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(54) PARKING MANAGEMENT METHOD AND SYSTEM

VERFAHREN UND SYSTEM ZUR PARKVERWALTUNG

PROCÉDÉ ET SYSTÈME DE GESTION DE PARKING

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(56) References cited:
WO-A-2006/096848 **US-A1- 2003 074 129**
US-B1- 6 285 297

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Description

Field of the invention

[0001] The present invention relates to parking management systems, in general, and particularly to an automatic parking management system for managing parking areas, particularly but not limitatively parking areas with non-delimited parking places.

Description of the related art

[0002] The ever increasing use of cars and the limited space available for parking them, particularly in urban areas, has led to serious problems in the parking management. The lack or shortage of available parking space is one of the major issues of practically all the urban centers. At the present time, it is very difficult for a driver wishing to travel to a urban area to know in advance if there will be available parking space for his/her car. This means that the driver, when he/she has reached the desired destination, is often forced to drive around the area in search of an available parking space; this is a waste of precious time, and increases the traffic and, ultimately, the overall air pollution. Additionally, when eventually a parking space is found, additional time is wasted for finding parking meters or tickets to pay the prescribed parking fee. Moreover, the conventional parking systems often require to be paid in advance, even if the exact parking duration is almost never known at the time the car is parked; this is a problem, because it is not rare that the parking fee paid in advance is insufficient, but the driver cannot extend the parking time by paying an additional fee.

[0003] A further issue regards the presence of parking rules distinguishing areas in which the parking is free, areas in which the parking requires the payment of a parking fee, areas in which parking is forbidden, areas in which parking is admitted only to restricted groups of people, *i.e.*, only to residents or to disabled people, areas in which parking is admitted only temporarily, *etc.*

[0004] Monitoring areas in which parking is regulated in any of the above manners is costly and time consuming. Typically, an entrusted person has to visually inspect all of the regulated parking area periodically, regardless of whether vehicles are actually parked there. This task becomes more difficult when the spaces are spread across a large area, such as a whole city block. Likewise, it is often expensive and logistically inconvenient for police or municipality officers to enforce parking regulations, keeping track of vehicles parked in forbidden areas or without paying the prescribed parking fee.

[0005] Conventional parking meters do not fully solve the abovementioned problems, because they are not capable of monitoring the presence/absence of vehicles in the parking. Indeed, adopting conventional parking meters requires a continuous monitoring action by dedicated personnel.

[0006] To overcome these problems, several parking management systems have been proposed in the last years, based on the automatic detection and communication to a remote entity of the occupancy of each individual parking place in a parking lot. All these systems generally require that the individual parking places can be uniquely identified, and that each parking place is either occupied or free.

[0007] For example, the U.S. patent 7,026,954 discloses an intelligent parking system for a parking lot comprising a plurality of individual parking spaces, like a parking garage. The parking system can provide space-specific location data to potential users to facilitate efficient utilization of parking lots. The data is generated in substantially real-time at the entrance to the parking garage. The system includes at least one object (vehicle) detector for each parking place.

[0008] The International patent application WO 98/04080 discloses a parking management communication system that may be used to monitor and reserve parking places, allowing law enforcement officials to monitor parking facilities with greater ease and expediency. In short, the parking management communication system includes a central control unit having a data base (including data like parking facility availability, vehicle identification, user identification and billing information), a central interface unit in wired or wireless communication with a user interface unit, like a mobile telephone. A user may report his arrival at the parking lot to the central interface unit and, after having parked his/her car in a parking place, the user reports the parking to the central interface unit. The parking of the vehicle may be sensed by a sensor, such as an optical sensor, which automatically reports the parking of the vehicle to the central interface unit.

[0009] US 2003/0074129 discloses an automatic computer driven system and method for delivering information regarding available parking spaces to motorists.

Summary of the invention

[0010] The Applicant observes that in both the two known solutions, each parking place is associated with at least one corresponding vehicle detector, which is capable of establishing if the parking place is occupied or not by a vehicle.

[0011] However, said solutions are not easily implemented in urban areas, *i.e.*, where the parking problems are more exacerbated. Indeed, in urban areas, parking lots including parking places which are individually delimited are not really common, being confined only to restricted areas, *e.g.*, multi-level parking lots. Conversely, in urban areas the parking areas often consist of undelimited, open parking places, usually arranged along the sides of the streets, near the sidewalks. In this case, the single parking place is neither delimited nor identifiable as such. Albeit this allows best packaging of the vehicles, it poses problems in realizing an automatic

parking management system.

[0012] With such a type of parking area, it is useless to identify the individual parking places, since each individual parking place becomes defined only once a vehicle is parked in it; indeed, the dimensions of each parking place are established by the vehicle occupying it: the longer the vehicle, the longer the parking place accommodating it. The known parking management systems are instead based on an a *priori* identification of each individual parking place, and are not suitable to be used in at least parts of urban parking areas.

[0013] In view of the state of the art outlined in the foregoing, the Applicant has faced the problem of realizing a parking management system which can be efficiently used for managing also parking areas having undelimited parking places, as in the case of parking areas along the sides of the street, and wherein what is relevant for the occupancy is the available parking length.

[0014] According to an aspect of the present invention, a parking management system as set forth in claim 1 is provided. The parking management system may manage at least one parking area and be adapted to provide parking management services to vehicle drivers looking for parking places. The parking management system includes a sensor system adapted to monitor the at least one parking area for providing occupancy indications about the occupancy of the parking area, and a data gathering and communication network, adapted to collect the occupancy indications from the sensor system and to derive therefrom indications about available parking spaces in the at least one parking area. The parking management system further includes a service management center adapted to receive said indications about the available parking spaces in the at least one parking area, and to receive from the vehicle driver a request of availability of a parking place; said request including data related to a size of the requested parking place. Based on said data related to the size of the requested parking place and said indications about the available parking spaces, the service management system notifies the vehicle driver the availability of the parking place of the requested size.

[0015] The Applicant believes that sending data related to the size of the requested parking place, in combination with a system for determining indications about available parking spaces, allows to efficiently provide a service for finding a suitable parking place in a parking area while assuring an optimal vehicle occupation of the parking area (e.g. leaving the parking places undelimited). Preferred embodiments of the parking management system are set forth in dependent claims 2 to 15.

[0016] According to another aspect of the invention, a method for managing the parking in at least one parking area as set forth in appended claim 15 is provided.

[0017] The method includes the steps of monitoring at least one parking area for providing occupancy indications about the occupancy of the parking area; collecting the occupancy indications and deriving therefrom indications about available parking spaces in the at least one parking area; receiving said indications about the available parking spaces in the at least one parking area at a service management center; receiving from a vehicle driver a request of availability of a parking place at the service management center, wherein said request includes data related to a size of the requested parking place; and, based on said data related to the size of the requested parking place and said indications about the available parking spaces, notify the vehicle driver the availability of the parking place of the requested size.

Brief description of the drawings

[0018] The features and advantages of the present invention will be best understood by reading the following detailed description of some embodiments thereof, given merely by way of non-limitative example, that will be conducted making reference to the accompanying drawings, wherein:

Figure 1 schematically depicts the general architecture of a parking management system according to an embodiment of the present invention;

Figure 2 schematically illustrates an exemplary structure of a database included in a service management center of the parking management system of **Figure 1,** according to an embodiment of the present invention;

Figure 3 is a flow chart schematically showing the interaction of a generic sensor node part of a sensor system of the parking management system of **Figure 1** with a corresponding local base unit, according to an embodiment of the present invention;

Figures 4A and **4B** depict a schematic flow chart showing the operations performed by the service management center when it interacts with a customer exploiting the parking management services offered by the parking management system, according to an embodiment of the invention;

Figure 5 schematically depicts the main steps of a method for planning the topology of parking areas in a region of interest, according to an embodiment of the present invention;

Figure 6 illustrates in more detail a portion of the parking area shown in **Figure 1,** in a cross-sectional view along a line crossing the sensor nodes;

Figures 7A and **7B** show an example of how the presence of parked vehicles is detected by the sensor nodes of the parking area of **Figures 1** and **6,** according to an embodiment of the present invention; and

Figure 8 schematically shows, in terms of blocks, the main functional components of a local base unit and of the service management center of the parking management system of **Figure 1,** according to an embodiment of the present invention;

Detailed description of the preferred embodiments

[0019] With reference to the drawings, in **Figure 1** a general architecture of a parking management system **100** according to an embodiment of the present invention is schematically shown.

[0020] In particular, in the figure a portion of a generic, *e.g.*, urban, street **105** is illustrated, including a roadway **110** which comprises, in the example considered; two lanes **110a, 110b.** A parking area **115,** having the shape of a strip, runs adjacent to the lane **110a** of the roadway **110,** close to a sidewalk **117;** the parking area **115** is separated from the adjacent lane **110a** of the roadway **110** by a horizontal road sign **120,** and forms a parking lane.

[0021] Vehicles can be parked in the parking area **115** so as to form an alignment, with the front bumper of a vehicle facing the back bumper of an adjacent vehicle.

[0022] The parking area **115** further includes one or more parking location signs **122,** each one adapted to provide a parking location code useful for identifying and locating the parking area **115,** or different zones (portions) thereof (for example, in case the parking area **115** corresponds to an entire street, a single parking location sign may be provided, adapted to identify the street as a whole; alternatively, more parking location signs may be provided, *e.g.*, adapted to identify two end sections and a central section of the street). The parking location signs **122** may be directly painted on the roadway **110** or on the sidewalk **117,** or they may be vertical road signs.

[0023] It has to be noted that the parking area **115** may be arranged in a different way: for example, it may have a different shape, *e.g.*, different from a strip, or it may include two strips, each one adjacent to a respective one of the lanes **110a, 110b** of the roadway **110.**

[0024] The parking management system **100** of the present invention is adapted to automatically monitor the parking area **115** for obtaining information related to the occupancy thereof, and to provide guidance to vehicle drivers who are looking for a parking place, notifying them the availability of parking space in the parking area **115.**

[0025] From the architecture viewpoint, the parking management system **100** of the present invention comprises three main component systems: a sensor system **125,** a data gathering and communication network **130** and a Service Management Center (SMC) **135.** Briefly, the sensor system **125** is adapted to monitor the parking area **115,** and to provide corresponding monitoring information to the SMC **135** through the data gathering and communication network **130.** The SMC **135** collects and processes the information from the sensor system. On the basis of the collected information, the SMC **135** provides parking management services to vehicle drivers in search of parking places.

[0026] The sensor system **125** includes a plurality of sensor nodes **140** arranged so as to monitor the parking area **115.** The sensor nodes **140** are deployed across the parking area **115,** and are each one capable of generating pieces of information that, altogether, are useful to determine the occupancy of the parking area **115** in real time; in particular, each sensor node **140** is adapted to detect the occupancy (due for example to the presence of a vehicle) of a respective portion of the parking area **115,** and to consequently generate an occupancy indication. In an embodiment of the present invention, since the parking area **115** of **Figure 1** is adapted to the parking of vehicles aligned aside the lane **110a,** said pieces of information generated by the different sensor node **140** are used for calculating the available (*i.e.*, empty, not occupied) linear parking spaces of the parking area **115.**

[0027] The occupancy indications generated by the sensor nodes **140** are collected by the data gathering and communication network **130,** processed and then transmitted to the SMC **135.** In an embodiment of the present invention, the data gathering and communication network **130** includes one or more, for example a plurality of concentrators or Local Base Units (LBUs) **145(i)** (i = 1 to n), each one adapted to collect the occupancy indications provided by one or more, for example a plurality of corresponding sensor nodes **140,** for example sensor nodes **140** that are located in the proximity of the corresponding LBUs. According to an embodiment of the present invention, each LBU **145(i)** is associated with the set of sensor nodes **140** that monitor the parking area **115** of a street **105,** or to a sub-set thereof, like for example the sensor nodes monitoring just one of the parking lanes of the street (in case the latter has two parking lanes), or portions thereof; however, a single LBU **145(i)** may be associated with the set of sensor nodes **140** of parking areas of more than just one street **105.** The LBUs and the associated sensor nodes are in communications relationship. For example, according to an embodiment of the present invention, each sensor node **140** is coupled to the corresponding LBU **145(i)** through a wireless connection; however, nothing prevents from having sensor nodes that are connected to the respective LBUs by means of wired connections. Each sensor node **140** is in particular capable of transmitting the occupancy indications to the corresponding LBU **145(i)** (either by its own motion or responsive to a polling of the LBU). Each LBU **145(i)** is adapted to process the occupancy indications received from the sensor nodes it is associated with, so as to derive indications about the available linear parking spaces in the parking area(s) **115** (or in the portion thereof that is monitored by the set of sensor nodes associated therewith).

