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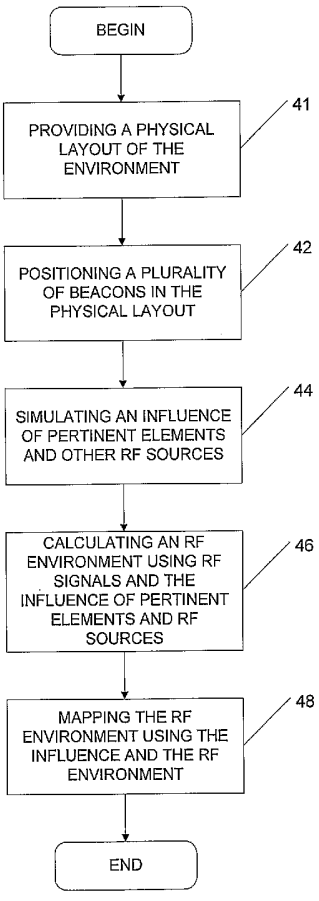
(54) Title: METHOD FOR CHARACTERIZING AN RF ENVIRONMENT OF AN AREA



(57) Abstract: A method and apparatus are disclosed for characterizing an RF environment. A physical layout of an area is provided and comprises an indication of physical properties of a plurality of obstacles; a plurality of beacons is positioned; an influence of the obstacles on RF signals is simulated, an RF environment is calculated using the RF signals and the simulated influence and a mapping onto the physical layout of the RF environment is performed.

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METHOD FOR CHARACTERIZING AN RF ENVIRONMENT OF AN AREA

TECHNICAL FIELD

This invention relates to the field of telecommunications. More precisely, this invention pertains to a method for characterizing an RF environment of an area in which a plurality of obstacles is located.

BACKGROUND OF THE INVENTION

It is desirable to characterize an RF environment of an area. Such characterizing may then be used for various applications such as for positioning a wireless mobile unit for instance.

Unfortunately, prior art characterizing of an RF environment suffers from many drawbacks.

For instance, the characterizing is usually limited to a single frequency range.

Furthermore, such characterizing usually requires to be performed at least one of a large amount of computing resources and a large amount of storing space which is costly.

Furthermore many individuals may be required in order to perform such characterizing.

There is therefore a need for a method and apparatus that will overcome at least one of the above-identified drawbacks.

SUMMARY OF THE INVENTION

It is an object of the invention to provide a method for characterizing an RF environment.

Yet another object of the invention is to provide a method for generating a database characterizing an RF environment.

According to a first aspect of the invention, there is provided a method for characterizing an RF environment of an area in which obstacles to RF transmission are located, the method comprising obtaining a physical layout of the area comprising an indication of physical properties of the obstacles, positioning a plurality of RF signal sources in the physical layout, simulating an influence of the obstacles on the RF signal sources; calculating an RF environment using the influence and the RF signals and mapping onto the physical layout the RF environment.

According to another aspect of the invention, there is provided a method for generating a database characterizing an RF environment of an area in which obstacles are located, the method comprising obtaining a physical layout of the area comprising an indication of physical properties of the obstacles, positioning a plurality of RF signal sources in the physical layout, simulating an influence of the obstacles on the RF signals, calculating an RF environment using the RF signals and the influence and generating a database mapping the RF environment with the physical layout.

In this specification, the term "known area" is intended to mean "an evolving map".

The term "obstacle" is intended to mean "an element which is modifying the transmission path of an electromagnetic signal".

BRIEF DESCRIPTION OF THE DRAWINGS

Further features and advantages of the present invention will become apparent from the following detailed description, taken in combination with the appended drawings, in which:

Fig. 1 is a diagram showing a plurality of wireless transmitting units, a wireless mobile unit and a wireless mobile unit positioning server;

Fig. 2 is a block diagram showing a first embodiment of a wireless mobile unit;

Fig. 3 is a block diagram showing a preferred embodiment of the wireless mobile unit positioning server;

Fig. 4 is a flowchart showing how a mapping of an RF environment is performed;

Fig. 5 is a flowchart showing how a physical layout of the area is provided;

Fig. 6 is a flowchart showing how calculating an RF environment using RF signals and the influence of obstacles and RF sources is performed.

It will be noted that throughout the appended drawings, like features are identified by like reference numerals.

DETAILED DESCRIPTION OF AN EMBODIMENT

Now referring to Fig. 1, there is shown a system comprising a wireless mobile unit 10, a plurality of wireless

transmitting units 12, 14, and 16, and a wireless mobile positioning server 18.

The wireless mobile unit 10 is a wireless transceiver capable of wirelessly communicating with at least one of the plurality of wireless transmitting units 12, 14, and 16 and the wireless mobile positioning server 18 according to a communication standard.

In an embodiment the communication standard is IEEE802.11x. Alternatively, the communication standard is Bluetooth(TM) or any other wireless communication standard.

Now referring to Fig. 2a, there is shown an embodiment of the wireless mobile unit 10.

The wireless mobile unit 10 comprises a wireless port 20, a processing unit 24 and an optional memory unit 26. The skilled addressee will appreciate that the wireless mobile unit 10 may further comprise various units, not shown here for clarity purposes, such a display unit, a speaker unit, etc. The wireless port 20 is adapted for transceiving a wireless signal according to the communication standard. It should be understood that while in one embodiment, the wireless port 20 may receive and transmit a wireless signal; in an alternative embodiment, the wireless port 20 may only transmit a wireless signal.

