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25 February 2010

(54) Title: LOCALIZATION METHOD FOR MOBILE ROBOTS BASED ON LANDMARKS

(57) Abstract: A method for estimating the location and orientation of a mobile robot with respect to landmarks whose positions are given using a sensor for measuring bearings of the landmarks with respect to the robot, where bias errors are present. The method comprises using the sensor to obtain bearings the landmarks. The location and orientation of the robot with respect to the landmarks is estimated, based on the measured bearings, and bias errors associated with the measured bearings are corrected to obtain corrected bearings. A correction function is used to finds the minimal sum of squared errors between measured bearings and the corrected bearings. The location and the orientation of the robot is determined to be where the sum of squared errors between measured bearings and the corrected bearings is minimal.

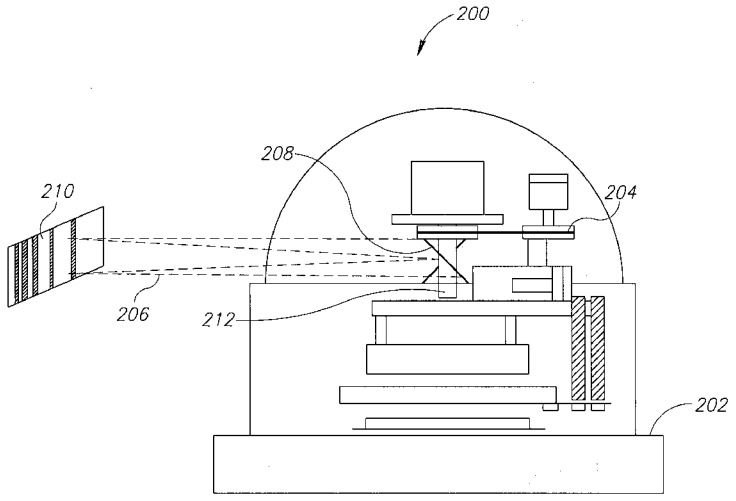

FIG.2

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/IL 08/00969

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - G05D 1/10 (2008.04)
USPC - 318/587
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(8) G05D 1/10 (2008.04)
USPC 318/587

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
IPC(8) G05D 1/10 (2008.04), USPC ? 318/587, 318/568.1, 381/567, 381/561.11, 382/155, 382/107, 382/153, 395/81, 395/84, 901/1, 901/46, 901/47 - keyword search, as below

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Google Scholar, USPTO West (databases: PGPB,USPT,USOC,EPAB,JPAB) - Search Terms: mobile, robot, landmark, reference, marker, error, correction, bearing, minimization, orientation, Shimshoni, angle, angular, squared, function, fiducial, camera, sensor, GPS, sonar, radar, laser, ultrasound, infrared, triangulate

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	LANGELAAN et al. "Passive GPS-Free navigation for Small UAVs" IEEE Aerospace Conference, 5-12 March 2005, pg. 1-9. Abstract; pg. 1; col 1, para 1, col 2, para 2, col 2, para 3; pg. 2; col 1, para 2, col 2, para 4; col 3, para 5, para 6, para 7, Eqn. 11; Eqn. 8.	1-12
Y	BETKE et al. "Mobile Robot Localization Using Landmarks" IEEE Trans. Robot. and Automation, Vol. 13, No. 2; April 1997, pg. 251-263. Abstract; pg. 256, col 2; pg. 251, col 1, para 2; pg. 251, col 2, para 4	1-12
A	US 5,995,884 A (ALLEN et al.) 30 November 1999 (30.11.1999)	1-12
L	Citation for LANGELLAN et al. "Passive GPS-Free navigation for Small UAVs" IEEE Aerospace Conference, 5-12 March 2005, pg. 1-9. Internet document downloaded from: http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?arnumber=1559602 on 16 October 2008. Utilized to verify the publication date of LANGELAAN et al.	1-12

☐ Further documents are listed in the continuation of Box C. ☐

* 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 application or patent 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)
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"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	Date of mailing of the international search report
16 November 2008 (16.11.2008)	20 NOV 2008
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

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