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(54) **System and process for estimating the availability and/or occupied status of car parks located in a given urban area at a given time**

(57) System and process for estimating the availability and/or occupied status of car parks located in a given urban area at a preset time,
the process comprising the following steps:
f. forwarding a request for parking space availability of a given urban area at a given - present or future - time (ti) to said main unit (7);
g. querying a database (17) in order to find direct and/or indirect data relating to the parking space availability of a given urban area (9) at the present time t_0;
h. constructing at least one statistical mathematical model adapted for investigating historical series and based on the direct and/or indirect data found in said database (17);
i. generating a response report of the parking space availability in a given urban area at a given - present or future - time (t1);
j. sending said report to said at least one computer device (15) associated with a user.

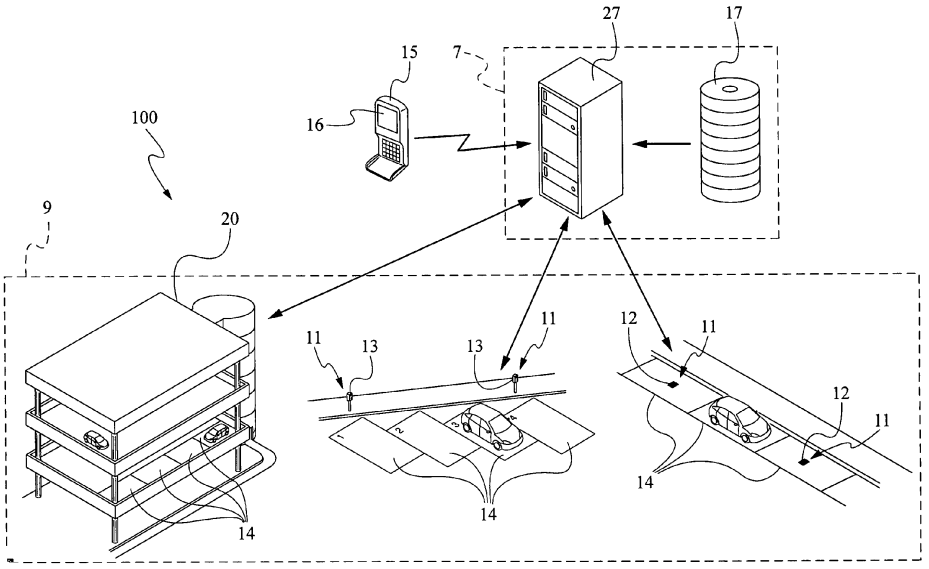

Fig. 1

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to a system and a process for determining the availability and/or occupied status of car parks located in a given zone at a preset time. More particularly, the present invention relates to a system and a process for determining the availability and/or occupied status of car parks located on the roadside and/or in car park structures in a given urban area.

PRIOR ART

[0002] Every day, thousands of motorists drive around towns and cities randomly looking for somewhere to park. This "hunting" results in traffic, loss of time, useless consumption of fuel, pollution, noise and accidents.

[0003] In order to overcome this problem, new systems are being developed in order to help motorists find an available parking space in a simple and quick manner.

[0004] The aim of these systems is to solve the problem of random searching for parking spaces by directing the drivers towards available parking zones, whether they are situated along the roadside or in special parking areas. Nowadays, there are two main systems which provide users with information regarding available parking spaces. The first system indicates the availability of parking space on displays which are positioned at strategic points along the roads, showing the availability and/or occupation level of car parks located inside buildings. The second system makes use of customized navigation devices and/or mobile telephones where the information is visualized on digital maps or through text messages. In addition to visualize the information regarding the availability of parking space, each of the above mentioned methods provides street routing directions.

[0005] The Applicant noticed that the aforementioned systems do not provide information regarding parking spaces situated along the roadside.

[0006] Therefore, there is still a problem of monitoring the number of parking spaces which are occupied along the sides of roads. However, there are various innovative solutions involving, for example, the use of magnetic sensors which detect the presence of a vehicle, the use of radars, processing of images or other techniques (some examples of the prior art can be found in EP1405285 "Smart parking advisor" in the name of Koninklijke Philips Electronics N.V. (Eindhoven, NL), or EP1701323 "Method for detecting a parking place", in the name of CIT ALCATEL (FR), or EP1361555 "System for managing parking space and/or for registration of vehicles in indoor and outdoor areas" in the name of SIEMENS AKTIENGESELLSCHAFT (GE), or W02006/005208 "Detection Terminals and Method for Observing a Parking Place with the Aid of a Terminal" in the name of IEM SA (CH).

[0007] The Applicant has noticed that the aforementioned systems are in any case very complex and do not provide a prediction of any kind. In other words, with the known systems, it is not possible to determine the percentage or number of spaces available in a given urban area, in a future time interval, with respect to the time when the request for such information is generated.