[0028] The SMC **135** is in communication relationship with the LBUs **145(i)** deployed within a prescribed area (for example, a urban district of a city, or even the whole city area). Particularly, each **LBU 145(i)** is connected to the SMC **135** through a wired or wireless connection, for example through an Ethernet, the Internet, a mobile telephony network like a GSM/GPRS/EDGE or UMTS telecommunication network. The SMC **135** is adapted to receive from the LBUs **145(i)** the indications of the available (e.g. linear) parking space in the monitored parking

area(s) **115.** In an embodiment of the present invention, the SMC **135** includes a database **150** for storing the data received from the LBUs **145(i),** and a function (for example a software engine) that is adapted to process said data so as to provide the parking management services to customers.

[0029] Users, typically drivers of vehicles **155,** who wish to take advantage of the services offered by the parking management system **100** can get in contact with the SMC **135** using their mobile phones **160,** or other suitable communications terminal like a smart phone, a palmtop, a laptop with a mobile phone card, through a telephony network **165** (possibly including, in addition to one or more public mobile telephony networks, the public switched telephone network).

[0030] **Figure 2** schematically illustrates an exemplary structure of the database **150** exploited by the SMC **135,** according to an embodiment of the present invention. The database **150** may in particular be structured in a tabular form, storing information about the availability of parking space and the identification of the vehicle drivers (hereinafter referred to as customers) exploiting the parking services provided by the parking management system **100.**

[0031] Particularly, the database **150** may include a parking space availability table **200** and, optionally, a customer identification table **210.** The parking space availability table **200** includes a plurality of records **220(i)** (i = to n), each one corresponding to a specific LBU **145(i)** and adapted to store data indicating the parking availability of the associated (portion of) parking area(s) **115.**

[0032] According to an embodiment of the present invention, each record **220(i)** includes a LBU identification (key) field **230(i),** a location field **240(i)** and a parking space availability field **250(i).**

[0033] The key field **230(i)** is adapted to store an identifier that identifies the LBU **145(i)** to which the record **220(i)** corresponds. The location field **240(i)** is adapted to store data that specifies the location(s) of the parking area(s) **115** monitored by the sensor nodes **140** associated with the LBU **145(i).**

[0034] The herein described embodiment of the present invention is particularly adapted to the management of parking areas **115** where parked vehicles are aligned along a parking lane and where the single parking places are not individually delimited, thus the availability of parking space strongly depends on the length of the vehicle that has to be parked. Indeed, vehicles having different lengths need empty parking places of different lengths: the longer the vehicle to be parked, the longer the parking place needed (other, additional aspects may affect the size, *e.g.* length of the parking space needed, as will be discussed later). Consequently, in order to allow the best packaging of the vehicles, short vehicles should be parked in parking places that are not too long (if available), leaving the longer parking places for the parking of the longer vehicles. For this purpose, the parking space availability field **250(i)** may include a plurality of subfields, corresponding to different predetermined lengths (thresholds) LMIN(j) (j=1 to m): based on the indications about the available linear parking spaces obtained from the LBU **145(i),** the SMC **135** classifies the available linear parking spaces with respect to the predetermined lengths LMIN(j). More particularly, for each predetermined length LMIN(j), the SMC **135** may calculate if there is at least one free parking place having a length higher than the predetermined length LMIN(j), and accordingly writes the result in the parking space availability field **250 (i).**

[0035] According to an embodiment of the present invention, the customer identification table **210** includes a plurality of customer-related records **260(k),** each one adapted to store information about a corresponding customer exploiting the parking services provided by the parking management system **100.** As will be described in the following of the present description, part of the data stored in each customer-related record **260(k)** is provided by the customer itself, while the other part is automatically generated by the SMC 135.

[0036] More particularly, each customer-related record **260(k)** comprises a customer identification (key) field **265(k)** adapted to store an identifier (*e.g.* numerical) code ID(k) that identifies a single customer. According to an embodiment of the present invention, the identifier code ID(k) is assigned to each customer by the SMC **135** when he/she contacts the SMC **135** asking for a parking service. According to a further embodiment of the present invention, the parking management system **100** allows the customer to subscribe to the parking services offered by the parking management system **100;** in this case, once a customer has subscribed, he is assigned an identifier code ID(k) which is thereafter used by the SMC **135** to identify the customer.

[0037] According to an embodiment of the present invention, the customer related record **260(k)** further includes a number plate field **270(k),** adapted to store the number plate of the vehicle that the customer has to park.

[0038] A still further field of the customer-related record **260(k),** referred to as cost field **275(k),** is an indication of the unitary cost (*e.g.*, the cost for an hour of parking) of the parking service that the customer has requested. For example, the unitary cost may be calculated by the SMC **135** depending on the vehicle to be parked (*e.g.*, on the basis of its length).

[0039] The customer-related record **260(k)** further includes a parking start-time field **280(k)** and a parking end-time field **285(k),** that are adapted to store an indication of the parking start- and end-times, and are used by the SMC **135** for establishing the effective duration of the parking service exploited by the customer, in order to evaluate the parking fee that the customer has to pay. More particularly, according to an embodiment of the present invention, the start-time field **280(k)** indicates the time at which the customer has parked his/her vehicle in the parking area **115,** while the end-time fields **285(k)** indicates the time at which the vehicle has left the parking

area **115.** Said time indications are obtained by the SMC **135** by actions of the customer, for example, through an SMS, and/or are verified by the parking management system **100** itself, as will be described in the following.

[0040] In this way, based on the information provided by the cost field **275(k),** the parking start-time field **280 (k)** and the parking end-time field **285(k),** the SMC **135** is able to compute the parking fee that the customer has to pay.

[0041] The operation of the parking management system **100** will be now described.

[0042] **Figure 3** illustrates a flow chart **300** schematically showing the interactions of a generic sensor node **140** of the sensor system **125** with its corresponding LBU **145(i),** according to an embodiment of the present invention.

[0043] The sensor node **140** is responsible for providing occupancy indications in respect of a corresponding area portion surrounding the sensor node **140.** The sensor node **140** is in particular capable of detecting the presence of an object (of dimension greater than that of the sensor node **140** dimension), like a vehicle, within the corresponding area portion. Once the sensor node **140** has been activated (*e.g.*, after its installation within the parking area **115),** it starts monitoring the corresponding portion of the parking area **115** (block **305),** in order to establish the presence or the absence of vehicles. For example, according to an embodiment of the present invention (described in greater detail later), the sensor node **140** is based on magneto-resistive technology, and includes a magnetic field sensor capable of sensing components of the magnetic field. Depending on the absence or presence of an object like a vehicle, the magnetic field in the area monitored by a generic sensor node is perturbated; the sensor node **140** evaluates whether or not the sampled magnetic field exceeds a predefined threshold, thereby establishing the presence or not of a vehicle over it; for example, if the sampled magnetic field exceeds the threshold, the area around the sensor node **140** is considered as occupied.

[0044] Said operations are for example repeated for a sensing period having a duration of the order of some minutes or less (decision block **310,** exit branch **N**)**.** After the expiration of said sensing period (decision block **310,** exit branch **Y),** the sensor node **140** transmits the occupancy indications related to its corresponding area portion to the corresponding LBU **145(i)** (block **315**).

[0045] By constantly repeating all the above described operations (going back to block **305**) the occupancy indications that are made available to the LBU are updated every sensing period. Since the sensing period has a time duration of the order of some minutes or less, the occupancy state of the area portions monitored by the different sensor nodes is updated essentially in real time.

[0046] The LBU **145(i)** waits for receiving the occupancy indications from the sensor node **140** (decision block **320,** exit branch **N);** during the sensing period, the state of occupation of the area portion around the sensor node **140** as seen by the LBU **145(i)** is based on the last received occupancy indications from the sensor node.

[0047] At the expiry of the sensing period, the sensor node **140** contacts the LBU for transmitting the fresh occupancy indications thereto (decision block **320,** exit branch Y), the LBU **145(i)** receives the occupancy indications from the sensor node **140** and preferably stores them in a local database (block **325).** The occupancy indications collected by the LBU **145(i)** from all the sensor nodes **140** associated therewith are then processed (block **330),** in order to determine the available parking space in the parking area(s) **115** to which the LBU **145 (i)** is associated.

[0048] In alternative, the LBU **145(i)** may periodically poll the sensor node **140** to get the fresh occupancy indications.

[0049] Then, the LBU **145(i)** transmits the indication about the available parking space to the SMC **135** (block **335),** where the data are processed. Particularly, the available linear parking spaces are classified with respect to the predetermined lengths LMIN(j), so as to fill the parking space availability field **250(i)** in the database **150,** as previously described in connection with **Figure 2.** In alternative embodiments of the invention, the transmission of the indication about the available parking space to the SMC **135** may occur at a different time, *i.e.* not necessarily with a time periodicity linked to the sensing periods of the sensor nodes.

[0050] Then (coming back to block **320**), the LBU **145 (i)** waits for receiving fresh occupancy indications from the sensor nodes **140.**

[0051] In this way, the parking space availability field **250(i)** may be updated essentially in real time.

[0052] Referring now to **Figures 4A** and **4B,** a flow chart **400** schematically showing the interactions of the SMC **135** with a customer of the parking management system **100** is depicted, according to an embodiment of the present invention.

[0053] As previously described, when a potential customer in search of a parking place wishes to take advantage of the services provided by the parking management system **100,** he/she contacts the SMC **135** through his/her communication terminal **160,** such as a mobile phone. For example, according to an embodiment of the present invention, the customer sends a service request SMS (Short Message Service) message **405** to the SMC **135.** By the service request SMS message **405,** the customer provides to the SMC **135** information **407** adapted to describe in detail the requested parking management service. An exemplary service request SMS message **405** may provide the following information **407:**

ID:49 AREA:streetxxxx TIME:13,00 LENGTH:4,00

[0054] The service request SMS message **405** includes a plurality of message fields (in this example, four), each one adapted to specify a portion of the information **407** describing the requested parking management serv-

ice.

[0055] The first message field *(ID:49,* in the example) is a code, identifying the customer, that needs to be provided only if the customer has subscribed to the parking management system **100** (for example, the code is assigned to the customer upon subscribing). In this way, the SMC **135** may identify the customer, comparing the received code with the identifier codes ID(k) stored in the customer identification table **210** of the database **150.** Alternatively, in case the customer is not a subscriber, said field can be replaced by the indication of the number plate of the vehicle to be parked. In this latter case, the SMC **135** may store the number plate in the number plate field **270(k)** of the customer indication table **210,** and then it may assign a temporary identifier code ID(k) to the customer.

[0056] The second message field *(AREA:streetxxx,* in the considered example) specifies instead the location where the customer desires to park his/her vehicle. Particularly, the customer may indicate a specific zone, like for example a street or a square, or he/she may provide a broader location, like an urban district. Then, as will be described in greater detail in the following of the description, the SMC **135** will determine, and then notify to the customer the nearest available parking space with respect to the indicated location. In an embodiment, an indication of the geographical location wherein the parking space is required may be derived from a satellite positioning system receiver (such as GPS or Galileo) associated to the user or to the vehicle of the user (e.g. in the form of coordinates). In another embodiment, such geographical location may be automatically retrieved by the SMC **135,** for example exploiting the localization functionalities of the mobile telecommunication network **165,** adapted to determine an at least approximate location of the mobile device **160** according to known techniques, e.g. in the field of GSM networks.

[0057] With the third message field *(TIME:13,00,* in the example) the customer can provide to the SMC **135** an approximate indication about the expected arrival time to the location where he/she desires to park.

[0058] The fourth message field *(LENGTH:4,00,* in the example) indicates the type of vehicle which the parking place is required for. More particularly, the indication provided with the fourth field of the SMS message is related to the length (or class of length) of the customer's vehicle. According to an embodiment of the present invention, the customer may also personalize further the request, for example in order to request a parking place relatively longer than the length of his/her vehicle; this feature is particularly useful for beginner drivers, who do not feel very comfortable with the parking maneuvers. In an embodiment, the model of the vehicle which the parking place is required for is sent to the SMC **135.** Optionally, the SMC **135** may calculate the length of the necessary parking place taking into account also the steering radius associated to the notified vehicle model (for example by querying an additional table in the database **150** dedicated to the steering radius data of the car models in circulation).

[0059] Once the customer has sent the service request SMS message **405,** the latter is received by the SMC **135** (block **410)** through the telecommunication network **165.**

[0060] Based on the code contained in the SMS message, the SMC **135** identifies the customer, performing a search among the identifier codes ID(k) stored in the customer identification table **210** of the database **150,** and selects the corresponding customer record **260(k).** In case the customer is not a subscriber, and/or the service request SMS message **405** does not include any customer identifier code, a new customer record **260(k)** with a new identifier code ID(k) is automatically created and assigned to the customer.