The processing unit 24 is used for processing the received signal and for providing a signal to transmit to using the wireless port 20.

The wireless mobile unit 10 further comprises the optional memory unit 26 which is used to store data provided by the processing unit 24. In an embodiment, the optional memory unit 26 is a volatile-type memory.

Now referring to Fig. 2b, there is shown another embodiment of the wireless mobile unit 10. In this embodiment, the wireless mobile unit 10 further comprises an inertial sensor unit 28. The inertial sensor unit 28 provides an inertial sensor signal to the processing unit 24. In an embodiment of the invention, the inertial sensor unit 28 is preferably a Micro-Electro-Mechanical Systems (MEMS) selected from the group consisting of accelerometers, gyroscopes, altimeters, magnetic compass, barometer, etc. Alternatively, the inertial sensor unit 28 may comprise an apparatus which uses a Voltage Controlled Oscillator (VCO) or a Numerically Controlled Oscillator (NCO). As further explained below, the inertial sensor unit 28 is used to further enhance the provision of the estimated position of the wireless mobile unit 10 comprising the inertial sensor unit 28.

Now referring back to Fig. 1, the plurality of wireless transmitting units 12, 14 and 16 may or not be adapted for communication with the wireless mobile unit 10. The plurality of wireless transmitting units 12, 14 and 16 may therefore comprise base stations for communicating with the wireless mobile unit 10 as well as any devices transmitting/radiating a wireless signal.

The skilled addressee will appreciate that such devices transmitting/radiating a wireless signal may be selected from the group consisting of mobile phones, computers, TV, satellite-transmitted signals, current/voltage transformers, rotating machines, or the like.

Now referring to Fig. 3, there is shown an embodiment of the wireless mobile unit positioning server 18.

The wireless mobile unit positioning server 18 comprises a physical layout providing unit 30, an electromagnetic simulation unit 32, a beacon data manipulation unit, an electromagnetic data acquisition unit 34, an electromagnetic environment data manipulation unit 35, an electromagnetic environment data storing unit 36, a position detection unit 38, a position providing unit 39 and a wireless receiving unit 40.

The physical layout providing unit 30 provides a physical layout data signal to the electromagnetic simulation unit 32.

The physical layout data relates to a given environment. It should be understood that the environment is not limited solely to closed or interior spaces.

The physical layout data signal comprises a physical location indication as well as pertinent data for each element which may affect radio wave transmission in the given environment. The skilled addressee will appreciate that the elements may comprise physical structures, walls, obstacles, objects, floor, ceiling, apparatus, furniture or the like.

The physical location indication is preferably given according to a 3-dimensional coordinate system while the pertinent data comprises information such as porosity, attenuation, loss, reflection, distortion, corruption, angular effect and a squared providing of these values with respect to a material and space as well as proximity or distance effect with respect to a transmitter. It will be appreciated that a squared value is used in order to obtain more reliable information about the influence caused by a material on an electromagnetic wave. In fact, the skilled

addressee will appreciate that for instance an incoming electromagnetic wave hitting perpendicularly a given material will propagate less in the material than in the case where the incoming electromagnetic wave hits the material with an angle smaller than 90 degrees.

In an embodiment, the physical layout providing unit 30 is implemented in the wireless mobile unit positioning server 18. Alternatively, the physical layout data signal is provided to the electromagnetic simulation unit 32 via a network, which is a Wide Area Network (WAN) such as the Internet. In another embodiment, the physical layout is provided by the wireless mobile unit 10.

The beacon data manipulation unit 33 provides a beacon data signal to the electromagnetic simulation unit 32. The beacon data manipulation unit 33 may be operated by a user which selects a desired position or by using an algorithm.

The beacon data signal comprises an indication of a position of a beacon communicating with the wireless mobile unit 10 in the environment. In an embodiment of the invention, the position of the beacon is a 3-dimensional position with respect to a given reference. The beacon data signal further comprises information pertinent to wireless transmission such as frequency of the beacon, transmission power of the beacon, an antenna radiation pattern, etc.

The electromagnetic data acquisition unit 34 is used for performing an electromagnetic data acquisition at selected places in the real environment. The selected places may be chosen according to various criteria. The criteria may be anyone of a signal stability, a signal quality, a signal availability, an absence or a small movement of the

wireless mobile unit and a tuning of a reading according to predetermined delays.

The acquired data signal comprises an indication of a physical location in the environment as well as an electromagnetic measure. The electromagnetic measure comprises for a given frequency range at least one of a signal/noise value and a power value.

The electromagnetic environment data manipulation unit 35 receives the acquired data signal and provides a manipulated acquired data signal to the electromagnetic simulation unit 32.

The wireless receiving unit 40 receives a wireless signal. It should be appreciated that the wireless signal may comprise data related to a wireless transmission of a plurality of devices, if applicable, and is not limited to data related to the wireless transmission of the wireless mobile unit 10 or to the wireless transmission of the wireless transmitting unit communicating with the wireless mobile unit 10 if applicable. Therefore and more precisely, the wireless receiving unit 40 provides a detected electromagnetic source signal to the electromagnetic simulation unit 32. The detected electromagnetic source signal comprises at least one of a signal/noise value and a power value for a given frequency range.

