 종래 기술에 따른 최적의 음직임 벡터를 구하기 위한 SAD는 다음과 수학식 1을 이용하여 산출되며, SAD가 가장 작은 후보 블록을 최적의 음직임 벡터로 결정하도록 구성된다.

【수학식 1】

\[
SAD(x, y) = \sum_{i=0}^{S-1} \sum_{j=0}^{T-1} |f(i,j) - r(i+x,j+y)|
\]

여기서, \(f(i, j)\)는 현재 프레임의 \((i, j)\) 좌표에서 화소값, \(r(i, j)\)는 참조
프레임의 \((i, j)\) 좌표에서 화소값, \(S\)와 \(T\)는 블록 매칭시 사용하는 블록의 크기를 나타낸다. 또한 수학식 1에서 \((x,y)\)는 움직임 벡터(motion vector)를 나타낸다.

반면, 본 발명에 의할 때, 조명 변화로 인한 현재 블록과 후보 블록 간의 오차를 최소화하기 위하여 조명 변화에 영향을 받지 않는 객체의 형태, 즉 패턴을 추출하여야 한다. 따라서, 상술한 수학식 1과는 다른 방법, 즉 하기 수학식 2와 제시된 바와 같이 각 블록에서 얻어진 평균값을 각 블록에 차분하여 패턴 블록을 생성한다.

【수학식 2】

\[
NewSAD(x,y) = \sum_{i=0}^{U-1} \sum_{j=0}^{V-1} \left| f(i,j) - M_{curr} \right| - \left| r(i+x,j+y) - M_{ref} \right|
\]

여기서, \(M_{curr}\)는 현재 블록의 화소 평균값을 의미하고, \(M_{ref}\)는 참조 프레임의 후보 블록의 화소 평균값을 의미한다. 예를 들어, \(U\)와 \(V\)는 각각 16 또는 8로 설정될 수 있다. \(U\times V\) 블록들의 차분 신호(difference signal)들은 H.264 표준에서 보여지는 바와 같이 4x4 DCT 및 양자화에 의해 코딩될 수 있다.

움직임 보상부(240)는 기존과는 상이한 움직임 보상 신식을 이용하여 움직임 보상을 수행할 수 있다. 움직임 보상부(240)는 잔여 신호를 부호화하기 위해 상기 수학식 2에 의하여 산출한 SAD 계산식으로 획득한 참조 블록을 이용한다. 하기 수학식 3과 같이, 현재 블록과 참조 블록의 각 화소값에 각각의 화소 평균값을 차분하여 움직임을 보상을 수행할 수 있다.
【수학식 3】

\[ NewR(i,j) = [f(i,j) - M_{\text{curr}}] - [r(i + MV_x j + MV_y) - M_{\text{ref}}] \]

\[ = f(i,j) - r(i + MV_x j + MV_y) - M_{\text{curr}} + M_{\text{ref}} \]

여기서, NewR은 화소 평균값을 차분해준 잔여 신호 (residual signal)를 의미한다. 위와 같이, 각 블록의 평균값으로 차분함으로써 잔여 신호의 평균을 0에서 가깝도록 조정하여 조명 변화로 인해 떨어진 압축 효율을 높일 수 있다.

상기 잔여신호 (NewR)은 이산여현변환 (DCT)과 양자화 (Quantization)를 거쳐 부호화된 잔여신호 (NewR')가 되고, 최종적으로 Entropy Coding 과정을 통해 부호화 과정이 종료된다.

도 2c는 본 발명의 바람직한 실시예에 따른 부호화 장치의 블록 다이어그램을 도시한 도면이다.

역으로, 복호화 과정에서는 상기, 부호화된 잔여신호 (NewR')는 역양자화 (inverse quantization)와 역이산여현변환 (inverse DCT)을 통해 복원된 잔여신호 (NewR'')가 되고 이를 통해 복원 (reconstruction)을 수행하게 된다. 하지만, 복호기에서 복원을 수행하기 위해선 반드시 현재 복호화 중인 블록의 화소 평균값이 필요하다. 그러기 때문에 현재 블록의 화소 평균값 (M_{\text{curr}})에 대한 추가적인 정보가 Syntax에 추가되어야 하며, 바람직한 실시예에 의할 때, 상기 값을 8bits 고정 길
이 코드(8bits fixed length code)로 표시할 수 있다.

복호화 장치의 움직임 보상부(250)는 참조 프레임의 회도 평균값 산출부 (260)에서 산출한 회도 평균값과 부호화 장치에서 수신한 움직임 벡터(motion vector). 현재 블록의 회도 평균값(Mcurr)을 이용하여, 상기 복원된 잔여신호 (NewR'')에 대한 복호화를 수행할 수 있다. 물론, 상호환한 벡에 해당 블록의 회도 평균값이 포함되지 않고 주변 블록들에 대한 값의 평균 또는 임의의 주변 블록에 대한 값을 이용하도록 하는 플래그 정보나 부가 정보가 헤더 내에 삽입된 경우에는 상용하는 값을 이용하여 복호화를 수행한다.

결과적으로 역양자화와 역이산화현별화 이후의 복원 과정은 하기의 수학식 4와 같이 나타낼 수 있다.

【수학식 4】

\[ f'(i,j) = r(i+MV_x,j+MV_y)+NewR''(i+j)+M_{curr}-M_{ref} \]

여기서, \( f'(i,j) \)는 복호화된 현재 프레임의 \((i,j)\) 좌표에서 화소값, \( r(i,j) \)는 참조 프레임의 \((i,j)\) 좌표에서 화소값, \((x,y)\)는 움직임 벡터(motion vector)를 지칭한다. 즉, 복원된 잔여신호(\(NewR''\))에 움직임 벡터를 고려한 참조 프레임의 화소값을 더한 후, 현재 블록의 화소 평균값을 더하고, 참조 프레임의 후보 블록의 화소 평균값을 빼면, 현재 프레임의 \((i,j)\) 좌표에서 화소값을 산출하여 복호할 수 있다.

여기서, 본 발명에 따른 조명 변화에 적응적인 움직임 예측 방법은 H.264을
포함하는 종래 모든 부호화 및 복호화 방식 뿐만 아니라, 향후 개발될 모든 부호화 및 복호화 방식에 적용할 수 있다. 실시예에 의할 때, 소정의 부호화 방식에 본 발명이 적용되는 경우, 부호화 모드는 기존 부호화 모드의 두 배가 된다. 이는 기존 방식에 따른 각 부호화 모드에 대응하여 최소 평균값을 이용한 부호화 모드가 각각 생성되기 때문이다. 따라서, 본 발명을 적용하는 경우, 상기 부호화 모드를 식별하기 위한 식별자를 플래그 필드 등에 표시하는 단계가 더 추가될 수 있다.

본 발명에 따른 움직임 예측 부호화 방법의 실험 결과를 도면에 도시된 그래프를 참조하여 설명하기로 한다.

본 발명을 이용한 실험은 H.264의 참조부호화기인 JM(joint model)8.2를 이용하여 실행하였으며 16x16 블록 모드만 사용한 경우와 가변 크기 블록(variable block size)의 모든 블록 모드(16x16, 16x8, 8x16, 8x8, 8x4, 4x8, 4x4)를 사용한 경우의 움직임 예측 및 보상을 수행하였다. 실험에 사용된 영상은 QVGA(Objects1, Flamencol)영상, CIF(Paris, Mobile and Calendar), QCIF(Foreman, Container)영상이다. 여기서, CIF, QCIF영상은 H.264의 실험 권고 영상이고, QVGA영상은 현재 ISO/IEC MPEG에서 EE(exploration experiment)단계에 있는 3D AV(3 Dimensions audio video)를 연구하고 있는 KDDI corp.에서 만든 실험 영상으로 Objects1영상은 조명이 감백거림을 반복하고 있으며, Flamencol영상은 조명이 밝아졌다 어두워지는 것을 반복하는 영상이다. 그리고 모든 실험 영상은 300프레임을 갖는 영상으로 첫 프레임만 화면에 부호화를 하고 나머지 프레임은 예측 부호화를 하였다(IPP...).
그리고 모든 실험에는 미리 설정된 을-왜곡 최적화 기술을 사용하였다. 제안된 방
법은 JM8.2에 구현되어 있는 전체 영역 탐색 기법으로 움직임 예측한 결과의
PSNR(peak signal to noise ratio)과 비교하였다.

도 3a 및 5b를 참조하면, 본 발명에 따른 움직임 예측 방법과 종래 기술에
따른 방법으로 움직임 예측을 수행한 결과에 을-왜곡 곡선이 도시되어 있다. 여기
서, 가로축은 비트율을 나타내고 세로축은 PSNR을 나타낸다. 도 3a를 참조하면,
16x16 블록 모드만 사용한 경우 비트율이 450kbps일 때 PSNR을 비교하면, 기존의
방법으로 움직임 예측을 한 것에 비해 본 발명에 따른 움직임 예측을 한 경우
0.3dB이상의 화질 향상을 보였다. 마찬가지로, 도 3b 내지 도 5b 역시 비슷한 경향
을 나타내고 있다.

여기서, 가변 크기 블록 모드를 사용한 경우에는 16x16모드만 사용한 경우에
비해 약간 작은 성능 향상을 보이는는데, 이는 가변 크기 블록을 이용함으로 인해 간
여 신호가 이미 축소되었기 때문이라 예상된다.

상술한 바와 같이, 본 발명은 블록들의 평균값으로 패턴 블록을 만들어서 이
패턴 블록을 이용하여 움직임 예측을 하고 패턴 블록간의 차분신호를 부호화하는
기법으로, 조명변화에 적응적으로 움직임 예측하는 기법을 제안하여 부호화 효율의
향상을 보였다. 또한, 실험에 사용한 Objects1이나 Flamencol과 같은 조명의 변화
가 있는 영상에서는 효율적인 비트의 감소를 가져오게 되고, 그 외의 경우에도 비
트 감소를 제공하였다.
【발명의 효과】

상술한 바와 같이 본 발명은 조명변화에 적응적인 움직임 예측(motion estimation) 및 움직임 보상(motion compensation)을 통하여, 효율적으로 영상을 부분화 및 복호화할 수 있는 효과가 있다.

