(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
27 May 2010 (27.05.2010)

PCT

(10) International Publication Number
WO 2010/059934 A3

(51) International Patent Classification:
*G01S 5/02* (2010.01) *H04W 64/00* (2009.01)
*H04L 12/28* (2006.01)

(21) International Application Number:
PCT/US2009/065319

(22) International Filing Date:
20 November 2009 (20.11.2009)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/116,996 21 November 2008 (21.11.2008) US
61/117,055 21 November 2008 (21.11.2008) US
12/622,289 19 November 2009 (19.11.2009) US

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI,

*[Continued on next page]*

(54) Title: WIRELESS POSITION DETERMINATION USING ADJUSTED ROUND TRIP TIME MEASUREMENTS

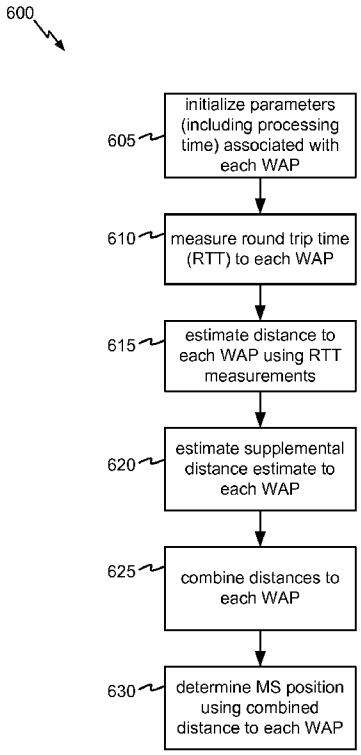


FIG. 6

(57) Abstract: One method for wirelessly determining a position of a mobile station includes measuring a round trip time (RTT) to a plurality of wireless access points, estimating a first distance to each wireless access point based upon the round trip time delay and an initial processing time associated with each wireless access point, estimating a second distance to each wireless access point based upon supplemental information, combining the first and second distance estimates to each wireless access point, and calculating the position based upon the combined distance estimates. Another method includes measuring a distance to each wireless access point based upon a wireless signal model, calculating a position of the mobile station based upon the measured distance, determining a computed distance to each wireless access point based upon the calculated position of the mobile station, updating the wireless signal model, and determining whether the wireless signal model has converged.

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NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

**(84) Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

**Declarations under Rule 4.17**:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

**Published**:

— *with international search report (Art. 21(3))*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

**(88) Date of publication of the international search report**:
12 August 2010

# INTERNATIONAL SEARCH REPORT

International application No
PCT/US2009/065319

A. CLASSIFICATION OF SUBJECT MATTER
INV. G01S5/02 H04L12/28 H04W64/00
ADD.

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)
G01S H04L H04Q H04W

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X | WO 2007/056738 A2 (QUALCOMM INC [US]; EDGE STEPHEN W [US]) 18 May 2007 (2007-05-18) | 1-5, 8-19, 22-33, 36-42 |
| Y | * abstract | 6,7,20, |
| | table 1 | 21,34,35 |
| A | paragraphs [0040] - [0043] | 90,104, |
| | paragraphs [0070] - [0074] | 117 |
| | paragraphs [0081] - [0087] | |
| | paragraph [0128] | |
| | ----- | |
| | -/-- | |

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

[X] See patent family annex.

* Special categories of cited documents :

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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 | Date of mailing of the international search report |
|---|---|
| 16 June 2010 | 23/06/2010 |

| Name and mailing address of the ISA/ | Authorized officer |
|---|---|
| European Patent Office, P.B. 5818 Patentlaan 2<br>NL - 2280 HV Rijswijk<br>Tel. (+31-70) 340-2040,<br>Fax: (+31-70) 340-3016 | Esbri, Oriol |

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International application No
PCT/US2009/065319

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| Y | AWAD A ET AL: "Adaptive Distance Estimation and Localization in WSN using RSSI Measures" 10TH EUROMICRO CONFERENCE ON DIGITAL SYSTEM DESIGN ARCHITECTURES, METHODS AND TOOLS (DSD 2007), LOS ALAMITOS, CALIF. [U.A.] : IEEE COMPUTER SOC, PISCATAWAY, NJ, USA, 29 August 2007 (2007-08-29), pages 471-478, XP031335137 ISBN: 978-0-7695-2978-3 columns 9-15 | 6,7,20, 21,34,35 |
| A | US 2007/002813 A1 (TENNY NATHAN E [US] ET AL) 4 January 2007 (2007-01-04) * abstract paragraphs [0014] - [0049] | 1,15,29 |
| X | JAN BLUMENTHAL ET AL: "Precise Positioning with a Low Complexity Algorithm in Ad hoc Wireless Sensor Networks" PIK. PRAXIS DER INFORMATIONSVERARBEITUNG UND KOMMUNIKATION, SAUR, MUENCHEN, DE LNKD- DOI:10.1515/PIKO.2005.80, [Online] vol. 28, no. 2, 1 June 2005 (2005-06-01), pages 80-85, XP002495976 ISSN: 0930-5157 Retrieved from the Internet: URL:http://rtl.e-technik-uni-rostock.de/%20frei/geosens/dateien/BRT05.pdf> [retrieved on 2005-06-01] columns 4-11; figure 3 | 43-46, 50-57, 60-64, 68-75, 78-82, 85-88 |
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# INTERNATIONAL SEARCH REPORT

International application No
PCT/US2009/065319

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| A | MACCRADY D ET AL: "Mobile Ranging With Low Accuracy Clocks" RADIO AND WIRELESS CONFERENCE, 1999. RAWCON 99. 1999 IEEE DENVER, CO, USA 1-4 AUG. 1999, PISCATAWAY, NJ, USA,IEEE, US LNKD- DOI:10.1109/RAWCON.1999.810937, 1 August 1999 (1999-08-01), pages 85-88, XP010365195 ISBN: 978-0-7803-5454-8 the whole document | 90,104, 117 |
| A | MAO ET AL: "Wireless sensor network localization techniques" COMPUTER NETWORKS, ELSEVIER SCIENCE PUBLISHERS B.V., AMSTERDAM, NL LNKD- DOI:10.1016/J.COMNET.2006.11.018, vol. 51, no. 10, 6 May 2007 (2007-05-06), pages 2529-2553, XP022063022 ISSN: 1389-1286 columns 4-14 | 90,104, 117 |
| A | US 2005/130669 A1 (MIZUGAKI KENICHI [JP] ET AL) 16 June 2005 (2005-06-16) * abstract figures 1,3,6,9,12,13 paragraphs [0027] - [0096] | 90,104, 117 |

# INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2009/065319

**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:

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 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.:

**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.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-42

upper and lower bounds for RSSI as a function of distance

2. claims: 43-89

wireless signal model

3. claims: 90-117

updating the estimated processing time

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2009/065319

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