[0008] Therefore, the Applicant has identified the need to provide a simple and easy way of requesting the availability of car parks, whether they are private car parks or parking spaces along the roadside, in predetermined urban areas and for given times, either in the present or in the future.

SUMMARY OF THE INVENTION

[0009] Therefore, according to a first aspect, the invention relates to a system for estimating the availability and/or occupied status of car parks located in a given urban area at a given - present or future - time (t1), comprising:

a. a plurality of devices for detecting and/or counting the cars in a given urban area;
b. at least one main unit for processing, analysing, modelling and storing direct data and/or indirect data regarding the availability and/or occupied status of the car parks; said main unit comprising at least one main server for processing, analysing and modelling the direct and indirect data regarding the availability and/or occupied status of the car parks; said main unit (7) being in communication via a communications network with said plurality of devices for detecting and/or counting the cars in a given urban area;
c. at least one computer device associated with a user and able to communicate with said main server, said computer device comprising at least one display device associated with said computer device for displaying the data.

[0010] In the above mentioned aspect, the present invention can have at least one of the preferred characteristic features which are described below.

[0011] Preferably, the main unit comprises at least one first interface for delivering the processed data regarding the availability of parking space to said at least one computer device and/or to at least one second server.

[0012] Preferably, the main unit comprises at least one first interface for delivering the data in a format suitable for the requirements of the user.

[0013] Advantageously, the plurality of devices for detecting and/or counting the cars in a given urban area comprise at least one video camera and/or at least one magnetic sensor and/or at least one ultrasound sensor and/or at least one light sensor and/or at least one inducer.

[0014] Conveniently, the electronic devices comprise at least one telephone device and/or at least one computer and/or at least one satellite navigator and/or at least

one information panel.

[0015] According to another aspect, the present invention relates to a process for estimating the availability and/or occupied status of the car parks located in a given urban area in a predefined time interval using the system as described above, comprising the steps of:

a) forwarding a request for checking the parking space availability level of a given urban area at a given - present or future - time (t1) to said main unit (7);
b) querying a database (17) in order to find direct and/or indirect data relating to the parking space availability of a given urban area at the present time t0;
c) constructing at least one statistical mathematical model adapted for investigating historical series and based on the direct and/or indirect data found in said database (17);
d) generating a response report relating to the parking space availability in a given urban area at a given - present or future - time (t1);
e) sending said report to said at least one computer device (15) associated with a user.

[0016] Preferably, the process also comprises a step of updating the database.

[0017] Advantageously, the step of updating the database comprises a substep of periodically updating the data regarding the parking space availability of the different urban areas based on the availability and/or occupation level detected substantially at the time of the update (t_{now}).

[0018] Conveniently, the step of updating the database comprises an update substep based on random events.

[0019] In order to eliminate data which is not correct, namely data which cannot be processed by the main unit, the process further comprises a step of analysing and selecting the data input into the main unit.

[0020] Advantageously, the direct data comprise:

- current data relating to the occupation level of the car parks in the urban areas; and
- historical data relating to the occupation level of the car parks in the urban areas.

[0021] In the context of the present invention, the expression "indirect data" is intended to mean all the data supplied by external secondary servers, such as the server of an urban traffic control authority which could supply data about a local event, such as a demonstration or accident affecting the available parking spaces.

[0022] Preferably, the step of querying a database in order to find direct and/or indirect data relating to the parking space availability of a given urban area at the present time t_{now} comprises a substep of checking the presence of direct data relating to the availability and/or occupied status of the car parks in a given urban area requested by the user.

[0023] Advantageously, if the outcome of said step of checking direct data relating to the availability and/or occupied status of the car parks for a given urban area requested by the user is positive, the process comprises the following substeps:

- constructing n number of mathematical models adapted for investigating historical series for the trend of the availability and/or occupation level of the requested urban area based on historical direct data detected at two different times in the past (T; T+Δt) where T is any time in the past; and Δt is a predetermined time interval such that T+ Δt < t_{now}, where t_{now} is the present time;
- for each mathematical model, estimating the availability and/or occupation level at the present time t_{now};
- comparing the estimated occupation level with the present effective availability and/or occupation level;
- selecting the mathematical model which minimizes the difference between the estimated availability and/or occupation level and the effective availability and/or occupation level;
- calculating the potential occupation level for a future time t1 with the selected mathematical model.

[0024] Advantageously, the step of constructing a model comprises a step of correcting the potential occupation level for a future time t1 based on said indirect data.

[0025] Preferably, the step of constructing a model comprises using at least one model selected from ARMA; ARFIMA; RW or MEAN.