또한, 본 발명은 음의 필드에 대해서는 화소 평균값의 삶입을 생략함으로서 부분화를 위해 부분화기로 전송되는 비트스트림의 전송량을 최소화할 수 있다.

또한, 본 발명은 조명 변화에 대하여 화면 내 부분화를 수행하지 아니하고, 효율적으로 압축을 수행할 수 있는 효과도 있다.

또한, 본 발명은 실제 환경에서 주변 조명변화에 강진한 코덱을 제공할 수 있는 효과도 있다.

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

【청구항 1】

응직임 예측 방법에 있어서,

(a) 현재 프레임 블록에 대한 현재 프레임 패턴 블록 및 참조 프레임 블록에 대한 참조 프레임 패턴 블록을 생성하는 단계;

(b) 상기 참조 프레임 패턴 블록 중에 상기 현재 프레임 패턴 블록에 대응하는 후보 패턴 블록에 대한 SAD를 산출하고, 상기 산출된 SAD 중 미리 설정된 조건에 대응하는 SAD에 대응하는 후보 패턴 블록을 응직임 벡터로 결정하는 단계;

(c) 상기 응직임 벡터에 대응하는 후보 패턴 블록과 상기 현재 프레임 패턴 블록의 차분 신호를 이용하여 잔여 신호를 생성한 후, 상기 잔여 신호에 대하여 미리 설정된 부호화 모드에 따라 이산여현변환과 양자화를 수행하여, 상기 현재 프레임 블록을 부호화하는 단계; 및

(d) 부호화된 현재 프레임 블록에 적용되는 화소 평균값 포함 여부를 나타내는 플래그 정보 및 상기 부호화 모드에 대한 식별 정보를 상기 부호화된 현재 프레임 블록에 상응하는 헤더 정보로 첨부하는 단계를 포함하여,

상기 플래그 정보에 의해 상기 현재 프레임 블록에 적용될 화소 평균값 포함 여부가 식별되는 것을 특징으로 하는 조명 변화에 적응적인 응직임 예측 방법.
【청구항 2】

제1항에 있어서,

상기 현재 프레임 블록은 16x16, 16x8, 8x16, 8x8, 8x4, 4x8 또는 4x4 중 적어도 어느 하나의 형태로 설정되는 것을 특징으로 하는 조명 변화에 적응적인 움직임 예측 방법.

【청구항 3】

제1항에 있어서,

상기 플래그 정보가 화소 평균값을 포함하지 않음을 표시하는 경우, 상기 현재 프레임 블록에 적응되는 화소 평균값은 주변에 위치하는 블록들 중 n개의 블록에 상응하는 화소 평균값들의 평균값이 이용되는 것을 특징으로 하는 조명 변화에 적응적인 움직임 예측 방법.

【청구항 4】

제1항에 있어서,

상기 플래그 정보가 화소 평균값을 포함하지 않고, 상기 해더 정보가 주변에 위치하는 블록들 중 임의의 블록에 상응하는 화소 평균값을 이용하도록 지시하는 부가 정보를 더 포함하는 경우, 상기 현재 프레임 블록에 적응되는 화소 평균값은 상기 부가 정보에 상응하는 블록의 화소 평균값이 이용되는 것을 특징으로 하는 조
명 변화에 적응적인 움직임 예측 방법.

【청구항 5】

제1항에 있어서,

상기 (a) 단계는

상기 현재 프레임 블록의 환도 성분 평균값 및 상기 참조 프레임 블록의 환도 성분 평균값을 산출하는 단계; 및

상기 현재 프레임 블록의 환도 성분에서 상기 현재 프레임 블록의 환도 성분 평균값을 차분하여 현재 프레임 패턴 블록을 생성하고, 상기 참조 프레임 블록의 환도 성분에서 상기 참조 프레임 블록의 환도 성분 평균값을 차분하여 참조 프레임 패턴 블록을 생성하는 단계를 포함하는 것을 조명 변화에 적응적인 움직임 예측 방법.

【청구항 6】

제1항에 있어서,

상기 현재 프레임 블록의 환도 평균값을 부호화하는 단계가 더 포함되는 것을 조명 변화에 적응적인 움직임 예측 방법.
【청구항 7】

제1항에 있어서,

상기 미리 설정된 조건에 대응하는 SAD는 최소의 SAD를 지칭하고, 상기 SAD는 하기 수학식에 의하여 산출되며,

\[
NewSAD(x, y) = \sum_{i=0}^{U-1} \sum_{j=0}^{V-1} |[f(i, j) - M_{curr}] - [r(i + x, j + y) - M_{ref}]|
\]

여기서, 상기 \( M_{curr} \)은 현재 프레임 블록의 화소 평균값, 상기 \( M_{ref} \)는 상기 후보 벡터 블록의 화소 평균값, 상기 \( f(i, j) \)는 현재 프레임의 \((i, j)\) 좌표에서 화소값, 상기 \( r(i + x, j + y) \)는 참조 프레임의 \((i + x, j + y)\) 좌표에서 화소값, 상기 \( U \) 및 상기 \( V \)는 블록 크기 사용하는 블록의 크기, 상기 \((x, y)\)는 움직임벡터를 지칭하는 것을 특징으로 하는 움직임 예측 방법.

【청구항 8】

제1항에 있어서,

상기 잔여 신호는 하기 수학식에 의하여 산출되며,

\[
NewR(i, j) = [f(i, j) - M_{curr}] - [r(i + MV_x, j + MV_y) - M_{ref}]
\]

\[
= f(i, j) - r(i + MV_x, j + MV_y) - M_{curr} + M_{ref}
\]

여기서, 상기 \( NewR \)은 상기 잔여 신호, 상기 \( M_{curr} \)은 현재 프레임 블록의 화소 평균값.
소 평균값, 상기 Mref는 상기 후보 패턴 블록의 화소 평균값, 상기 f(i, j)는 현재 프레임의 (i, j) 좌표에서 화소값, 상기 r(i, j)는 참조 프레임의 (i, j) 좌표에서 화소값, 상기 (x, y)는 움직임벡터를 지칭하는 것을 특징으로 하는 움직임 예측 방법.

【정구항 9】

움직임 예측 장치에 있어서,

현재 프레임 블록에 대한 현재 프레임 패턴 블록 및 참조 프레임 블록에 대한 참조 프레임 패턴 블록을 생성하기 위한 패턴 블록 생성부;

상기 참조 프레임 패턴 블록 중에 상기 현재 프레임 패턴 블록에 대응하는 후보 패턴 블록에 대한 SAD를 산출하고, 상기 산출된 SAD 중 미리 설정된 조건에 대응하는 SAD에 대응하는 후보 패턴 블록을 움직임 벡터로 결정하기 위한 움직임 벡터 결정부;

상기 움직임 벡터에 대응하는 후보 패턴 블록과 상기 현재 프레임 패턴 블록의 차분 신호를 이용하여 잔여 신호를 생성하기 위한 움직임 보상부; 및

부호화된 현재 프레임 블록에 적용되는 화소 평균값 포함 여부를 나타내는 헤더 정보 및 상기 부호화 모드에 대한 식별 정보를 상기 부호화된 현재 프레임 블록에 상용하는 헤더 정보로 첨부하는 수단을 포함하되,

상기 헤더 정보에 의해 상기 현재 프레임 블록에 적용될 화소 평균값 포함
여부가 식별되는 것을 특정으로 하는 조명 변화에 적응적인 움직임 예측 장치.

【참조항 10】
제9항에 있어서,
상기 플래그 정보가 화소 평균값을 포함하지 않음을 표시하는 경우, 상기 현재 프레임 블록에 적용되는 화소 평균값은 주변에 위치하는 블록들 중 n개의 블록에 상응하는 화소 평균값들의 평균값이 이용되는 것을 특징으로 하는 조명 변화에 적응적인 움직임 예측 장치.

【참조항 11】
제9항에 있어서,
상기 플래그 정보가 화소 평균값을 포함하지 않고, 상기 헤더 정보가 주변에 위치하는 블록들 중 일부의 블록에 상응하는 화소 평균값을 이용하되 특정지시하는 부가 정보를 더 포함하는 경우, 상기 현재 프레임 블록에 적용되는 화소 평균값은 상기 부가 정보에 상응하는 블록의 화소 평균값이 이용되는 것을 특징으로 하는 조명 변화에 적응적인 움직임 예측 장치.

【참조항 12】
제9항에 있어서.
상기 패턴 블록 생성부는
상기 현재 프레임 블록의 휘도 성분 평균값 및 상기 참조 프레임 블록의 휘도 성분 평균값을 산출하고, 상기 현재 프레임 블록의 휘도 성분 평균값을 차분하여 현재 프레임 패턴 블록을 생성하고, 상기 참조 프레임 블록의 휘도 성분에서 상기 참조 프레임 블록의 휘도 성분 평균값을 차분하여 참조 프레임 패턴 블록을 생성하는 것을 특징으로 하는 조명 변화에 적응적인 움직임 예측 장치.

【청구항 13】

제9항에 있어서,
상기 잔여 신호에 대한 이산여현변환과 양자화를 수행하는 수단을 더 포함하는 것을 조명 변화에 적응적인 움직임 예측 장치.

【청구항 14】

제9항에 있어서,
상기 미래 설정된 조건에 대응하는 SAD는 최소의 SAD를 지칭하고, 상기 움직임 벡터 결정부는 하기 수학식에 의하여 상기 SAD를 산출하며,

\[ NewSAD(x,y) = \sum_{i=0}^{U-1} \sum_{j=0}^{V-1} [f(i,j) - M_{curr}] - [r(i+x,j+y) - M_{ref}] \]
여기서, 상기 Mcurr는 현재 프레임 블록의 화소 평균값, 상기 Mref는 상기 후보 패턴 블록의 화소 평균값, 상기 f(i,j)는 현재 프레임의 (i,j) 좌표에서 화소값, 상기 r(i+x, j+y)는 참조 프레임의 (i+x, j+y) 좌표에서 화소값, 상기 U 및 상기 V는 블록 매칭시 사용하는 블록의 크기, 상기 (x,y)는 움직임벡터를 지칭하는 것을 특정으로 하는 조명 변화에 적응적인 움직임 예측 장치.

