

VERTICAL LOCATION TRACKING USING WIFI

FIELD OF INVENTION

[0001] The present invention relates to vertical location tracking, and more
5 particularly, methods and systems for vertical location tracking in a vertical
building using a plurality of WiFi signals.

BACKGROUND

[0002] Real-time locating systems are used to automatically identify and
10 track the location of objects or people in real time. Nowadays it has provided
numerous applications in logistical and operational areas.

[0003] Among the current technologies, it is common to use mobile
devices to capture GPS coordinates for location detection and tracking. A
GPS receiver in a mobile device receives signals from GPS satellites,
15 calculates the distance to each satellite, and determines its own position
through trilateration. While GPS can provide accurate results for two-
dimensional positions based on this process, it is not capable of tracking
accurate locations on different vertical levels in a building.

[0004] RFID and Bluetooth technologies have been adopted for real-time
20 location tracking in buildings but the cost is significant. A number of RFID
readers or Bluetooth beacons need to be installed to transmit signals to the
RFID tags or Bluetooth devices. When area of concern grows, cost will
further escalate due to the increase in number of hardware being deployed.

[0005] The problem is even greater when taking field force attendance. In this scenario, the task can be demanding and especially challenging when the number of field workers is huge. For companies with considerable work force in a built-up area, stake holders or field managers will need to track the work force movements and progress, for example, to check whether a worker was onsite to do a scheduled maintenance job and how long a worker stayed onsite.

[0006] Thus, what is needed is a robust method / system that is able to detect, record and track locations on different vertical levels of a building economically.

SUMMARY

[0007] According to a first aspect, there is provided a method for vertical location tracking. The method includes scanning a plurality of WiFi signals at a predetermined location on one of a plurality of vertical levels and, for each of the plurality of WiFi signals scanned, recording a service set identifier (SSID) of the WiFi signal, a received signal strength (RSS) of the WiFi signal, and the one of the plurality of vertical levels.

[0008] According to a second aspect, there is provided a system for vertical location tracking. The system includes a plurality of mobile devices and a database. The plurality of mobile devices are configured to receive a plurality of WiFi signals from a plurality of WiFi routers with SSIDs, each one of the WiFi routers on one of a plurality of vertical levels and broadcasting a

WiFi signal. The database stores the SSIDs of the WiFi signals, the RSS of the WiFi signals and the one of the plurality of vertical levels. Thereafter, one of the plurality of mobile devices accesses the database and compares SSID and RSS of the WiFi signals received from the plurality of WiFi routers to
5 determine a vertical location on one of the plurality of vertical levels.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The accompanying figures, where like reference numerals refer to identical or functionally similar elements throughout the separate views and
10 which together with the detailed description below are incorporated in and form part of the specification, serve to illustrate various embodiments and to explain various principles and advantages in accordance with a present embodiment.

[0010] FIG. 1 depicts a flowchart of a method for vertical location tracking
15 using WiFi in accordance with a present embodiment.

[0011] FIG. 2 depicts an illustration of a mapping service in accordance with the present embodiment.

[0012] FIG. 3 depicts an illustration of corridor position tracking in accordance with the present embodiment.

20 **[0013]** FIG. 4 depicts an illustration of a query service in accordance with the present embodiment.

[0014] FIG. 5 depicts a flowchart of the query service and a diagram depicting obtaining vertical location results from query parameters in accordance with the present embodiment.

[0015] FIG. 6 depicts an illustration of initiating a self-mapping process in
5 accordance with the present embodiment.

[0016] And FIG. 7, comprising FIGs. 7A, 7B and 7C, depicts illustrations of graphical user interfaces for the mobile device application for scanning WiFi and registering locations in accordance with the present embodiment.

[0017] Skilled artisans will appreciate that elements in the figures are
10 illustrated for simplicity and clarity and have not necessarily been depicted to scale. For example, the dimensions of some of the elements in the illustrations or diagrams may be exaggerated in respect to other elements to help to improve understanding of the present embodiments.

DETAILED DESCRIPTION

15 **[0018]** Embodiments of the present invention will be described, by way of example only, with reference to the drawings. Like reference numerals and characters in the drawings refer to like elements or equivalents.

[0019] Some portions of the description which follows are explicitly or implicitly presented in terms of algorithms and functional or symbolic
20 representations of operations on data within a computer memory. These algorithmic descriptions and functional or symbolic representations are the

means used by those skilled in the data processing arts to convey most effectively the substance of their work to others skilled in the art. An algorithm is here, and generally, conceived to be a self-consistent sequence of steps leading to a desired result. The steps are those requiring physical
5 manipulations of physical quantities, such as electrical, magnetic or optical signals capable of being stored, transferred, combined, compared, and otherwise manipulated.