[0026] Preferably, if the outcome of said step of checking the presence of direct data relating to the availability and/or occupied status of the car parks for a given urban area requested by the user is negative, the process comprises the following substeps:

a) selecting an urban area similar to the requested urban area;
b) for said selected urban area:

- constructing n number of mathematical models adapted for investigating historical series for the trend of the availability and/or occupation level of the selected urban area based on historical direct data detected at two different times in the past (T; T+Δt) where T is any time in the past; and Δt is a predetermined time interval such that T+ Δt < t_{now}, where t_{now} is the present time;
- for each mathematical model, estimating the availability and/or occupation level at the present time t_{now};
- comparing the estimated occupation level with the present effective availability and/or occupation level;
- selecting the mathematical model which mini-

mizes the difference between the estimated availability and/or occupation level and the effective availability and/or occupation level;
- calculating the potential occupation level of the selected area for a future time t1 with the selected mathematical model;
- inferring the potential availability and/or occupation level of the requested urban area using a mathematical regression method.

[0027] In the context of the present invention, $T+\Delta t < t_{now}$ means that the time T selected in the past plus the predetermined interval Δt does not reach the present time t_{now}.

[0028] Still in the context of the present invention, the expression "availability and/or occupied level of the car parks" is intended to mean the number of parking spaces available in a given urban area compared to the total number of parking spaces present.

[0029] Conveniently, the step of constructing a model comprises a step of correcting the potential occupation level for a future time t1 based on said indirect data.

[0030] Preferably, the step of selecting an urban area similar to the requested urban area comprises:

comparing predetermined characteristic parameters of the urban areas;
selecting the urban area which minimizes the differences between said parameters and the parameters of the requested urban area.

[0031] Conveniently, the selected mathematical regression method comprises a regression method of the kriging or co-kriging type.

[0032] Further features and advantages of the invention will emerge more clearly from the detailed description of some preferred but not limiting embodiments of a process and system for estimating the availability and/or occupied status of car parks located in a given urban area at a preset time according to the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0033] Said description will be provided hereinbelow with reference to the accompanying drawings which are provided merely by way of a non-limiting example and in which:

- Figure 1 is a schematic view of a system for estimating the availability and/or occupied status of car parks located in a given urban area at a given - present or future - time (t1) according to the present invention;
- Figure 2 shows a block diagram of the system for estimating the availability and/or occupied status of car parks located in a given urban area at a given - present or future - time (ti) according to the present invention;
- Figure 3A shows schematically, as a block diagram, a substep of the process according to the invention for periodically updating the data regarding the parking space availability in different urban areas as detected substantially at the time of the update (t_{now});
- Figure 3B shows schematically, as a block diagram, a substep of the process according to the invention for updating a database based on random events;
- Figure 4 shows schematically, as a block diagram, a substep of the process according to the invention for analysing the data stored in said database before delivering the requested data to the user;
- Figure 5 shows schematically, as a block diagram, a substep of the process according to the invention for delivering the requested data to the user;
- Figure 6 shows schematically, as a block diagram, a substep of the process according to the invention for predicting the requested data; and
- Figure 7 shows schematically, as a block diagram, a substep of the process according to the invention for inferring the requested data.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

[0034] With reference to the figures, a system for estimating the availability and/or occupied status of the car parks located in a given urban area at a preset time according to the present invention is identified by reference number 100.

[0035] As shown in Figures 1 and 2, the system 100 comprises a plurality of devices 11 for detecting and/or counting the cars in a given urban area 9, at least one main unit 7 for processing, analysing, modelling and storing direct and indirect data regarding the availability and/or occupied status of parking spaces 14, at least one computer device 15 associated with a user and able to communicate with the main unit 7, and at least one display device 16, associated with the computer device 15, for displaying the data.

[0036] As shown in Figure 1, the devices 11 for detecting and/or counting the cars can be sensors 12 for detecting the presence of a motor vehicle which are arranged along roads, each sensor 12 being associated with a parking space 14. These detection sensors 12 can be magnetic sensors and/or ultrasound sensors and/or light sensors and/or an inducer. These sensors 12 are known in the art and, therefore, are not further described.

[0037] Alternatively or simultaneously, as devices 11 for detecting and/or counting the cars, it is possible to envisage video cameras which are associated with an accounting system to monitor the entry to and departure from parking areas or pay car parks, or counting devices for counting the motor vehicles entering or leaving specific parking areas, the devices of this type being able to be connected, for example, to the entry/exit barriers of multi-storey car parks such as, for example, the multi-storey car park 20 shown in Figure 1.

[0038] Finally, as shown in Figure 1, further indirect devices for detecting and/or counting the cars can be parking meters 13 in the parking spaces 14 and, in this case, the information sent from the parking meters to the main unit 7 is not directly the occupation status of the parking spaces, but an estimate based on the payment (in any) of the fee for use of the space for a given period, unless the parking area, i.e. the whole of parking spaces 14, is equipped with a further detection or counting device, such as one of those mentioned above.