[0061] Afterward, the SMC **135** identifies the area around the location indicated in the service request SMS message **405,** in order to evaluate the availability of parking spaces (block **415).** For this purpose, the SMC **135** scrolls the parking space availability table **200** of the database **150,** so as to find the location field **240(i)** which corresponds to the location indicated in the service request SMS message **405.** Then, the SMC **135** selects the record **220(i)** including the location field **240(i),** and scrolls the sub-fields of the corresponding parking space availability field **250(i),** in such a way as to assess the lengths of the available parking area portions in the parking area **115.** More particularly, the SMC **135** identifies the sub-field corresponding to the smallest length LMIN (j) which is not smaller than the length indicated in the service request SMS message **4058** (possibly taking into account also the extra length needed for parking the vehicle). In this way, the SMC **135** determines if there is at least one free parking place having a length compatible with the length indicated in the service request SMS message **405.**

[0062] In case no parking place of the desired length is available (decision block **420,** exit branch N), the SMC **135** notifies the customer that it is impossible to park the vehicle in the selected location (block **425**). For example, the notification can be performed by the SMC **135** by means of an SMS message sent to the mobile phone **160** of the customer. Alternatively, or in addition, according to an embodiment of the present invention, the SMC **135** may scroll again the parking space availability table **200,** in order to examine further records **220(i).** Particularly, the SMC **135** may identify those records **220(i)** whose location fields **240(i)** correspond to locations close or near (within a predetermined distance range) to those indicated into the service request SMS message **405,** and performs again the abovementioned operations.

[0063] In case a parking place of the desired length has been ascertained to be available (decision block **420,** exit branch Y), the SMC **135** notifies the customer that it is possible to park the vehicle (block **427**), for example by sending a parking space availability SMS message **429** to the customer mobile phone **160.** In addition, the

parking space availability SMS message provides to the customer a precise indication of where the parking place is located. According to an embodiment of the present invention, said parking space location indication provided to the customer may include the address (*e.g.*, street, or square, with civic number) where the parking place is located, together with a parking location code corresponding to the nearest parking location sign **122.** If the customer is equipped with a GPS or with another graphic communication interface storing a map of the area, the SMC **135** can also provide indications suitable to determine the path to be followed to reach the parking place, together with an estimation of the time needed. According to a further embodiment of the present invention, if the SMC **135** is equipped with, or operatively coupled to an integrated system for the mobility management, many real time information concerning mobility of the area can be provided to the drivers, for instance the estimation of the time needed to reach the parking place, updated on the basis of real-time traffic conditions.

[0064] Once the customer has identified the parking place assigned thereto by the SMC 135, he/she parks the vehicle, and notifies the SMC **135** or the accomplishment of the parking, for example sending an SMS message **433** thereto. The SMC **135** receives said notification, and verifies whether, in a time period close to the receipt of the service request SMS message **405** and in a location close to the parking location sign **122** that has been indicated to the customer, the occupancy indications provided from the corresponding sensor nodes **140** is changed or not (block 430).

[0065] In case the occupancy indications provided by the sensor nodes **140** of the indicated location remains unchanged for an excessive period of time, meaning that no vehicle has been parked in the area, (decision block **435,** exit branch N), the SMC **135** starts a confirmation procedure, requesting (*e.g., via* SMS) the customer to provide a precise indication of the location in which he/she has parked the vehicle (block **440**)**.** For example, according to an embodiment of the present invention, the customer may have to check the nearest parking location sign **122,** read and provide (*e.g.* via SMS) the corresponding parking location code to the SMC **135,** in such a way to allow the latter to identify and verify the actual parking place occupied by the customer's vehicle.

[0066] Once the accomplishment of the parking has been correctly verified (decision block **435,** exit branch Y or, in case of confirmation procedure, exit branch of block **440**), the SMC **135** notifies the positive verify result to the customer, and, in addition, it may request a confirmation SMS message **447** (block **445**); if, in an alternative embodiment of the invention, the number plate of the customer's vehicle was not provided to the SMC **135** at the time the service request SMS message **405** was sent, in the confirmation SMS message the customer may be requested to enter the number plate of his/her vehicle.

[0067] After the confirmation SMS message has been received from the customer, the SMC **135** fills the start time field **280(k)** in the customer record **260(k)** with a time indication that corresponds to the time of receipt of the service request SMS **405** (block **450**); alternatively, the time indication may correspond to the time of receipt of the confirmation message from the user.

[0068] When the customer wishes to take the vehicle back, thereby leaving the parking place free, he/she communicates his/her intention to the SMC **135,** *e.g.*, through a leaving notification SMS message **457,** indicating also the number plate of the vehicle (block **455**). Then, the customer drives the vehicle away.

[0069] In the same way as described in the foregoing, the SMC **135** verifies if, within a specified time period close to the receipt of the leaving notification SMS message and in a location near the parking location sign **122** where the customer had parked his/her vehicle, the occupancy indications provided from the corresponding sensor nodes **140** signals a change (from occupied to free). In the affirmative case, the SMC **135** fills the parking end time field **285(k)** in the customer record **260(k)** with the time that corresponds to the receipt of the leaving notification SMS message (block **460**). If on the contrary within the specified time period no parking place is detected to have been freed, the SMC **135** may send to the customer, *e.g.* via an SMS message, a notification, and ask for a confirmation; in any event, the parking space is not considered to have been freed until so detected by the sensor nodes **140.**

[0070] When the customer leaves the parking, the SMC **135** calculates the parking fee that the customer has to pay for the parking (block **465**). For example, the parking fee can be calculated by subtracting the time indication stored in the start time field **280(k)** from the time indication stored in the end time field **285(k),** and then multiplying the subtraction result by the unitary cost provided in the cost field **275(k).**

[0071] The amount of the parking fee is then notified to the customer, *e.g.*, via an SMS **475,** together with a confirmation indication including the parking end time and the total parking time (block **470**).

[0072] In order to exploit the services offered by the parking management system **100** of the present invention, the customer has the possibility of paying in several different ways.

[0073] According to an embodiment of the present invention, for the subscriber customers, the payment may be regulated on a periodical basis, for example once per month; the parking fees originating from all the parking services exploited in the month are added up and the cumulated amount is billed to the customer. For this purpose, the customer record **260(k)** may include an extra field for storing a running total of the parking fee to be paid.

[0074] According to a further embodiment, the parking fee is directly debited from a bank account of the customer.

[0075] Alternatively, the parking managing system **100**

may have an arrangement with one or more telephone companies, in such a way that the parking fee can be debited from a customer account.

[0076] According to a still further embodiment of the invention, the payment of the parking fee can be accomplished exploiting the LBUs **145(i).** In this case, the LBUs **145(i)** are configured for enabling payment services, both by credit cards and cash.

[0077] The parking management system **100** of the present invention may be advantageously used for implementing a system that automatically manages the unauthorized parking. Said system can be used by the police or by the municipality officers for keeping track of the parking places which have been occupied without authorization, and for which the payment has not been accomplished. Indeed, by observing the parking space availability table **200** and the customer identification table **210** of the database **150** of the SMC **135,** it is possible to recognize whether there are zones of the parking area **115** in which vehicles have been parked without authorization.

[0078] More particularly, the police officers may request to the SMC **135** information about the location of the parking places that have been ascertained to be abusively occupied within one or more parking areas **115.** The SMC **135** provides the requested information to the police officers, possibly together with additional information, like, for example, the zones wherein the unauthorized parking is mainly concentrated. Additionally, the SMC **135** may provide an optimized planning for the police intervention (going first to the zones where there are more vehicles that are parked without authorization).

[0079] Having obtained said information, the police officers may go to the identified zones, equipped with suitable communication interfaces, like for example palmtops equipped with an image identification device, and they may personally take note of the number plates of the vehicle that have been parked without authorization.

[0080] Referring now to **Figure 5,** the main steps of a method for planning the topology of parking areas **115** in a region of interest, *e.g.*, a urban district, are schematically illustrated, according to an embodiment of the present invention.

[0081] More particularly, starting from a map **500** of the region of interest in which the parking areas **115** have to be planned, a road graph diagram **505** which describes every road branch of the map **500** is obtained, with graph nodes identifying road junctions. In the example at issue, six road branches **510, 515, 520, 525, 530, 535,** with corresponding junctions **Ni** (between the road branches **510, 515, 535**), **Nj** (between the road branches **515, 520, 530), Nk** (between the road branches **520, 525**) and **Nl** (between the road branches **510, 525**) are identified in the drawing.

[0082] For each (right and left) side of each road branch, a road arc is defined. In the example at issue, the road branch **515** has two road arcs: a road arc **Aij,** starting from the junction **Ni** and ending to the junction **Nj** is associated with the left side of the road branch **515,** and a road arc **Aji,** starting from the junction **Nj** and ending to the junction **Ni** is associated with the right side of the road branch **515.** A parking area **115** including a plurality of sensor nodes **140,** like the parking area **115** illustrated in **Figure 1,** may be established for one or both of the road arcs **Aij, Aji** of the road branches where it is intended to allow parking. A parking location sign **122** and a corresponding **LBU 145(i)** may be installed for each road arc **Aij, Aji.**

[0083] However, in case the road branches are short, it is possible to install a single LBU **145(i)** in association with two or more road branches. Also, more than one road arc can be defined for each side of a road branch, which may be useful in the case of relatively long road branches. In this case, a parking location sign **122** may be installed for each road arc.

[0084] **Figure 6** illustrates in detail a portion of the parking area **115** of **Figure 1** in a cross-sectional view along a line **AA** crossing the sensor nodes **140.**

[0085] The sensor nodes **140** are adapted to recognize the presence of an object, like a vehicle, in an area portion surrounding them. Preferably, the sensor nodes **140** may be structured in such a way that they do not need to be supplied by external power sources. Preferably, the sensor nodes **140** are designed to be miniaturized, low cost and low power-consuming devices.

[0086] For example, the sensor nodes **140** can be implemented by battery-powered magneto-resistive sensor chip devices, having a reduced processing capability, sufficient to allow them performing preliminary data processing.

[0087] In particular, the sensor nodes **140** are installed under the road surface, for example embedded in seats obtained by curing the asphalt layer, aligned along a line (**AA** in the drawing) more or less at the middle of the parking lane **115.** Alternatively (not shown in **Figure 6**) the sensor nodes **140** can be installed on the road surface (*e.g.*, they may be attached to the surface of the asphalt layer by gluing). In some circumstances, it may be preferable to install the sensor nodes **140** on the edge of the sideway, for example along the sideway vertical wall (as schematically indicated by line **A'A'** in **Figure 1**), or on the sideway, in proximity of the parking area (as indicated schematically by line **A"A"** in **Figure 1**).

[0088] The sensor nodes **140** are preferably installed at regular distances to each other, with a spacing **D** of, advantageously, 2 meters or less, for example ranging from about 20 centimeters to about 2 meters. More preferably, the distance between each sensor and any neighboring sensor is less than or equal to about 150 cm. A particularly advantageous distance is comprised from about 40 cm to about 120 cm. The shorter the spacing D between adjacent sensor nodes **140,** the better the resolution achieved on the occupancy indications.

[0089] Preferably, in order to reduce the power consumption of the sensor nodes **140,** each sensor node **140** may be configured to communicate with the corre-

sponding LBU **145(i)** only when it detects a change in the occupancy state of the corresponding area portion.

[0090] The position of each sensor node **140** with respect to the corresponding LBU **145(i)** is determined during the planning of the parking area topology, being for example recorded by a localization device during the planning. Alternatively, the localization of the single sensor nodes **140** can be achieved by measuring the power of the radio signal transmitted by the sensor nodes **140** in assigned positions

[0091] According to an embodiment of the present invention, each sensor node **140** may include a bi-axial magnetic field sensor, adapted to sense two different components of the magnetic field modified by the presence of a vehicle: the magnetic field vertical component **Vz(t),** (perpendicular to the road surface) with respect to the background magnetic field in the absence of vehicle Vz0, and the magnetic field horizontal component **Vxy (t)** (in the plane of the road surface), with respect to the background magnetic field in the absence of vehicle Vxy0. According to an embodiment of the present invention, each sensor node **140** is adapted to sample the value of the magnetic field components **Vz(t)** and **Vxy(t)** at a predetermined sampling rate, for example of some Hz. The values of the magnetic field components **Vz(t)** and **Vxy(t)** strongly depend on the presence of an object like a vehicle. If the sensor node **140** evaluates whether or not the sampled magnetic field components **Vz(t)** and **Vxy(t)** have exceeded a predefined value, the presence of a vehicle over it is established.