The electromagnetic simulation unit 32 receives the physical layout data signal provided by the physical layout providing unit 30, the beacon data signal provided by the beacon data manipulation unit 33, the manipulated acquired data signal provided by the electromagnetic environment data manipulation unit 35 and the detected electromagnetic sources signal provided by the wireless receiving unit. The

electromagnetic simulation unit 32 may further receive a simulated data signal provided by the electromagnetic environment data storing unit 36. The electromagnetic simulation unit 32 performs a simulation of the electromagnetic environment using the physical layout data signal, the beacon data signal, the manipulated acquired data signal and the detected electromagnetic sources and provides a simulated data signal to the electromagnetic environment data storing unit 36. The electromagnetic simulation unit 32 is therefore used for building the electromagnetic environment data storing unit 36. The skilled addressee should understand that a mapping of the electromagnetic environment is dynamically performed by the electromagnetic simulation unit 32 and that the electromagnetic environment data storing unit 36 is continuously updated. Only selected parts of the electromagnetic environment data storing unit 36 are preferably updated which avoid unnecessary computations. The selected part are selected according to various criteria such as a frequency range, a knowledge of a former position of the wireless mobile unit 10, a level of activity in a given part of the electromagnetic environment, a client need, etc.

The electromagnetic environment data storing unit 36 stores data preferably in a matrix form and comprises electromagnetic data for the environment.

It will be appreciated that the electromagnetic environment data manipulation unit 35 may also provide at least one part of the acquired data signal to the electromagnetic environment data storing unit 36.

The position detection unit 38 receives a measured data signal provided by the wireless receiving unit 40 and uses

the electromagnetic environment data storing unit 36 to create an estimated position signal as explained below.

The estimated position signal is provided to the position providing unit 39. The position providing unit 39 may provide the estimated position signal of the wireless mobile unit 10 to a plurality of destinations depending on an application sought. For instance, the wireless mobile positioning server 18 may performs a tracking of the wireless mobile unit 10 without submitting any information to the wireless mobile unit 10. Alternatively, it may be desirable to provide the estimated position signal to the wireless mobile unit 10.

Now referring to Fig. 4, there is shown how a mapping of an RF environment is performed.

According to step 41, a physical layout of the environment is provided.

Now referring to Fig. 5, there is shown how the physical layout of the environment is provided.

According to step 50, a physical layout is scanned. The physical layout may be selected from the group consisting of floor plans, maps, architecture sketches, libraries comprising data about materials used for at least one of building and furnishing a place, etc. Alternatively, the physical layout is directly provided in an electronic format such as a binary file of a given file format such as AutoCAD(TM).

In an embodiment, the physical layout is scanned using the physical layout providing unit 30.

According to step 52, obstacles and RF sources are identified in the scanned physical layout. In fact, after scanning the physical layout, a processing is performed in order to detect in the scanned physical layout pertinent elements that may affect radiowave transmission such as structural elements as well as RF sources. The pertinent elements may comprise physical structures, walls, obstacles, objects, floor, ceiling, apparatus, or the like. The processing is performed in accordance with the type of physical layout provided. In an embodiment of the invention, the physical layout to scan is a plan of the building.

Still referring to Fig. 5 and according to step 54, needs for beacons are determined in the scanned physical layout considering the identified obstacles.

In an embodiment, the needs for beacons are determined in the scanned layout by providing the physical layout data signal to the electromagnetic simulation unit 32 and performing a simulation using the electromagnetic simulation unit 32. The skilled addressee will appreciate that pertinent elements may influence the propagation of wireless signals and that accordingly it is desirable to find out needs for beacons for communicating with a wireless mobile unit 10 for the purpose of communicating with the wireless mobile unit 10. Furthermore, the needs for positioning the wireless mobile unit 10 may be achieved using other wireless transmitting units communicating on various frequency ranges. In an embodiment, the needs for beacons are displayed to a user via a user interface not shown in the drawings. More precisely, the needs for beacons are identified by marking a corresponding physical area of the provided layout with a specific color. The

color may be used to indicate various qualities of signals available and/or frequency ranges.

Now referring back to Fig. 4 and according to step 42, a plurality of beacons is positioned in the physical layout. The plurality of beacons is positioned in the physical layout using the beacon data manipulation unit 33.

In one embodiment, the plurality of beacons is positioned via a user interface, not shown in the figure. In such case, the user selects a suitable position for positioning the plurality of beacons according to the determined needs for beacons. Alternatively, the plurality of beacons is positioned automatically according to the determined needs for beacons.

According to step 44, an influence of the pertinent elements and other RF sources is simulated. More precisely, the electromagnetic simulation unit 32 receives the physical layout data signal provided by the physical layout providing unit 30 and the beacon data signal provided by the beacon data manipulation unit 33 and simulates the influence of the pertinent elements in the propagation of wireless signals transmitted by the other RF sources. In an embodiment, the simulation is performed as follows. According to a first step, a pertinent wireless transmitting source is selected. According to a second step, the physical layout is partitioned into a plurality of zones which are created for each of the selected pertinent wireless transmitting source. It will be appreciated that each zone of the plurality of zones is defined as a geographical zone wherein a plurality of wireless signals transmitted by the selected pertinent wireless transmitting source propagates in a similar way. The skilled addressee will therefore appreciate that such

zones are 3-dimensional polygons. According to a third step, a simulation is performed for a plurality of points in each zone. In one embodiment the plurality of points comprises the edges of the zone. According to a fourth step, an interpolation is performed for each other points of the zone using the results of the simulation performed for the plurality of points. The skilled addressee will appreciate that this is of great advantage for simulating the influence of each pertinent elements in the propagation of wireless signals transmitted by a pertinent wireless transmitting source.

According to step 46, an RF environment is calculated using RF signals and the influence of pertinent elements and the plurality of beacons.

Now referring to 6, there is shown how the RF environment is calculated.

