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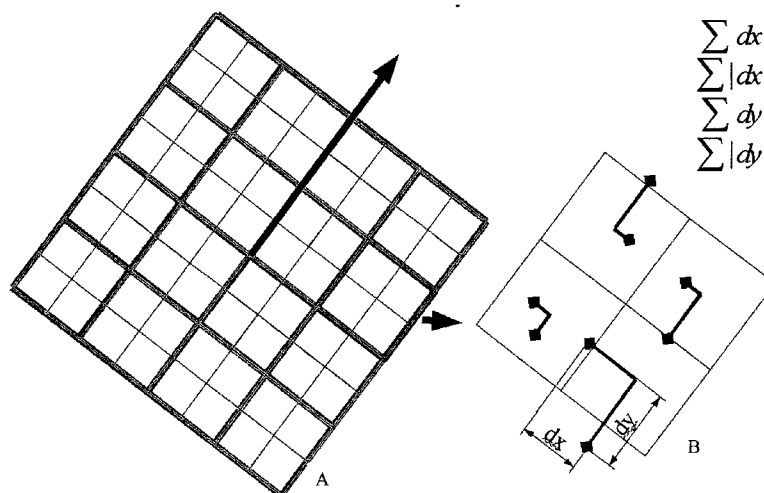
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[Continued on next page]

(54) Title: ROBUST INTEREST POINT DETECTOR AND DESCRIPTOR



(57) Abstract: Methods and apparatus for operating on images are described, in particular methods and apparatus for interest point detection and/or description working under different scales and with different rotations, e.g. for scale-invariant and rotation-invariant interest point detection and/or description. The present invention can provide improved or alternative apparatus and methods for matching interest points either in the same image or in a different image. The present invention can provide alternative or improved software for implementing any of the methods of the invention. The present invention can provide alternative or improved data structures created by multiple filtering operations to generate a plurality of filtered images as well as data structures for storing the filtered images themselves, e.g. as stored in memory or transmitted through a network. The present invention can provide alternative or improved data structures including descriptors of interest points in images, e.g. as stored in memory or transmitted through a network as well as datastructures associating such descriptors with an original copy of the image or an image derived therefrom, e.g. a thumbnail image.



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— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

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| A. CLASSIFICATION OF SUBJECT MATTER INV. G06K9/46 | | | | |
| According to International Patent Classification (IPC) or to both national classification and IPC | | | | |
| B. FIELDS SEARCHED | | | | |
| Minimum documentation searched (classification system followed by classification symbols) G06T G06K | | | | |
| Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched | | | | |
| Electronic data base consulted during the international search (name of data base and, where practical, search terms used) EPO-Internal, INSPEC, COMPENDEX | | | | |
| C. DOCUMENTS CONSIDERED TO BE RELEVANT | | | | |
| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. | | |
| X | US 6 711 293 B1 (LOWE DAVID G [CA]) 23 March 2004 (2004-03-23) abstract | 1,2 | | |
| Y | column 8, line 43 - column 9, line 14 figures 9,12 <div style="text-align: center;">----- -/--</div> | 9-20 | | |
| <input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex. | | | | |
| * Special categories of cited documents : | | | | |
| <table style="width: 100%; border: none;"> <tr> <td style="width: 50%; border: none; vertical-align: top;"> *A* document defining the general state of the art which is not considered to be of particular relevance *E* earlier document but published on or after the international filing date *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) *O* document referring to an oral disclosure, use, exhibition or other means *P* document published prior to the international filing date but later than the priority date claimed </td> <td style="width: 50%; border: none; vertical-align: top;"> *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. *8* document member of the same patent family </td> </tr> </table> | | | *A* document defining the general state of the art which is not considered to be of particular relevance *E* earlier document but published on or after the international filing date *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) *O* document referring to an oral disclosure, use, exhibition or other means *P* document published prior to the international filing date but later than the priority date claimed | *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. *8* document member of the same patent family |
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| Date of the actual completion of the international search <div style="text-align: center; font-weight: bold;">2 April 2008</div> | Date of mailing of the international search report <div style="text-align: center; font-weight: bold;">08/04/2008</div> | | | |
| Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016 | Authorized officer <div style="text-align: center; font-weight: bold;">Eveno, Nicolas</div> | | | |

