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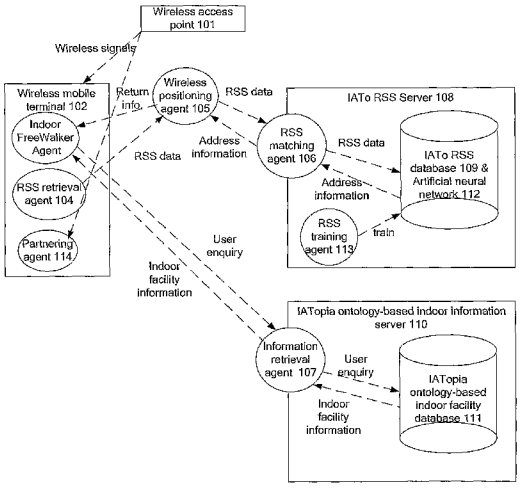
(54) **Title:** A SYSTEM AND METHOD FOR INTELLIGENT INDOOR POSITIONING WITH RECEIVED SIGNAL STRENGTH



(57) **Abstract:** A system for intelligent indoor positioning with received signal strength, wherein said system comprises IATo received signal strength (RSS) retrieval agent, IATo RSS server, IATo wireless positioning agent, IATo RSS matching agent, IATo Free Walker agent, IATo Partnering agents and access points for communication between said multiple agents and/or servers. The present invention provides a comprehensive product and service to satisfy the need of indoor positioning and guiding. By integrating intelligent RSS technology, mobile technology, Intelligent Agent Technology (IAT) and real-time indoor positioning, users may find any real-time location-based services, information and facilities more accurately and effectively. The present invention may be applied in shopping malls, exhibition centres, hospitals, hotels, casinos, stadiums, airports, government buildings and museums, etc.

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A SYSTEM AND METHOD FOR INTELLIGENT INDOOR POSITIONING WITH RECEIVED SIGNAL STRENGTH

Technical field

[0001] The present invention relates to communication system and information system, more particularly, relates to a system and method for intelligent indoor positioning with received signal strength.

Background of the invention

[0002] With the development of information system, more and more real-time, on spot and latest information are needed. Nowadays, there are many kinds of positioning technology available, for example, Global Positioning System (GPS), Mobile Positioning System (MPS), and Wireless Positioning System (WPS). However, positioning technology with indoor location awareness, real-time information and control system are highly needed. Not only because of the safety and control aspects, but also to provide the user with add value services.

[0003] Positioning technologies in the prior art, for example, GPS and MPS employ trigonometrical schemes to calculate the object's position. They can provide a realizable and efficient outdoor positioning technology. However, in indoor environment with different landscape and barriers, said GPS and MPS positioning technologies are limited, thus, conventional GPS and MPS technologies can not be applied.

[0004] In a huge indoor building complex, such as shopping mall, airport, etc. When people are traveling in these large buildings, people will easily get lost or unable to find the destination. At this point, people will ask for help from the staff of map inside the building. However, as staff have their particular patrol routines, they are not able to show the destination faraway; meanwhile, maps inside the building are not portable. People usually cannot find their destination faraway base

on their memories of the map.

[0005] The present invention provides a comprehensive product and service to satisfy the need of indoor positioning and guidance. Integrating of the state-of-art intelligent received signal strength technology in real-time indoor positioning and Intelligent Agent Technology (IAT), more accurate and faster positioning and guidance are provided to users. Further, apart from guidance information, the present invention may also provide the user with restaurant, movie, and traffic information.

Brief description of the invention

[0006] To solve the problem in the prior art, the present invention provides a system for intelligent indoor positioning with received signal strength (RSS), wherein said system comprises IATo received signal strength (RSS) retrieval agent, IATo RSS server, IATo wireless positioning agent, IATo RSS matching agent, IATo FreeWalker agent, IATo Partnering agents and access points for communication between said multiple agents and/or servers.

[0007] Said IATo RSS server stores RSS values;

[0008] Said IATo RSS retrieval agent receive RSS values, and carries the matching results from said IATo RSS matching agent return to said IATo FreeWalker;

[0009] Said IATo wireless positioning agent acquires RSS values received by RSS retrieval agent;

[0010] Said IATo RSS matching agent compares the RSS values acquired by said IATo wireless agent and RSS values in said RSS server to determine the exact address of said wireless terminal, and to return said exact address to said IATo wireless positioning agent;

[0011] Said IATo FreeWalker receives the exact address received by said IATo wireless positioning agent.

[0012] Advantageously, said system further comprises IATo Partnering Agent for user to check the location of his/her partner(s) who carries(carry) said wireless terminal(s) by activating the matching function of said IATo wireless positioning agent.

[0013] Advantageously, said system further comprises IATo ontology-based indoor information server for storing indoor facility information, and IATo based information retrieval agent for user to retrieve information from said indoor information server.

[0014] Advantageously, said IATo RSS server comprises:

[0015] RSS database for storing indoor RSS information;

[0016] Artificial neural network that embedded in IATo RSS server, for intelligently training and updating RSS information.

[0017] Agent communication and authentication centre for controlling and managing the travelling and authentication of said IATo wireless positioning agent and said IATo matching agent.

[0018] Advantageously, said system further compsies IATo RSS training agent for training said artificial neural network with the processed RSS information in said IATo RSS information database.

[0019] Advantageously, when the data flow congests between said IATo RSS server and/or different wireless terminal devices, said wireless positioning device may communicate with the nearest IATo wireless positioning agents.

[0020] Advantageously, said IATo agents are with high autonomy, may enter different devices, servers, gateways and/or platforms via Internet, said IATo agents may adapt to different network environment and different bandwidths.