According to step 60, an RF environment is estimated using the RF signals transmitted and the influence of the pertinent elements and other RF sources.

According to step 62, a test is performed in order to find out if the estimated RF environment is suitable for a given application.

In the case where the estimated RF environment is not suitable for the given application, the positioning of a beacon is modified in the physical layout using the beacon data manipulation unit 33.

Now referring back to Fig. 4 and according to step 48, the RF environment is mapped using the simulated influence of the pertinent elements and the other RF sources and further using the calculated RF environment.

The mapped RF environment is stored in the electromagnetic environment data storing unit 36 and may be used in order to provide an estimated position signal of the wireless mobile unit 10 as shown in the co-pending patent application that is concurrently filed and is entitled "Method for positioning an RF transceiver in a known area".

The mapped RF environment may be provided as a matrix or as a database. It should be understood that such mapped RF environment comprises a plurality of entries, each comprising data indicative of a wireless signal and a corresponding position established preferably in a 3-dimensional coordinate system for each of at least one frequency range.

It will be appreciated by the skilled addressee that a beacon is an example of a RF signal source.

Furthermore, it should be understood that the mapped RF environment comprises a plurality of subsets or sub-matrices, in the case where the mapped RF environment is provided as a matrix. The plurality of subsets is defined according to the plurality of zones defined herein above.

The skilled addressee will appreciate that providing such plurality of sub-matrices is of great advantage as it enables the updating of a limited part of the mapped RF environment. In fact, updating a limited part of the mapped RF environment is of great interest as it enables an efficient use of the processing resources required to update data.

While illustrated in the block diagrams as groups of discrete components communicating with each other via distinct data signal connections, it will be understood by

those skilled in the art that the preferred embodiments are provided by a combination of hardware and software components, with some components being implemented by a given function or operation of a hardware or software system, and many of the data paths illustrated being implemented by data communication within a computer application or operating system. The structure illustrated is thus provided for efficiency of teaching the present preferred embodiment.

It should be noted that the present invention can be carried out as a method, can be embodied in a system, a computer readable medium or an electrical or electro-magnetical signal.

The embodiments of the invention described above are intended to be exemplary only. The scope of the invention is therefore intended to be limited solely by the scope of the appended claims.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A method for characterizing an RF environment of an area in which obstacles to RF transmission are located, said method comprising:

obtaining a physical layout of said area comprising an indication of physical properties of said obstacles;

positioning a plurality of RF signal sources in said physical layout;

simulating an influence of said obstacles on said RF signal sources;

calculating an RF environment using said influence and said RF signals; and

mapping onto said physical layout said RF environment.

2. The method as claimed in claim 1, wherein said providing of said physical layout of said area comprises scanning a layout and identifying said obstacles in said layout.

3. The method as claimed in claim 2, wherein said layout is selected from a group consisting of floor plans, maps, architecture sketches and libraries comprising data about RF attenuation of materials in said area.

4. The method as claimed in claim 2, wherein said identifying of said obstacles in said layout is performed using automatic processing of said layout.

5. The method as claimed in any one of claims 1 to 4, wherein said obstacles comprise at least one of physical structures, walls, obstacles, objects, floor, ceiling, apparatus, and furniture.

6. The method as claimed in any one of claims 2 to 5, wherein said providing of said physical layout of said area further comprises determining needs for RF signal sources, further wherein said positioning of a plurality of RF signal sources in said physical layout is performed according to said determined needs.

7. The method as claimed in claim 6, wherein said determined needs for RF signal sources are displayed on a user interface.

8. The method as claimed in claim 7, wherein said determined needs for RF signal sources are displayed on a user interface using a specific color indicative of at least one of quality of signal and a frequency range.

9. The method as claimed in any one of claims 1-8, wherein said plurality of RF signal sources are positioned manually in said physical layout.

10 The method as claimed in any one of claims 1-8, wherein said plurality of RF signal sources are positioned automatically in said physical layout.

11. The method as claimed in any one of claims 1-10, wherein said simulating of an influence of said obstacles on said RF signal sources comprises selecting a given RF signal source; partitioning said physical layout into a plurality of zones wherein a corresponding RF signal of

said selected given RF signal source propagates in a similar way; simulating at least one point of said plurality of zones and interpolating for each other points of said plurality of zones using the simulated at least one point.

12. The method as claimed in claim 11, wherein said at least point simulated comprises the edges of the plurality of zones.

13. The method as claimed in any one of claims 1 to 12, wherein said calculating of an RF environment comprises estimating said RF environment using said influence and said RF signals and checking if said estimated RF environment is suitable for a given application.

14. The method as claimed in claim 13, wherein when said estimated RF environment is not suitable for a given application, the method further comprising modifying at least one of the RF signal sources.

15. A method for generating a database characterizing an RF environment of an area in which obstacles are located, said method comprising:

obtaining a physical layout of said area comprising an indication of physical properties of said obstacles;

positioning a plurality of RF signal sources in said physical layout;

simulating an influence of said obstacles on said RF signals;

calculating an RF environment using said RF signals and said influence; and

generating a database mapping said RF environment with said physical layout.

16. The method as claimed in claim 15, wherein said providing of said physical layout of said area comprises scanning a layout and identifying said obstacles in said layout.

17. The method as claimed in claim 16, wherein said layout is selected from a group consisting of floor plans, maps, architecture sketches and libraries comprising data about RF attenuation of materials in said area.

18. The method as claimed in claim 16, wherein said identifying of said obstacles in said layout is performed using automatic processing of said layout.

