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(71) Applicant: **MIMOS BERHAD** [MY/MY]; Technology Park Malaysia, 57000 Kuala Lumpur (MY).

(72) Inventors: **TING, Kee Ngoh**; c/o MIMOS Berhad, Technology Park Malaysia, 57000 Kuala Lumpur (MY). **NG, Seh Chun**; c/o MIMOS Berhad, Technology Park Malaysia, 57000 Kuala Lumpur (MY). **CHIENG, Heng Tze**; c/o MIMOS Berhad, Technology Park Malaysia, 57000 Kuala Lumpur (MY).

(74) Agent: **TAY, Wee Chao**; c/o Author IP, No. 2-3, Taman Arosa, Jalan Haji Jaib, 84000 Muar, Johor (MY).

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— *as to the identity of the inventor (Rule 4.17(i))*

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

[Continued on next page]

(54) Title: METHOD AND SYSTEM FOR DETERMINING A LOCATION OF AN INDOOR RECEIVER

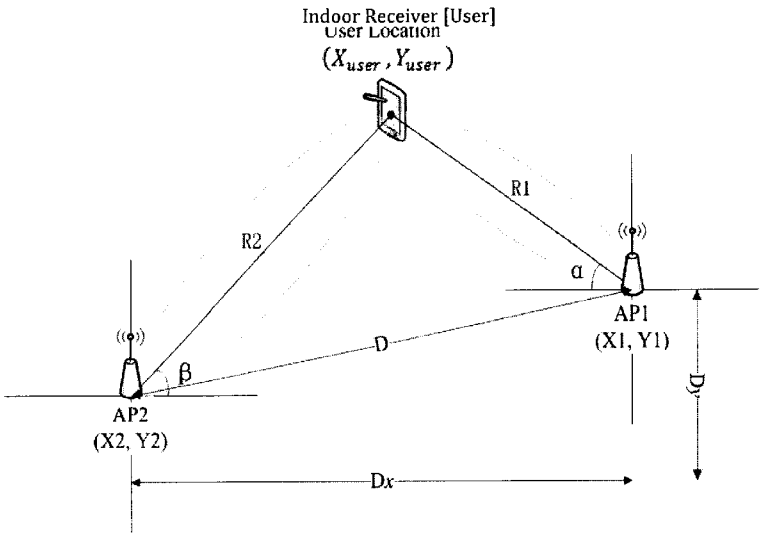


Figure 2

(57) Abstract: The present invention relates to a method for determining a location of an indoor receiver by using a system comprising at least pair of transmitters having a smart antenna, a transmit angle generator (TAG), a transmit angle controller (TAC), and a positioning packet generator (PPG), the method is characterized by the steps of: providing a plurality of transmission angles of the transmitters (100); generating a plurality of information packets (IP), wherein each IP comprises a transmission angle and a transmitter location (200); broadcasting the plurality of IP to the indoor receiver (300); inputting the plurality of IP into a table (400); selecting IP with the highest received signal strength (RSS) value (500); and calculating the location of the indoor receiver (600) based on the transmission angle and transmitter location of the selected IP.

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METHOD AND SYSTEM FOR DETERMINING A LOCATION OF AN INDOOR RECEIVER

TECHNICAL FIELD OF THE INVENTION

This invention relates to a method and a system for determining a location of an indoor receiver.

BACKGROUND OF THE INVENTION

A positioning system, for examples, interplanetary-radio communication system, global navigation satellite system (GNSS), and regional system, is used to determine the location of an object. People are widely relying on these positioning systems, especially global positioning system (GPS) of the GNSS, but unlike in outdoor environments, GPS does not work well in indoor spaces.

For indoor positioning, instead of using satellites, the positioning system relies on nearby anchors with a known position which either actively locate tags or provide environmental contexts for devices to identify and communicate with. The non-GPS positioning techniques include techniques such as triangulation, proximity, and scene analysis.

Some of the conventional methods for determining indoor location require at least 3 access points to predict and calculate the location. However, such methods are inefficient and the prediction of the location may not be accurate. Furthermore, some of the conventional techniques are also too complex to be implemented and are too expensive to be integrated, especially in small-to medium-scaled industries.