[0092] The sensor nodes **140** may further be adapted to combine together the sensed magnetic field components **Vz(t)** and **Vxy(t),** in order to reduce the possibility of missing detection of vehicles.

[0093] A simple choice provides for combining the modulus of the sensed magnetic field components **Vz(t)** and **Vxy(t),** in such a way to obtain a sensed signal **S(t)** equal to:

$$S(t) = |Vz(t)| + |Vxy(t)|.$$

[0094] During each sensing period (see blocks **305** and **310** of the flow chart **300** of **Figure 3)** each sensor node **140** evaluates whether or not the sensed signal **S (t)** has exceeded a predefined threshold **TH.** If the sensed signal **S(t)** has exceeded the threshold **TH,** the corresponding area portion around the sensor node **140** is marked as occupied. As a consequence, the sensor node **140** asserts, for example to a high logic value **"1",** an occupancy flag signal. Otherwise, the corresponding area portion near the sensor node **140** is marked as free, and the sensor node **140** deasserts, for example to a low logic value "0", the occupancy flag signal. In this way, according to this embodiment, the occupancy indications provided by each sensor node **140** is represented by the value taken by the occupancy flag signal.

[0095] After the expiration of the sensing period (decision block **310,** exit branch Y of the flow chart **300** of **Figure 3),** the value of the occupancy flag signal is communicated by the sensor node **140** to the LBU **145(i)** (see block **315** of the flow chart **300** of **Figure 3).**

[0096] The occupancy flag signals of a plurality of sensor nodes **140** are then collected by the corresponding LBU **145(i),** in order to be processed in such a way to estimate the available parking space of the parking area **115** to which the LBU **145(i)** is associated.

[0097] With reference to **Figures 7A** and **7B,** an example of how the presence of parked vehicles is detected by the sensor nodes **140** of the parking area **115** is described, according to an embodiment of the present invention.

[0098] More particularly, in this example two vehicles **705** and **710** are assumed to be parked in a row, with a gap between the back bumper of the vehicle **705** and the front bumper of the vehicle **710** of about six meters. Moreover, in this example it is assumed that the space **D** between adjacent sensor nodes **140** is equal to approximately 50 centimeters.

[0099] Figure **7B** is a diagram **720** illustrating the amplitude of the sensed signals **S(t)** sensed by the sensor nodes **140** of **Figure 7A,** at a certain time instant. More particularly, the diagram **720** has a horizontal axis **730** indicating the positions of the sensor nodes **140** with respect to the first sensor node **140** of Figure **7A,** starting from the left of the drawing, (the values are expressed in cm); in the diagram, the small dots correspond each one to a sensor node; a vertical axis **740** indicates the amplitude of the corresponding sensed signals **S(t)** (the values are expressed in mV).

[0100] According to this example, the threshold **TH** which is used to discriminate the presence or absence of an object over a sensor node has been set to 15 mV.

[0101] As can be observed in **Figure 7B,** the presence and the position of the first vehicle **705** affect the sensed signals sensed by ten sensor nodes **140** (labeled as **750** in the figure) causing the corresponding sensed signals **S(t)** to take values higher than the threshold **TH.** The presence and the position of the second vehicle **710** affect the sensed signals sensed by nine sensor nodes **140** (labeled as **760** in the figure) causing, subject to the below, the corresponding sensed signals **S(t)** to take values higher than the threshold **TH.**

[0102] It has to be remarked that the mere fact that a vehicle is parked over a sensor node does not necessarily mean that the sensed signal sensed by that sensor node exceeds the predetermined threshold **TH;** for example, in the considered example it can be observed that a sensor node (labeled as **770** in the figure) positioned under the second vehicle **710** senses a signal **S(t)** lower than the threshold **TH.** This can occur for different reasons, like for example a malfunctioning of the sensor node **140** or a magnetic noise source near the sensor node **140** or a specific magnetic characteristic of the vehicle. In order to overcome problems like this, according to an embod-

iment of the present invention the generic LBUs **145(i)** is capable of establishing whether the values of sensed signals **S(t)** provided by the sensor nodes that are below the threshold **TH** correspond to false indications of absence of a vehicle. For example, according to an embodiment of the present invention, in order to assess where there are free parking places, account is taken of the occupancy indications provided by groups of adjacent sensor nodes, instead of just considering the sensor nodes in isolation; in particular, the occupancy flag signals provided by the sensor nodes **140** associated within an LBU are collected, and arranged to form a parking occupancy flag string. According to the example shown in the drawings, the occupancy flag signals of the sensor nodes **140** form the following parking occupancy flag string:

0,0,0,0,0,0,0,0,0,1,1,1,1,1,1,1,1,1,1,0,0,0,0,0,0,0,0,0,
0,0,0,0,0,1,1,0,1,1,1,1,1,1,0,0,0.

[0103] The succession of ten "1"s in the occupancy flag string denotes the presence of the vehicle 705. Regarding the second vehicle **710,** the corresponding group of flag signals is "1,1,0,1,1,1,1,1,1", with a sensor node apparently not detecting the presence of the vehicle, possibly due to noise or malfunctioning; the LBU performs a low-pass filtering of the values in the string, so that it is transformed into "1,1,1,1,1,1,1,1,1", and thus the isolated "0" is replaced by a "1".

[0104] **Figure 8** schematically shows, in terms of blocks, the main functional components of an LBU **145 (i)** and of the SMC **135,** in an embodiment of the present invention. It has to be noted that each of the functional components can be implemented by software, hardware, or a mix of the two.

[0105] More particularly, the LBU **145(i)** includes an input communication interface **805,** adapted to communicate with the sensor nodes **140** to which the LBU is associated, for receiving from them the occupancy indications. The occupancy indications provided by the sensor nodes **140** associated with the LBU are collected by an occupancy indications collector unit **810** and stored into a LBU local database **815.** For example, according to an embodiment of the present invention, the local database **815** is adapted to store the parking occupancy flag strings including the flag signals provided by the sensor nodes **140.** An occupancy indications processor **820** is adapted to process the occupancy indications stored in the local database **815,** in such a way to derive indications about the available parking spaces in the parking area **115.** A communication interface **825** allows communications with the SMC **135,** for sending thereto the information about the available parking spaces in the parking area monitored by the LBU.

[0106] The SMC **135** includes an LBU communication interface **830,** enabling communications with the various LBU **145(i),** for receiving therefrom the indications about the available parking spaces, and a customer communications interface **835,** for the communications with the customers (adapted for example to receive SMS messages from the customers, and to send notification SMS messages to the customers). The indications about the available parking spaces received from the various LBU **145(i)** are collected by a collector unit **840** and stored in the database **150.** A processor unit **845** is adapted to process data stored in the database **150.**

[0107] The present invention provides an automatic parking management system that is adapted to automatically monitor parking areas for obtaining information related to the occupancy thereof, and to provide guidance to vehicle drivers who are in search of a parking place, notifying them of the availability of parking space in the parking area.

[0108] The parking management system according to the present invention is particularly suitable to be used for managing parking areas having undelimited parking spaces.

[0109] Indeed, the present invention provides a smart solution adapted to solve all the typical drawbacks that a vehicle driver in search of a free parking place has to face, particularly in case the search is performed in urban areas, where the parking areas are usually along the sides of the streets.

[0110] Thanks to the parking management system of the present invention, it may be possible to reduce the traffic and the overall air pollution in urban areas.

[0111] The customers of the parking management system may pay the exploited parking services in several different ways, depending on the customer's preferences. Also, the payment may be rendered proportional to the space, *e.g.* the length occupied by a vehicle in the parking area.

[0112] Moreover, the parking management system of the present invention may be advantageously used by the police or by the municipality officers to manage the unauthorized parking in an easy way.

[0113] Furthermore, by archiving the information stored in the database of the service management center, it is possible to study the history of the parking areas managed by the parking management system of the present invention. Particularly, keeping track of the occupancy indications provided by the sensor nodes of the parking areas and keeping track of the various payments, the management of the parking may be advantageously optimized. This feature is particularly useful when taking into account parking rules distinguishing areas in which parking is admitted only to restricted groups of people, areas in which parking is admitted only temporarily, and so on.

[0114] The present invention has been described making reference to some exemplary embodiments. Naturally, in order to satisfy contingent and specific requirements, a person skilled in the art may apply to the solution described above many modifications and alterations. It should be understood that various omissions, substitu-

tions and changes in the form and details of the described embodiments, as well as other embodiments are possible; moreover, it is expressly intended that specific elements and/or method steps described in connection with any disclosed embodiment of the invention may be incorporated in any other embodiment as a general matter of design choice.

[0115] For example, even if the embodiments that have been described mainly refer to the management of parking areas with undelimited parking places, the present invention can also be applied to parking lots including parking places which are individually delimited.

[0116] Although in the present description reference has been made to a sensor system wherein each sensor node is configured to be independently coupled with the corresponding local base unit by means of a communication link, similar considerations apply if the occupancy indications provided by a group of sensor nodes are provided to the local base unit through a common communication link, for example managed by a single sensor node configured to be wired-connected with the sensor nodes of the group.

[0117] Use of magneto-resistive devices as sensor nodes is merely illustrative; indeed, the sensor nodes may be implemented using other types of sensors capable of sensing the magnetic field.

[0118] Moreover, it will be apparent to those skilled in the art that the modulus of the magnetic field components sensed by a sensor node can be combined, so as to determine a different sensing signal, in a way that is different from that previously described.

[0119] Furthermore, the occupancy indications of the parking area may be provided by sensing physical quantities other than the magnetic field. For example, each sensor node can be a photo detector (*e.g.*, a photodiode, or a phototransistor) capable to visually inspect the area around the sensor node. Alternatively, the occupancy indications may be determined using pressure sensors, adapted to perceive the presence of a vehicle by detecting its weight. In any case, the present invention can make use of any sensing device capable of detecting the presence of vehicles.

[0120] Additionally, the system and method of the present invention is also adapted to manage parking areas having two or more discrete typologies of parking spaces, *e.g.* two or more parking lengths.

Claims

1. A parking management system **(100)** including:

- a sensor system **(125)** adapted to monitor at least one parking area **(115)** for providing occupancy indications about the occupancy of the parking area;
- a data gathering and communication network **(130),** adapted to collect the occupancy indications from the sensor system and to derive therefrom indications about available parking spaces in the at least one parking area; and
- a service management center **(135)** configured to:

receive said indications about the available parking spaces in the at least one parking area;
receive from a user a request **(405)** of availability of a parking place, wherein said request includes data **(407)** related to a size of the requested parking place, and
based on said data related to the size of the requested parking place and said indications about the available parking spaces, notify the user of the availability of the parking place of the requested size, wherein the sensor system includes a plurality of sensor nodes **(140)** distributed in correspondence to the at least one parking area, and each one adapted to detect the occupancy of a respective portion of the at least one parking area and to provide the respective occupancy indication,

characterized in that a respective distance of each sensor node from any neighboring sensor node is lower than or equal to 2 meters.

2. The parking management system of claim 1, wherein said parking area has non-delimited parking places.

3. The parking management system of claim 1 or 2, wherein the data gathering and communication network includes at least one local base unit **(145(i))** coupled with at least one sensor node and being adapted to collect the respective occupancy indication therefrom.

4. The parking management system of claim 3, wherein each sensor node of said plurality is configured to provide the respective occupancy indication to the corresponding local base unit through a communications link including one or more among a wired and a wireless communication link.

5. The parking management system of claim 3 or 4, wherein the at least one local base unit is configured to provide the indications about the available parking spaces to the service management center through a communications link including one or more among a wired and a wireless communication link.

6. The parking management system of any one of claims 1 to 5, wherein the sensor nodes are deployed in correspondence to the parking area in at least one linear succession.

7. The parking management system of claim 6, wherein each sensor node is located at a fixed distance **(D)** from the neighboring sensor nodes.

8. The parking management system of any one of claims 1 to 7, wherein a respective distance of each sensor node from any neighboring sensor node is lower than or equal to approximately 150 cm.

9. The parking management system of any one of claims 1 to 8, wherein each sensor node includes a magnetic field sensor capable of sensing at least one component **(Vz(t), Vxy(t))** of a magnetic field in the respective portion of the parking area.

10. The parking management system of any one of the preceding claims, wherein said indications about the available parking spaces are in the form of indications of available parking surface areas.

11. The parking management system of any one of claims 1 to 10, wherein said indications about the available parking spaces include indications about the available linear parking spaces in the parking area.