19. The method as claimed in any one of claims 15 to 18, wherein said obstacles comprise at least one of physical structures, walls, obstacles, objects, floor, ceiling, apparatus, and furniture.

20. The method as claimed in any one of claims 17 to 19, wherein said providing of said physical layout of said area further comprises determining needs for RF signal sources, further wherein said positioning of a plurality of RF signal sources in said physical layout is performed according to said determined needs.

21. The method as claimed in claim 20, wherein said determined needs for RF signal sources are displayed on a user interface.

22. The method as claimed in claim 21, wherein said determined needs for RF signal sources are displayed on a user interface using a specific color indicative of at least one of quality of signal and a frequency range.

23. The method as claimed in any one of claims 15-22, wherein said plurality of RF signal sources are positioned manually in said physical layout.

24. The method as claimed in any one of claims 15-22, wherein said plurality of RF signal sources are positioned automatically in said physical layout.

25. The method as claimed in any one of claims 15-22, wherein said simulating of an influence of said obstacles on said RF signal sources comprises selecting a given RF signal source; partitioning said physical layout into a plurality of zones wherein a corresponding RF signal of said selected given RF signal source propagates in a similar way; simulating at least one point of said plurality of zones and interpolating for each other points of said plurality of zones using the simulated at least one point.

26. The method as claimed in claim 25, wherein said at least point simulated comprises the edges of the plurality of zones.

27. The method as claimed in any one of claims 15 to 26, wherein said calculating of an RF environment comprises estimating said RF environment using said influence and said RF signals and checking if said estimated RF environment is suitable for a given application.

28. The method as claimed in claim 27, wherein when said estimated RF environment is not suitable for a given application, the method further comprising modifying at least one of the RF signal sources.

29. A computer program embodied in an electrical or an electromechanical carrier signal having codes adapted to performed the method as claimed in any one of claims 1 to 28.

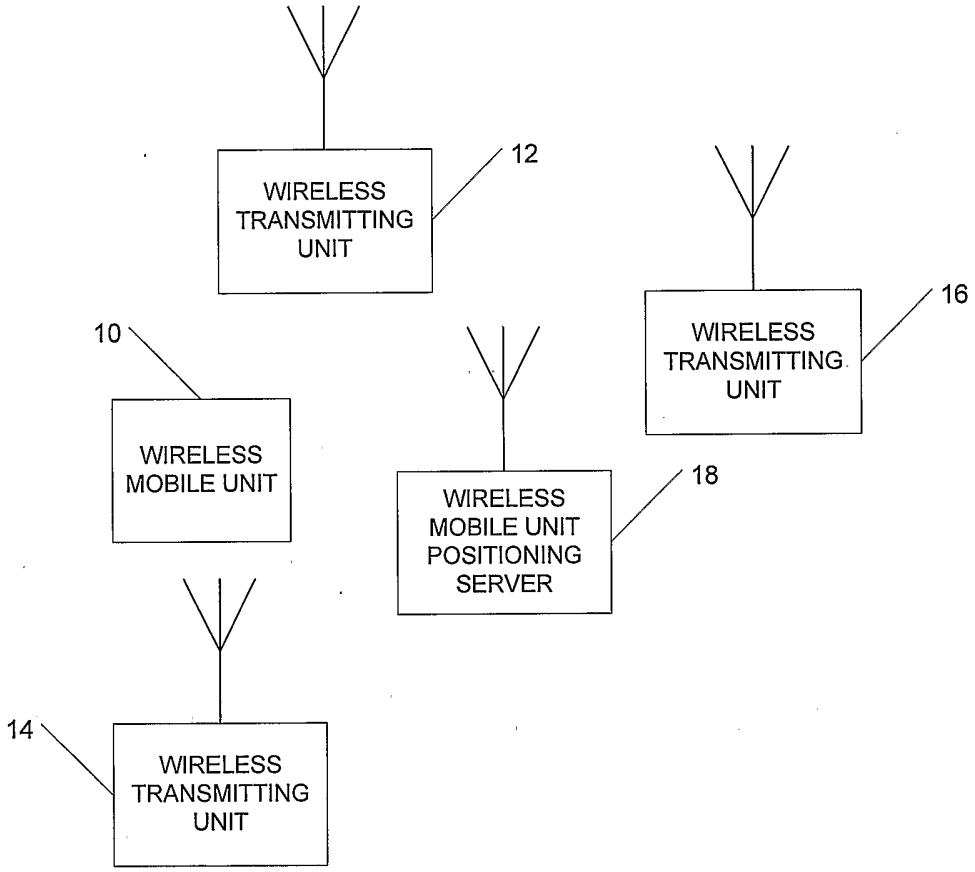
WIRELESS TRANSMITTING UNIT
12
WIRELESS TRANSMITTING UNIT
16
10
WIRELESS MOBILE UNIT
WIRELESS MOBILE UNIT POSITIONING SERVER
18
14
WIRELESS TRANSMITTING UNIT