International publication no. WO 2011/090541 A1 is related to an indoor positioning system based on GPS signals. In this patent, among the features are having at least 3 GPS antennae for picking up specific GPS signals, and at least 3 RF GPS repeaters. One of the shortcomings of the invention in said patent is

that the GPS can be inaccurate and more complicated to use in indoor spaces. It may also pose another challenge if the indoor space is not able to receive satellite signals. In addition, the method disclosed in the patent which requires multiple calculations to determine the accuracy and real ranges of the indoor receiver may overwhelm the system and user. Thus, there is a need to overcome said shortcomings.

Patent US 8,395,968 B2 relates to indoor position determination using building information and/or power lines. However, the application may not be universal as not all building information is obtainable and reliable, and most of the hardwares integrated in the device of said patent are generally expensive. Besides that, the corners and walls of the building may disrupt the signals transmitted by the device while predicting the location of the indoor device.

Patent publication no. US 2013/0003572 A1 disclosed an indoor position determination method and system based on WLAN signal strength. In this patent, the position of the indoor device is determined and calculated in access point. The disadvantage of using the method and system proposed in said patent is that the design of WLAN infrastructure usually requires error-prone calibration for avoiding dead-corners in receiving the signal and that the signal is randomly distributed. Besides that, the method in said patent which includes comparing signal strength pattern of each access points may not be accurate.

Accordingly, it can be seen in the prior art that there exists a need to provide a method and a system for determining a location of an indoor receiver accurately and efficiently without complicating the whole methodology.

SUMMARY OF THE INVENTION

It is an objective of the present invention to provide a system for determining the location of an indoor receiver. In accordance with the objective of the present invention the system for determining the location of an indoor receiver, is characterized by: at least a pair of transmitters having a smart antenna for

broadcasting a plurality of IP to the indoor receiver, wherein each IP comprises a transmission angle and a transmitter location; a transmit angle generator (TAG) for determining the angle of each transmission angle; a transmit angle controller (TAC) for controlling the smart antenna to create the transmission angle having the angle determined by TAG; and a positioning packet generator (PPG) for generating the plurality of IP.

It is also an objective of the present invention to provide a method for determining the location of an indoor receiver. Furthermore, an objective of the present invention is to perform position calculation in a client's device which is also known as the indoor receiver. It is another objective of the present invention to use a minimum of two transmitters to determine the location of the indoor receiver.

Accordingly, these objectives may be achieved by following the teachings of the present invention. The present invention relates to a method for determining the location of an indoor receiver, the method is characterized by the steps of: providing a plurality of transmission angles from at least a pair of transmitter having a smart antenna; generating a plurality of information packets (IP) by the pair of transmitters, wherein each IP comprises a transmission angle and a transmitter location; broadcasting the plurality of IP to the indoor receiver; inputting the plurality of IP into a table by the indoor receiver; selecting the IP with the highest received signal strength (RSS) value from each of the transmitters; and calculating the location of the indoor receiver based on the transmission angle and the transmitter location of the selected IP.

BRIEF DESCRIPTION OF THE DRAWINGS

The features of the invention will be more readily understood and appreciated from the following detailed description when read in conjunction with the accompanying drawings of the preferred embodiment of the present invention, in which:

Figure 1 is a flowchart of a method for determining the location of an indoor receiver;

Figure 2 is a diagram showing triangulation method to calculate the location of the indoor receiver; and

Figure 3 shows a table stored in the indoor receiver.

DETAILED DESCRIPTION OF THE INVENTION

The above mentioned and other features and objects of this invention will become more apparent and better understood by reference to the following detailed description. It should be understood that the detailed description made known below is not intended to be exhaustive or to limit the invention to the precise disclosed form as the invention may assume various alternative forms. On the contrary, the detailed description covers all the relevant modifications and alterations made to the present invention, unless the claims expressly state otherwise. The present invention will now be described with reference to Figures 1 to 3.

The present invention provides a system for determining a location of the indoor receiver, which is characterized by: at least a pair of transmitters having a smart antenna for broadcasting a plurality of IP to the indoor receiver, wherein each IP comprises a transmission angle and a transmitter location; a transmit angle generator (TAG) for determining the angle of each transmission angle; a transmit angle controller (TAC) for controlling the smart antenna to create the transmission angle having the angle determined by TAG; and a positioning packet generator (PPG) for generating the plurality of IP.

In accordance with an embodiment of the present invention, the transmitter is access point or base station.

In accordance with another embodiment of the present invention, the smart antenna is of switched beam, phased array, or directional type.