【참고항 15】

제9항에 있어서,

상기 움직임 보상부는 하기 수학식에 의하여 상기 잔여 신호를 산출하며,

\[ NewR(i,j) = [f(i,j)-M_{curr}]-[r(i+MV_xi+MV_yj)-M_{ref}] \]

\[ = f(i,j)-r(i+MV_xi+MV_yj)-M_{curr}+M_{ref} \]

여기서, 상기 NewR은 상기 잔여 신호, 상기 Mcurr은 현재 프레임 블록의 화소 평균값, 상기 Mref는 상기 후보 패턴 블록의 화소 평균값, 상기 f(i,j)는 현재 프레임의 (i,j) 좌표에서 화소값, 상기 r(i,j)는 참조 프레임의 (i,j) 좌표에서 화소값, 상기 (x,y)는 움직임벡터를 지칭하는 것을 특정으로 하는 조명 변화에 적응적인 움직임 예측 장치.
【도면】

【도 1】

시작

조영 변화 발생 인식 → S100

패턴 불록화 → S110

후보 패턴 불록 결정 → S120

차분 신호 DCT/영자화 → S130

화소 평균값을 점부 → S140

종료
【도 2c】

Mean of the Current Frame

Motion Vector

Motion Compensated Prediction

Prior Coded Approximated Frame

Motion Compensated Prediction

Reference Buffer

Approximated Input Frame (To Display)

Inverse Quantize Inverse DCT

Entropy Code

Encoded Residual (New')

Inverse Quantize

Mean of the Reference Frame

Motion Approximated Frame (Calculate a Mean of Line)

Motion Vector

250

Motion Compensated Prediction

250
Objects1 (QVGA, 10Hz)

- JM82
- Proposed ME

PSNR (dB)

Bitrates (kbps)

- JM82 using VBS
- Proposed ME using VBS

PSNR (dB)

Bitrates (kbps)
[도 3b]

Flamenco1 (QVGA, 10Hz)

- JM82
- Proposed ME

- JM82 using VBS
- Proposed ME using VBS
도 4a

Paris (CIF, 10 Hz)

PSNR (dB) vs. Bitrates (kbps)

- JM82
- Proposed ME

PSNR (dB) vs. Bitrates (kbps)

- JM82 using VBS
- Proposed ME using VBS
[도 4b]

Mobile & Calendar (CIF, 10Hz)

- JM82
- Proposed ME

PSNR (dB)

Bitrates (kbps)

- JM82 using VBS
- Proposed ME using VBS

PSNR (dB)

Bitrates (kbps)
【도 5a】

Foreman(QCIF, 10Hz)

- JM82
- Proposed ME

PSNR(dB)

Bitrates(kbps)

- JM82 using VBS
- Proposed ME using VBS

PSNR(dB)

Bitrates(kbps)
【Fig. 5b】

Foreman (QCIF, 10Hz)

- JME2
- Proposed ME

- JME2 using VBS
- Proposed ME using VBS

PSNR (dB) vs. Bitrates (kbps)
POWER OF ATTORNEY OR AUTHORIZATION OF AGENT

Application Number: 11/289,650
Filing Date: November 30, 2005
First Named Inventor: Yung-Lyul Lee et. al.
Title: Motion Estimation And...
Group Art Unit: 2613
Examiner Name: To be assigned
Attorney Docket Number: 076980.0102

I hereby appoint:

☑ Practitioners at Customer Number 24735

☐ Practitioner(s) named below:

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☑ 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

Name: DAE G. J.YUN on behalf of

DAE G. J.YUN
Humax Co., Ltd.

Signature: DAE G. J.YUN

Date: March 02, 2006

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 1 forms are submitted.
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**Title of Invention:**
Motion estimation and compensation method and device adaptive to change in illumination

**First Named Inventor:**
Yung-Lyul Lee

**Customer Number:**
24735

**Filer:**
JAMES B ARPIN/Darlene Hoskins

**Filer Authorized By:**
JAMES B ARPIN

**Attorney Docket Number:**
076980.0102

**Receipt Date:**
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30-NOV-2005

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**Warnings:**

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.
IN THE UNITED STATES PATENT AND TRADEMARK OFFICE


Application No.: 11/289,650

Filed: November 30, 2005

For: MOTION ESTIMATION AND COMPENSATION METHOD AND DEVICE ADAPTIVE TO CHANGE IN ILLUMINATION

Examiner: To Be Assigned

Group Art Unit: 2613

Confirmation No. 5922

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
STTTTATEMENT UNDER 37 CFR 3.73(b)

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

Application No./Patent No./Control No.: 11/289,660 Filed/Issue Date: November 30, 2005

Entitled: Motion Estimation And Compensation Methods And Devices Adaptive To Changes In Illumination

Hunmax 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. [ ] 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 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 302.06]

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

_________________________ March 02, 2006

Signature

Printed or Typed Name on behalf of Telephone Number

Humax Co., Ltd.

Title

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:

MOTION ESTIMATION AND COMPENSATION METHODS AND DEVICES ADAPTIVE TO CHANGES IN ILLUMINATION

as described in an application for United States Letters Patent filed on November 30, 2005, and accorded Application No. 11/289,650;

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
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-Lyu Lee

KWAK EUN KYUNG

Feb. 24, 2006
Date
Euee-S Jang

KWAK EUN KYUNG

Feb. 27, 2006
Date
Chung-Ku Lee

KWAK EUN KYUNG

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)
IN THE UNITED STATES PATENT AND TRADEMARK OFFICE


Application No.: 11/289,650

Filed: November 30, 2005

For: MOTION ESTIMATION AND COMPENSATION METHOD AND DEVICE ADAPTIVE TO CHANGE IN ILLUMINATION

Examiner: To Be Assigned

Group Art Unit: 2613

Confirmation No. 5922

RESPONSE TO NOTICE TO FILE MISSING PARTS

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

Sir:

In response to the attached Notice to File Missing Parts of Nonprovisional Application (NTFMP) mailed January 9, 2006, by the U.S. Patent and Trademark Office (PTO), Applicants are enclosing an executed Declaration for Patent Application, and are requesting the PTO to charge the filing, search and examination fees, additional claims fee, and the late filing surcharge to the undersigned’s deposit account.

Specifically Applicants respectfully request that the PTO charge the amount of $1580.00 to cover the filing fee ($1000.00), additional claims fee ($450.00), 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.

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
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 $450 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 $1580 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 $450
  ■ $200 for 1 independent claims over 3.
  ■ $250 for 5 total claims over 20.

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. 11/289,650, 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;

I/we have reviewed and understand the contents of the above-identified application, including the claims, as amended by any amendment specifically referred to above;

I/we acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me/us to be material to patentability as defined in 37 CFR 1.56, including material information which became available between the filing date of the prior application and the National or PCT International filing date of the continuation-in-part application, if applicable; and

All statements made herein of my/own knowledge are true, all statements made herein on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001, and may jeopardize the validity of the application or any patent issuing thereon.

FULL NAME OF INVENTOR(S)

Inventor one: 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.

Burden Hour Statement: The collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is used by the public to file (and the PTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This form is estimated to take 1 minute to complete. This time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Assistant Commissioner for Patents, Washington, DC 20231.
# Electronic Patent Application Fee Transmittal

**Application Number:** 11289650

**Filing Date:** 30-Nov-2005

**Title of Invention:** Motion estimation and compensation method and device adaptive to change in illumination

**First Named Inventor:** Yung-Lyul Lee

**Filer:** JAMES B ARPIN/Darlene Hoskins

**Attorney Docket Number:** 076980.0102

Filed as Large Entity

## Utility Filing Fees

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Petition:

Patent-Appeals-and-Interference:

Post-Allowance-and-Post-Issurance:

Extension-of-Time:

Miscellaneous:

**Total in USD ($)** 1580
**Electronic Acknowledgement Receipt**

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<td>JAMES B ARPIN/Darlene Hoskins</td>
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**Payment information:**

- Submitted with Payment: yes
- Payment was successfully received in RAM
- RAM confirmation Number: 5

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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**
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**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/EQ/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.

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**Total Files Size (in bytes):** 243122
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.

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- Additional claim fees of $450 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 $1580 for a Large Entity

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- $130 Surcharge.
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• The application examination fee has not been paid. Applicant must submit $200 to complete the examination fee for a large entity

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  ■ $200 for 1 independent claims over 3.
  ■ $250 for 5 total claims over 20.

Replies should be mailed to: Mail Stop Missing Parts
Commissioner for Patents
P.O. Box 1450
Alexandria VA 22313-1450

A copy of this notice MUST be returned with the reply.

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

UTILITY PATENT APPLICATION TRANSMITTAL

Attorney Docket Number: 076980.0102
First Named Inventor: Yung-Lyu LEE et al.
Title: Motion Estimation And Compensation Method And Device Adaptive To Change In Illumination

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: 29 (Including Abstract)

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<td>TOTAL FILING FEE</td>
<td>$1200.00</td>
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3. ☑ Drawings - Total Sheets: 10 (Fig(s). 1-5B)
4. Oath or Declaration - Total Pages: 1
   a. ☐ Newly executed (original or copy)
      ☑ New (unexecuted)
   b. ☐ Copy from a prior application
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Signed statement attached deleting inventor(s) named in prior application.

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11. ☐ Information Disclosure Statement with PTO-1449 and Reference(s)
    ☐ Copies of Information Disclosure Statement Citations

12. ☐ Preliminary Amendment

13. ☒ Return Receipt Postcard

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    ☐ Small Business Concern
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15. ☒ Foreign Priority is Claimed as Follows:

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16. ☒ Other: Application Data Sheet

17. ☐ Continuation ☐ Divisional ☐ Continuation-in-Part of
Prior Application No.: _____________ filed ______________________

☐ Complete Application Based on Provisional Application No.: _____________
filed ______________________

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Respectfully submitted,

By: __________________________
   James B. Arpin
   Registration No 33,470

JBA/djw

Enclosures
MOTION ESTIMATION AND COMPENSATION METHOD AND DEVICE
ADAPTIVE TO CHANGE IN ILLUMINATION

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a motion estimation method and device adaptive to change in illumination, more particularly to a method and device that can efficiently encode and decode an image by use of a motion estimation (ME) process and a motion compensation (MC) process adaptive to change in illumination.