[0039] All the devices 11 for detecting and/or counting the motor vehicles are in communication with the main unit 7 and provide periodically, as described in greater detail below, information about the occupation level of a predetermined urban area 9.

[0040] The main unit 7 comprises at least one main server 27 and at least one database 17 for storing the data relating to the parking space availability of a given urban area, whether they are direct data and/or indirect data.

[0041] The main unit 7 as schematically illustrated in the block diagram shown in Figure 2 comprises, in a known manner, input/output (I/O) interfaces and at least one network in addition to the server 27 (CPU) and a database (memory) 17.

[0042] The main unit 7 also comprises at least one first interface for delivering the data regarding the availability of parking space processed by the server to the first computer devices 15, indicated in Figure 2 by the label "user device".

[0043] The main unit 7 also comprises at least one second interface for standardizing the data input into the main unit 7, indicated in Figure 2 by the label "data standardization".

[0044] The data input into the main unit can be direct data relating to the occupation level and availability of car parks, and/or indirect data supplied by further servers, secondary servers, such as for example the server of an urban traffic control authority, or web platforms.

[0045] By way of an example, the data supplied by the web platforms could consist of data relating to the weather conditions, while the data from the server of an urban traffic control authority could be data relating to a local event, such as a demonstration, which can therefore affect the availability/occupation level of car parks in a given urban area.

[0046] The first computer devices 15 associated with the users and able to communicate with the server 27 can consist of a desktop computer, a portable computer, a PDA (personal digital assistant), a mobile phone, a satellite navigator and/or an information panel or any electronic device which allows access to a network connection, such as a telephone line and/or the Internet.

[0047] From Figure 2 it can also be seen how the main unit, via the connection network, could also be connected to a further server, indicated by the label "external processor", so as to supply the latter with processed data regarding the occupation / availability level of parking space in the urban areas.

[0048] The afore mentioned system is adapted for implementing a process according to the present invention in order to estimate the availability and/or occupied status of car parks located in a given urban area at a given - present or future - time (ti).

[0049] The process comprises at least the following steps:

a) forwarding a request for the parking space availability of a given urban area 9 at a given - present or future - time (ti) to said main unit 7;

b) querying a database 17 in order to find direct and/or indirect data relating to the parking space availability of a given urban area 9 at the present time t_{now};

c) constructing at least one statistical mathematical model adapted for investigating historical series and based on the direct and/or indirect data found in said database 17;

d) generating a response report about the parking space availability in a given urban area at a given - present or future - time (t1);

e) sending said report to said at least one computer device 15 associated with a user.

[0050] The availability request consists, for example, in the request as to whether parking spaces are available in a given urban area 9.

[0051] In the context of the present invention, the expression "urban area" is intended to mean a part of a town or city.

[0052] In order to be able to estimate the occupation and/or availability level at any time (ti) as soon as a request is received from a user, the process comprises at least one step involving updating the database 17, preferably at least one substep of performing a periodic update, and at least one substep of performing an update based on a random event.

[0053] By way of an example, Figure 3A shows a block diagram illustrating an embodiment of the substep of updating the data regarding the parking space availability of the different urban areas, as detected substantially at the time of the updating operation (ti).

[0054] At different times ti selected beforehand, for example every 2 minutes, the server 27 activates a request for new data from the various devices 11.

[0055] Following reception of the data sent from the devices 11, a step of checking the quality of the data is performed by means of the data standardization interface, in order to check whether the data is in the correct format and adapted for being processed by the server 27.

[0056] A selection step is then performed whereby, if the data is suitable, it is stored in the database 17, otherwise it will be erased.

[0057] The step of checking the quality of the data is moreover based on the module "information on specific data" in which a data check request is generated. In other

words, since this data may come from different and varying sources, the server 27 generates a request which indicates what must be checked from among the varying types of information received.

[0058] By way of an example, Figure 3B shows a block diagram illustrating an embodiment of the substep of updating the data based on random events.

[0059] This step is substantially equivalent to that shown in Figure 3A, except that the server 27 does not initiate a request for receiving new data, but receives spontaneously data from external secondary servers, such as that of an urban traffic control authority, which can provide data about a local event such as a demonstration or accident.

[0060] In order to able to provide an estimate, the process is based on direct data, namely both current data, i.e. data just detected, regarding the occupation level of car parks in urban areas and historical data regarding the occupation level of the car parks in urban areas, namely data already detected and stored in the database 17.

[0061] Once a request is received from a user as to the number of spaces available in a given urban area for a given time (t1), for example in the future, the server 27 checks for the presence of direct data relating to the availability and/or occupied status of the car parks in the requested urban area 9.