[0021] According to one aspect of the invention, a method for intelligent indoor positioning with received signal strength is provided, comprises:

[0022] S1. Said IATo RSS retrieval agent retrieves the RSS values of the

current position of the wireless mobile terminal;

[0023] S2. Said IATo wireless positioning agent retrieves RSS values from said IATo RSS retrieval agent;

[0024] S3. IATo RSS matching agent matches the RSS values retrieved by IATo wireless positioning agent with the RSS values in said IATo RSS server, to determine the exact address of said wireless mobile terminal.

[0025] S4. IATo FreeWalker agent receives the address values carried by IATo wireless positioning agent.

[0025] Advantageously, the present invention further comprises a method for collecting RSS data and training said IATo RSS server, comprises:

[0026] S1. Divide the indoor environment into grid points, collect the RSS information of the wireless access point corresponding to each grid points via said IATo RSS retrieval agent;

[0027] S2. Said IATo RSS retrieval agent transfer RSS information to said IATo wireless positioning agent;

[0028] S3. Said IATo wireless positioning agent enters said IATo RSS server with RSS information, and stores said RSS information into said IATo RSS server to perform data cleaning, data normalization and data conversion.

[0029] S4. Said IATo training agent trains the artificial neural network in said IATo RSS server with processed RSS information.

[0030] Advantageously, said IATo wireless positioning agent of matched devices carries the address information of matched device enters the user's wireless mobile terminal, thus to display the matched user's position on the display of the user's IATo FreeWalker.

[0031] The present invention provides a comprehensive product and service to satisfy the need of indoor positioning and guiding. By integrating intelligent RSS technology and real-time indoor positioning, users may find shops more accurate

and faster. The present invention may be applied in shopping malls, exhibition centres, hospitals, casinos, airports, stadiums, government buildings and museums, etc.

Brief description of the drawings

[0032] Figure 1 is the block diagram of the indoor positioning system, in accordance with the present invention;

[0033] Figure 2 is the flow diagram of the training of the artificial neural network in the RSS server, in accordance with the present invention;

[0034] Figure 3 is the flow diagram of the positioning process of the wireless mobile terminal base on the RSS, in accordance with the present invention;

[0035] Figure 4 is the schematic diagram of the first embodiment, in accordance with the present invention;

[0036] Figure 5 is the schematic diagram of the second embodiment, in accordance with the present invention;

[0037] Figure 6 is the exemplary schematic diagram of the wireless terminal device, in accordance with the present invention.

Detailed description of the present invention

[0038] Figure 1 is the block diagram of the indoor positioning system, in accordance with the present invention. Said system comprises wireless access point 101, wireless mobile terminal 102, RSS server 108, IATo ontology-based indoor information server 110 and IATo wireless positioning agent 105, for receiving RSS values from RSS retrieval agent, and to carry the matching results of RSS matching agent return to IATo FreeWalker agent 103. Said wireless mobile terminal 102 comprises IATo FreeWalker 103 for receiving address value returned by IATo wireless positioning agent, IATo RSS retrieval agent 104 for retrieving the RSS of the current position of wireless mobile terminal, and IATo partnering agent 114 for partnering with other wireless mobile terminals. Said IATo RSS server 108

comprises IATo RSS database 109 for storing RSS values and artificial neural network 112 embedded into IATo RSS server; RSS matching agent 106 for comparing RSS values received by IATo wireless positioning agent and RSS values stored in RSS server to determine the exact address of wireless mobile terminal; and RSS training agent 113 for training artificial neural networks 109. Said IATo ontology-based indoor facility information server comprises IATo ontology-based database 111 and information retrieval agent 107, said information retrieval agent 107 retrieves information from the indoor facility information server according to user's requirements.

[0039] IATo indoor FreeWalker agent 103 may be any portable devices, for example, PALM, PDA, Sub-notebook computers, Pocket PC, smart phone and/or portable computer, and indoor positioning device, which may be bound to said portable device or may be separated from said portable device, for example, wireless receiver. Said wireless receiver is used to receive synchronous wireless signal data for automatic user positioning. Because it is used for guiding system, therefore, spatial data must be displayed on the screen of said portable device. Said system will display the indoor map, meanwhile, the user's current location will also be displayed on said indoor map. Apart from display real-time indoor map, said device may also display the useful information to user according to the current location in an automatic and on-spot manner, and graphical and/or video information may also be provided on the user device.

[0040] IATo indoor FreeWalker agent provides six core functions: 1) Route guiding function; 2) Real-time location-based interactive ontology tree-based information display function; 3) Interactive fuzzy query function; 4) Partnering function; 5) Location-based SMS function and 6) Intelligent Itinerary planning function. Route guiding function helps the user to locate his/her current position and the points-of-interests (POIs) by representing a real-time graphical indicate on

the indoor map, i.e. drawing a red line to show the user where he/she has passed and a orange box indicate the point of interest such as the restaurants, bookshops, cinemas and landmarks, etc. By adopting the ontology-based context modeling technique, the tree-based information display provides a well-organized information source for user to choose, locate and find his/her preferred facilities / merchants. Moreover, AI technology such as fuzzy logics is used to support intelligent searching (such as fuzzy searching based on price and distance) as an add-valued feature for user to find the preferred products / POIs / facilities.

[0041] IATo RSS retrieval agent 104 operates at the client side. The main function of the RSS retrieval agent 104 is to collect the RSS of the current location, for example, the overall wireless pattern of the mobile terminal at the current location. Said RSS pattern (known as "wireless FingerPrints") is used to identifier a certain location of indoor facility.

[0042] Before the RSS Server is operated for indoor positioning, all the collected RSS (within the facility) are stored, data-cleaned and normalized within the RSS server 108. IATo RSS training agent 113 is used to training the artificial neural networks 112 within the RSS server 108 for later use for indoor positioning.

[0043] In the latest IATOPIA invention, state-of-art neural networks and training methods such as Multi-layered Feed Forward Back propagation Networks, RBF Neural Networks, ART Neural Networks, K-mean clustering, K-Nearest Neighbourhood clustering, SOM clustering, Chaotic attraction clustering techniques are adopted. (All these AI methods and models are embedded in the IATOPIA Intelligent Layer Module).

