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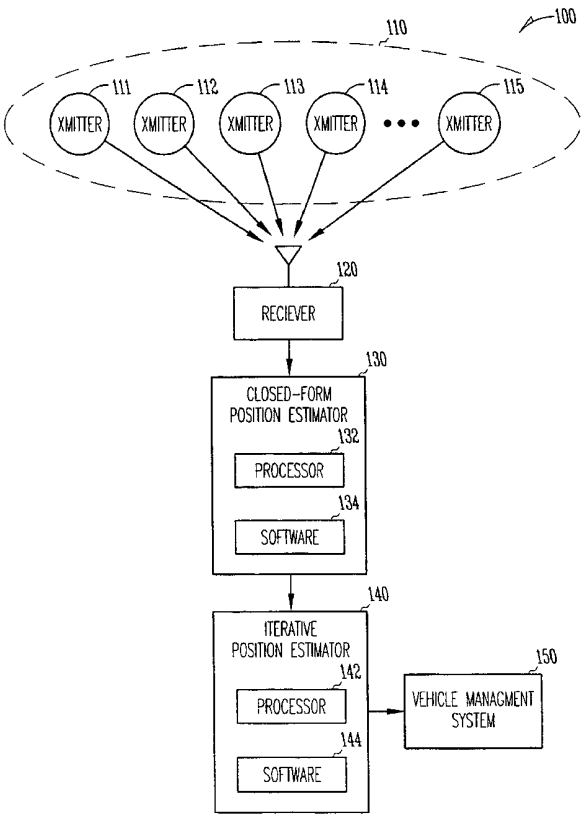
[Continued on next page]

(54) Title: SYSTEM, METHOD, AND SOFTWARE FOR NON-ITERATIVE POSITION ESTIMATION USING RANGE MEASUREMENTS



(57) Abstract: The typical global positioning system (GPS) estimates the three-dimensional, global position of a radio receiver and associated vehicle, such as an aircraft, using the range measurements between the radio receiver and a set of earth-orbiting satellite transmitters. Estimating the position of the receiver from these range measurements generally entails using an iterative calculation process, which computes a series of position estimates, with each successive estimate converging with increasing accuracy toward the actual receiver position. This iterative approach, however, is not only time consuming, but sometimes fails to converge toward the actual receiver position. Though others have tried to solve these problems, their approaches either fail to consistently converge on a single solution or give multiple solutions. Accordingly, the inventors devised, among other things, new non-iterative methods, for using range measurements to estimate position. One exemplary position-estimation method entails receiving a set of two or more range measurements; defining an error function based on the set of range measurements, with the error function having only one local minimum; and then determining a position estimate based the one local minimum of the error function. This and other exemplary embodiments of the invention promise to reduce the time for computing position estimates.

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A. CLASSIFICATION OF SUBJECT MATTER
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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 G01S

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, WPI Data, PAJ, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 914 686 A (SCHIPPER JOHN F) 22 June 1999 (1999-06-22) abstract column 4, line 4 -column 9, line 21 --- -/--	1,6,9, 12,14, 15, 17-21, 23,24

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"A" document defining the general state of the art which is not considered to be of particular relevance

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"&" document member of the same patent family

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Name and mailing address of the ISA	Authorized officer
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	Niemeijer, R

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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	ELGERSMA M: "Initial Solution of Pseudo-Range Equations" WORKSHOP MATHEMATICAL CHALLENGES IN GLOBAL POSITIONING SYSTEMS (GPS), 16-18 AUGUST 2000, INSTITUTE FOR MATHEMATICS AND ITS APPLICATIONS (IMA), UNIVERSITY OF MINNESOTA, 'Online! XP002196393 Retrieved from the Internet: <URL:http://www.ima.umn.edu/gps/abstracts/elgersma1.html> 'retrieved on 2002-04-15! abstract ---	1,9,12
A	LEVA J L: "AN ALTERNATIVE CLOSED-FORM SOLUTION TO THE GPS PSEUDO-RANGE EQUATIONS" IEEE TRANSACTIONS ON AEROSPACE AND ELECTRONIC SYSTEMS, IEEE INC. NEW YORK, US, vol. 32, no. 4, 1 October 1996 (1996-10-01), pages 1430-1439, XP000688912 ISSN: 0018-9251 Section "Introduction" ---	1,7,9, 11-14, 18-20
A	BANCROFT S: "AN ALGEBRAIC SOLUTION OF THE GPS EQUATIONS" IEEE TRANSACTIONS ON AEROSPACE AND ELECTRONIC SYSTEMS, IEEE INC. NEW YORK, US, vol. AES-21, no. 7, January 1985 (1985-01), pages 56-69, XP000972710 ISSN: 0018-9251 cited in the application Section "Algorithmic Statement of Results" -----	1,7,9, 11-14, 18-20

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
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US 5914686 A	22-06-1999	US 5825328 A	20-10-1998