[0062] If the outcome of the step of checking the presence of direct data relating to the availability and/or occupied status of the car parks for the urban area requested by the user is positive, namely if this data can be detected because devices 11 for detecting and/or counting cars are present in the urban area 9, then a prediction step comprising the following substeps is performed:

> n number of mathematical models adapted for investigating historical series for the trend of the availability and/or occupation level of the requested urban area 9 are constructed. The construction of the afore mentioned mathematical models is based on historical direct data detected in two different times in the past (T; T+Δt) where T is any time in the past; and Δt is a predetermined time interval such that T+ Δt < t_{now}, where t_{now} is the present time. For each mathematical model thus created, the availability and/or occupation level at the present time t_{now} is estimated. In other words, the model is applied in order to estimate the availability and/or occupation level at the present time t_{now}.

[0063] At this point, for each model constructed, the availability and/or occupation level at the present time t_{now} is compared with the effective availability and/or occupation level at the present time t_{now}. In other words, at the time t_{now}, the estimated availability / occupation level is compared with the effective level detected by the devices 11.

[0064] Then, the mathematical model which minimizes the difference between the estimated availability and/or occupation level and the effective availability and/or occupation level is selected.

[0065] This is then followed by calculating, using the selected mathematical model, the potential occupation level for the future time t1 requested by the user, and the prediction is delivered to the user who requested it.

[0066] The above described prediction step has been shown by means of a block diagram in Figure 6.

[0067] In the context of the present invention, the term "prediction" is intended to mean an estimate of the occupation level at a future time t1 based on direct data.

[0068] In detail, downstream of the request by the user, the process may envisage the input of personal data introduced by the user, such as current location of the user, estimated arrival time, maximum distance which is to be travelled on foot between target destination and parking space, and maximum parking time.

[0069] In this case, the mathematical model generated takes account of the aforementioned data.

[0070] The various mathematical models which can be selected during the prediction step include Arma, ARFIMA, RW or MEAN.

[0071] The prediction step can also comprise a further substep, not shown in the block diagram of Figure 6, in which the model construction step comprises a step of correcting the potential availability and/or occupation level for a future time t1 depending on the indirect data, namely data from external secondary servers, such as that of an urban traffic control authority, which can provide information relating to a local event, such as a demonstration or accident affecting the available parking spaces.

[0072] The step of delivering the prediction data to the user who requested the same is illustrated, for example, by the block diagram shown in Figure 5.

[0073] Once the data to be delivered, represented by the block "available data", has been obtained, the server 27 generates a data delivery request. The data to be delivered is then analysed, in order to determine whether it is in the correct format, by means of the data delivery interface shown in Figure 2 and, if the data is in the correct format, delivery is performed.

[0074] Instead, Figure 7 shows the block diagram of a process step, called inference step, which is an alternative to the prediction step illustrated by the block diagram in Figure 6.

[0075] In this case, once a request is received from a user as to the number of spaces available in a given urban area 9 for a given time t1, for example in the future, the server 27 checks for the presence of direct data relating to the availability and/or occupied status of the car parks in the requested urban area 9.

[0076] If the outcome of the step of checking the presence of direct data relating to the availability and/or occupied status of the car parks for the urban area requested by the user is negative, namely, if this data cannot be detected because devices 11 for detecting and/or count-

ing cars are not present in the urban area 9, then an inference step comprising the following substeps is performed:

An urban area 9 similar to the urban area 9 requested by the user is selected.

[0077] For the selected urban area, n number of mathematical models adapted for investigating historical series for the trend of the availability and/or occupation level of the selected urban area are constructed. In this case also, the construction of the mathematical models is based on historical direct data detected in two different times in the past (T; T+Δt) where T is any time in the past and Δt is a predetermined time interval such that T+ Δt < t_{now}, where t_{now} is the present time.

[0078] For each mathematical model, the availability and/or occupation level at the present time t_{now} is estimated. In other words, the model is applied in order to calculate the availability and/or occupation level at the present time t_{now}.

[0079] The estimated occupation level is then compared with the effective availability and/or occupation level at the present time t_{now}. In other words, at the time t_{now}, the estimated availability and/or occupation level is compared with the effective level detected by the devices 11.

[0080] Then, the mathematical model which minimizes the difference between the estimated availability and/or occupation level and the effective availability and/or occupation level is selected.

[0081] At this point, the potential occupation level for a future time t1 of the selected area is calculated using the selected mathematical model.

[0082] The potential availability and/or occupation level of the requested urban area is then inferred using a mathematical regression method based on the potential availability and/or occupation level of the selected area, and the prediction is delivered to the user who requested it.

[0083] The regression method can be of the kriging or co-kriging type.

[0084] The substep of selecting an urban area 9 similar to the requested urban area 9 comprises:

comparing predetermined characteristic parameters of the urban areas;
selecting the urban area which minimizes the differences between the characteristic parameters and the parameters of the requested urban area.

[0085] For example, these characteristic parameters can be considered to be the number of car parks, the opening times of the shops, the number of people living in that area, the number of offices, the opening hours of the offices, etc.