[0044] IATo wireless positioning Agent 105 is the core mobile wireless positioning agent operated in this intelligent indoor positioning system. The main functions of this IATo Wireless Positioning Agent are two folds:

1. Communicate between the IATo RSS Server and the mobile device to transfer

the location information to the IATOPIA Indoor FreeWalker Agent within the mobile device;

2. Communicate between "neighbourhood" positioning agent about the location information in case data traffic jam / congestion occurs between the IATo RSS Server and different mobile devices within the indoor facility.

[0045] One important feature of this invention using Intelligent Agent Technology (IAT) is that all these intelligent agents are highly autonomy, mobile and robust. In other words, they can: Travel freely between different devices / servers / gateways / platforms over the wireless Internet environment; Travel and adopt to different networking environment (e.g. 3G, 2.5G, etc) and different bandwidths.

[0046] IATo RSS Server 108 is the core invention mentioned in this patent document. The main functions of the IATOPIA FingerPrint Server provides / acts as:

1. The "Brain" (Knowledge-base) of the whole indoor positioning system which contains all the FPs information (knowledge) of the indoor facility;

2. The neural network embedded within this IATo RSS server acts as the intelligent WiFi FP (Fingerprint) knowledge training and updating centre;

3. Agent communication and registration centre to control and administrate the mobility and authentication of the IATOPIA Wireless Positioning and IATOPIA Partnering Agents.

[0047] IATo partnering agent 114 aims at the provision of partnering function. In other words, within a particular mobile device, the user not only can see his/her own current location within the indoor facility, she/he can also see the current location of his/her partner(s) whenever the user enables the partnering function in this system. Besides, user can also send location-based short messages (LBSMS) to these IATo FreeWalker partner(s) as well.

[0048] Figure 2 is the flow diagram of the training of the artificial neural networks in the RSS server, in accordance with the present invention. The training of said artificial neural networks are described in connection with figure 1, comprising the following steps:

[0049] Step 101, divide the indoor environment into grid points, collect the RSS information of the wireless access point corresponding to each grid points via said IATo RSS retrieval agent;

[0050] Step 102, said IATo RSS retrieval agent transfer RSS information to said IATo wireless positioning agent;

[0051] Step 103, said IATo wireless positioning agent enters said IATo RSS server with RSS information, and stores said RSS information into said IATo RSS server to perform data cleaning, data normalization and data conversion.

[0052] Step 104, said IATo training agent trains the artificial neural network in said IATo RSS server with processed RSS information.

[0053] Figure 3 is the flow diagram of the positioning process of the wireless mobile terminal base on the RSS, in accordance with the present invention. The positioning process will be described in connection with figure 1, compising the following steps:

[0054] Step 201, said IATo RSS retrieval agent retrieves the RSS of the current position of the wireless mobile terminal;

[0055] Step 202, said IATo wireless positioning agent retrieves RSS values from said IATo RSS retrieval agent;

[0056] Step 203, IATo RSS matching agent matches the RSS values retrieved by IATo wireless positioning agent with the RSS values in said IATo RSS server, to determine the exact address of said wireless mobile terminal.

[0057] Step 204, IATo FreeWalker agent receives the address value carried by IATo wireless positioning agent.

[0058] Figure 4 is the schematic diagram of the first embodiment. Figure 4 illustrated the plan view of a shopping mall that installed with the intelligent indoor positioning system in the present invention. Three wireless access points 401, 402, and 403 are installed in the shopping mall for the communication among each of the agents of the intelligent indoor positioning system. At the beginning, the RSS server is trained as the following steps, first, divide the indoor environment into grid points, collect the RSS information of the wireless access point corresponding to each grid points via said IATo RSS retrieval agent; second, said IATo RSS retrieval agent transfer RSS information to said IATo wireless positioning agent; then, said IATo wireless positioning agent enters said IATo RSS server with RSS information, and stores said RSS information into said IATo RSS server to perform data cleaning, data normalization and data conversion; at last, said IATo training agent trains the artificial neural networks in said IATo RSS server with processed RSS information. At this point, the RSS information of each grid point is stored into the RSS database.

[0059] The user's destination is shop 2, after the user enters the shopping mall with the wireless mobile terminal 404.

[0060] At first, the agent communication and authorization centre in said RSS server verifies the indoor positioning agent of the wireless mobile terminal to assure the user's identification of the wireless mobile terminal, and whether if the user is authorized to use the intelligent indoor positioning system. After determining said user may use the intelligent indoor positioning system, said intelligent indoor positioning system are used to locate the wireless mobile terminal 404; then, IATo RSS retrieval agent retrieves the RSS values of the wireless mobile terminal in the current location; then IATo wireless positioning agent receives RSS values from RSS retrieval agent; and then, IATo RSS matching agent compares RSS values retrieved by IATo wireless positioning agent and the

RSS values stored in the IATo RSS server to obtain the exact address of said wireless mobile terminal; at last, IATo FreeWalker agent receives the address value returned by IATo wireless positioning agent.

[0061] Figure 5 is the schematic diagram of the second embodiment. Parents and their children are in different location in the shopping mall, and they are not visible to each other. In this regard, parents may apply the IATo partnering function of the present invention to look for their children. The IATo wireless positioning agent of the children's wireless mobile terminal enters the parents' wireless mobile terminal with the address information of the children's wireless mobile terminal, thus to display the children's position on the display of parents' IATo FreeWalker.

[0062] If there are too many wireless mobile terminals within one shopping mall, and the congestion can not be overcome in the network technology in the prior art, the data flow among RSS server and/or different wireless mobile terminals may congest, therefore, the wireless positioning agent in the present invention may communicate with nearby wireless positioning agents to overcome this problem.

[0063] The IATo agents in the present invention are with high autonomy, may enter different device, servers, gateways and/or platform via Internet, said IATo agents may adapt to different network environment and different bandwidths.