FIGURE 1

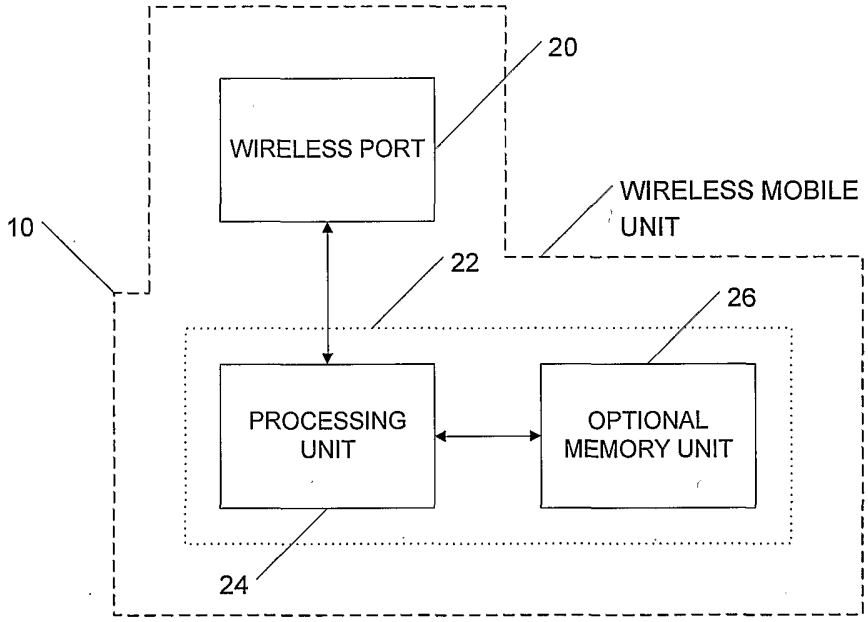
20
WIRELESS PORT
WIRELESS MOBILE UNIT
10
22
26
PROCESSING UNIT
OPTIONAL MEMORY UNIT
24

FIGURE 2

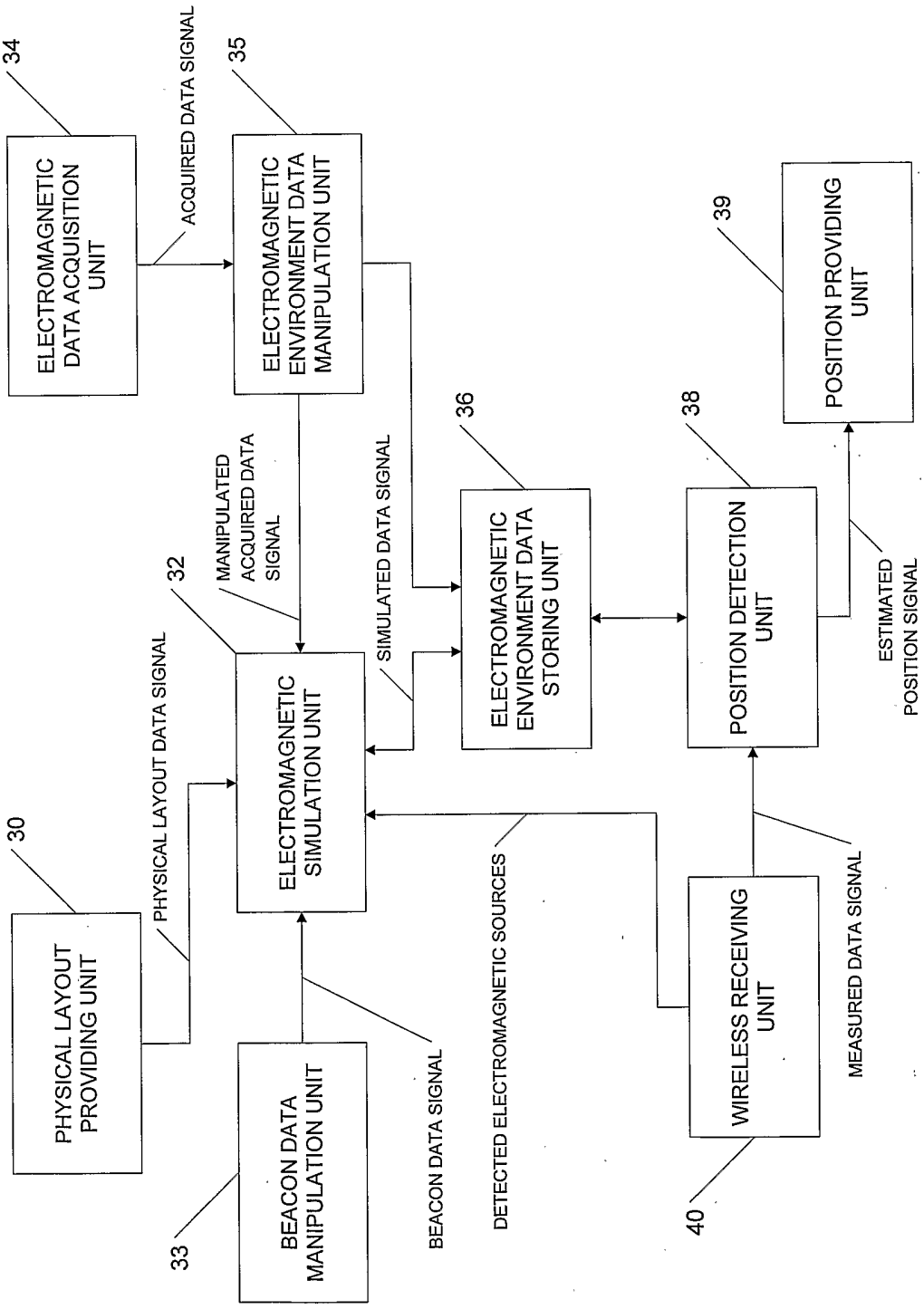
ELECTROMAGNETIC DATA ACQUISITION UNIT
34
ACQUIRED DATA SIGNAL
ELECTROMAGNETIC ENVIRONMENT DATA MANIPULATION UNIT
35
POSITION PROVIDING UNIT
39
MANIPULATED ACQUIRED DATA SIGNAL
SIMULATED DATA SIGNAL
ELECTROMAGNETIC ENVIRONMENT DATA STORING UNIT
36
POSITION DETECTION UNIT
38
32
PHYSICAL LAYOUT DATA SIGNAL
ELECTROMAGNETIC SIMULATION UNIT
ESTIMATED POSITION SIGNAL
30
PHYSICAL LAYOUT PROVIDING UNIT
BEACON DATA SIGNAL
DETECTED ELECTROMAGNETIC SOURCES
WIRELESS RECEIVING UNIT
MEASURED DATA SIGNAL
33
BEACON DATA MANIPULATION UNIT
40