[0086] The above inference step can also comprise a further substep - not shown in the block diagram of Figure 7 - wherein the potential availability and/or occupation level for a future time t1 is corrected for indirect data, i.e. data from external secondary servers, such as that of an urban traffic control authority, which can provide data relating to a local event, such as a demonstration or accident affecting the availability of parking spaces.

[0087] The step of delivering the inferred data to the user who requested the same is entirely similar to the step of delivering the predicted data as illustrated by the block diagram in Figure 5, to which reference should be made.

[0088] Figure 4 shows an optional analysis substep of the process, based on the internal requirements of the system. This substep is a true data analysis step which is performed by the "historical data analyser" module and, for example, it is a pre-analysis either for determining the percent occupied status along a road or in a district, etc., or for determining at what time of the day the occupation level was higher than 85%. These are pre-analyses of the available data. If the data is already valid (checked beforehand by the quality control), the calculation is made on the data already present in the database 17.

[0089] In detail, the server 27 generates a data analysis request of a certain type, the corresponding data is then saved and the true analysis carried out, whereby the result of said analysis can be stored in the database 17 or sent to further secondary servers.

[0090] The present invention has been described with reference to a number of embodiments. Various modifications can be made to the embodiments described in detail while remaining within the scope of protection of the invention as defined by the following claims.

Claims

1. System for estimating the availability and/or occupied status of car parks located in a given urban area (9) at a given - present or future - time (ti), comprising:

   a. a plurality of devices (11) for detecting and/or counting the cars in a given urban area;
   b. at least one main unit (7) for processing, analysing, modelling and storing direct and/or indirect data regarding the availability and/or occupied status of the car parks; said main unit (7) comprising at least one main server (27) for processing, analysing and modelling both the direct and indirect data regarding the availability and/or occupied status of the car parks and at least one database (17) comprising direct and/or indirect data regarding the parking space availability of the different urban areas as detected by said plurality of devices (11), said main unit (7) being in communication via a communications network with said plurality of devices (11) for detecting and/or counting the cars in a given urban area (9);

c. at least one computer device (15) associated with a user and able to communicate with said main server (27), said computer device (15) comprising at least one display device (16) associated with said computer device (15) for displaying the data.

2. System for estimating the availability and/or occupied status of car parks located in a given urban area (9) at a given - present or future - time (ti) according to Claim 1, **characterized in that** said main unit (7) comprises at least one first interface (8) for delivering the processed data regarding the availability of parking space to said at least one computer device (15) and/or to at least one second server.

3. System for estimating the availability and/or occupied status of car parks located in a given urban area (9) at a given - present or future - time (ti) according to Claim 1 or 2, **characterized in that** said plurality of devices (11) for detecting and/or counting the cars in a given urban area (9) comprise at least one video camera and/or at least one magnetic sensor and/or at least one ultrasound sensor and/or at least one light sensor and/or at least one inducer.

4. System for estimating the availability and/or occupied status of car parks located in a given urban area (9) at a preset time according to any one of the preceding claims, **characterized in that** said electronic devices (15) comprise at least one telephone device and/or at least one computer and/or at least one satellite navigator and/or at least one information panel.

5. Process for estimating the availability and/or occupation status of car parks located in a given urban area (9) at a given - present or future - time (ti) using the system according to any one of the preceding Claims 1 to 4, comprising:

a. forwarding a request for parking space availability of a given urban area at a given - present or future - time (ti) to said main unit (7);
b. querying a database (17) in order to find direct and/or indirect data relating to the parking space availability of a given urban area (9) at the present time t_0;
c. constructing at least one statistical mathematical model adapted for investigating historical series and based on the direct and/or indirect data found in said database (17);
d. generating a response report about the parking space availability in a given urban area (9) at a given - present or future - time (t1);
e. sending said report to said at least one computer device (15) associated with a user.

6. Process for estimating the availability and/or occupied status of car parks located in a given urban area (9) at a given - present or future - time (ti) according to Claim 5, **characterized by** comprising a step of updating said database (17).

7. Process for estimating the availability and/or occupied status of car parks located in a given urban area at a given - present or future - time (t1) according to Claim 6, **characterized in that** said step of updating said database (17) comprises a substep of periodically updating the data regarding the parking space availability of the different urban areas as detected substantially at the time of the update (t_{now}).

8. Process for estimating the availability and/or occupied status of car parks located in a given urban area (9) at a given - present or future - time (ti) according to Claim 6 or 7, **characterized in that** said step of updating said database (17) comprises an update substep based on random events.

9. Process for estimating the availability and/or occupied status of car parks located in a given urban area (9) at a given - present or future - time (ti) according to Claim 8, **characterized in that** it comprises a data delivery step adapted for checking the quality of the data to be supplied to the user.