[0064] Figure 6 is the exemplary schematic diagram of the wireless terminal device, in accordance with the present invention. Figure 6 illustrated the application in PALM. The interface shown in figure 6 is under full screen mode. In non-full screen mode, brief introduction of shops, discount information, advertisements, contact information etc. may be shown around the map in tree-type display pattern.

[0065] While the present invention has been described with reference to certain embodiments, it will be understood by those skilled in the art that various

changes may be made and equivalents may be substituted without departing from the scope of the present invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the present invention without departing from its scope. Therefore, it is intended that the present invention not be limited to the particular embodiment disclosed, but that the present invention will include all embodiments falling within the scope of the appended claims.

Claims

1. A system for intelligent indoor positioning with received signal strength, wherein said system comprises IATo received signal strength retrieval agent, IATo received signal strength server, IATo wireless positioning agent, IATo received signal strength matching agent, IATo FreeWalker agent, IATo Partnering agent and access points for communication between said multiple agents and/or servers.

Said IATo received signal strength server stores Received signal Strength values;

Said IATo received signal strength retrieval agent receive received signal strength values, and carries the matching results from said IATo received signal strength matching agent return to said IATo FreeWalker;

Said IATo wireless positioning agent acquires received signal strength values received by received signal strength retrieval agent;

Said IATo received signal strength matching agent compares the received signal strength values acquired by said IATo wireless agent and received signal strength values in said received signal strength server to determine the exact address of said wireless terminal, and to return said exact address to said IATo wireless positioning agent;

Said IATo FreeWalker receives the exact address received by said IATo wireless positioning agent.

2. The system in claim 1, wherein said system further comprises IATo Partnering agent for user to check the location of his/her partner who carries said wireless terminal by activating the matching function of said IATo wireless positioning agent and sending messages to these IATo FreeWalker partners.

3. The system in claim 1, wherein said system further comprises IATo ontology-based indoor information server for storing indoor facility information, and IATo based information retrieval agent for user to retrieve information from

said indoor information server.

4. The system in claim 2, wherein said received signal strength server comprises:

RSS database for storing indoor RSS information;

Artificial neural networks that embedded in IATo received signal strength server are used for intelligently training and updating received signal strength information.

Agent communication and authentication centre for controlling and managing the travelling and authentication of said IATo wireless positioning agent and said IATo matching agent.

5. The system in claim 4, wherein said system further compsies IATo received signal strength training agent for training said artificial neural network with the processed received signal strength information in said IATo received signal strength information database.

6. The system in claim 1, when the data flow congests between said IATo received signal strength server and/or different wireless terminal devices, said wireless positioning device may communicate with the nearest IATo wireless positioning agents.

7. The system in claim 1, wherein said IATo agents are with high autonomy, may enter different device, servers, gateways and/or platform via Internet, said IATo agents may adapt to different network environment and different bandwidths.

8. A method for intelligent indoor positioning with received signal strength is provided, comprises:

S1. Said IATo received signal strength retrieval agent retrieves the received signal strength of the current position of the wireless mobile terminal;

S2. Said IATo wireless positioning agent retrieves received signal sttrength values from said IATo received signal strength retrieval agent;

S3. IATo received signal strength matching agent matches the received signal

strength values retrieved by IATo wireless positioning agent with the received signal strength values in said IATo received signal strength server, to determine the exact address of said wireless mobile terminal.

S4. IATo FreeWalker agent receives the address value carried by IATo wireless positioning agent.

9. The method in claim 8, further comprises a method for collecting received signal strength data and training said IATo received signal strength server, comprises:

S1. Divide the indoor environment into grid points, collect the received signal strength information of the wireless access point corresponding to each grid points via said IATo received signal strength retrieval agent;

S2. Said IATo received signal strength retrieval agent transfer received signal strength information to said IATo wireless positioning agent;

S3. Said IATo wireless positioning agent enters said IATo received signal strength server with received signal strength information, and stores said received signal strength information into said IATo received signal strength server to perform data cleaning, data normalization and data conversion;

S4. Said IATo training agent trains the artificial neural networks in said IATo received signal strength server with processed received signal strength information.

10. The method in claim 8, wherein said IATo wireless positioning agent of matched devices carries the address information of matched device enters the user's wireless mobile terminal, thus to display the matched user's position on the display of the user's IATo FreeWalker.