2. Description of Related Art

ITU-T and ISO/IEC developed the H.26x series and MPEG-x series while studying to improve efficiency in image encoding. H.264 (part 10 Advanced Video Coding, MPEG-4) was completed in 2003 and thus many bits could be saved. Studies for block matching motion estimation (BMME) were vigorously carried out with development of such video coding standards. In most methods, the sum of absolute differences (SAD) (hereinafter, referred to as "SAD") between blocks of the current frame and candidate blocks of the reference frame is calculated, and the position of the candidate block of the reference frame corresponding to the least SAD is determined as a motion vector of the blocks of the current frame.

Then, discrete cosine transform (DCT) and quantization are performed to difference signals (residual) between the candidate block and the current frame block, and variable length coding (VLC) is performed like the motion vector. Here, since the search for the motion vector means that the motion vector is acquired by removing temporal redundancy between the current frame and the reference frame, the encoding efficiency is remarkably improved, but there are the following problems:
When illumination changes (e.g., scene change in an image, fade-up or fade-down, or flickering) between inter-views input through different cameras at the same time axis or between same-views input through the same camera at continuous time axes at the time of multi-view video coding, calculating SADs between blocks, using the conventional art, to obtain the least SAD and encode a difference signal takes an excessive quantity of bits, drastically slowing the compression ratio.

Generally, when there is a scene change, intra encoding is more effective than the motion estimation and the motion compensation for the changed frame. This is because the pattern of the current frame block cannot be found in any search area of the reference frame. Similarly, when there is flickering or a change in lighting, similar results are obtained by use of the same method of encoding the difference signal through the motion estimation. Hence, it is often intra encoded. However, in this case, since there was no scene change, a block having a pattern similar to the current frame block can be found from the reference frame, but it takes a large volume of bits for encoding the difference between the block and the current frame block.

TECHNICAL OBJECTIVES

The present invention is contrived to solve the above-mentioned problems by providing a motion estimation/compensation method and device adaptive to change in illumination that can efficiently encode and decode an image by use of motion estimation and motion compensation adaptive to change in illumination.

Another objective of the present invention is to provide a motion estimation/compensation method and device adaptive to change in illumination that can minimize the amount of bit streams transmitted to a decoder by omitting insertion of a mean pixel value for an arbitrary field.

Another objective of the present invention is to provide a motion estimation/compensation method and device adaptive to change in illumination that can
efficiently compress an image without performing intra coding for change in illumination.

Another objective of the present invention is to provide a codec that is strong against change in illumination in actual surroundings.

Other objectives of the present invention will become apparent from a preferred embodiment described below.

DESCRIPTION

According to an aspect of the present invention, there is provided a motion estimation method adaptive to change in illumination.

The motion estimation method according to a preferred embodiment of the invention comprises the steps of: (a) generating a current frame pattern block for a current frame block and a reference frame pattern block for a reference frame block; (b) calculating the sum of absolute differences (SAD) for candidate pattern blocks corresponding to the current frame pattern block among the reference frame pattern blocks and determining the candidate pattern block corresponding to the SAD satisfying a predetermined condition among the calculated SADs as a motion vector; (c) encoding the current frame block, by generating a residual signal using a difference signal between the candidate pattern block corresponding to the motion vector and the current frame pattern block then performing discrete cosine transform and quantization to the residual signal with a predetermined encoding mode; and (d) adding flag information indicating the addition of a mean pixel value applied to the encoded current frame block and identification information on the encoding mode as header information corresponding to the encoded current frame block.

In the motion estimation method, step (a) can comprise the steps of: calculating a mean brightness value of the current frame block and a mean brightness value of the reference frame block; and generating the current frame pattern block by subtracting the
mean brightness value of the current frame block from brightness values of the current
frame block and generating the reference frame pattern blocks by subtracting the mean
brightness value of the reference frame block from brightness values of the reference
frame block.

The motion estimation method can further comprise the step of encoding the
mean pixel value of the current frame block.

The SAD corresponding to the predetermined condition refers to the least SAD,
and the SAD can be calculated by the following equation:

\[ \text{NewSAD} (x, y) = \sum_{i=0}^{U-1} \sum_{j=0}^{V-1} \left| f(i, j) - M_{\text{curr}} \right| - \left| r(i + x, j + y) - M_{\text{ref}} \right| \]

where \( M_{\text{curr}} \) denotes the mean pixel value of the current frame block, \( M_{\text{ref}} \) denotes the
mean pixel value of the candidate pattern blocks, \( f(i,j) \) denotes a pixel value at a
coordinate \((i,j)\) of the current frame, \( r(i,j) \) denotes a pixel value of a coordinate \((i,j)\) of
the reference frame, \( U \) and \( V \) denote the sizes of blocks used for matching the blocks,
and \((x,y)\) denotes the motion vector.

The residual signal can be calculated by the following equation:

\[ \text{NewR} (i, j) = \left| f(i, j) - M_{\text{curr}} \right| - \left| r(i + MV_x, j + MV_y) - M_{\text{ref}} \right| \]

\[ = f(i,j) - r(i + MV_x, j + MV_y) - M_{\text{curr}} + M_{\text{ref}} \]

where \( \text{NewR} \) denotes the residual signal, \( M_{\text{curr}} \) denotes the mean pixel value of the
current frame block, \( M_{\text{ref}} \) denotes the mean pixel value of the candidate pattern blocks,
\( f(i,j) \) denotes a pixel value at a coordinate \((i,j)\) of the current frame, \( r(i,j) \) denotes a pixel
value of a coordinate \((i,j)\) of the reference frame, \( U \) and \( V \) denote the sizes of blocks
used for matching the blocks, and \((x,y)\) denotes the motion vector.

The motion estimation method according to another embodiment of the
invention may comprise the steps of: (a) generating a current frame pattern block for a
current frame block and a reference frame pattern block of a reference frame block; (b)
calculating the sum of absolute differences (SADs) for candidate pattern blocks
corresponding to the current frame pattern block among the reference frame pattern
blocks and determining the candidate pattern block corresponding to the SAD satisfying a predetermined condition among the calculated SADs as a motion vector; (c) encoding the current frame block, by generating a residual signal using a difference signal between the candidate pattern block corresponding to the motion vector and the current frame pattern block then performing discrete cosine transform and quantization to the residual signal with a predetermined encoding mode; and (d) adding flag information indicating whether a mean pixel value of the encoded current frame block is included and identification information on the encoding mode to the encoded current frame block as header information. Here,

whether the mean pixel value of the current frame block is included can be identified by the flag information.

The current frame block may be set to at least one type of 16×16, 16×8, 8×16, 8×8, 8×4, 4×8, and 4×4.

When the flag information indicates that the mean pixel value is not included, a mean value of mean pixel values corresponding to n blocks surrounding the current frame block may be used as the mean pixel value of the current frame block.

When the flag information does not contain the mean pixel value and the header information further contains additional information indicating that the mean pixel value corresponding to any block among the blocks surrounding the current frame block should be used, a mean pixel value of the block corresponding to the additional information may be used as the mean pixel value of the current frame block.

In the motion estimation method, step (a) can comprise the steps of: calculating a mean brightness value of the current frame block and a mean brightness value of the reference frame block; and generating the current frame pattern block by subtracting the mean brightness value of the current frame block from brightness values of the current frame block and generating the reference frame pattern blocks by subtracting the mean brightness value of the reference frame block from brightness values of the reference
frame block.

The motion estimation method may further comprise the step of encoding the mean pixel value of the current frame block.

The SAD satisfying the predetermined condition may indicate the least SAD and the SAD may be calculated by the following equation:

\[
NewSAD (x, y) = \sum_{i=0}^{U-1} \sum_{j=0}^{V-1} \left| f(i, j) - M_{\text{curr}} - [r(i + x, j + y) - M_{\text{ref}}] \right|
\]

where \( M_{\text{curr}} \) denotes the mean pixel value of the current frame block, \( M_{\text{ref}} \) denotes the mean pixel value of the candidate pattern blocks, \( f(i,j) \) denotes a pixel value at a coordinate \((i,j)\) of the current frame, \( r(i+x,j+y) \) denotes a pixel value of a coordinate \((i+x,j+y)\) of the reference frame, \( U \) and \( V \) denote the sizes of blocks used for matching the blocks, and \((x,y)\) denotes the motion vector.

The residual signal may be calculated by the following equation:

\[
NewR (i, j) = [f(i, j) - M_{\text{curr}}] - [r(i + MV_x, j + MV_y) - M_{\text{ref}}]
\]

\[
= f(i, j) - r(i + MV_x, j + MV_y) - M_{\text{curr}} + M_{\text{ref}}
\]

where \( NewR \) denotes the residual signal, \( M_{\text{curr}} \) denotes the mean pixel value of the current frame block, \( M_{\text{ref}} \) denotes the mean pixel value of the candidate pattern blocks, \( f(i,j) \) denotes a pixel value at a coordinate \((i,j)\) of the current frame, \( r(i,j) \) denotes a pixel value of a coordinate \((i,j)\) of the reference frame, \( U \) and \( V \) denote the sizes of blocks used for matching the blocks, and \((x,y)\) denotes the motion vector.

According to another aspect of the invention, there is provided a motion estimation device adaptive to change in illumination.

The motion estimation device according to a preferred embodiment of the invention can comprise: a pattern block generating unit generating a current frame pattern block of a current frame block and reference frame pattern blocks of a reference frame block; a motion vector determining unit calculating the sum of absolute differences (SAD) of candidate pattern blocks corresponding to the current frame pattern block among the reference frame pattern blocks and determining the candidate
pattern block corresponding to the SAD satisfying a predetermined condition among the calculated SADs as a motion vector; a motion compensation unit generating a residual signal using a difference signal between the candidate pattern block corresponding to the motion vector and the current frame pattern block; and an adding unit adding flag information indicating the addition of a mean pixel value applied to the encoded current frame block and identification information on the encoding mode as header information corresponding to the encoded current frame block.