Referring to Figure 1, the present invention also relates to a method for determining the location of an indoor receiver, the method is characterized by the steps of: providing a plurality of transmission angles from at least a pair of transmitters (100) having a smart antenna; generating a plurality of information packets (IP) by the pair of transmitters, wherein each IP comprises a transmission angle and a transmitter location (200); broadcasting the plurality of IP to the indoor receiver (300); inputting the plurality of IP into a table by the indoor receiver (400); selecting the IP with the highest received signal strength (RSS) value from each of the transmitters (500); and calculating the location of the indoor receiver (600) based on the transmission angle and the transmitter location of the selected IP.

In an embodiment of the present invention, more than two transmitters may be used depending on the requirements of the system and the indoor space.

In another embodiment of the present invention, the transmitter is access point or base station.

A smart antenna of types such as switched beam, phased array, or directional antenna is coupled to the transmitter for broadcasting the plurality of IP to the indoor receiver in a small beam-width radiation pattern or directional pattern. Each of the IP has different transmission angle, which is determined by a transmission angle generator (TAG). Thereafter, this particular information is relayed to a transmit angle controller (TAC), which then decides as how to control the smart antenna depending on the type of smart antenna in order to create the transmission angle with the angle determined by TAG. Therefore, the plurality of IP that are broadcasted by the transmitters has different transmission angles.

In another embodiment, the TAG and TAC are located in the transmitter.

In yet another embodiment of the present invention, the step of generating the plurality of IP by the pair of transmitters (200), is carried out by a positioning packet generator (PPG). In a further embodiment of the present invention, the PPG is located in the transmitter.

In still another embodiment of the present invention, the indoor receiver has an omni-directional antenna to receive the plurality of IP.

In a preferred embodiment of the present invention, the step of inputting the plurality of IP into the table by the indoor receiver (400) further comprises the steps: of extracting the transmission angles and the transmitter locations from the IP, and inputting said transmission angles and said transmitter locations into the table. The indoor receiver continuously updates and inputs the plurality of IP into the table as the transmitters continuously broadcast the plurality of IP to the indoor receiver. Figure 3 shows an example of the table stored in the indoor receiver.

In another embodiment of the present invention, the step of selecting IP with the highest RSS values from each of the transmitters (500) further comprises the steps of: identifying the highest RSS value projected from each of the transmitters; selecting the IP with respect to the highest RSS value by referring to the table; and extracting the transmission angle and the transmitter location from the selected IP. These steps take place in the indoor receiver. The highest RSS value indicates that the broadcast signal is the strongest among the rest, thus implying that the transmission angle is pointing closer to the location of the indoor receiver. The extracted transmission angle and transmitter location will then be used to calculate the location of the indoor receiver. The calculation of the location of the indoor receiver takes place in the indoor receiver.

In a further embodiment of the present invention, by referring to Figure 2, the step of calculating location of the indoor receiver (600) further includes equations

(1) - (4).

$$R_1 = \frac{\left(D_y - \frac{D_x \sin(\beta)}{\cos(\beta)}\right)}{\left(\sin(\alpha) - \frac{\cos(\alpha)\sin(\beta)}{\cos(\beta)}\right)} \quad (1)$$

$$R_2 = \frac{D_x - R_1 \cos(\alpha)}{\cos(\beta)} \quad (2)$$

$$X_{user} = (X_2 + R_2) \times cos(\beta) \quad (3)$$

$$Y_{user} = (Y_2 + R_2) \times sin(\beta) \quad (4)$$

In an embodiment of the present invention, the step of calculating location of the indoor receiver (600) is by using triangulation method.

Although the present invention has been described with reference to specific embodiments, it will be apparent for those skilled in the art that many variations and modifications can be done within the scope of the invention as described in the specification and defined in the following claims.

CLAIMS

1. A system for determining a location of an indoor receiver, the system is characterized by:
   a) a pair of transmitters having a smart antenna for broadcasting a plurality of information packets (IP) to the indoor receiver, wherein each IP comprises a transmission angle and a transmitter location;
   b) a transmit angle generator (TAG) for determining the angle of each transmission angle;
   c) a transmit angle controller (TAC) for controlling the smart antenna to create the transmission angle having the angle determined by TAG; and
   d) a positioning packet generator (PPG) for generating the plurality of IP.