12. The parking management system of any one of claims 1 to 11, wherein the notification to the user of the availability of the parking place of the requested size further includes an indication of the geographical position of the requested parking place of the requested size.

13. The parking management system of any of the preceding claims, wherein the service management center is configured to communicate with the user through a user interface unit **(160).**

14. The parking management system of claim 13, wherein the user interface unit is a mobile phone.

15. A method for managing the parking in at least one parking area, the method including the steps of:

monitoring the at least one parking area for providing occupancy indications about the occupancy of the parking area;
collecting the occupancy indications and deriving therefrom indications about available parking spaces in the at least one parking area;
receiving said indications about the available parking spaces in the at least one parking area at a service management center;
receiving from a user a request of availability of a parking place at the service management center, wherein said request includes data related to a size of the requested parking place; and
based on said data related to the size of the requested parking place and said indications about the available parking spaces, notify the user of the availability of the parking place of the requested size, wherein said monitoring the at least one parking area includes the steps of:

detecting the occupancy of a respective portion of the at least one parking area by means of a respective sensor node of a plurality of sensor nodes distributed in correspondence to the parking area; and, based on said respective detected occupancy, providing the respective occupancy indication,
characterized in that a respective distance of each sensor node from any neighboring sensor node is lower than or equal to 2 meters.

Patentansprüche

1. Parkverwaltungssystem (100), beinhaltend:

ein Sensorsystem (125), das eingerichtet ist, um mindestens einen Parkbereich (115) zu überwachen zum Bereitstellen von Belegungsangaben über die Belegung des Parkbereichs;
ein Datenansammel- und Kommunikationsnetz (130), das eingerichtet ist, um die Belegungsangaben von dem Sensorsystem zu sammeln und davon Angaben über verfügbare Parkplätze in dem mindestens einen Parkbereich abzuleiten; und
ein Service-Verwaltungscenter (135), das konfiguriert ist zum:

Empfangen der Angaben über die verfügbaren Parkplätze in dem mindestens einen Parkbereich;
Empfangen von einem Benutzer einer Anfrage (405) der Verfügbarkeit von einem Parkplatz, wobei die Anfrage Daten (407) bezüglich der Größe des angefragten Parkplatzes beinhaltet, und
basierend auf den Daten bezüglich der Größe des angefragten Parkplatzes und der Angaben über die verfügbaren Parklücken, Benachrichtigen des Benutzers über die Verfügbarkeit des Parkplatzes der angefragten Größe, wobei das Sensorsystem eine Vielzahl von Sensorknoten (140) beinhaltet, die bezüglich des mindestens einen Parkbereichs verteilt sind, und wobei jeder eingerichtet ist, um die Belegung eines jeweiligen Teils des mindestens einen Parkbereichs zu erfassen und, um die jeweilige Belegungsangabe bereitzustellen,

dadurch gekennzeichnet, dass eine jeweilige Distanz von jedem Sensorknoten von einem benachbarten Sensorknoten kleiner oder gleich 2 Metern ist.

2. Parkverwaltungssystem nach Anspruch 1, wobei der Parkbereich nicht-begrenzte Parkplätze aufweist.

3. Parkverwaltungssystem nach Anspruch 1 oder 2, wobei das Datenansammel- und Kommunikationsnetz mindestens eine lokale Basiseinheit (145(i)) beinhaltet, die mit mindestens einem Sensorknoten gekoppelt ist und eingerichtet ist, um die jeweilige Belegungsangabe davon zu sammeln.

4. Parkverwaltungssystem nach Anspruch 3, wobei jeder Sensorknoten der Vielzahl konfiguriert ist, um die jeweilige Belegungsangabe zur entsprechenden lokalen Basiseinheit durch ein Kommunikations-Link bereitzustellen, der einen oder mehrere unter einem Kabel gebundenen und einem kabellosen Kommunikations-Link beinhaltet.

5. Parkverwaltungssystem nach Anspruch 3 oder 4, wobei mindestens eine lokale Basiseinheit konfiguriert ist, um die Angaben über die verfügbaren Parklücken zu dem Service-Verwaltungscenter durch ein Kommunikations-Link bereitzustellen, der eines oder mehrere unter einem Kabel gebundenen und einem kabellosen Kommunikations-Link beinhaltet.

6. Parkverwaltungssystem nach einem der Ansprüche 1 bis 5, wobei die Sensorknoten bezüglich dem Parkbereich in mindestens einer linearen Abfolge ausgebracht sind.

7. Parkverwaltungssystem nach Anspruch 6, wobei jeder Sensorknoten an einer festen Distanz (D) von dem benachbarten Sensorknoten lokalisiert ist.

8. Parkverwaltungssystem nach einem der Ansprüche 1 bis 7, wobei eine jeweilige Distanz von jedem der Sensorknoten zu einem Nachbarsensorknoten geringer oder gleich etwa 150 cm ist.

9. Parkverwaltungssystem nach einem der Ansprüche 1 bis 8, wobei jeder Sensorknoten einen Magnetfeldsensor beinhaltet, der in der Lage ist, mindestens eine Komponente (Vz(t), Vxy(t)) eines magnetischen Felds in dem jeweiligen Teil des Parkbereichs wahrzunehmen.

10. Parkverwaltungssystem nach einem der vorangegangenen Ansprüche, wobei die Angaben über die verfügbaren Parklücken in der Form von Angaben von verfügbaren Parkoberflächenbereichen sind.

11. Parkverwaltungssystem nach einem der Ansprüche 1 bis 10, wobei die Angaben über die verfügbaren Parklücken Angaben über die verfügbaren linearen Parklücken in dem Parkbereich beinhalten.

12. Parkverwaltungssystem nach einem der Ansprüche 1 bis 11, wobei die Benachrichtigung zu dem Benutzer der Verfügbarkeit des Parkplatzes der angefragten Größe ferner eine Angabe der geographischen Position des angefragten Parkplatzes der angefragten Größe beinhaltet.

13. Parkverwaltungssystem nach einem der vorangegangenen Ansprüche, wobei das Service-Verwaltungscenter konfiguriert ist, um mit dem Benutzer durch eine Benutzerschnittstelleneinheit (160) zu kommunizieren.

14. Parkverwaltungssystem nach Anspruch 13, wobei die Benutzerschnittstelleneinheit ein Mobiltelefon ist.

15. Verfahren zum Verwalten des Parkens in mindestens einem Parkbereich, wobei das Verfahren die Schritte beinhaltet:

Überwachen des mindestens einen Parkbereichs zum Bereitstellen von Belegungsangaben über die Belegung des Parkbereichs;
Sammeln der Belegungsangaben und Ableiten von Angaben über verfügbare Parklücken in dem mindestens einen Parkbereich;
Empfangen der Angaben über die verfügbaren Parklücken in dem mindestens einen Parkbereich an einem Service-Verwaltungscenter;
Empfangen, von einem Benutzer, einer Anfrage der Verfügbarkeit von einem Parkplatz an dem Service-Verwaltungscenter, wobei die Anfrage Daten bezüglich der Größe des angefragten Parkplatzes beinhaltet; und
basierend auf den Daten bezüglich der Größe des angefragten Parkplatzes und den Angaben über die verfügbaren Parklücken, Benachrichtigen des Benutzers über die Verfügbarkeit des Parkplatzes der angefragten Größe, wobei das Überwachen des mindestens einen Parkbereichs die Schritte umfasst:

Erfassen der Belegung eines jeweiligen Teils des mindestens einen Parkbereichs mittels eines jeweiligen Sensorknotens von einer Vielzahl von Sensorknoten, die bezüglich des Parkbereichs verteilt sind; und, basierend auf der jeweiligen erfassten Belegung, Bereitstellen der jeweiligen Belegungsangabe,
dadurch gekennzeichnet, dass eine jeweilige Distanz von jedem Sensorknoten von einem benachbarten Sensorknoten ge-

ringer oder gleich 2 Metern ist.

Revendications

1. Système de gestion du stationnement (100) comprenant:

   - un système de capteurs (125) adapté au contrôle d'au moins une aire de stationnement (115) pour fournir des indications d'occupation sur l'occupation de l'aire de stationnement;
   - un réseau de communication et de collecte de données (130), adapté pour recueillir les indications d'occupation du système de capteurs et d'en déduire des indications sur des espaces de stationnement disponibles dans l'au moins une aire de stationnement; et
   - un centre de gestion de service (135) configuré pour:

     recevoir lesdites indications au sujet des espaces de stationnement disponibles dans l'au moins une aire de stationnement;
     recevoir d'un utilisateur une demande (405) de disponibilité d'un espace de stationnement, dans lequel ladite demande comprend des données (407) liées à une taille de l'espace de stationnement demandé, et sur la base de ces données relatives à la taille de l'espace de stationnement demandé et desdites indications sur les espaces de stationnement disponibles, notifier à l'utilisateur la disponibilité de l'espace de stationnement de la taille demandée,

   dans lequel le système de capteurs comprend plusieurs noeuds de détection (140) distribués de manière à correspondre à l'au moins une aire de stationnement, et chacun conçu pour détecter l'occupation d'une partie respective de l'au moins une aire de stationnement et pour fournir l'indication d'occupation respective,
   caractérisé en ce qu'une distance respective entre chaque noeud de détection et n'importe quel noeud de détection voisin est inférieure ou égale à 2 mètres.

2. Système de gestion du stationnement selon la revendication 1, dans lequel ladite aire de stationnement a des espaces de stationnement non délimitées.

3. Système de gestion du stationnement selon la revendication 1 ou 2, dans lequel le réseau de communication et de collecte de données comprend au moins une unité de base locale (145(i)) couplée à au moins un noeud de détection et étant adaptée à recueillir les indications d'occupation respectives depuis celui-ci.

4. Système de gestion du stationnement selon la revendication 3, dans lequel chaque noeud de détection desdits plusieurs noeuds de détection est configuré pour fournir l'indication d'occupation respective à l'unité de base locale correspondante par un lien de communications comprenant un lien ou davantage parmi un réseau filaire et un lien de communication sans fil.

5. Système de gestion du stationnement selon la revendication 3 ou 4, dans lequel l'au moins une unité locale de base est configurée pour fournir les indications sur les espaces de stationnement disponibles au centre de gestion de service par un lien de communication comprenant un lien ou davantage parmi un réseau filaire et un lien de communication sans fil.

6. Système de gestion du stationnement selon l'une quelconque des revendications 1 à 5, dans lequel les noeuds de détection sont déployés de manière à correspondre à l'aire de stationnement en au moins une succession linéaire.

7. Système de gestion du stationnement selon la revendication 6, dans lequel chaque noeud de détection est situé à une distance fixe (D) des noeuds de détection voisins.

8. Système de gestion du stationnement selon l'une quelconque des revendications 1 à 7, dans lequel une distance respective entre chaque noeud de détection et n'importe quel noeud voisin est inférieure ou égale à environ 150 cm.

9. Système de gestion du stationnement selon l'une quelconque des revendications 1 à 8, dans lequel chaque noeud de détection comprend un capteur de champ magnétique capable de détecter au moins un composant (Vz(t), Vxy(t)) d'un champ magnétique dans la partie correspondante de l'aire de stationnement.

10. Système de gestion du stationnement selon l'une quelconque des revendications précédentes, dans lequel lesdites indications sur les espaces de stationnement disponibles sont sous la forme d'indications de surfaces de stationnement disponibles.

11. Système de gestion du stationnement selon l'une quelconque des revendications 1 à 10, **caractérisé en ce que** lesdites indications sur les espaces de stationnement disponibles comportent des indications sur les espaces linéaires de stationnement disponibles dans l'aire de stationnement.

12. Système de gestion du stationnement selon l'une quelconque des revendications 1 à 11, dans lequel la notification à l'utilisateur de la disponibilité de l'espace de stationnement de la taille demandée comprend en outre une indication de la position géographique de l'espace de stationnement demandé de la taille demandée.

13. Système de gestion du stationnement selon l'une quelconque des revendications précédentes, dans lequel le centre de gestion de service est configuré pour communiquer avec l'utilisateur par une unité d'interface utilisateur (160).

14. Système de gestion du stationnement selon la revendication 13, dans lequel l'unité d'interface utilisateur est un téléphone mobile.