The pattern block generating unit may: calculate a mean brightness value of the current frame block and a mean brightness value of the reference frame block; generate the current frame pattern block by subtracting the mean brightness value of the current frame block from brightness values of the current frame block; and generate the reference frame pattern blocks by subtracting the mean brightness value of the reference frame block from brightness values of the reference frame block.

The motion estimation device may further comprise a unit carrying out discrete cosine transform and quantization for the residual signal.

The SAD corresponding to the predetermined condition refers to the least SAD and the motion vector determining unit can calculate the SAD with the following equation:

$$NewSAD\ (x, y) = \sum_{i=0}^{U-1} \sum_{j=0}^{V-1} \left[ f(i, j) - M_{\text{curr}} \right] - \left[ r(i + x, j + y) - M_{\text{ref}} \right]$$

where $M_{\text{curr}}$ denotes the mean pixel value of the current frame block, $M_{\text{ref}}$ denotes the mean pixel value of the candidate pattern blocks, $f(i,j)$ denotes a pixel value at a coordinate $(i,j)$ of the current frame, $r(i,j)$ denotes a pixel value of a coordinate $(i,j)$ of the reference frame, $U$ and $V$ denote the sizes of blocks used for matching the blocks, and $(x,y)$ denotes the motion vector.

The motion compensation unit can calculate the residual signal with the following equation:

$$NewR\ (i, j) = \left[ f(i, j) - M_{\text{curr}} \right] - \left[ r(i + MV_x, j + MV_y) - M_{\text{ref}} \right]$$
\[ f(i,j)-r(i+MV_x,j+MV_y)-M_{cur}+M_{ref} \]

where \( NewR \) denotes the residual signal, \( M_{cur} \) denotes the mean pixel value of the current frame block, \( M_{ref} \) denotes the mean pixel value of the candidate pattern blocks, \( f(i,j) \) denotes a pixel value at a coordinate \((i,j)\) of the current frame, \( r(i,j) \) denotes a pixel value of a coordinate \((i,j)\) of the reference frame, \( U \) and \( V \) denote the sizes of blocks used for matching the blocks, and \((x,y)\) denotes the motion vector.

The motion estimation device according to another preferred embodiment of the invention can comprise: a pattern block generating unit generating a current frame pattern block for a current frame block and a reference frame pattern block for a reference frame block; a motion vector determining unit calculating the sum of absolute differences (SAD) of candidate pattern blocks corresponding to the current frame pattern block among the reference frame pattern blocks and determining the candidate pattern block corresponding to the SAD satisfying a predetermined condition among the calculated SADs as a motion vector; a motion compensation unit generating a residual signal using a difference signal between the candidate pattern block corresponding to the motion vector and the current frame pattern block; and an adding unit adding flag information indicating whether a mean pixel value of the encoded current frame block is included and identification information on the encoding mode to the encoded current frame block as header information. Here, whether the mean pixel value of the current frame block is included can be identified by the flag information.

When the flag information indicates that the mean pixel value is not included, a mean value of mean pixel values corresponding to \( n \) blocks surrounding the current frame block may be used as the mean pixel value of the current frame block.

When the flag information does not contain the mean pixel value and the header information further contains additional information indicating that the mean pixel value corresponding to any block among the blocks surrounding the current frame block should be used, a mean pixel value of the block corresponding to the additional
information may be used as the mean pixel value of the current frame block.

The pattern block generating unit may: calculate a mean brightness value of the current frame block and a mean brightness value of the reference frame block; generate the current frame pattern block by subtracting the mean brightness value of the current frame block from brightness values of the current frame block; and generate the reference frame pattern blocks by subtracting the mean brightness value of the reference frame block from brightness values of the reference frame block.

The motion estimation device may further comprise a unit carrying out discrete cosine transform and quantization to the residual signal.

The SAD satisfying the predetermined condition may indicate the least SAD and the motion vector determining unit may calculate the SAD with the following equation:

\[ \text{NewSAD} (x, y) = \sum_{i=0}^{U-1} \sum_{j=0}^{V-1} \left[ f(i, j) - M_{\text{curr}} \right] \left[ r(i + x, j + y) - M_{\text{ref}} \right] \]

where \( M_{\text{curr}} \) denotes the mean pixel value of the current frame block, \( M_{\text{ref}} \) denotes the mean pixel value of the candidate pattern blocks, \( f(i,j) \) denotes a pixel value at a coordinate \((i,j)\) of the current frame, \( r(i+x,j+y) \) denotes a pixel value of a coordinate \((i+x,j+y)\) of the reference frame, \( U \) and \( V \) denote the sizes of blocks used for matching the blocks, and \((x,y)\) denotes the motion vector.

The motion compensation unit may calculate the residual signal with the following equation:

\[ \text{NewR} (i, j) = \left[ f(i, j) - M_{\text{curr}} \right] - \left[ r(i + MV_x, j + MV_y) - M_{\text{ref}} \right] = f(i,j) - r(i+MV_x,j+MV_y) - M_{\text{curr}} + M_{\text{ref}} \]

where \( \text{NewR} \) denotes the residual signal, \( M_{\text{curr}} \) denotes the mean pixel value of the current frame block, \( M_{\text{ref}} \) denotes the mean pixel value of the candidate pattern blocks, \( f(i,j) \) denotes a pixel value at a coordinate \((i,j)\) of the current frame, \( r(i,j) \) denotes a pixel value of a coordinate \((i,j)\) of the reference frame, \( U \) and \( V \) denote the sizes of blocks used for matching the blocks, and \((x,y)\) denotes the motion vector.
BRIEF DESCRIPTION OF THE DRAWINGS

The above and other features and advantages of the present invention will become more apparent in the detailed description of a preferred embodiment thereof with reference to the attached drawings in which:

Fig. 1 is a flowchart illustrating an operation order of an adaptive motion estimation method according to a preferred embodiment of the invention;

Fig. 2A is a block diagram illustrating a configuration of an encoding device according to a preferred embodiment of the invention;

Fig. 2B is a diagram illustrating a method of omitting insertion of a mean pixel value for a block according to a preferred embodiment of the invention;

Fig. 2C is a block diagram illustrating a configuration of a decoding device according to a preferred embodiment of the invention; and

Figs. 3A to 5B are graphs illustrating bit rate-distortion curves corresponding to motion estimation results by use of a motion estimation method according to the invention and a conventional motion estimation method.

DETAILED DESCRIPTION OF THE INVENTION

Hereinafter, a motion estimation/compensation device and method adaptive to change in illumination according to a preferred embodiment of the present invention will be described in detail with reference to the attached drawings such that the present invention can be easily put into practice by those skilled in the art. In the drawings, like elements are denoted by like reference numerals and thus repeated description thereof is omitted.

Fig. 1 is a flowchart illustrating an operation order of an adaptive motion
estimation method according to a preferred embodiment of the invention.

In the adaptive motion estimation method according to the invention, when illumination of an image changes or the image flickers, a block most similar in pattern is searched for and encoded without performing an intra coding process.

That is, by considering that the brightness value \( Y \) of a block increases or decreases as a whole with change in illumination, a mean brightness value of a current block is calculated and a new pattern block is generated by subtracting the calculated mean value from the brightness value \( Y \). A reference pattern block for a reference frame is generated through the same process.

The present invention provides a method of performing a motion estimation process using the generated current pattern block and the reference pattern block and performing an encoding process (hereinafter, referred to as "pattern encoding method").

According to the invention, the objective image quality (PSNR: Peak Signal-to-Noise Ratio) is enhanced by 0.1 dB to 0.3 dB at the same bit rate and thus it is possible to provide a codec that is strong against change in illumination in actual circumstances.

Now, an operation order of the pattern encoding method according to the invention is described with reference to Fig. 1.

First, in S100, the change in illumination such as flickering is recognized, and then it is determined that the pattern encoding method using the motion estimation according to the invention should be performed without performing the conventional intra coding process.

In S110, candidate blocks having a pattern most similar to the current frame block are searched for from the reference frame blocks. For this purpose, a pattern block of the current frame block is generated by calculating a mean value of brightness values \( Y \) in the current frame block and subtracting the mean brightness value from the brightness values \( Y \). Then, pattern blocks of the reference frame blocks are generated from the reference frame through the same process.
When the pattern blocks of the current frame block and the reference frame blocks are all generated, the SADs between the pattern blocks are calculated and a candidate pattern block exhibiting the least SAD is determined as the final motion vector, in S120.

Thereafter, the generated pattern blocks are used for enhancing an encoding efficiency. That is, in S130, a discrete cosine transform (DCT) process and a quantization process are performed to a difference signal (hereinafter, referred to as "residual signal") between the pattern block of the candidate block indicated by the final motion vector and the pattern block of the current frame block, thereby performing the encoding process without using many bits. Here, a mean pixel value may be encoded together.

In S140, the encoded mean pixel value of the current frame block is added to the encoded current frame block and then is transmitted to a decoder. Here, the mean pixel value can be encoded and transmitted by use of conventional coding processes or coding processes to be developed in the future. At this time, the block may be set to a type such as of 16×16, 16×8, 8×16, 8×8, 8×4, 4×8, or 4×4. By omitting the transmission of the mean pixel values of some blocks, it is possible to reduce the amount of bit streams to be transmitted.

In this way, since blocks which should be inevitably subjected to the intra coding can be encoded by use of the motion estimation, it is possible to enhance the encoding efficiency.

Now, specific encoding and decoding methods according to the invention will be described with reference to Figs. 2A to 2C. Fig. 2A is a block diagram illustrating a configuration of an encoding device according to a preferred embodiment of the invention, Fig. 2B is a diagram illustrating a method of omitting insertion of a mean pixel value for a block according to a preferred embodiment of the invention, and Fig. 2C is a block diagram illustrating a configuration of a decoding device according to a
preferred embodiment of the invention.