2. A system according to claim 1, wherein the transmitter is access point or base station.

3. A system according to claim 1, wherein the smart antenna is of switched beam, phased array, or directional type.

4. A method for determining a location of an indoor receiver, the method is characterized by the steps of:
   a) providing a plurality of transmission angles from at least a pair of transmitters (100) having a smart antenna;
   b) generating a plurality of information packets (IP) by the pair of transmitters, wherein each IP comprises a transmission angle and a transmitter location (200);
   c) broadcasting the plurality of IP to the indoor receiver (300);
   d) inputting the plurality of IP into a table by the indoor receiver (400);
   e) selecting IP with the highest received signal strength (RSS) value from each of the transmitters (500); and

f) calculating the location of the indoor receiver (600) based on the transmission angle and the transmitter location of the selected IP.

5. A method according to claim 4, wherein the step of providing a plurality of transmission angles from the pair of transmitters (100) further comprises the steps of:

a) determining the angle of each transmission angle by a transmit angle generator (TAG);

b) controlling the smart antenna by a transmit angle controller (TAC) to create the transmission angle having the angle determined by TAG.

6. A method according to claim 4, wherein the step of generating a plurality of IP by the pair of transmitters (200) is carried out by a positioning packet generator (PPG) within the pair of transmitters.

7. A method according to claim 4, wherein the step of inputting the plurality of IP into the table by the indoor receiver (400) further comprises the steps of:

a) the indoor receiver extracts the transmission angles and the transmitter locations from the IP; and

b) inputting said transmission angles and transmitter locations into the table.

8. A method according to claim 4, wherein the step of selecting IP with the highest received signal strength (RSS) value from each of the transmitters (500) further comprises the steps of:

a) identifying the highest RSS value projected from each of the transmitters;

b) selecting IP with respect to the highest RSS value by referring to the table; and

c) extracting the transmission angle and the transmitter location from the selected IP.

9. A method according to claim 4, wherein the step of calculating the location of the indoor receiver (600) is by using triangulation method.

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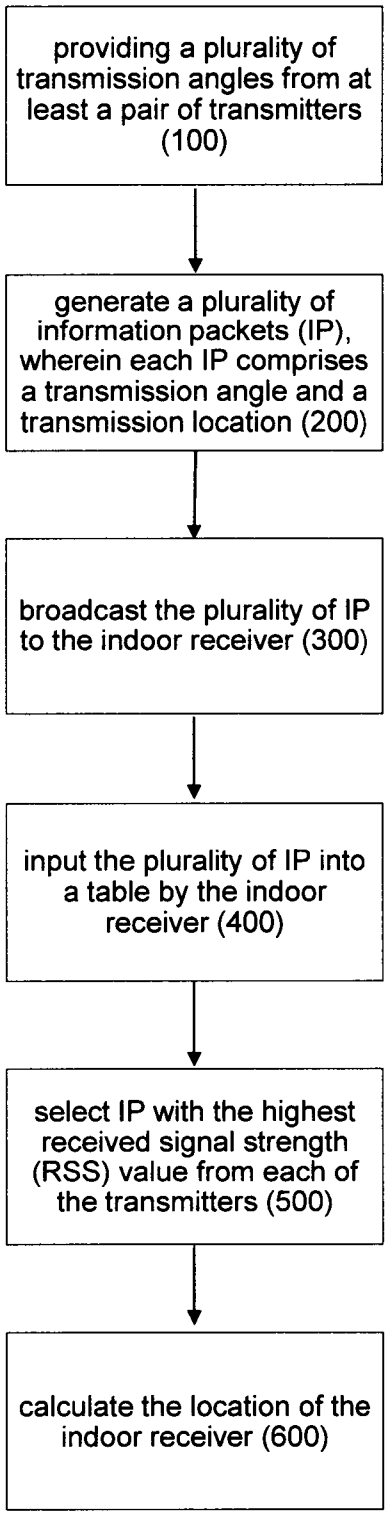

providing a plurality of transmission angles from at least a pair of transmitters (100)
generate a plurality of information packets (IP), wherein each IP comprises a transmission angle and a transmission location (200)
broadcast the plurality of IP to the indoor receiver (300)
input the plurality of IP into a table by the indoor receiver (400)
select IP with the highest received signal strength (RSS) value from each of the transmitters (500)
calculate the location of the indoor receiver (600)