[0020] Unless specifically stated otherwise, and as apparent from the following, it will be appreciated that throughout the present specification,
10 discussions utilizing terms such as “determining”, “reconfiguring”, “modifying”, “receiving”, “rendering”, “compensating”, “adjusting”, “inducing” or the like, refer to the action and processes of a computer system, or similar electronic device, that manipulates and transforms data represented as physical quantities within the computer system into other data similarly represented as
15 physical quantities within the computer system or other information storage, transmission or display devices.

[0021] Referring to FIG. 1, a flowchart 100 of a method for vertical location tracking using WiFi in accordance with a present embodiment is depicted. At step 102, a plurality of WiFi signals is scanned at a predetermined location on
20 one of a plurality of vertical levels. Each of the WiFi signal may be broadcasted by a WiFi router on one of a plurality of vertical levels. The predetermined location may be any location on a plurality of vertical levels, such as lift lobby, corridor, and staircase. At step 104, SSID of the WiFi

signals, RSS of the WiFi signals and the one of the plurality of vertical levels are recorded. The recorded SSID of the WiFi signals, RSS of the WiFi signals and the one of the plurality of vertical levels may be stored in a database. Steps 102 and 104 may be considered as procedures of a mapping service
5 provided by the method. At step 106, a location in terms of vertical level is determined in response to receiving a plurality of WiFi signals, by comparing a SSID and a RSS of each of the plurality of WiFi signals received to the recorded SSID and RSS of the WiFi signals in step 104. Step 106 may be considered as a procedure of a query service provided by the method.

10 **[0022]** Referring to FIG. 2, an illustration 200 of the mapping service by a mobile device 202 in accordance with the present embodiment is depicted. According to the present embodiment, a user 20 with the mobile device 202 is stationary at the location of level 2 lift lobby for the mapping service. The mobile device 202 scans the available WiFi signals broadcasted by the level
15 1 WiFi router 22a, level 2 WiFi router 22b and level 3 WiFi router 22c and obtains the SSID and RSS of each of the available WiFi signals. The SSID and RSS of the scanned WiFi signals from WiFi routers 22a, 22b and 22c are recorded together with the location of the user, i.e. level 2. The WiFi information containing SSID and RSS of each WiFi signal and location
20 information of the user in terms of vertical levels may be registered in a server 210 and stored in a database 220.

[0023] In an alternative embodiment, in addition to vertical levels, the mapping service may further comprise corridor positions. Referring to FIG. 3,

an illustration 300 of corridor position tracking in accordance with the present embodiment is depicted. The user 20 with the mobile device 202 is stationary at the location of level 3, approximately 5 meters from lift lobby for the mapping service. The mobile device 202 scans the available WiFi signals
5 broadcasted by the level 3 lift lobby WiFi router 32a and level 3 WiFi router 32b, and obtains the SSID and RSS of each of the available WiFi signals. The SSID and RSS of the scanned WiFi signals from WiFi routers 32a and 32b are recorded together with the location of the user, i.e. level 3, 5 meters from lift lobby.

10 **[0024]** Referring to FIG. 4, an illustration 400 of a query service, including receiving WiFi signals from at least two WiFi routers and retrieving location information by a pattern matching algorithm, is depicted in accordance with the present embodiment. According to the present embodiment, the user 20 with the mobile device 202 receives two WiFi signals in his current location.
15 The primary WiFi signal has a SSID as BB and a RSS of 60, and the secondary WiFi signal has a SSID as AA and a RSS of 30. The set of SSIDs and corresponding RSSs is recognized as query parameters. In response to receiving the WiFi signals, the server 210 compares the query parameters to the recorded SSID and RSS of the WiFi signals, retrieves a record containing
20 the same query parameters from the database 220, and determines the location of the user 20 (i.e. level 2) based on a pattern matching algorithm. Notably, the pattern matching algorithm does not require the mobile device 202 to receive all the WiFi signals that are previously recorded during the

mapping service in order to determine the location. As shown in the present embodiment, in the absence of level 3 WiFi router 22c, the pattern matching algorithm may still provide a correct location of the user 20 based on other available WiFi signals received. Nevertheless, it is necessary to receive a
5 minimum of two WiFi signals as query parameters in order to determine the location.

