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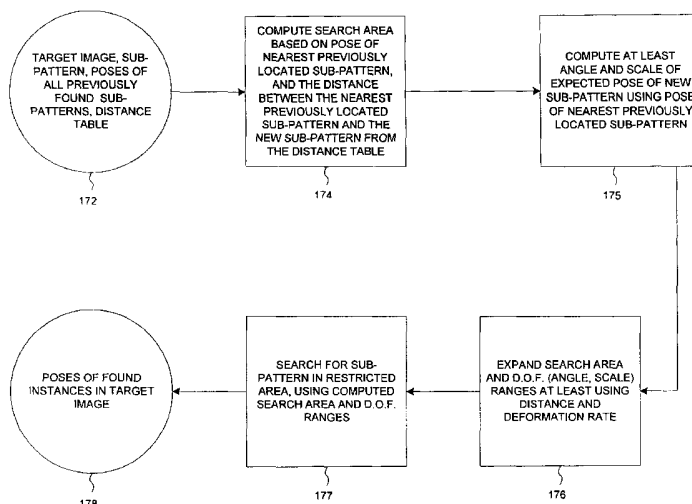
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(54) Title: METHODS FOR FINDING AND CHARACTERIZING A DEFORMED PATTERN IN AN IMAGE



(57) Abstract: A method is disclosed for finding a deformed pattern in an image using a plurality of sub-patterns. By advantageously restricting sub-pattern search ranges, search speed is improved, and the incidence of spurious matches is reduced. The method also quickly decides which sub-pattern result, of several potential candidates, is most likely to be the correct match for a deformed sub-pattern. Also, a method is provided for characterizing a deformed pattern in an image by using results from feature-based search tools to create a mapping that models the deformation of the pattern. A transform, selectable by a user, is fit to the results from the search tools to create a global deformation mapping. This transformation is fit only to feature points derived from matches resulting from successful sub-pattern search, without including data from areas of the pattern that were blank, not matched, or otherwise didn't contain information about the pattern's distorted location.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G06K9/64

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 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, COMPENDEX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y X	<p>US 2002/054699 A1 (WEESE JUERGEN ET AL) 9 May 2002 (2002-05-09) abstract paragraphs [0002], [0005], [0009], [0011] - [0013], [0016], [0017], [0020], [0025]; figures 1,2 -----</p> <p>US 5 933 516 A (HARTLEY RICHARD IAN ET AL) 3 August 1999 (1999-08-03) col. 2, line 58 - col. 3, line 54 ("Summary of the invention"); col. 4, lines 39-49; figures 1,2,3a,3b,4a,4b -----</p> <p style="text-align: center;">-/--</p>	<p>23,24, 36,37 1,9-22, 25-35, 38-47</p> <p>1-8</p>

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

° Special categories of cited documents :

- "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
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- "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
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- "&" document member of the same patent family

Date of the actual completion of the international search

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International Application No

PCT/US2004/023130

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	BELONGIE S ET AL: "SHAPE MATCHING AND OBJECT RECOGNITION USING SHAPE CONTEXTS" IEEE TRANSACTIONS ON PATTERN ANALYSIS AND MACHINE INTELLIGENCE, IEEE INC. NEW YORK, US, vol. 24, no. 4, April 2002 (2002-04), pages 509-522, XP001144050 ISSN: 0162-8828	1,9-22, 27,29, 38-47
A	abstract; 1 Introcutioin; 3 Matching with Sape Context (except for 3.1-3.4); figure 2	36,37
Y	----- SONKA M., FITZPATRICK J M: "Handbook of Medical Imaging, Volume 2: Medical Image Processing and Analysis" 2000, SPIE PRESS, BELLINGHAM, WA, XP002318380 ISBN: 0-8194-3622-4 Chapter 8	25-30
Y	----- BOOKSTEIN F L: "PRINCIPAL WARPS: THIN-PLATE SPLINES AND THE DECOMPOSITION OF DEFORMATIONS" IEEE TRANSACTIONS ON PATTERN ANALYSIS AND MACHINE INTELLIGENCE, IEEE INC. NEW YORK, US, vol. 11, no. 6, 1 June 1989 (1989-06-01), pages 567-585, XP000034113 ISSN: 0162-8828 the whole document	29
Y	----- ZHANG ZHENGYOU: "Parameter estimation techniques: A tutorial with application to conic fitting" IMAGE VISION COMPUT; IMAGE AND VISION COMPUTING JAN 1997 ELSEVIER SCIENCE LTD, OXFORD, ENGL, vol. 15, no. 1, January 1997 (1997-01), pages 59-76, XP002318379 Sections: 1. Introduction 2. A glance over parameter estimation in general 9. Robust estimation	31-35
X	----- OHM, JENS-RAINER: "Digitale Bildcodierung" 1995, SPRINGER VERLAG, BERLIN 217580, XP002303066 ISBN: 3-540-58579-6	24,25, 38-41
Y	----- section 6.2 "Bewegungschätzung"	1
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INTERNATIONAL SEARCH REPORT

International Application No

PCT/US2004/023130

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>STOCKMAN G ET AL: "Matching images to models for registration and object detection via clustering" IEEE TRANSACTIONS ON PATTERN ANALYSIS AND MACHINE INTELLIGENCE, IEEE INC. NEW YORK, US, vol. PAMI-4, no. 3, May 1982 (1982-05), pages 229-241, XP002189636 ISSN: 0162-8828 page 229 - page 230</p> <p style="text-align: center;">-----</p>	1,2,8, 23-25, 31,39,43
A	<p>WEI WEN ET AL: "RECOGNITION AND INSPECTION OF TWO-DIMENSIONAL INDUSTRIAL PARTS USING SUBPOLYGONS" PATTERN RECOGNITION, ELSEVIER, KIDLINGTON, GB, vol. 25, no. 12, 1 December 1992 (1992-12-01), pages 1427-1434, XP000336454 ISSN: 0031-3203 the whole document</p> <p style="text-align: center;">-----</p>	
A	<p>DE 44 06 020 C (ZENTRUM FUER NEUROINFORMATIK G) 29 June 1995 (1995-06-29) the whole document</p> <p style="text-align: center;">-----</p>	
A	<p>BILESCHI S M ET AL: "advances in Component-based Face Detection" LECTURE NOTES IN COMPUTER SCIENCE, SPRINGER VERLAG, NEW YORK, NY, US, vol. 2388, 2002, pages 135-143, XP002297851 ISSN: 0302-9743 the whole document</p> <p style="text-align: center;">-----</p>	

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2004/023130

Box 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 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 all searchable claims.
2. As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
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.
- 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: 1-22

Method for finding a deformed pattern in a digital image using a sub-division technique

2. claims: 23-35, 42-47

Method for computing a (deformation-) transform between two images by determining source and corresponding destination points and fitting a mapping to map source points onto corresponding destination points

3. claims: 36-41

Method for deriving feature points from (sub-)patterns

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US2004/023130

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