Figure 1

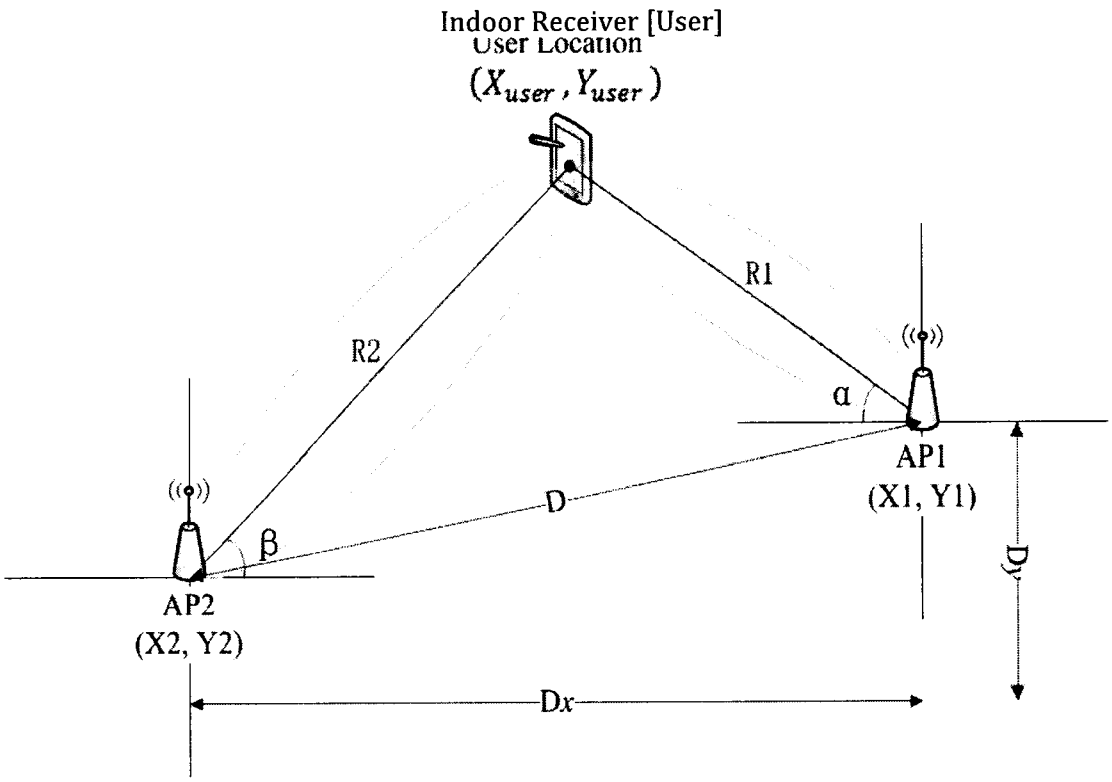

Indoor Receiver [User]
User Location
(X_{user}, Y_{user})
R1
R2
α
β
D
AP1
(X1, Y1)
AP2
(X2, Y2)
Dy
Dx

Figure 2

Index	Transmitter 1 (X_1, Y_1)		Transmitter 2 (X_2, Y_2)	
1	RSS (1)	α (1)	RSS (1)	β(1)
2	RSS (2)	α (2)	RSS (2)	β(2)
(*n*)	RSS (*n*)	α (*n*)	RSS (*n*)	β(*n*)

Figure 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/MY2014/000135

A. CLASSIFICATION OF SUBJECT MATTER
INV. G01S5/00 G01S5/08 G01S5/12
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

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 practicable, search terms used)
EPO-Internal, WPI Data, COMPENDEX, 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 2009/312037 A1 (JO DAEHYUNG [KR] ET AL) 17 December 2009 (2009-12-17) paragraphs [0010], [0012] - [0016] paragraphs [0029], [0030], [0034] - [0072] paragraphs [0083] - [0100] paragraphs [0106] - [0109] paragraphs [0116] - [0125] paragraphs [0115] - [0125] figures 1,3	1-9
Y	WO 2007/017435 A1 (IBM [US]; IBM UK [GB]; JOHNSON MICHAEL JOSEPH [US]) 15 February 2007 (2007-02-15) page 1 - page 6	1,4

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

[X] 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

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Date of the actual completion of the international search	Date of mailing of the international search report
24 November 2014	01/12/2014

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, Fax: (+31-70) 340-3016	Naddeo, Giovanni

1

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INTERNATIONAL SEARCH REPORT

International application No
PCT/MY2014/000135

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

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