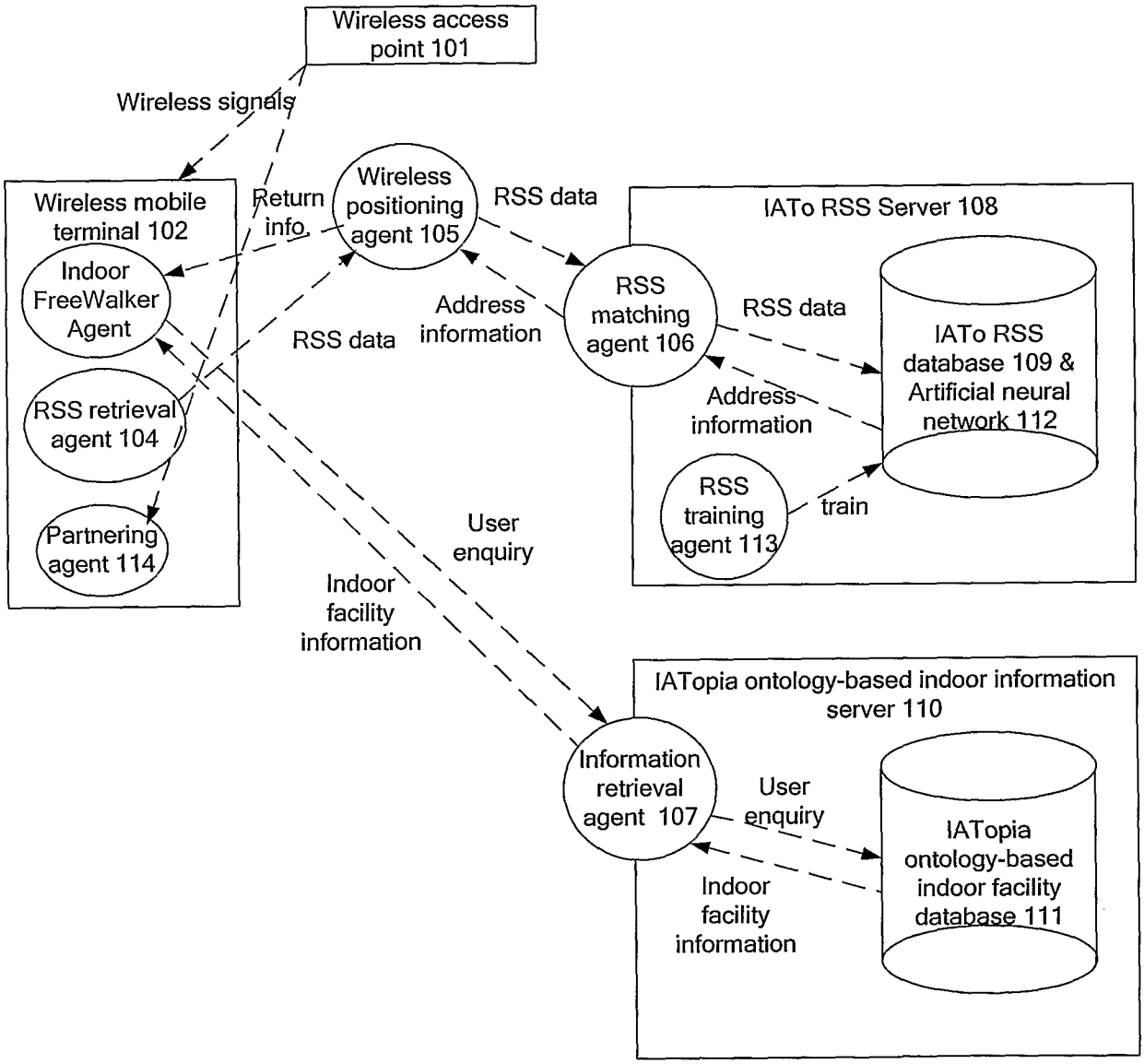

Figure 1

替换页(细则第26条)

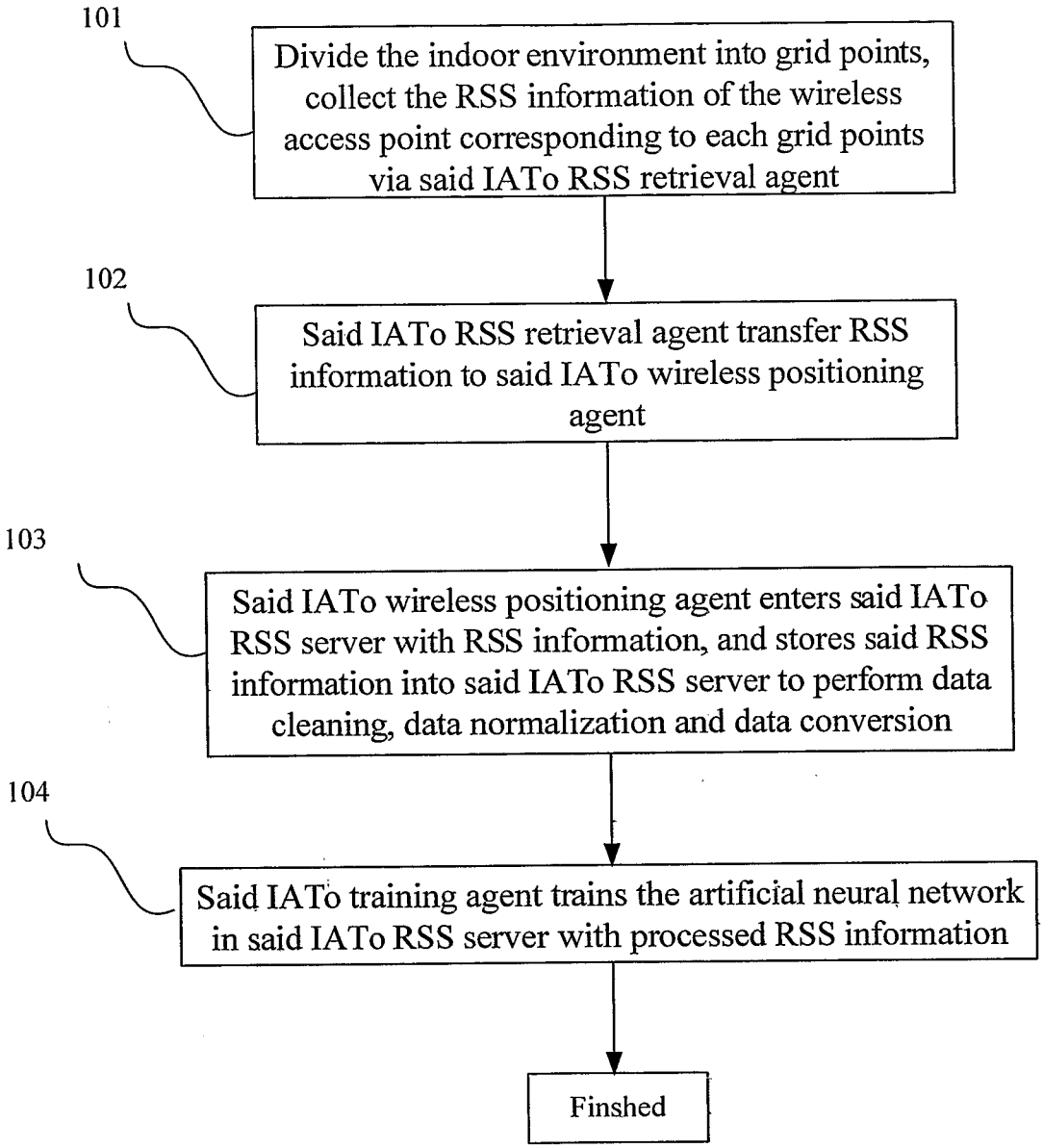
101
Divide the indoor environment into grid points, collect the RSS information of the wireless access point corresponding to each grid points via said IATo RSS retrieval agent
102
Said IATo RSS retrieval agent transfer RSS information to said IATo wireless positioning agent
103
Said IATo wireless positioning agent enters said IATo RSS server with RSS information, and stores said RSS information into said IATo RSS server to perform data cleaning, data normalization and data conversion
104
Said IATo training agent trains the artificial neural network in said IATo RSS server with processed RSS information
Finshed