FIGURE 3

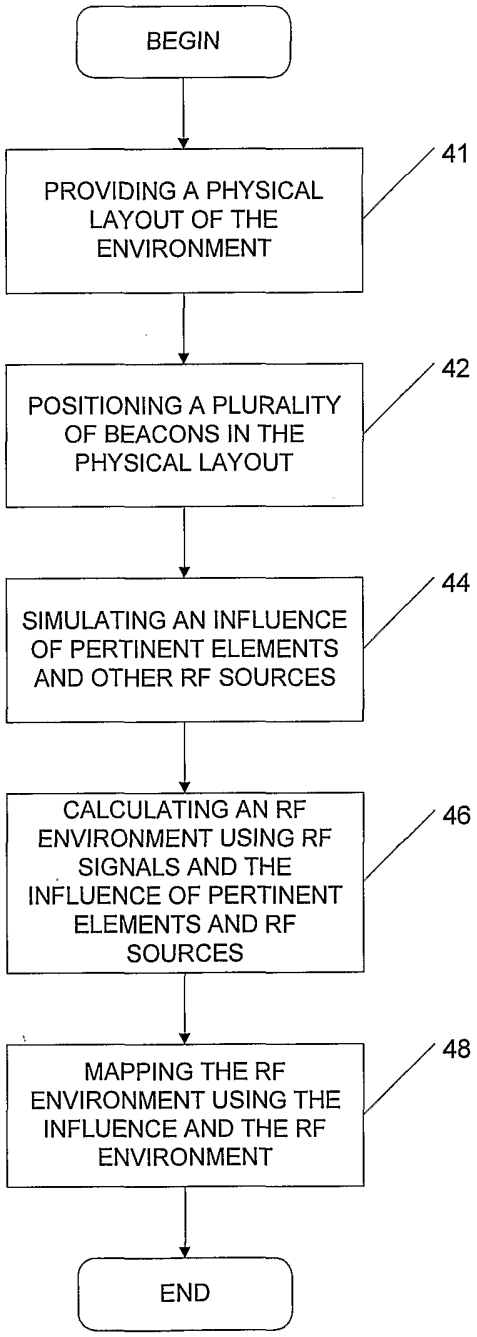
BEGIN
PROVIDING A PHYSICAL LAYOUT OF THE ENVIRONMENT
41
POSITIONING A PLURALITY OF BEACONS IN THE PHYSICAL LAYOUT
42
SIMULATING AN INFLUENCE OF PERTINENT ELEMENTS AND OTHER RF SOURCES
44
CALCULATING AN RF ENVIRONMENT USING RF SIGNALS AND THE INFLUENCE OF PERTINENT ELEMENTS AND RF SOURCES
46
MAPPING THE RF ENVIRONMENT USING THE INFLUENCE AND THE RF ENVIRONMENT
48
END

FIGURE 4

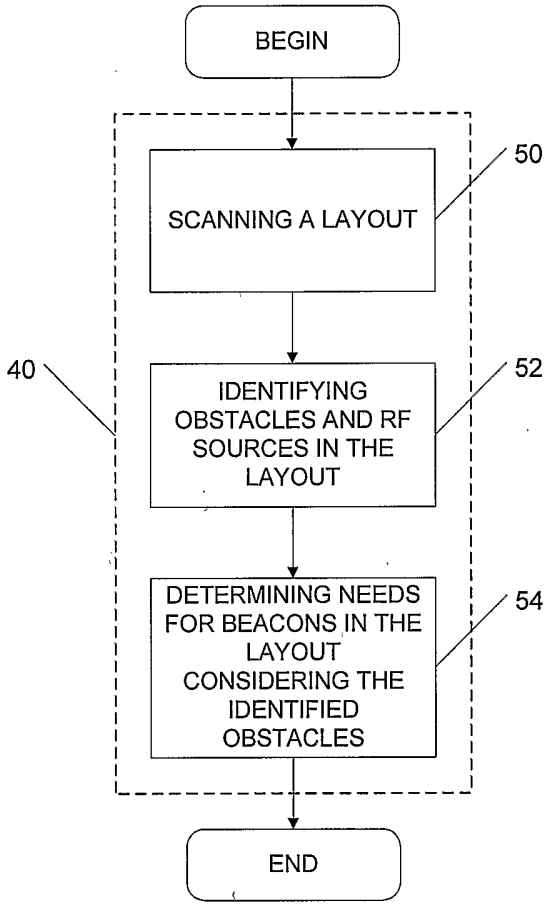
BEGIN
SCANNING A LAYOUT
50
40
IDENTIFYING OBSTACLES AND RF SOURCES IN THE LAYOUT
52
DETERMINING NEEDS FOR BEACONS IN THE LAYOUT CONSIDERING THE IDENTIFIED OBSTACLES
54
END