10. Process for estimating the availability and/or occupied status of car parks located in a given urban area (9) at a given - present or future - time (ti) according to Claim 5, **characterized in that** said direct data comprise

- current data relating to the occupation level of the car parks in the urban areas; and
- historical data relating to the occupation level of the car parks in the urban areas.

11. Process for estimating the availability and/or occupied status of car parks located in a given urban area (9) at a given - present or future - time (ti) according to Claim 5, **characterized in that** it comprises a step of checking the presence of direct data relating to the availability and/or occupied status of the car parks in a given urban area (9) requested by the user.

12. Process for estimating the availability and/or occupied status of car parks located in a given urban area (9) at a given - present or future - time (ti) according to Claim 11, **characterized in that**, if the outcome of said step of checking the presence of direct data relating to the availability and/or occupied status of the car parks in a given urban area (9) requested by the user is positive, it comprises the following substeps:

- constructing n number of mathematical models

adapted for investigating historical series for the trend of the availability and/or occupation level of the requested urban area (9) based on historical direct data detected at two different times in the past (T; T+Δt) where T is any time in the past and Δt is a predetermined time interval such that T+ Δt < t_{now}, where t_{now} is the present time;
- for each mathematical model, estimating the availability and/or occupation level at the present time t_{now};
- comparing the estimated occupation level with the present effective availability and/or occupation level;
- selecting the mathematical model which minimizes the difference between the estimated availability and/or occupation level and the effective availability and/or occupation level;
- calculating the potential occupation level for a future time t1 with the selected mathematical model.

13. Process for estimating the availability and/or occupied status of car parks located in a given urban area (9) at a given - present or future - time (ti) according to Claim 12, **characterized in that** said step of constructing a model comprises a step of correcting the potential occupation level for a future time t1 based on said indirect data.

14. Process for estimating the availability and/or occupied status of car parks located in a given urban area (9) at a given - present or future - time (ti) according to Claim 12, **characterized in that** said step of constructing a model comprises using at least one model selected from Arma; ARFIMA; RW or MEAN.

15. Process for estimating the availability and/or occupied status of car parks located in a given urban area (9) at a given - present or future - time (ti) according to Claim 11, **characterized in that**, if the outcome of said step of checking the presence of direct data relating to the availability and/or occupied status of the car parks in a given urban area requested by the user is negative, it comprises the following substeps:

a) selecting an urban area similar to the requested urban area;
b) for said selected urban area:

- constructing n number of mathematical models adapted for investigating historical series for the trend of the availability and/or occupation level of the selected urban area based on historical direct data detected at two different times in the past (T; T+Δt) where T is any time in the past and Δt is a predetermined time interval such that T+ Δt < t_{now}, where t_{now} is the present time;
- for each mathematical model, estimating the availability and/or occupation level at the present time t_{now};
- comparing the estimated occupation level with the present effective availability and/or occupation level;
- selecting the mathematical model which minimizes the difference between the estimated availability and/or occupation level and the effective availability and/or occupation level;
- calculating the potential occupation level of the selected area for a future time t1 with the selected mathematical model;
- inferring the potential availability and/or occupation level of the requested urban area with a mathematical regression method.

16. Process for estimating the availability and/or occupied status of car parks located in a given urban area (9) at a given - present or future - time (ti) according to Claim 15, **characterized in that** said step of constructing a model comprises a step of correcting the potential occupation level for a future time t1 based on said indirect data.

17. Process for estimating the availability and/or occupied status of car parks located in a given urban area at a given - present or future - time (ti) according to Claim 15, **characterized in that** said step of selecting an urban area similar to the requested urban area comprises:

- comparing predetermined characteristic parameters of the urban areas;
- selecting the urban area which minimizes the differences between said parameters and the parameters of the requested urban area.

18. Process for estimating the availability and/or occupied status of car parks located in a given urban area at a given - present or future - time (t1), according to Claim 15, **characterized in that** said regression method comprises a regression method of the kriging or co-kriging type.