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| C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT | | |
|--|---|-----------------------|
| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
| X | <p>MORTENSEN E N ET AL: "A SIFT Descriptor with Global Context" COMPUTER VISION AND PATTERN RECOGNITION, 2005. CVPR 2005. IEEE COMPUTER SOCIETY CONFERENCE ON SAN DIEGO, CA, USA 20-26 JUNE 2005, PISCATAWAY, NJ, USA, IEEE, 20 June 2005 (2005-06-20), pages 184-190, XP010817430 ISBN: 0-7695-2372-2 abstract section 3 last paragraph section 4.2 paragraph 1 section 4.3 paragraph 1</p> | 1,2,6 |
| Y | <p>LINDBERG T: "FEATURE DETECTION WITH AUTOMATIC SCALE SELECTION" INTERNATIONAL JOURNAL OF COMPUTER VISION, KLUWER ACADEMIC PUBLISHERS, NORWELL, US, vol. 30, no. 2, November 1998 (1998-11), pages 79-116, XP000800306 ISSN: 0920-5691 abstract page 80 last paragraph sequences 4.2,4.3,4.4,5 figures 3,4</p> | 9-32 |
| Y | <p>BAY H ET AL: "Interactive Museum Guide" PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON UBIQUITOUS COMPUTING, XX, XX, 11 September 2005 (2005-09-11), pages 1-4, XP002400157 sequence 2.1</p> | 9-32 |
| A | <p>MIKOLAJCZYK K ET AL: "A performance evaluation of local descriptors" IEEE TRANSACTIONS ON PATTERN ANALYSIS AND MACHINE INTELLIGENCE, IEEE SERVICE CENTER, LOS ALAMITOS, CA, US, vol. 27, no. 10, October 2005 (2005-10), pages 1615-1630, XP002384824 ISSN: 0162-8828 abstract section 2 section 3.1.2</p> | 1-7 |

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INTERNATIONAL SEARCH REPORT

International application No

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|-----------|--|-----------------------|
| A | <p>YAN KE ET AL: "PCA-SIFT: a more distinctive representation for local image descriptors" PROCEEDINGS OF THE 2004 IEEE COMPUTER SOCIETY CONFERENCE ON COMPUTER VISION AND PATTERN RECOGNITION IEEE COMPUT. SOC LOS ALAMITOS, CA, USA, vol. 2, 27 June 2004 (2004-06-27), pages II-506, XP002451829 ISBN: 0-7695-2158-4 abstract section 3 paragraphs 1-2 section 3.1</p> | 1-7 |
| A | <p>GRABNER M ET AL: "Fast Approximated SIFT" PROCEEDINGS OF THE ASIAN CONFERENCE ON COMPUTER VISION, XX, XX, 13 January 2006 (2006-01-13), pages 918-927, XP002400158 abstract sequences 1,2</p> | 9-32 |
| Y | <p>JUNQIU WANG ET AL: "Vision-based Global Localization Using a Visual Vocabulary" ROBOTICS AND AUTOMATION, 2005. PROCEEDINGS OF THE 2005 IEEE INTERNATIONAL CONFERENCE ON BARCELONA, SPAIN 18-22 APRIL 2005, PISCATAWAY, NJ, USA, IEEE, 18 April 2005 (2005-04-18), pages 4230-4235, XP010875389 ISBN: 0-7803-8914-X abstract sequences II-B</p> | 8 |
| Y | <p>LOWE D G: "Object recognition from local scale-invariant features" COMPUTER VISION, 1999. THE PROCEEDINGS OF THE SEVENTH IEEE INTERNATIONAL CONFERENCE ON KERKYRA, GREECE 20-27 SEPT. 1999, LOS ALAMITOS, CA, USA, IEEE COMPUT. SOC, US, 20 September 1999 (1999-09-20), pages 1150-1157, XP010350490 ISBN: 0-7695-0164-8 abstract sequences 3.1,4</p> | 8 |

INTERNATIONAL SEARCH REPORT

International application No.
PCT/EP2007/003811

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. As all required additional search fees were timely paid by the applicant, this international search report covers allsearchable claims.
2. As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-7,9-32

point of interest detection and characterization

1.1. claims: 1-7

descriptor computation for a point of interest

1.2. claims: 9-32

detection of a point of interest

2. claim: 8

orientation computation for a point of interest

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2007/003811

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|--|------------------|-------------------------|------------------|
| US 6711293 | B1 | 23-03-2004 | NONE |