15. Procédé pour la gestion du stationnement dans au moins une aire de stationnement, le procédé comprenant les étapes suivantes:

surveiller l'au moins une aire de stationnement pour fournir des indications d'occupation sur l'occupation de l'aire de stationnement;
recueillir les indications d'occupation et en déduire des indications sur des espaces de stationnement disponibles dans l'au moins une aire de stationnement;
recevoir lesdites indications sur les espaces de stationnement disponibles dans l'au moins une aire de stationnement dans un centre de gestion de service;
recevoir d'un utilisateur une demande de disponibilité d'un espace de stationnement au centre de gestion de service, dans lequel ladite demande comprend des données relatives à la taille de l'espace de stationnement demandé; et

à partir desdites données relatives à la taille de l'espace de stationnement demandé et desdites indications sur les espaces de stationnement disponibles, notifier à l'utilisateur la disponibilité de l'espace de stationnement de la taille demandée,
dans lequel ladite surveillance de l'au moins une aire de stationnement comprend les étapes suivantes:

détecter l'occupation d'une partie respective de l'au moins une aire de stationnement par au moyen d'un noeud de détection respectif et de plusieurs noeuds de détection répartis de manière à correspondre à l'aire de stationnement;

et, à partir desdites occupations détectées respectives, fournir l'indication d'occupation respective,
caractérisé en ce qu'une distance respective entre chaque noeud de détection et n'importe quel noeud de détection voisin est inférieure ou égale à 2 mètres.

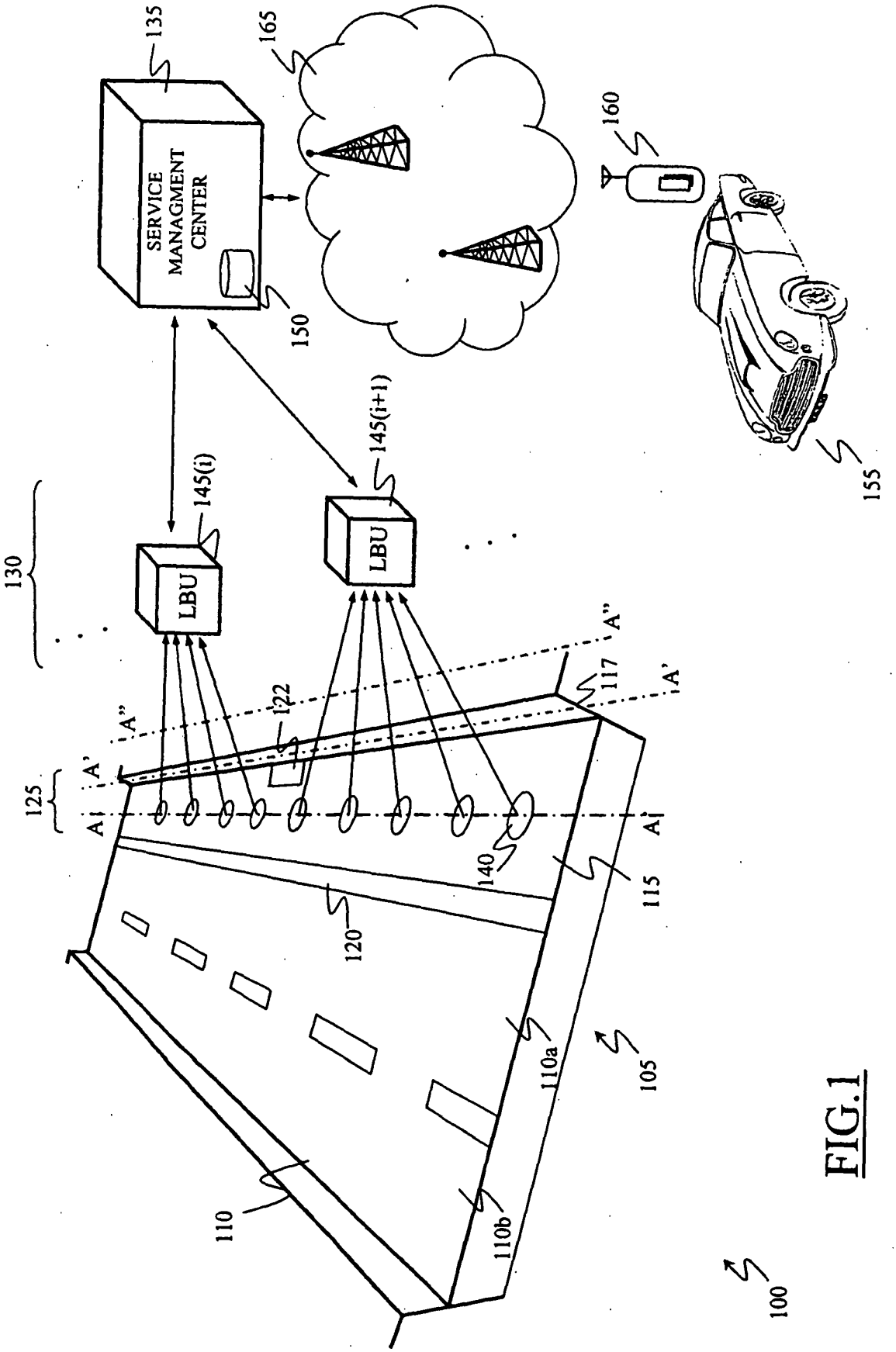

135
SERVICE MANAGMENT CENTER
165
160
150
155
145(i)
145(i+1)
LBU
LBU
130
125
A'
A''
122
117
140
115
120
110
110b
110a
105
100

FIG.1

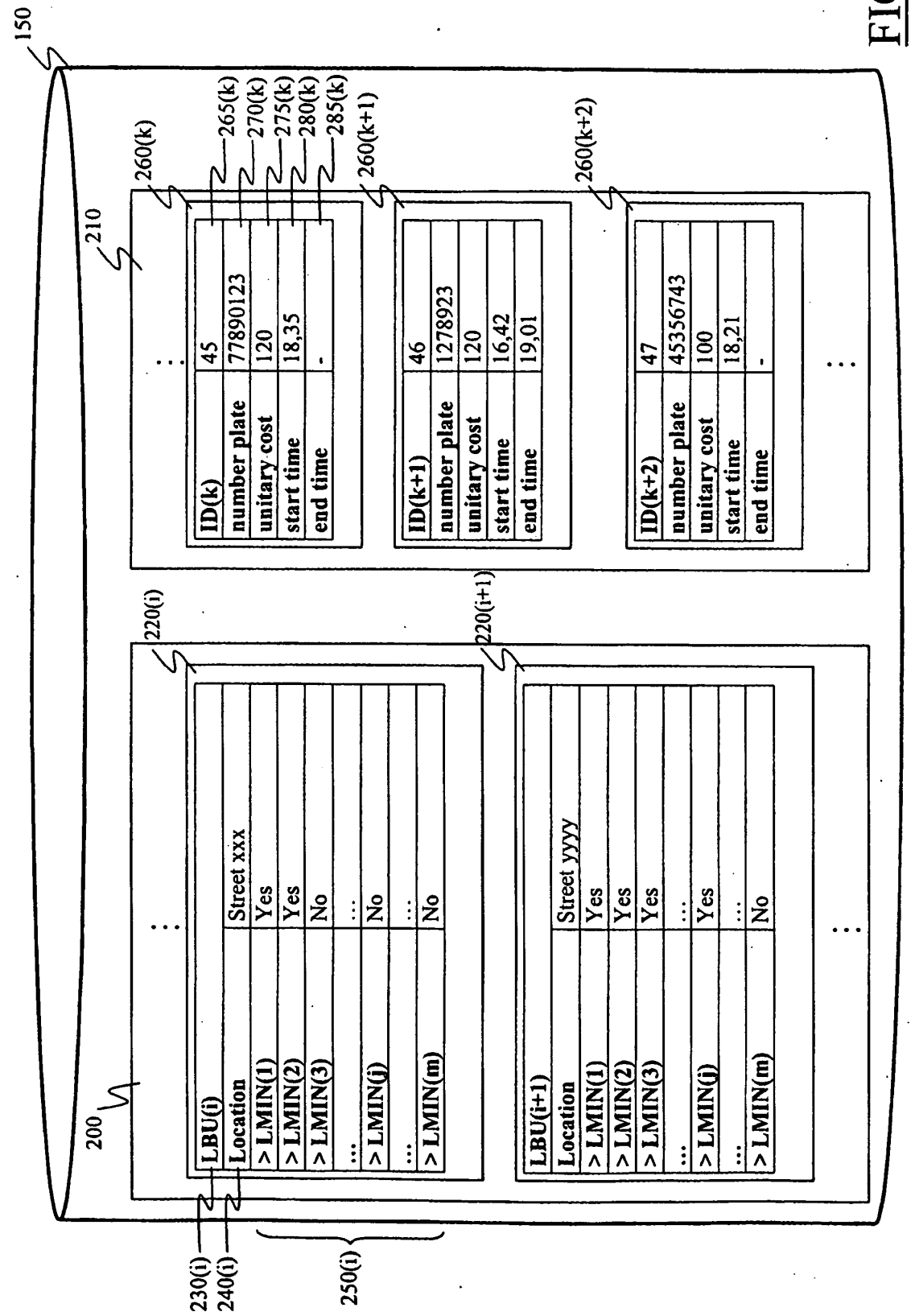

150
200
210
220(i)
220(i+1)
260(k)
260(k+1)
260(k+2)
265(k)
270(k)
275(k)
280(k)
285(k)
230(i)
240(i)
250(i)
LBU(i)
Location
Street xxx
> LMIN(1)
Yes
> LMIN(2)
Yes
> LMIN(3)
No
> LMIN(j)
No
> LMIN(m)
No
LBU(i+1)
Location
Street yyyy
> LMIN(1)
Yes
> LMIN(2)
Yes
> LMIN(3)
Yes
> LMIN(j)
Yes
> LMIN(m)
No
ID(k)
45
number plate
77890123
unitary cost
120
start time
18,35
end time
-
ID(k+1)
46
number plate
1278923
unitary cost
120
start time
16,42
end time
19,01
ID(k+2)
47
number plate
45356743
unitary cost
100
start time
18,21
end time
-

FIG.2

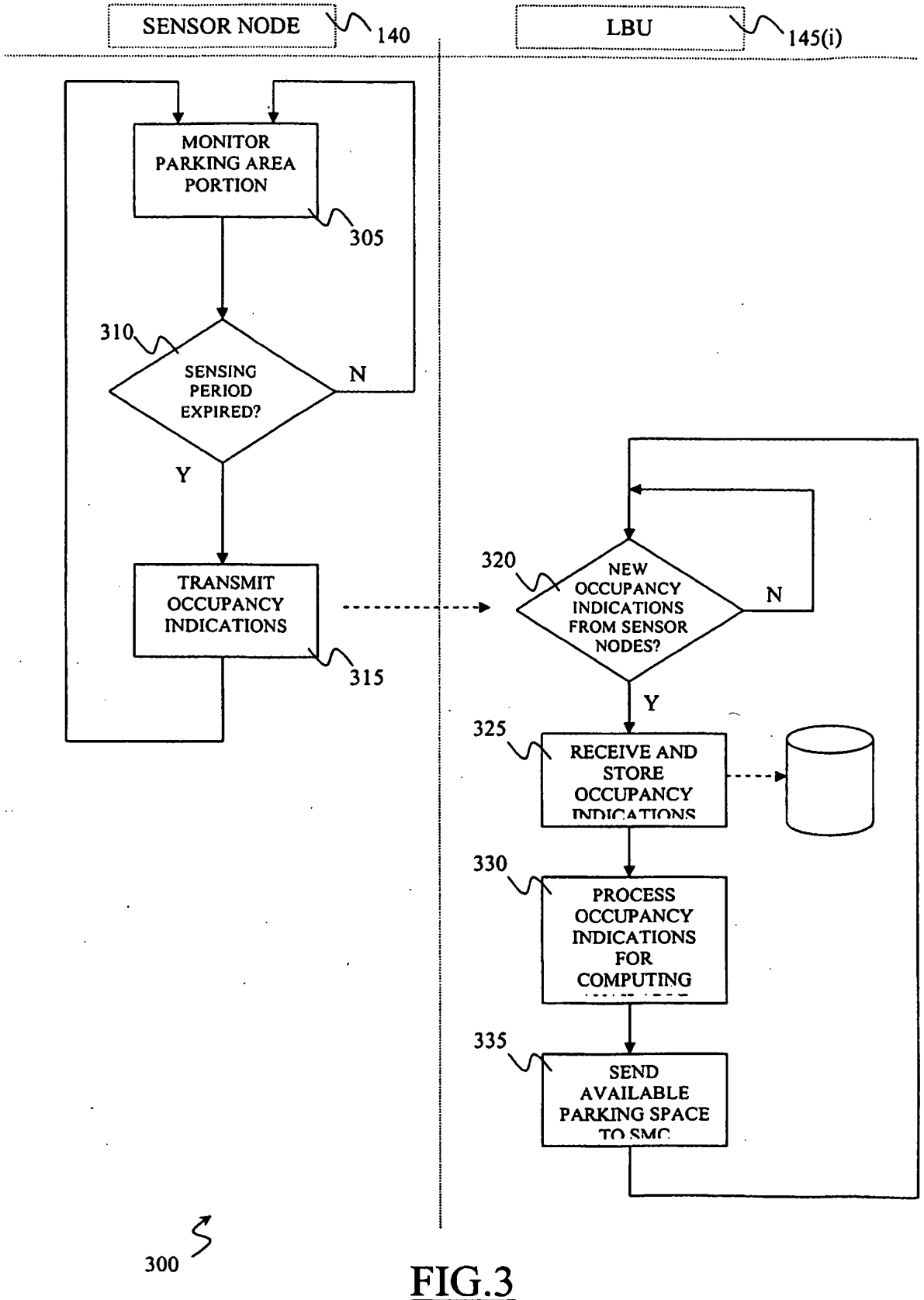

SENSOR NODE
140
LBU
145(i)
MONITOR PARKING AREA PORTION
305
310
SENSING PERIOD EXPIRED?
N
Y
TRANSMIT OCCUPANCY INDICATIONS
315
320
NEW OCCUPANCY INDICATIONS FROM SENSOR NODES?
N
Y
325
RECEIVE AND STORE OCCUPANCY INDICATIONS
330
PROCESS OCCUPANCY INDICATIONS FOR COMPUTING
335
SEND AVAILABLE PARKING SPACE
300

