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(54) Title: SYSTEM AND METHOD FOR RECONVERGING GNSS POSITION ESTIMATES

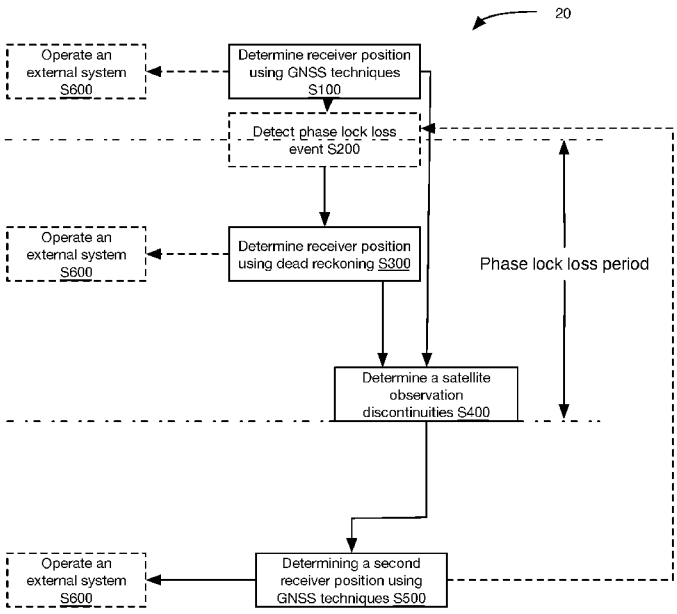

FIGURE 3

(57) Abstract: A system and method for determining a receiver position can include determining a receiver position based on a set of satellite observations, determining the receiver position based on sensor measurements, determining a satellite observation discontinuity; based on the satellite observation discontinuity, determining a second receiver position.

[Continued on next page]

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US21/18191

A. CLASSIFICATION OF SUBJECT MATTER

IPC - G01S 19/44; G01S 19/04; G01S 19/45; G01S 19/55 (2021.01)

CPC - G01S 19/44; G01S 19/04; G01S 19/074; G01S 19/45; G01S 19/55; G01S 19/08

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)
See Search History document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
See Search History document

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y — A	EP 2966477 A1 (ANAVS GMBH) 13 January 2016; abstract; paragraphs [0017], [0018], [0026], [0035], [0040], [0054], [0055], [0077], [0091]	1-4, 8, 9 — 5-7
Y — A	US 9,182,497 B2 (GEIER, G ET AL.) 10 November 2015; column 6, line 34-52; claims 1, 4 & 6	1-4, 8, 9 — 5-7
Y — A	US 2018/0299562 A1 (COHERENT TECHNICAL SERVICES, INC.) 18 October 2018; paragraphs [0027], [0032], [0059]	3, 4 — 5-7
A	US 9,709,683 B2 (LEANDRO, R ET AL.) 18 July 2017; entire document	1-9

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"D" document cited by the applicant in the international application
"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)
"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
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 September 2021 (30.09.2021)	DEC 23 2021
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. 571-273-8300	Authorized officer Shane Thomas Telephone No. PCT Helpdesk: 571-272-4300

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US21/18191

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:
-***-Please See Supplemental Page-***-

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 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.:
1-9

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.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US21/18191

-***-Continued From Box No. III: Observations where unity of invention is lacking-***-

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fee must be paid.

Group I: Claims 1-9 are directed towards a system estimating position by removing integer-valued carrier phase ambiguities.
Group II: Claims 10-20 are directed towards a method determining high integrity receiver position using a cycle slip standard deviation.

The inventions listed as Groups I-II do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

The special technical features of Group I include at least a system comprising an integer fixing module configured to determine an integer-valued carrier phase ambiguity associated with each satellite of the set of global navigation satellites; a position filter configured to estimate a position of the receiver based on the satellite observations with the associated integer-valued carrier phase ambiguities removed, which are not present in Group II.

The special technical features of Group II include at least a method comprising determining a cycle slip between the set of satellite observations and a second set of satellite observations measured after the phase lock loss period based on the high integrity receiver position prior to the phase lock loss event; and when a standard deviation of the cycle slip is less than a standard deviation threshold, determining a second high integrity receiver position using the cycle slip, which are not present in Group I.

The common technical features shared by Groups I-II are determining a receiver position based on a set of satellite observations; determining a cycle slip based on IMU measurements during a phase lock period.

However, these common features are previously disclosed by US 9182497 B2 to GEIER, G et al. (hereinafter "GEIER"). GEIER discloses determining a receiver position based on a set of satellite observations (estimating a position vector using GPS (satellite observations); claim 4 of GEIER); determining a cycle slip based on IMU measurements during a phase lock period (a cycle clip detector uses an IMU dead reckoning sensor (measurements) and a phase lock loop tracking device (lock period); column 5, line 54 to column 6, line 4; claims 1, 4 & 6 of GEIER).

Since the common technical features are previously disclosed by GEIER, these common features are not special and so Groups I-II lack unity.