[0025] In an alternative embodiment, the pattern matching algorithm used in the query service may have a predetermined accuracy range. Referring to FIG. 5, a diagram 500 of determining vertical location results based on a
10 predetermined accuracy range set by the pattern matching algorithm is depicted in accordance with the present embodiment. According to the present embodiment, two WiFi signals are received by the user's mobile device, where the primary WiFi signal has a SSID as BB and a RSS of 58 and the secondary WiFi signal has a SSID as AA and a RSS of 33. Despite
15 that no record with the identical query parameters exists in the database, with an accuracy range set at 10, the server retrieves the record containing a RSS 30 for SSID AA and a RSS 60 for SSID BB and determines the location of the user 20 (i.e. level 2) based on the pattern matching algorithm. Similar to the previous embodiment, it is necessary to receive a minimum of two WiFi
20 signals as query parameters in order to determine the location.

[0026] Referring to FIG. 6, an illustration 600 of the mobile device 202 initiating a self-mapping process by discovering, registering and updating new WiFi SSID(s) and RSS(s) is illustrated in accordance with the present

embodiment. In one embodiment, the self-mapping process is initiated when a previously recorded WiFi signal broadcasted by the level 1 WiFi router 22a no longer exists. In another embodiment, the self-mapping process is initiated when the pattern matching result is below a lower threshold of the predetermined accuracy range. In response, the mobile device 202 scans, discovers and registers a newly discovered WiFi router 22d in the server 210. and updates The SSID and RSS of the WiFi signal broadcasted by the newly discovered WiFi router 22d is updated in the database 220 without going through a re-mapping process.

10 **[0027]** And referring to FIG. 7, comprising FIGs. 7A, 7B and 7C, an illustration 700 of graphical user interfaces for mobile device application to scan WiFi signals and register a vertical location is illustrated in accordance with the present embodiment. In FIG. 7A, the user may enter the address and select the WiFi network. In FIG. 7B, the user may select his current location in terms of vertical level. In FIG. 7C, the user confirms the selection by
15 choosing “Yes” and completes the registration of the location (i.e. level 5).

[0028] It should further be appreciated that the exemplary embodiments are only examples, and are not intended to limit the scope, applicability, operation, or configuration of the invention in any way. Rather, the foregoing
20 detailed description will provide those skilled in the art with a convenient road map for implementing an exemplary embodiment of the invention, it being understood that various changes may be made in the function and arrangement of elements and method of operation described in an exemplary

embodiment without departing from the scope of the invention as set forth in the appended claims.

CLAIMS

1. A method for vertical location tracking, the method comprising:
scanning a plurality of WiFi signals at a predetermined location on one
of a plurality of vertical levels; and

5 for each of the plurality of WiFi signals scanned, recording a service
set identifier (SSID) of the WiFi signal, a received signal strength (RSS) of
the WiFi signal, and the one of the plurality of vertical levels.

2. The method of claim 1, wherein recording the one of the plurality of
10 vertical levels further comprises recording a plurality of predetermined
locations on the one of the plurality of vertical levels.

3. The method of claim 1, wherein the method further comprises
determining a vertical level in response to receiving a plurality of WiFi signals,
15 by comparing a SSID and a RSS of each of the plurality of WiFi signals
received to the recorded SSID and RSS of the WiFi signals.

4. The method of claim 3, wherein determining the vertical level further
comprises determining a location on the vertical level in response to the SSID
20 and RSS of one or more of the plurality of WiFi signals.

5. The method of claim 3, wherein comparing the RSS of each of the plurality of public WiFi signals to the recorded RSS of the WiFi signals is based on a pattern matching algorithm.

5 6. The method of claim 5, wherein the pattern matching algorithm picks at least two recorded RSSs.

7. The method of claim 6, wherein the pattern matching algorithm sets a predetermined accuracy range.

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8. The method of claim 1, the method further comprising initiating a self-mapping process when at least one of the plurality of recorded WiFi signals no longer exists.

15 9. The method of claim 1, the method further comprises initiating a self-mapping process when a pattern matching result is at a lowest percentage of the predetermined accuracy range.

10. The method of claims 8 and 9, wherein the self-mapping process
20 comprises:

scanning at least one new WiFi signal at the predetermined location on the one of a plurality of vertical levels;

for each of the new WiFi signals scanned, recording a SSID of the new WiFi signal, a RSS of the new WiFi signal, and the one of the plurality of vertical levels.

5 11. A system for vertical location tracking, the system comprising:

 a plurality of mobile devices, wherein each of the plurality of mobile devices are configured to receive a plurality of WiFi signals from a plurality of WiFi routers with SSIDs, each one of the WiFi routers on one of a plurality of vertical levels and broadcasting a WiFi signal; and

10 a database, wherein the database stores the SSIDs of the WiFi signals, the RSS of the WiFi signals and the one of the plurality of vertical levels,

 wherein thereafter one of the plurality of mobile devices accesses the database and compares SSID and RSS of the WiFi signals received from the
15 plurality of WiFi routers to determine a vertical location on one of the plurality of vertical levels.