The encoding device according to the invention includes a mean brightness value calculating unit for a current frame 210, a mean brightness value calculating unit for a reference frame 220, a motion estimation unit 230, and a motion compensation unit 240.

The motion estimation unit 230 comprises a pattern block generating section 231 for a current frame and a pattern block generating section 233 for a reference frame so as to search the reference frame blocks for a candidate block having a pattern most similar to the pattern of the current frame block. The pattern block generating section 231 for a current frame subtracts the mean brightness value of the current frame calculated by the mean brightness value calculating unit from respective brightness values of the current frame and thus generates a pattern block of the current frame block. The pattern block generating section 233 for a reference frame generates pattern blocks of the reference frame blocks through the use of the same process.

At this time, the mean brightness value calculating unit 210 for a current frame can insert Mcurr denoting the mean pixel value of the current block into a header of a bit stream for transmission to a decoder. This is because the decoder may require the mean pixel value of the current block for reconstructing the current block. For example, Mcurr, which is 8-bit information inserted into the header of a bit stream, can be added to the rear end of a macro block type field.

As described below, by omitting the insertion of Mcurr for some blocks, the amount of bit stream to be transmitted may be minimized. In this case, 1-bit flag information allowing the decoder to recognize Mcurr of the corresponding block may be added thereto. For example, the flag information may be added at the rear end of a macro block type field. Several methods are exemplified as follows, among a variety of methods of recognizing and using Mcurr of the current block by use of Mcurr corresponding to other blocks indicated by the flag information when the addition of
Mcurr is omitted.

First, when a bit stream is transmitted to a decoder with omitting the addition of Mcurr for the block, in which the flag information is set to, for example, 1, the decoder can decode the corresponding block by using a mean pixel value of peripheral blocks decoded previously for the block 240, in which the flag information is set to 1. In Fig. 2B, a mean value of Mcurr values such as $M_{\text{curr-1}}$, $M_{\text{curr-2}}$, and $M_{\text{curr-1}}$ of the peripheral blocks decoded previously can be used as Mcurr of the block 240 corresponding to Flag 1 for decoding the block 240. The number and position of blocks used for calculating the mean value can be set in various manners.

Next, by omitting the addition of Mcurr for the block 245, in which the flag information is set to 1, and adding a 1-bit instruction value indicating to decode the corresponding block using Mcurr of the peripheral blocks decoded previously, the amount of bit stream to be transmitted can be reduced. That is, in order to decode the block 245 corresponding to Flag 1 in Fig. 2B, differences between Mcurr values of the peripheral blocks decoded previously, for example, $M_{\text{curr-1}}$ and $M_{\text{curr-2}}$, and the Mcurr value calculated for the corresponding block 245 are calculated, and the Mcurr value of the block exhibiting the smaller difference is used. For example, suppose that the difference between $M_{\text{curr-1}}$ and the Mcurr value of the corresponding block is $d_1$ and the difference between $M_{\text{curr-2}}$ and the Mcurr value of the corresponding block is $d_2$.

When $d_1$ is smaller, additional information indicating that $M_{\text{curr-1}}$ is used as the Mcurr of the corresponding block 245 can be added successively to the flag information. Of course, the range of blocks for calculating the difference value can be set variously. The 8-bit Mcurr value of the corresponding block can be added thereto, not the 1-bit additional information.

Now, the case that Mcurr is transmitted to the decoder from the encoder will be mainly described.

When the pattern block of the current frame block and the pattern blocks of the
reference frame blocks are all generated, the motion vector determining section 235 calculates the SADs between the pattern blocks and determines the final motion vector by use of a candidate pattern block exhibiting the least SAD.

Here, the motion vector determining section 235 calculates the SADs through the use of new mathematical equations for the purpose of enhancing the efficiency of the block patternning.

First, in the related art, the SADs for determining the final motion vector is calculated by Eq. 1 described below and a candidate block pattern having the least SAD is determined as the final motion vector.

Eq. 1

\[
SAD (x, y) = \sum_{i=0}^{S-1} \sum_{j=0}^{T-1} |f(i, j) - r(i + x, j + y)|
\]

where \(f(i,j)\) denotes a pixel value at a coordinate \((i,j)\) of the current frame, \(r(i,j)\) denotes a pixel value of a coordinate \((i,j)\) of the reference frame, and \(S\) and \(T\) denote the sizes of blocks used for matching the blocks. Here, \((x,y)\) denotes the motion vector.

On the contrary, in the invention, a type of an object not affected by the change in illumination, that is, a pattern, should be extracted so as to minimize an error between the current frame block and the candidate block due to the change in illumination. Therefore, by using a method different from the method utilizing Eq. 1, that is, by using Eq. 2, the pattern blocks can be generated by subtracting the mean pixel value of the respective blocks from the pixel values of the respective blocks.

Eq. 2

\[
NewSAD (x, y) = \sum_{i=0}^{U-1} \sum_{j=0}^{V-1} |f(i, j) - M_{\text{curr}} - [r(i + x, j + y) - M_{\text{ref}}]| \]

where \(M_{\text{curr}}\) denotes the mean pixel value of the current frame block and \(M_{\text{ref}}\) denotes the mean pixel value of the candidate pattern blocks. For example, \(U\) and \(V\) can be set to 16 or 8. Difference signals between \(U\times V\) blocks can be encoded through the use of 4\(\times\)4 DCT and quantization as shown in H.264 Standard.

The motion compensation unit 240 can perform the motion compensation by
use of a motion compensation method difference from that of the related art. The motion compensation unit 240 uses a reference block acquired through the SAD calculating equation of Eq. 2 so as to encode the residual signals. As can be seen from Eq. 3, the motion compensation can be performed by subtracting the mean pixel value from the pixel values of the current block and the reference block.

\[ \text{NewR}(i, j) = [f(i, j) - M_{\text{curr}}] - [r(i + MV_x, j + MV_y) - M_{\text{ref}}] \]

where \( \text{NewR} \) denotes the residual signal obtained through subtraction of the mean pixel value. In this way, the mean value of the residual signals can be adjusted close to 0 by subtracting the mean pixel value of the blocks thereby enhancing the compression efficiency reduced due to the change in illumination.

The residual signals \( \text{NewR} \) are encoded through the use of the DCT and quantization into residual signals \( \text{NewR'} \) and thus are finally subjected to an entropy coding process. In this way, the encoding process is finished.

The block diagram illustrating a configuration of an encoding device according to a preferred embodiment of the invention.

In the course of decoding, the encoded residual signals \( \text{NewR'} \) are reconstructed through inverse quantization and inverse DCT into residual signals \( \text{NewR}'' \). However, the mean pixel value of the current block is necessarily required for allowing the decoder to perform the reconstruction. Accordingly, additional information on the mean pixel value \( M_{\text{curr}} \) of the current block should be added to the syntax and can be expressed in an 8-bit fixed length code in a preferred embodiment.

The motion compensation unit 250 of the decoding device can decode the reconstructed residual signals \( \text{NewR}'' \) by use of the mean brightness value calculated by the mean brightness value calculating unit 260 for a reference frame, the motion vector received from the encoding device, and the mean brightness value \( M_{\text{curr}} \) of the current

block. As described above, when the mean brightness value of the corresponding block is not included and the flag information or the addition information indicating that a mean value of the peripheral blocks or a value of a predetermined peripheral block should be used is added to the header, the decoding can be performed using the corresponding value.

Consequently, the reconstruction process after the inverse quantization and the inverse DCT can be expressed as Eq. 4 described below.

\[
f'(i, j) = [r(i + MV_x, j + MV_y) + NewR''(i + j) + M_{curr} - M_{ref}]\]

where \( f'(i,j) \) denotes a pixel value at a coordinate \((i,j)\) of the decoded current frame, \( r(i,j) \) denotes a pixel value of a coordinate \((i,j)\) of the reference frame, and \((x,y)\) denotes the motion vector. That is, by adding the pixel values of the reference frame in consideration of the motion vector to the reconstructed residual signal \( NewR'' \), adding the mean pixel value of the current block thereto, and then subtracting the mean pixel value of the candidate block of the reference frame, the pixel value at the coordinate \((i,j)\) of the current frame can be calculated and decoded.

Here, the motion estimation method adaptive to the change in illumination according to the invention can apply to all encoding and decoding methods to be developed in the future, as well as all the existing encoding and decoding methods, including the H.264 standard. When the invention applies to an encoding method, the number of encoding modes is increased to double. This is because an encoding mode employing the mean pixel value is generated for each existing encoding mode. Therefore, a process step of adding an identifier for identifying the encoding mode to a flag field or the like may be additionally provided.

Test results for the encoding method employing the motion estimation according to the invention will be described with the graphs shown in the figures.

The test was executed by use of JM (Joint Model) 8.2, which is a reference
encoder of H.264 Standard. The motion estimation and compensation were performed to the case that only a 16×16 block mode is used and the case that all the block modes (16×16, 16×8, 8×16, 8×8, 8×4, 4×8, and 4×4) of a variable block size are used. Images used in the test are a QVGA (Object 1, Flamenco 1) image, a CIF (Paris, Mobile and Calendar) image, and a QCIF (Foreman, Container) image. Here, the CIF and QCIF images are the recommended images for test in H.264, and the QVGA image is a test image made by KDDI Corp., which studies 3DAV (3 Dimensions Audio Video) which is laid in the step of EE (Exploration Experiment) in ISO/IEC MPEG. The Object 1 image is an image repeating the flickering of illumination and the Flamenco 1 image is an image repeating the increase and decrease in illumination. All the test images have 300 frames. Only the first frame was subjected to the intra coding and the other frames were subjected to the estimation encoding (IPPPPPP...). A predetermined bit rate-distortion optimization technique was used for all the experiments. By using an entire area search technique embodied in IM8.2, PSNRs (Peak Signal to Noise Ratio) were compared with those of the motion estimation result.

Referring to Figs. 3A to 5B, bit rate-distortion curves as results of performing the motion estimation by use of the motion estimation method according to the invention and the conventional method are shown. Here, the axis of abscissa denotes a bit rate and the axis of ordinate denotes PSNR. Referring to Fig. 3B, when only the 16×16 block mode is used and the bit rate 450 kbps, the motion estimation according to the invention, enhances by 0.3dB or more PSNR in comparison with the motion estimation according to the conventional method. Similarly, Figs. 3B to 5B show similar tendencies.