FIG.3

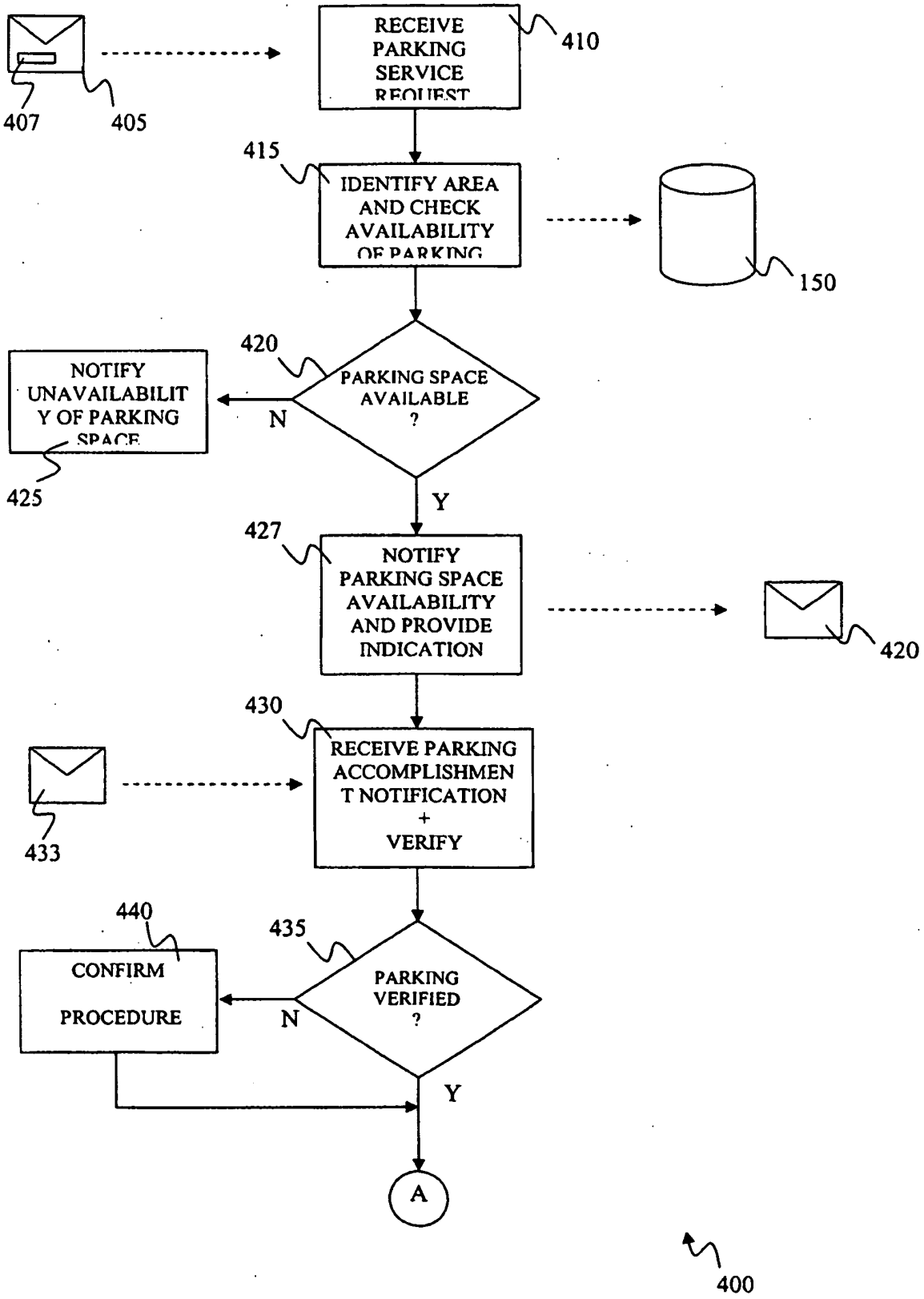

RECEIVE PARKING SERVICE REQUEST
410
407
405
415
IDENTIFY AREA AND CHECK AVAILABILITY OF PARKING
150
420
PARKING SPACE AVAILABLE ?
N
NOTIFY UNAVAILABILITY OF PARKING SPACE
425
Y
427
NOTIFY PARKING SPACE AVAILABILITY AND PROVIDE INDICATION
420
430
RECEIVE PARKING ACCOMPLISHMENT NOTIFICATION + VERIFY
433
440
435
CONFIRM PROCEDURE
PARKING VERIFIED ?
N
Y
A
400

FIG.4A

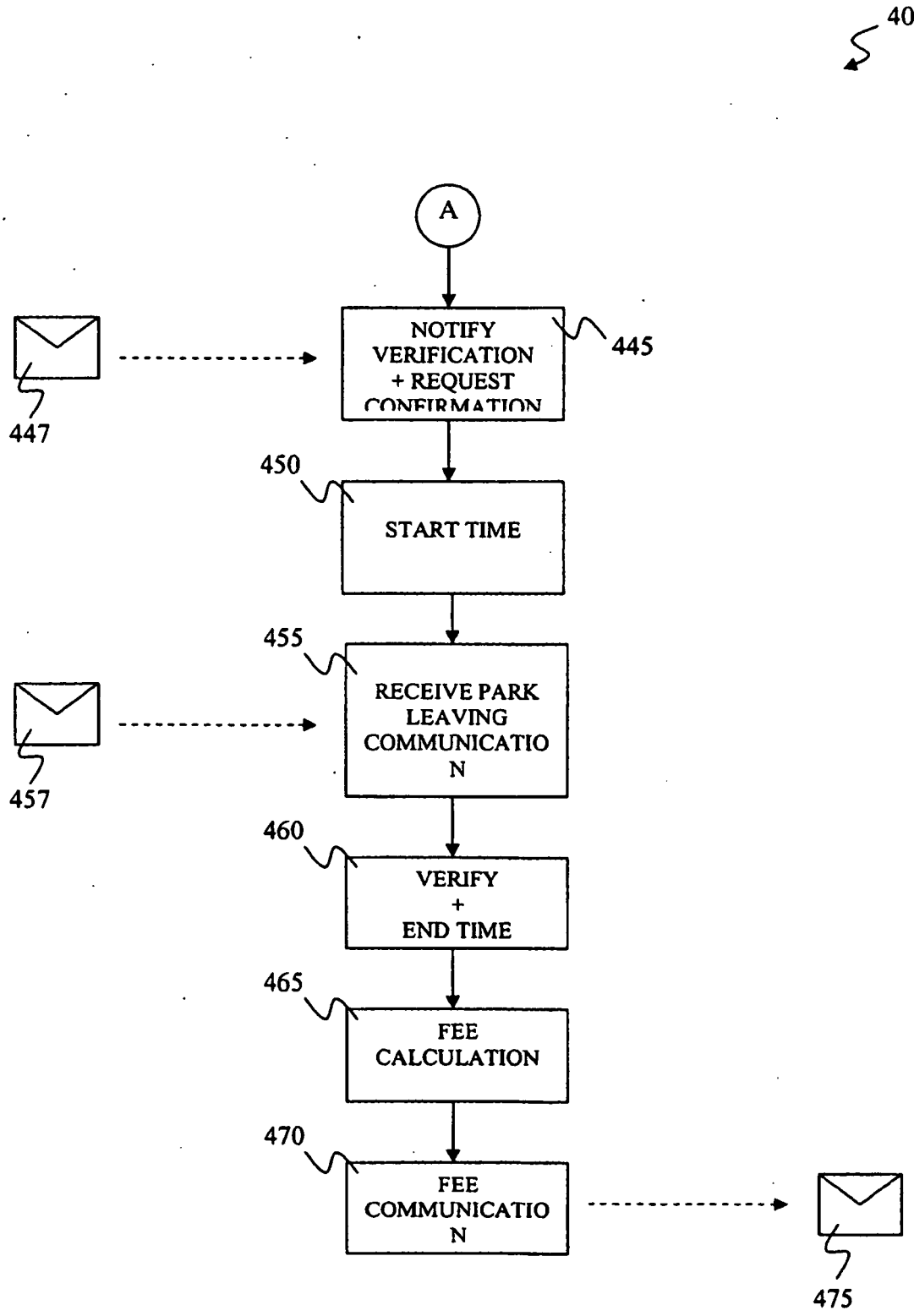

400
A
NOTIFY VERIFICATION + REQUEST CONFIRMATION
445
447
450
START TIME
455
RECEIVE PARK LEAVING COMMUNICATIO N
457
460
VERIFY + END TIME
465
FEE CALCULATION
470
FEE COMMUNICATIO N
475

