

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

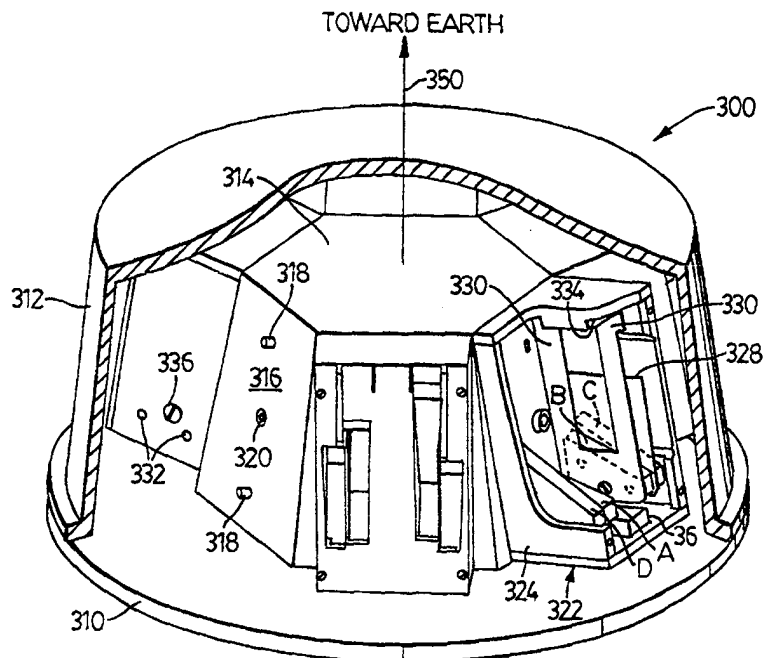
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(54) Title: SATELLITE ATTITUDE SENSOR USING THERMAL IMAGING

(57) Abstract

The present invention provides a method for distinguishing a boundary of an object, and the object itself, from its background. In the method electromagnetic radiation is detected from at least two fields of view substantially spanning the boundary of the object and background adjacent to the boundary and superimposed or overlaid as images onto a detector (36). The method includes correlating spatial transitions in intensity of the overlaid images on the detector with a boundary of the object. When used for determining the attitude of a satellite with respect to the earth, the detector is a thermal infrared detector (36) thereby providing a sharp contrast between the thermal emission of the earth and cold space. The invention provides a simple, effective method and device for determining satellite orientation and/or attitude with respect to a thermal infrared-emitting target body. The sensor includes a segmented limb-looking mirror (32) to provide multiple fields-of-view within the field-of-regard

and superimposing these fields-of-view as images onto a common detector (36). The required resolution can be obtained while providing a wide range of operational orbital altitudes. The attitude of the satellite can vary by a large angle from the minimal orientation while still permitting an accurate determination of attitude. Multiple channels in a modular form provide redundancy, improved accuracy, and the opportunity of providing more diverse configurations. The utilization of uncooled microbolometer arrays as imaging detectors removes the requirement for additional cooling equipment thereby providing a low cost, small size and low mass sensor with configurational flexibility and no moving parts.



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INTERNATIONAL SEARCH REPORT

International Application No

PCT/CA 97/00672

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B64G1/36 G01S3/786 B64G3/00

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 6 B64G G01S G02B

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)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	FR 2 533 883 A (SOCIETE ANONYME D'ETUDES ET REALISATIONS NUCLEAIRES SODERN) 6 April 1984	1-5,7
Y	see page 3, line 18 - page 4, line 18	8,27,36
A	see page 4, line 29 - page 9, line 3; figures 1-4	11-13
Y	FR 2 353 043 A (SOCIETE ANONYME D'ETUDES ET REALISATIONS NUCLEAIRES - SODERN) 23 December 1977 see page 3, line 1 - page 9, line 30; figures 1-5	8
X	US 5 477 052 A (DOCTOR) 19 December 1995	1,2,4,5,7
A	see column 1, line 56 - column 3, line 20	13,27,36
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☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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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

"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.

"&" document member of the same patent family

Date of the actual completion of the international search

14 May 1998

Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT

International Application No

PCT/CA 97/00672

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	US 4 785 169 A (GONTIN) 15 November 1988 see column 3, line 7 - column 5, line 10 ---	1,2,7 13,27,36
A	US 3 936 629 A (DESVIGNES) 3 February 1976 see column 1, line 65 - column 5, line 3; figures 1-6 ---	1,7
A	WO 95 16219 A (CENTRE NATIONAL D'ETUDES SPATIALES) 15 June 1995 see page 4, line 28 - page 6, line 34; figure 1 ---	1,6,7,11
Y A	US 4 628 206 A (ASTHEIMER) 9 December 1986 see column 2, line 42 - column 4, line 30; figures 1-5 ---	13-15, 27,36 1,7, 16-20, 27, 30-35, 39,40
Y	US 3 253 150 A (FARMER) 24 May 1966 see column 2, line 69 - column 5, line 12; figures 1-4 ---	13-15
A	US 5 055 689 A (PROFITT ET AL.) 8 October 1991 see column 2, line 16 - column 4, line 2; figures 1-7 -----	1,7,13, 27,36

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA 97/00672

Box I Observations where certain claims were found unsearchable (Continuation of item 1 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 II Observations where unity of invention is lacking (Continuation of item 2 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.:

1-40

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: 1-12

METHOD AND DEVICE FOR DISTINGUISHING A BOUNDARY OF AN OBJECT FROM ITS BACKGROUND, COMPRISING ELECTROMAGNETIC RADIATION MEANS, OPTICAL FOCUSING MEANS, AND PROCESSING MEANS FOR CORRELATING A SPATIAL TRANSITION IN RADIATION INTENSITY OF AN IMAGE FOCUSED ON SAID ELECTROMAGNETIC RADIATION DETECTING MEANS.

2. Claims: 13-26

DEVICE FOR DETERMINING SATELLITE ORIENTATION AND ATTITUDE WITH RESPECT TO A CELESTIAL BODY HAVING PIXELATED DETECTION MEANS FOR SPATIALLY SAMPLING AN IMAGE, MIRRORS, AND PROCESSING MEANS

3. Claims: 27-40

DEVICE FOR DETERMINING ORIENTATION AND ATTITUDE OF A SATELLITE WITH RESPECT TO A CELESTIAL BODY, COMPRISING AT LEAST THREE OPTICAL MODULES WITH OPTICAL FOCUSING MEANS FOR COLLECTING RADIATION FROM AT LEAST TWO FIELDS OF VIEW, AND PROCESSING MEANS

4. Claims: 41-42

SATELLITE SENSOR DEVICE FOR DETECTING FIRES ON EARTH

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/CA 97/00672

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
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