FIGURE 5

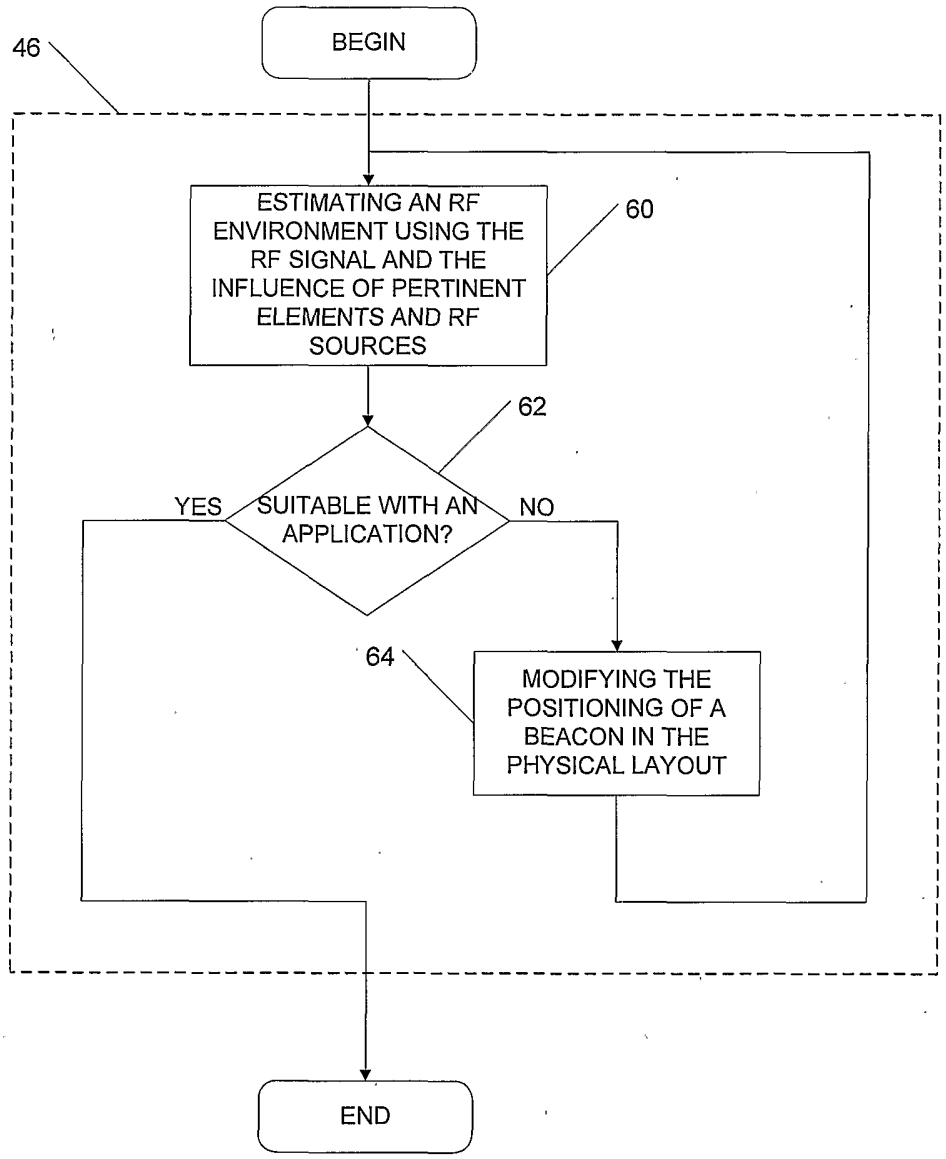
46
BEGIN
ESTIMATING AN RF ENVIRONMENT USING THE RF SIGNAL AND THE INFLUENCE OF PERTINENT ELEMENTS AND RF SOURCES
60
62
YES
SUITABLE WITH AN APPLICATION?
NO
64
MODIFYING THE POSITIONING OF A BEACON IN THE PHYSICAL LAYOUT
END

FIGURE 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2005/000983

A. CLASSIFICATION OF SUBJECT MATTER
IPC(7): G01S 1/02

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, H04B, G06F, H04Q

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

Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used)
Delphion and US West Database
Keywords: rf environment, obstacle, map, physical layout

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6,625,454 B1 (RAPPAPORT et al.) 23 September 2003 (23-09-2003) Figs. 1-4 column 4, lines 9-25 column 6, lines 33-67 column 8, line 56 - column 9, line 3 column 9, lines 4-24	1, 9-15, 23-29
Y		2-8, 16-22
Y	WO 00/73874 A2 (RAPPAPORT et al.) 7 December 2000 (07-12-2000) abstract page 5, lines 3-6 page 13, lines 3-5 page 14, line 25 - page 15, line 6	2-8, 16-22
A	US 6,317,599 B1 (RAPPAPORT et al.) 13 November 2001 see whole document	1-29
A	US 6,442,507 B1 (SKIDMORE et al.) 27 August 2002 see whole document	1-29

[ ] 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

"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

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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

"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
11 October 2005 (11-10-2005)	18 October 2005 (18-10-2005)

Name and mailing address of the ISA/CA	Authorized officer
Canadian Intellectual Property Office Place du Portage I, C114 - 1st Floor, Box PCT 50 Victoria Street Gatineau, Quebec K1A 0C9 Facsimile No.: 001(819)953-2476	Dennis Atkinson (819) 953-0816

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/CA2005/000983

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