FIG.4B

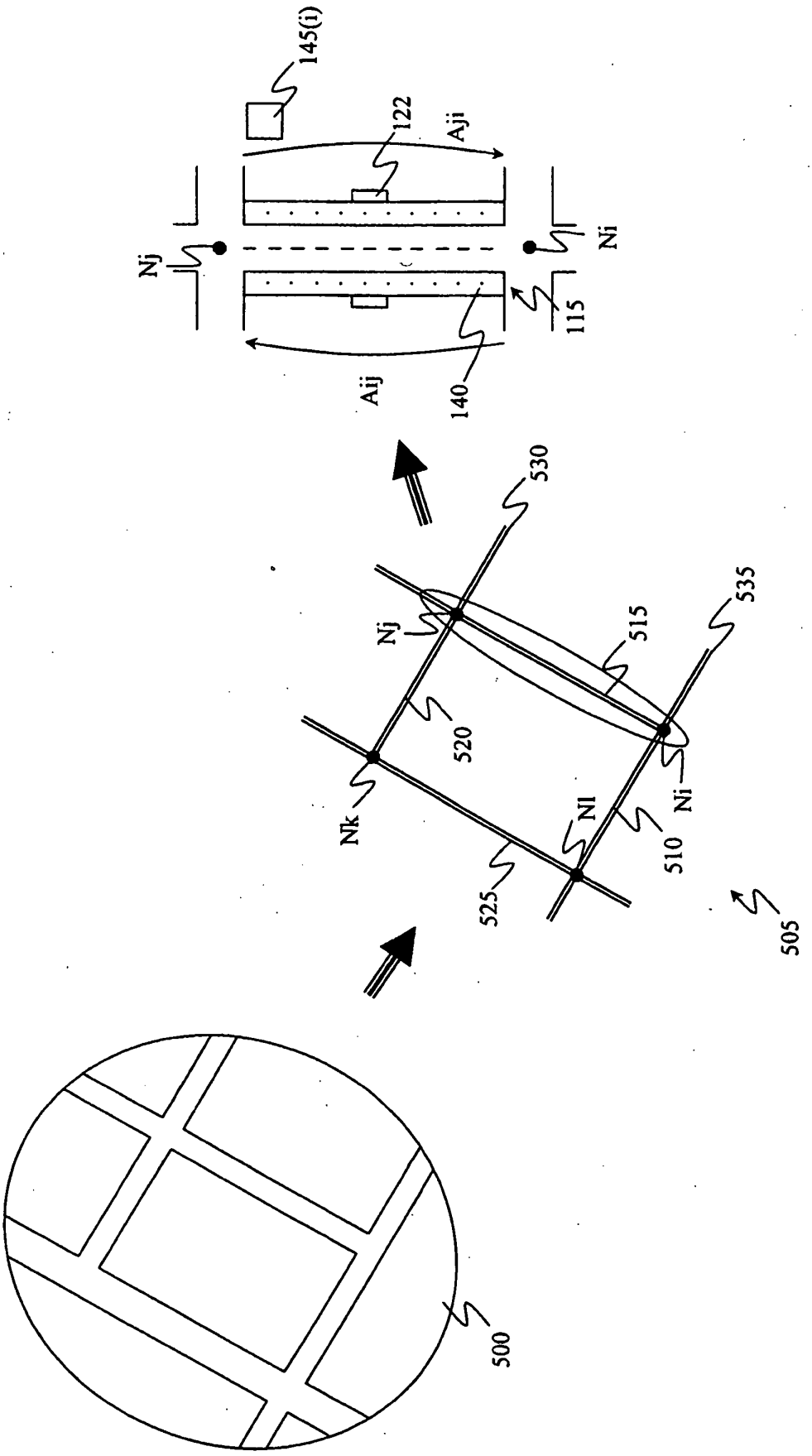

145(i)
122
Aji
Nj
Ni
115
Aij
140
530
535
515
520
Nk
Nl
510
525
505
500

FIG.5

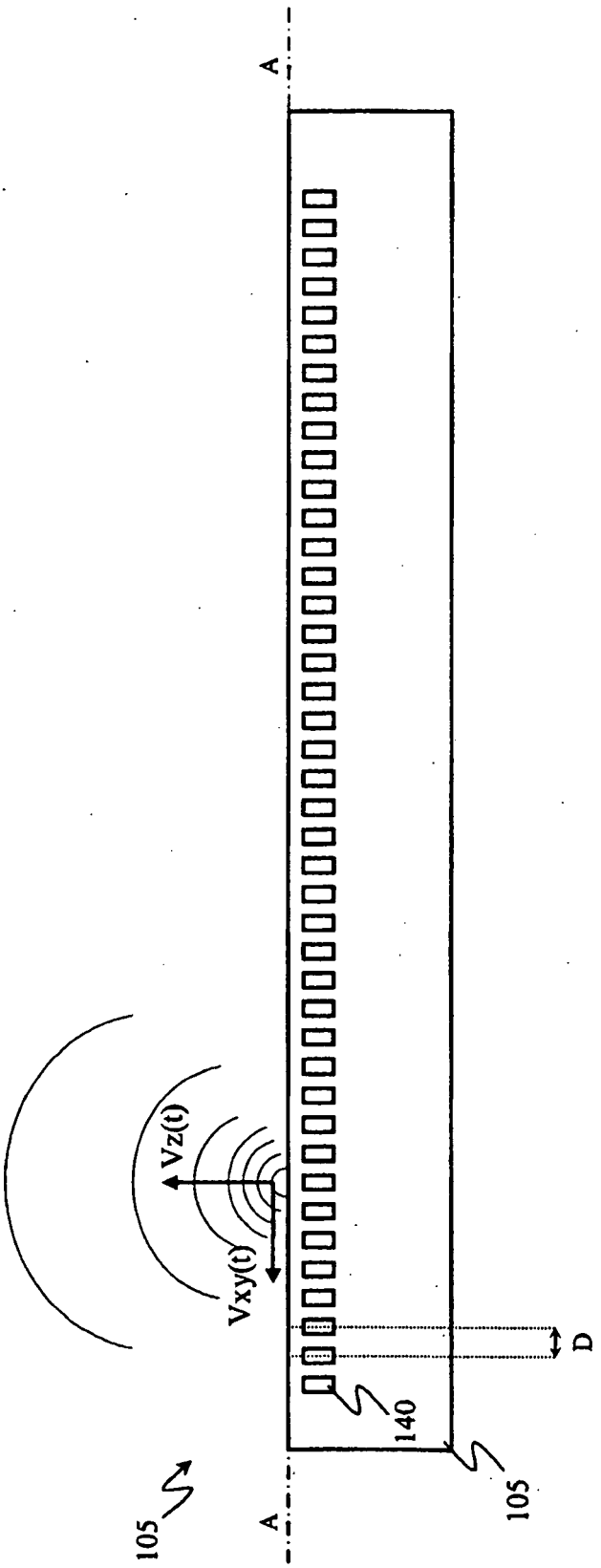


FIG.6

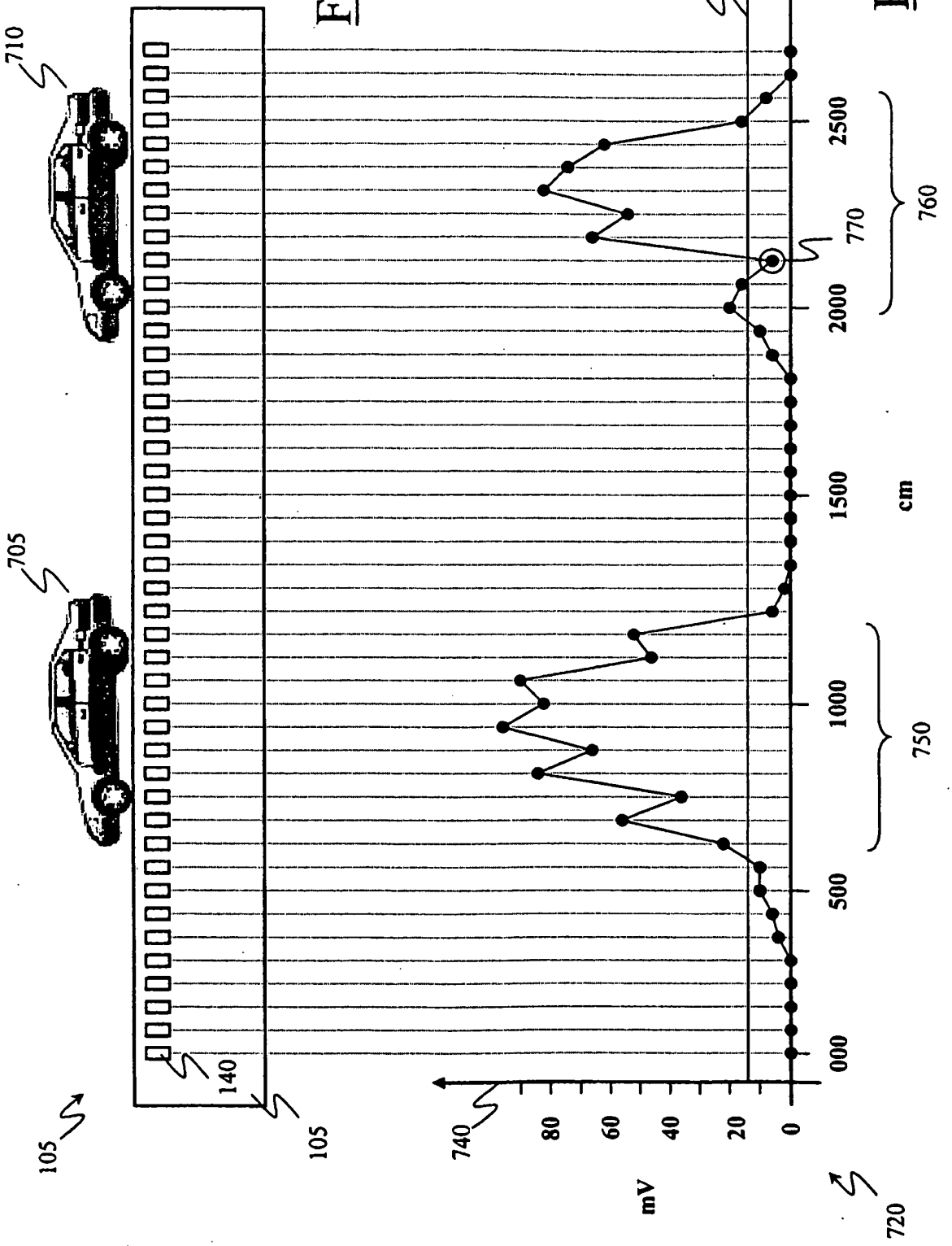

710
705
105
140
105
740
80
60
40
20
0
mV
720
000
500
1000
1500
2000
2500
cm
750
760
770
TH
730

FIG.7A

FIG.7B

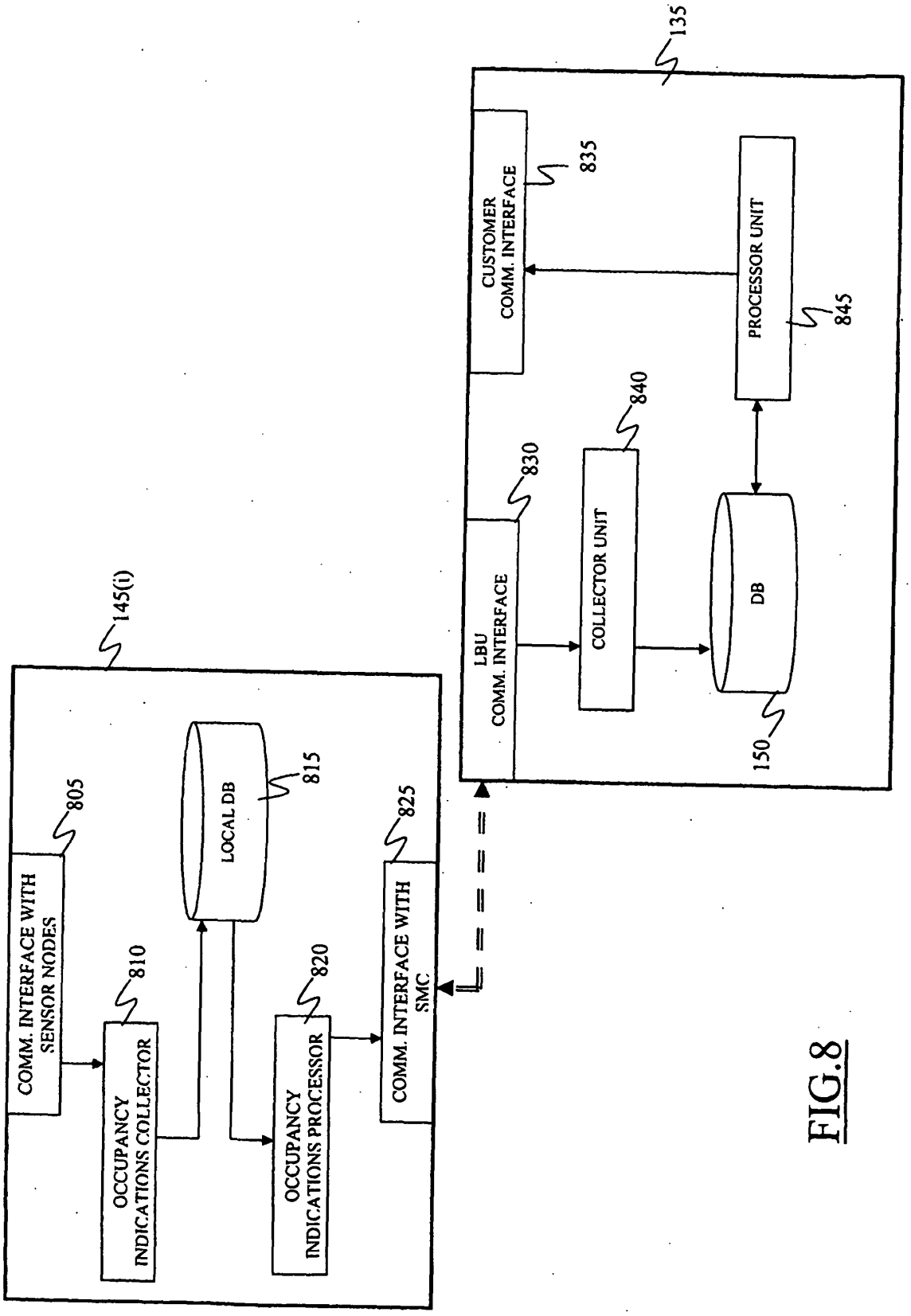

135
CUSTOMER COMM. INTERFACE
835
PROCESSOR UNIT
845
840
830
LBU COMM. INTERFACE
COLLECTOR UNIT
DB
150
145(i)
805
COMM. INTERFACE WITH SENSOR NODES
LOCAL DB
815
825
810
820
OCCUPANCY INDICATIONS COLLECTOR
OCCUPANCY INDICATIONS PROCESSOR
COMM. INTERFACE WITH SMC

FIG.8

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 7026954 B **[0007]**
- WO 9804080 A **[0008]**
- US 20030074129 A **[0009]**