Here, when the variable size block mode is used, the enhancement in performance is smaller than that when only the 16×16 block mode is used. It is considered that this is because the residual signals are previously reduced due to the use of the variable size blocks.
In the motion estimation method adaptive to the change in illumination according to the invention described above, the pattern blocks is generated using the mean values of the blocks, the motions estimation is performed using the pattern blocks, and the difference signals between the pattern blocks are encoded. The method causes improvement in encoding efficiency. The efficient reduction of bits is caused in such an image having the change in illumination such as Object 1 or Flamenco 1, and the reduction of bit is obtained in other images.

According to the invention described above, an image can be efficiently encoded and decoded by use of the motion estimation and motion compensation adaptive to the change in illumination.

Further, it is possible to minimize the amount of bit streams to be transmitted to a decoder by omitting insertion of a mean pixel value for some fields.

Furthermore, it is possible to efficiently compress an image without performing the intra coding for the change in illumination.

In addition, it is possible to provide a codec that is strong against the change in illumination in actual surroundings.

Although a preferred embodiment and the modified examples of the present invention have been described, the present invention is not limited to the embodiment and examples, but may be modified in various forms without departing from the scope of the appended claims, the detailed description, and the accompanying drawings of the present invention. Therefore, it is natural that such modifications belong to the scope of the present invention.
WHAT IS CLAIMED IS:

1. A motion estimation method adaptive to change in illumination, comprising the steps of:
   (a) generating a current frame pattern block for a current frame block and a reference frame pattern block for a reference frame block;
   (b) calculating the sum of absolute differences (SAD) for candidate pattern blocks corresponding to the current frame pattern block among the reference frame pattern blocks and determining the candidate pattern block corresponding to the SAD satisfying a predetermined condition among the calculated SADs as a motion vector;
   (c) encoding the current frame block, by generating a residual signal using a difference signal between the candidate pattern block corresponding to the motion vector and the current frame pattern block then performing discrete cosine transform and quantization to the residual signal with a predetermined encoding mode; and
   (d) adding flag information indicating the addition of a mean pixel value applied to the encoded current frame block and identification information on the encoding mode as header information corresponding to the encoded current frame block;

   wherein the addition of a mean pixel value to be applied to the current frame block is identified by the flag information.

2. The motion estimation method according to claim 1, wherein step (a) includes the steps of:
   calculating a mean brightness value of the current frame block and a mean brightness value of the reference frame block; and
   generating the current frame pattern block by subtracting the mean brightness value of the current frame block from brightness values of the current frame block and
generating the reference frame pattern blocks by subtracting the mean brightness value of the reference frame block from brightness values of the reference frame block.

3. The motion estimation method according to claim 1, further comprising encoding the mean pixel value of the current frame block.

4. The motion estimation method according to claim 1, wherein the SAD satisfying the predetermined condition indicates the least SAD and the SAD is calculated by the following equation:

\[
NewSAD\ (x, y) = \sum_{i=0}^{U-1} \sum_{j=0}^{V-1} \left\lfloor f(i, j) - M_{\text{cur}} \right\rfloor - \left\lfloor r(i + x, j + y) - M_{\text{ref}} \right\rfloor
\]

where \( M_{\text{cur}} \) denotes the mean pixel value of the current frame block, \( M_{\text{ref}} \) denotes the mean pixel value of the candidate pattern blocks, \( f(i,j) \) denotes a pixel value at a coordinate \((i,j)\) of the current frame, \( r(i,j) \) denotes a pixel value of a coordinate \((i,j)\) of the reference frame, \( U \) and \( V \) denote the sizes of blocks used for matching the blocks, and \((x,y)\) denotes the motion vector.

5. The motion estimation method according to claim 1, wherein the residual signal is calculated by the following equation:

\[
NewR\ (i, j) = \left\lfloor f(i, j) - M_{\text{cur}} \right\rfloor - \left\lfloor r(i + MV_x, j + MV_y) - M_{\text{ref}} \right\rfloor
\]

\[
= f(i, j) - r(i + MV_x, j + MV_y) - M_{\text{cur}} + M_{\text{ref}}
\]

where \( NewR \) denotes the residual signal, \( M_{\text{cur}} \) denotes the mean pixel value of the current frame block, \( M_{\text{ref}} \) denotes the mean pixel value of the candidate pattern blocks, \( f(i,j) \) denotes a pixel value at a coordinate \((i,j)\) of the current frame, \( r(i,j) \) denotes a pixel value of a coordinate \((i,j)\) of the reference frame, \( U \) and \( V \) denote the sizes of blocks used for matching the blocks, and \((x,y)\) denotes the motion vector.

6. A motion estimation device comprising:
a pattern block generating unit generating a current frame pattern block of a
current frame block and reference frame pattern blocks of a reference frame block;
a motion vector determining unit calculating the sum of absolute differences
(SAD) of candidate pattern blocks corresponding to the current frame pattern block
among the reference frame pattern blocks and determining the candidate pattern block
corresponding to the SAD satisfying a predetermined condition among the calculated
SADs as a motion vector;
a motion compensation unit generating a residual signal using a difference
signal between the candidate pattern block corresponding to the motion vector and the
current frame pattern block; and
an adding unit adding flag information indicating the addition of a mean pixel
value applied to the encoded current frame block and identification information on the
encoding mode as header information corresponding to the encoded current frame
block;
wherein the addition of a mean pixel value to be applied to the current frame
block is identified by the flag information.

7. The motion estimation device according to claim 6, wherein the pattern
block generating unit:
calculates a mean brightness value of the current frame block and a mean
brightness value of the reference frame block;
generates the current frame pattern block by subtracting the mean brightness
value of the current frame block from brightness values of the current frame block; and
generates the reference frame pattern blocks by subtracting the mean brightness
value of the reference frame block from brightness values of the reference frame block.

8. The motion estimation device according to claim 6, further comprising
9. The motion estimation device according to claim 6, wherein the SAD determining unit calculates the SAD with the following equation:

\[ \text{NewSAD} (x, y) = \sum_{i=0}^{U-1} \sum_{j=0}^{V-1} \left| f(i, j) - M_{\text{cur}} - [r(i + x, j + y) - M_{\text{ref}}] \right| \]

where \( M_{\text{cur}} \) denotes the mean pixel value of the current frame block, \( M_{\text{ref}} \) denotes the mean pixel value of the candidate pattern blocks, \( f(i,j) \) denotes a pixel value at a coordinate \((i,j)\) of the current frame, \( r(i,j) \) denotes a pixel value of a coordinate \((i,j)\) of the reference frame, \( U \) and \( V \) denote the sizes of blocks used for matching the blocks, and \((x,y)\) denotes the motion vector.

10. The motion estimation device according to claim 6, wherein the motion compensation unit calculates the residual signal with the following equation:

\[ \text{NewR} (i, j) = \left[ f(i, j) - M_{\text{cur}} \right] - \left[ r(i + MV_x, j + MV_y) - M_{\text{ref}} \right] \]

\[ = f(i,j) - r(i + MV_x, j + MV_y) - M_{\text{cur}} + M_{\text{ref}} \]

where \( \text{NewR} \) denotes the residual signal, \( M_{\text{cur}} \) denotes the mean pixel value of the current frame block, \( M_{\text{ref}} \) denotes the mean pixel value of the candidate pattern blocks, \( f(i,j) \) denotes a pixel value at a coordinate \((i,j)\) of the current frame, \( r(i,j) \) denotes a pixel value of a coordinate \((i,j)\) of the reference frame, \( U \) and \( V \) denote the sizes of blocks used for matching the blocks, and \((x,y)\) denotes the motion vector.

11. A motion estimation method comprising the steps of:

(a) generating a current frame pattern block for a current frame block and a reference frame pattern block for a reference frame block;

(b) calculating the sum of absolute differences (SADs) for candidate pattern blocks corresponding to the current frame pattern block among the reference frame block...
pattern blocks and determining the candidate pattern block corresponding to the SAD  
satisfying a predetermined condition among the calculated SADs as a motion vector;  
(c) encoding the current frame block, by generating a residual signal using a  
difference signal between the candidate pattern block corresponding to the motion  
vector and the current frame pattern block then performing discrete cosine transform  
and quantization to the residual signal with a predetermined encoding mode; and  
(d) adding flag information indicating whether a mean pixel value of the  
encoded current frame block is included and identification information on the encoding  
mode to the encoded current frame block as header information,  
wherein whether the mean pixel value of the current frame block is included is  
identified by the flag information.

12. The motion estimation method according to claim 11, wherein the  
current frame block is set to at least one type of 16×16, 16×8, 8×16, 8×8, 8×4, 4×8, and  
4×4.

13. The motion estimation method according to claim 11, wherein when  
the flag information indicates that the mean pixel value is not included, a mean value of  
mean pixel values corresponding to n blocks surrounding the current frame block is  
used as the mean pixel value of the current frame block.

14. The motion estimation method according to claim 11, wherein when  
the flag information does not contain the mean pixel value and the header information  
further contains additional information indicating that the mean pixel value  
corresponding to any block among the blocks surrounding the current frame block  
should be used, a mean pixel value of the block corresponding to the additional  
information is used as the mean pixel value of the current frame block.
15. The motion estimation method according to claim 11, wherein step (a) includes the steps of:

   calculating a mean brightness value of the current frame block and a mean brightness value of the reference frame block; and

   generating the current frame pattern block by subtracting the mean brightness value of the current frame block from brightness values of the current frame block and generating the reference frame pattern blocks by subtracting the mean brightness value of the reference frame block from brightness values of the reference frame block.

16. The motion estimation method according to claim 11, further comprising the step of encoding the mean pixel value of the current frame block.