Figure 2

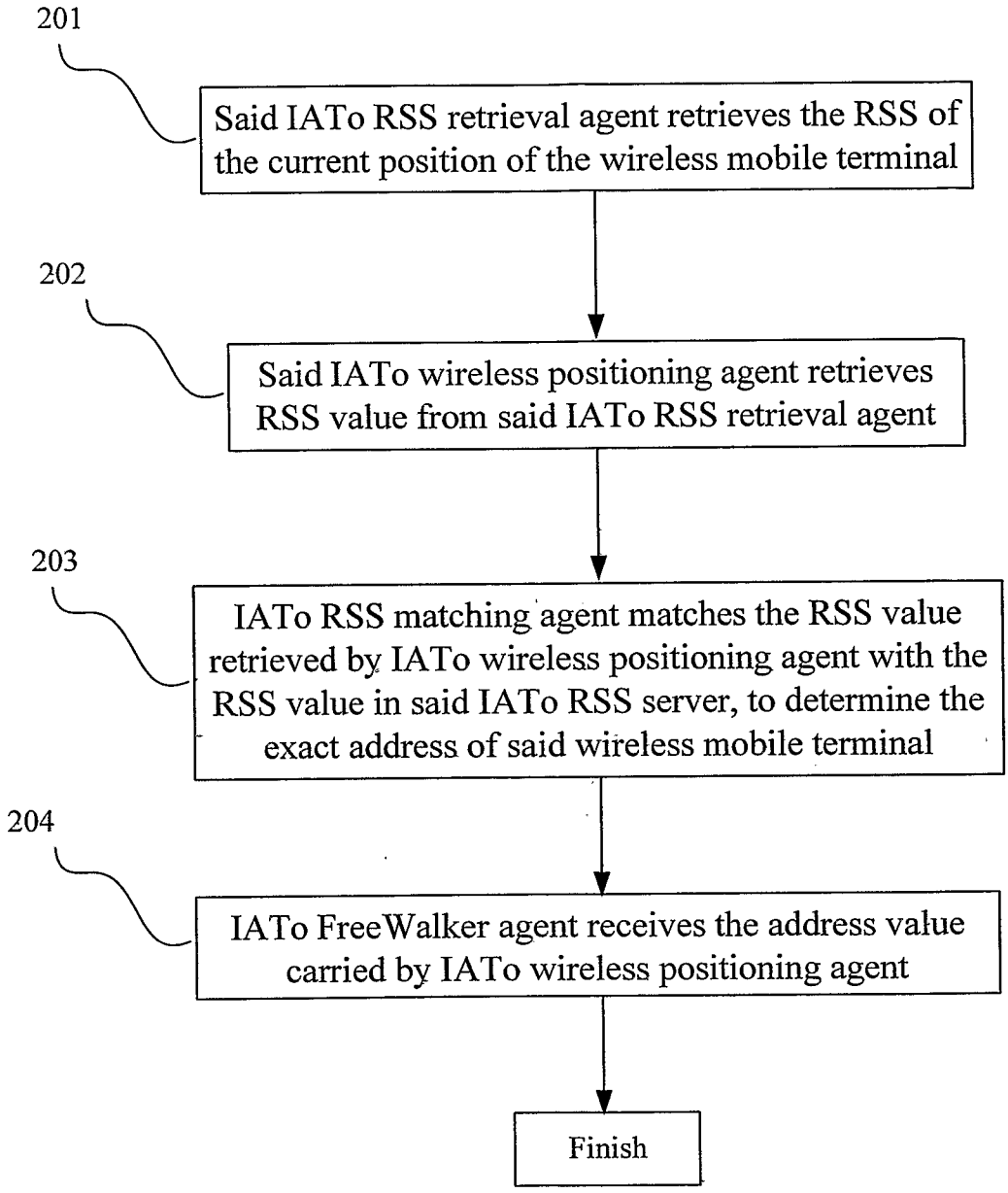
201
Said IATo RSS retrieval agent retrieves the RSS of the current position of the wireless mobile terminal
202
Said IATo wireless positioning agent retrieves RSS value from said IATo RSS retrieval agent
203
IATo RSS matching agent matches the RSS value retrieved by IATo wireless positioning agent with the RSS value in said IATo RSS server, to determine the exact address of said wireless mobile terminal
204
IATo FreeWalker agent receives the address value carried by IATo wireless positioning agent
Finish