17. The motion estimation method according to claim 11, wherein the SAD satisfying the predetermined condition indicates the least SAD and the SAD is calculated by the following equation:

\[
\text{NewSAD} \ (x, y) = \sum_{i=0}^{U-1} \sum_{j=0}^{V-1} \left[ f(i, j) - M_{\text{curr}} \right] - \left[ r(i + x, j + y) - M_{\text{ref}} \right]
\]

where \( M_{\text{curr}} \) denotes the mean pixel value of the current frame block, \( M_{\text{ref}} \) denotes the mean pixel value of the candidate pattern blocks, \( f(i,j) \) denotes a pixel value at a coordinate \((i,j)\) of the current frame, \( r(i+x,j+y) \) denotes a pixel value of a coordinate \((i+x,j+y)\) of the reference frame, \( U \) and \( V \) denote the sizes of blocks used for matching the blocks, and \((x,y)\) denotes the motion vector.

18. The motion estimation method according to claim 11, wherein the residual signal is calculated by the following equation:

\[
\text{NewR} \ (i, j) = \left[ f(i, j) - M_{\text{curr}} \right] - \left[ r(i + M V_x, j + M V_y) - M_{\text{ref}} \right] = f(i,j) - r(i+M V_x, j+M V_y) - M_{\text{curr}} + M_{\text{ref}}
\]
where $NewR$ denotes the residual signal, $M_{curr}$ denotes the mean pixel value of the current frame block, $M_{ref}$ denotes the mean pixel value of the candidate pattern blocks, $f(i,j)$ denotes a pixel value at a coordinate $(i,j)$ of the current frame, $r(i,j)$ denotes a pixel value of a coordinate $(i,j)$ of the reference frame, $U$ and $V$ denote the sizes of blocks used for matching the blocks, and $(x,y)$ denotes the motion vector.

19. A motion estimation device comprising:

a pattern block generating unit generating a current frame pattern block for a current frame block and reference frame pattern blocks for a reference frame block;

a motion vector determining unit calculating the sum of absolute differences (SAD) for candidate pattern blocks corresponding to the current frame pattern block among the reference frame pattern blocks and determining the candidate pattern block corresponding to the SAD satisfying a predetermined condition among the calculated SADs as a motion vector;

a motion compensation unit generating a residual signal using a difference signal between the candidate pattern block corresponding to the motion vector and the current frame pattern block; and

an adding unit adding flag information indicating whether a mean pixel value of the encoded current frame block is included and identification information on the encoding mode to the encoded current frame block as header information,

wherein whether the mean pixel value of the current frame block is included is identified by the flag information.

20. The motion estimation device according to claim 19, wherein when the flag information indicates that the mean pixel value is not included, a mean value of mean pixel values corresponding to $n$ blocks surrounding the current frame block is used as the mean pixel value of the current frame block.
21. The motion estimation device according to claim 19, wherein when the flag information does not contain the mean pixel value and the header information further contains additional information indicating that the mean pixel value corresponding to any block among the blocks surrounding the current frame block should be used, a mean pixel value of the block corresponding to the additional information is used as the mean pixel value of the current frame block.

22. The motion estimation device according to claim 19, wherein the pattern block generating unit:

- calculates a mean brightness value of the current frame block and a mean brightness value of the reference frame block;
- generates the current frame pattern block by subtracting the mean brightness value of the current frame block from brightness values of the current frame block; and
- generates the reference frame pattern blocks by subtracting the mean brightness value of the reference frame block from brightness values of the reference frame block.

23. The motion estimation device according to claim 19, further comprising a unit carrying out discrete cosine transform and quantization to the residual signal.

24. The motion estimation device according to claim 19, wherein the SAD satisfying the predetermined condition indicates the least SAD and the motion vector determining unit calculates the SAD with the following equation:

\[ \text{NewSAD} (x, y) = \sum_{i=0}^{U-1} \sum_{j=0}^{V-1} \left[ f(i, j) - M_{\text{curr}} \right] - \left[ r(i + x, j + y) - M_{\text{ref}} \right] \]

where \( M_{\text{curr}} \) denotes the mean pixel value of the current frame block, \( M_{\text{ref}} \) denotes the mean pixel value of the candidate pattern blocks, \( f(i,j) \) denotes a pixel value at a
coordinate \((i,j)\) of the current frame, \(r(i+x,j+y)\) denotes a pixel value of a coordinate \((i+x,j+y)\) of the reference frame, \(U\) and \(V\) denote the sizes of blocks used for matching the blocks, and \((x,y)\) denotes the motion vector.

25. The motion estimation device according to claim 19, wherein the motion compensation unit calculates the residual signal with the following equation:

\[
\text{New}R(i,j) = [f(i,j) - M_{\text{curr}}] - [r(i + MV_x, j + MV_y) - M_{\text{ref}}]
\]

\[
= f(i,j) - r(i + MV_x, j + MV_y) - M_{\text{curr}} + M_{\text{ref}}
\]

where \(\text{New}R\) denotes the residual signal, \(M_{\text{curr}}\) denotes the mean pixel value of the current frame block, \(M_{\text{ref}}\) denotes the mean pixel value of the candidate pattern blocks, \(f(i,j)\) denotes a pixel value at a coordinate \((i,j)\) of the current frame, \(r(i,j)\) denotes a pixel value of a coordinate \((i,j)\) of the reference frame, \(U\) and \(V\) denote the sizes of blocks used for matching the blocks, and \((x,y)\) denotes the motion vector.
ABSTRACT OF DISCLOSURE

Provided are a motion estimation device and method adaptive to change in illumination. The motion estimation method includes the steps of: generating a current frame pattern block for a current frame block and a reference frame pattern block for a reference frame block; calculating the sum of absolute differences (SAD) for candidate pattern blocks corresponding to the current frame pattern block among the reference frame pattern blocks and determining the candidate pattern block corresponding to the SAD satisfying a predetermined condition among the calculated SADs as a motion vector; encoding the current frame block, by generating a residual signal using a difference signal between the candidate pattern block corresponding to the motion vector and the current frame pattern block then performing discrete cosine transform and quantization to the residual signal with a predetermined encoding mode; and adding flag information indicating the addition of a mean pixel value applied to the encoded current frame block and identification information on the encoding mode as header information corresponding to the encoded current frame block. By omitting insertion of a mean pixel value for some fields, it is possible to minimize the amount of bit streams transmitted to a decoder.
1/10
FIG. 1

START

RECOGNIZE CHANGE IN ILLUMINATION ~ S100

GENERATE PATTERN BLOCK ~ S110

DETERMINE CANDIDATE PATTERN BLOCK ~ S120

PERFORM OCT AND QUANTIZATION TO DIFFERENCE SIGNAL ~ S130

ADD MEAN PIXEL VALUE ~ S140

END
FIG. 2B

(a) BLOCK CORRESPONDING TO FLAG 1(240)

(b) BLOCK CORRESPONDING TO FLAG 1(245)
FIG. 3A
Objects1 (QVGA, 10Hz)

- JMB2
- Proposed ME

![Graph 1: PSNR (dB) vs Bitrates (kbps)]

- JMB2 using VBS
- Proposed ME using VBS

![Graph 2: PSNR (dB) vs Bitrates (kbps)]
Flamenco1 (QVGA, 10Hz)

- JM82
- Proposed ME

- JM82 using VBS
- Proposed ME using VBS
Foreman (QCIF, 10Hz)

PSNR (dB)

Bitrates (kbps)

- JMB82
- Proposed ME

PSNR (dB)

Bitrates (kbps)

- JMB82 using VBS
- Proposed ME using VBS
DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

As the below named inventor(s), I/we declare that:

This declaration is directed to:

- The attached application, or
- Application No. ________________________, filed on ____________________.
  - as amended on ________________________(if applicable);

I/we believe that I/we am/are the original and first inventor(s) of the subject matter which is claimed and for which a patent is sought;

I/we have reviewed and understand the contents of the above-identified application, including the claims, as amended by any amendment specifically referred to above;

I/we acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me/us to be material to patentability as defined in 37 CFR 1.56, including material information which became available between the filing date of the prior application and the National or PCT International filing date of the continuation-in-part application, if applicable; and

All statements made herein of my/own knowledge are true, all statements made herein on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001, and may jeopardize the validity of the application or any patent issuing thereon.

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<td>Citizen of:</td>
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<td>Inventor three:</td>
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☐ Additional inventors are being named on additional form(s) attached hereto.

Burden Hour Statement: This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is used by the public to file (and the PTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This form is estimated to take 1 minute to complete. This time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Assistant Commissioner for Patents, Washington, DC 20231.
Application Data Sheet

Application Information
Application Type:: Regular
Subject Matter:: Utility
Title:: Motion Estimation And Compensation Method And Device Adaptive To Change In Illumination
Attorney Docket Number:: 076980.0102
Request for Early Publication?:: No
Request for Non-Publication?:: No
Suggested Drawing Figure:: 1
Total Drawing Sheets:: 10
Small Entity:: No

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Fax: Number:: (202) 639-7890
E-Mail address:: jim.arpin@bakerbotts.com

Representative Information
Domestic Priority Information
### Foreign Priority Information

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### Assignment Information
Patent Application Fee Determination Record

| Basic Fee (37 CFR 1.16(a), (b), or (c)) | Number Filed | Number Extra |
| Search Fee (37 CFR 1.16(b), (j), or (m)) | |
| Examination Fee (37 CFR 1.16(o), (p), or (q)) | |
| Total Claims (37 CFR 1.16(i)(j)) | 25 | 5 |
| Independent Claims (37 CFR 1.16(i)(j)) | 4 minus 3 | 1 |

**Application Size Fee (37 CFR 1.16(i))**

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

N/A

**Multiple Dependent Claim Present (37 CFR 1.16(i))**

**Total**

1450

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**Small Entity**

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| Other Than Small Entity |
| Rate ($) | Fee ($) |
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| 500 | |
| 200 | |

**Total**

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**Application as Amended - Part II**

| Total (37 CFR 1.16(i)) |
| Independent (37 CFR 1.16(i)) |
| Application Size Fee (37 CFR 1.16(i)) |

**First Presentation of Multiple Dependent Claim (37 CFR 1.16(i))**

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| Other Than Small Entity |
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**Total**

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**Application as Filed - Part I**

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<td>Examination Fee (37 CFR 1.16(o), (p), or (q))</td>
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