Figure 3

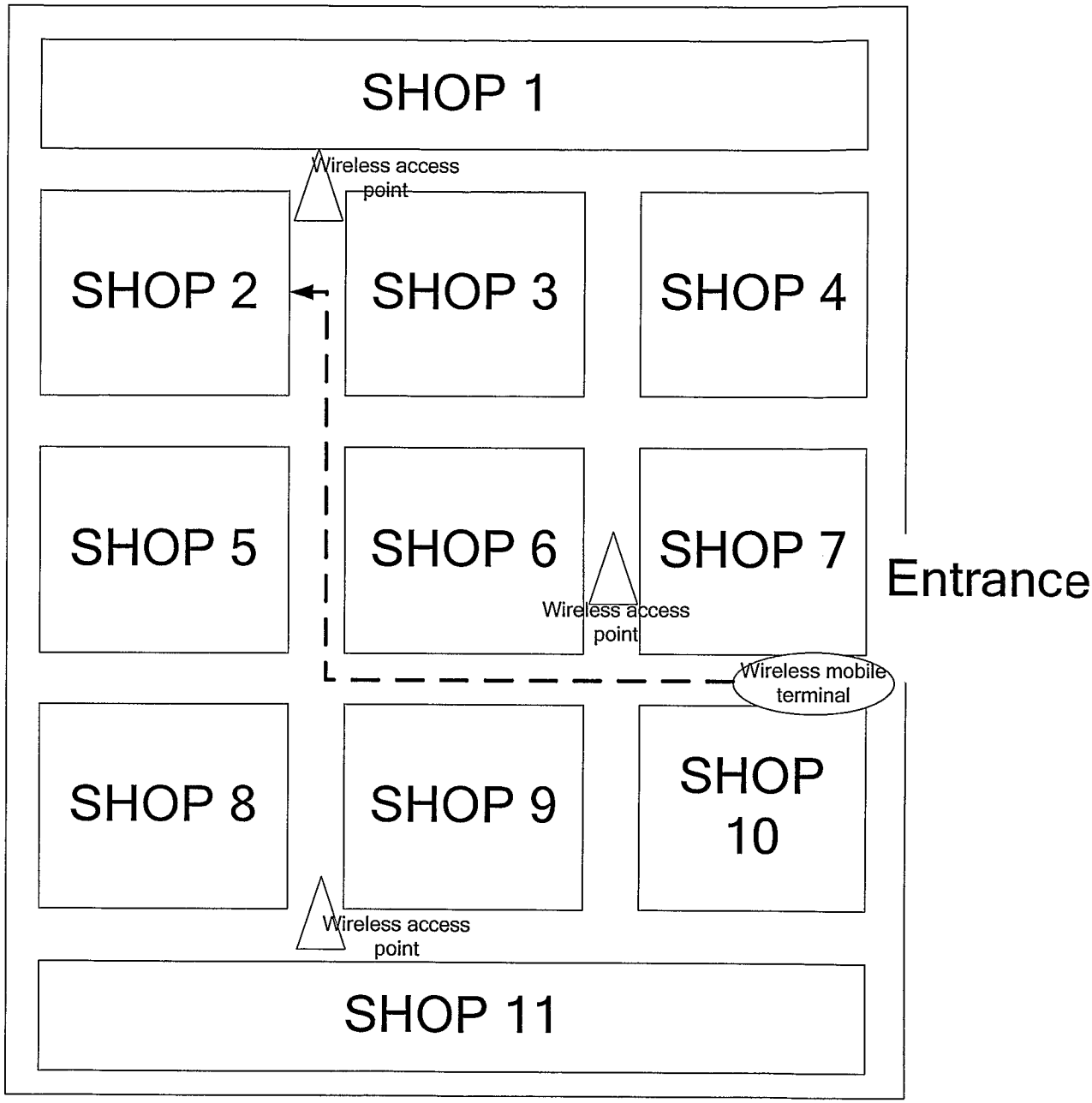

Figure 4

替换页(细则第26条)

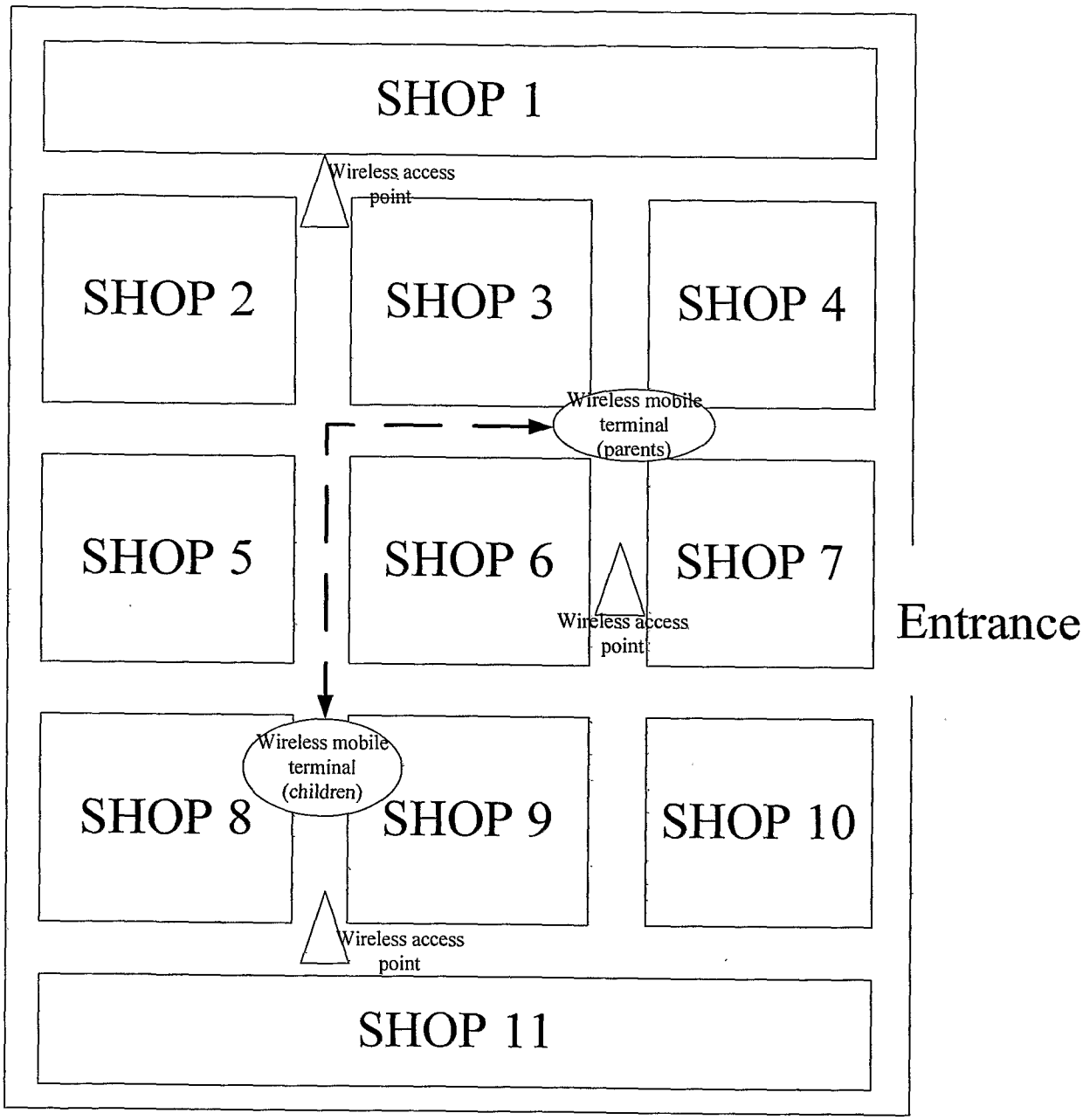
SHOP 1
Wireless access point
SHOP 2
SHOP 3
SHOP 4
Wireless mobile terminal (parents)
SHOP 5
SHOP 6
SHOP 7
Wireless access point
Entrance
Wireless mobile terminal (children)
SHOP 8
SHOP 9
SHOP 10
Wireless access point
SHOP 11

Figure 5

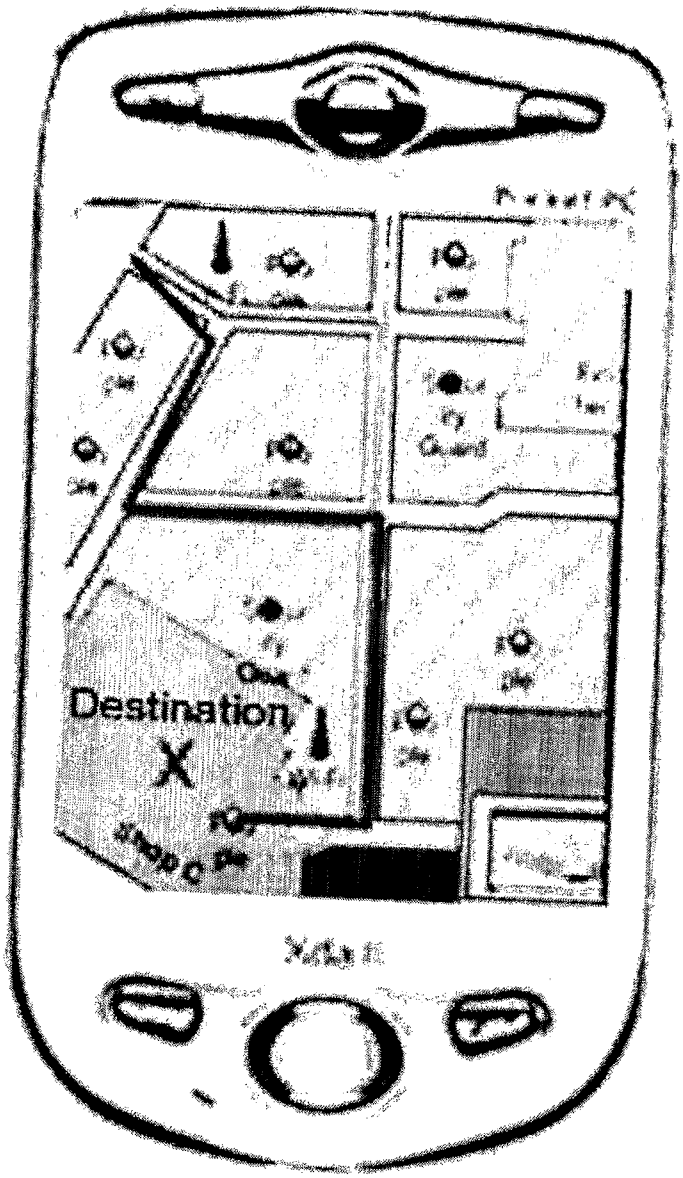

Figure 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2007/000495

A. CLASSIFICATION OF SUBJECT MATTER

H04Q7/38(2006.01)i

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:H04Q7/38,G01S11/06,G01S5

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)

CPRS,CNKI,WPI,EPODOC,PAJ::POSITION, LOCAT+, PLAC+, SIGNAL?, STRENGTH, INTENSITY, INDOOR, IN W HOUSE, IAT+, INTELLIGENCE, INTELLIGENT, COMPAR+, MATCH+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP1689126A1(ALCATEL) 09 Aug. 2006(09.08.2006) see the [0027]-[0037] in the description, Fig.2	1,3,6-8,10
A		2,4,5,9
A	CN1717592A(KONINK PHILIPS ELECTRONICS NV et al) 04 Jan. 2006(04.01.2006) see the whole document	1-10
A	CN1722897A(ZTE CORP) 18 Jan. 2006(18.01.2006) see the whole document	1-10
A	EP1355505A1(ACCENTURE GLOBAL SERVICES GMBH et al) 22 Oct. 2003(22.10.2003) see the whole document	1-10

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

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Date of the actual completion of the international search	Date of mailing of the international search report
16 Aug. 2007(16.08.2007)	**30 Aug. 2007 (30.08.2007)**
Name and mailing address of the ISA/CN The State Intellectual Property Office, the P.R.China 6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China 100088 Facsimile No. 86-10-62019451	Authorized officer CHAO Lulin Telephone No. (86-10)62084538

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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