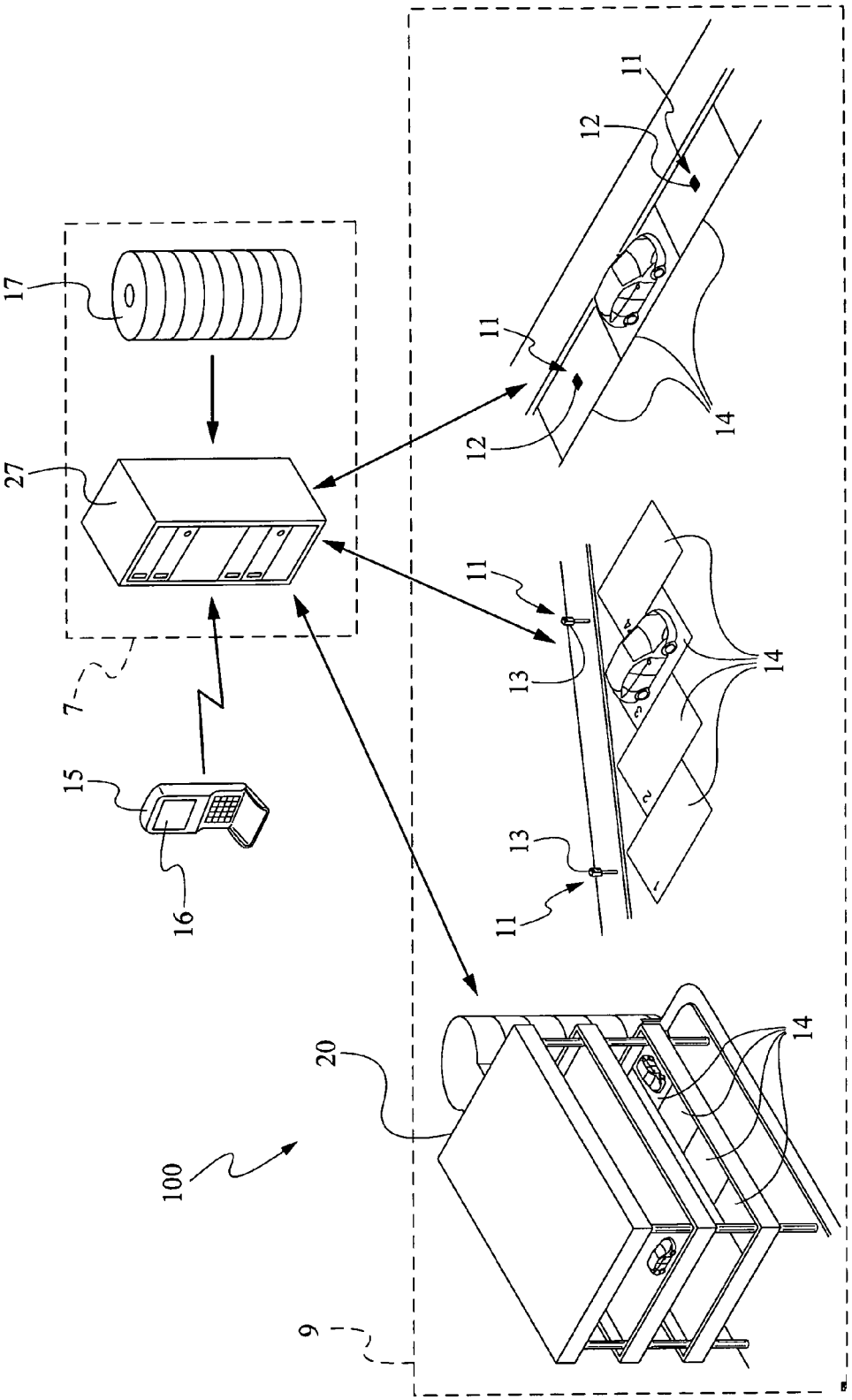

Fig. 1

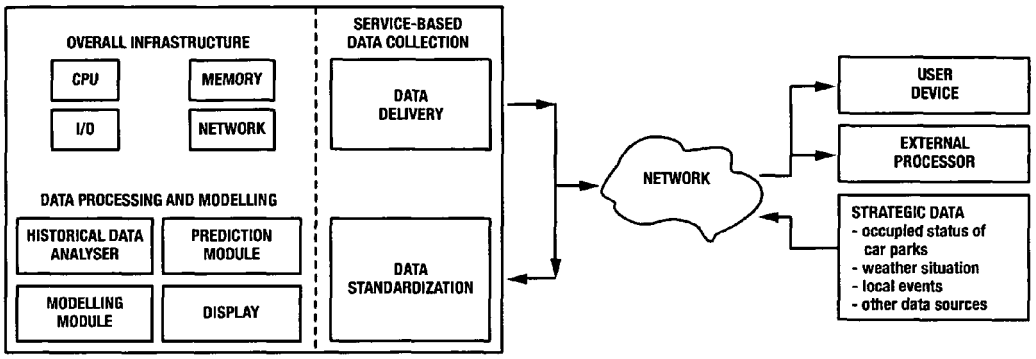
OVERALL INFRASTRUCTURE
CPU
MEMORY
I/O
NETWORK
DATA PROCESSING AND MODELLING
HISTORICAL DATA ANALYSER
PREDICTION MODULE
MODELLING MODULE
DISPLAY
SERVICE-BASED DATA COLLECTION
DATA DELIVERY
DATA STANDARDIZATION
NETWORK
USER DEVICE
EXTERNAL PROCESSOR
STRATEGIC DATA
- occupied status of car parks
- weather situation
- local events
- other data sources

Fig. 2

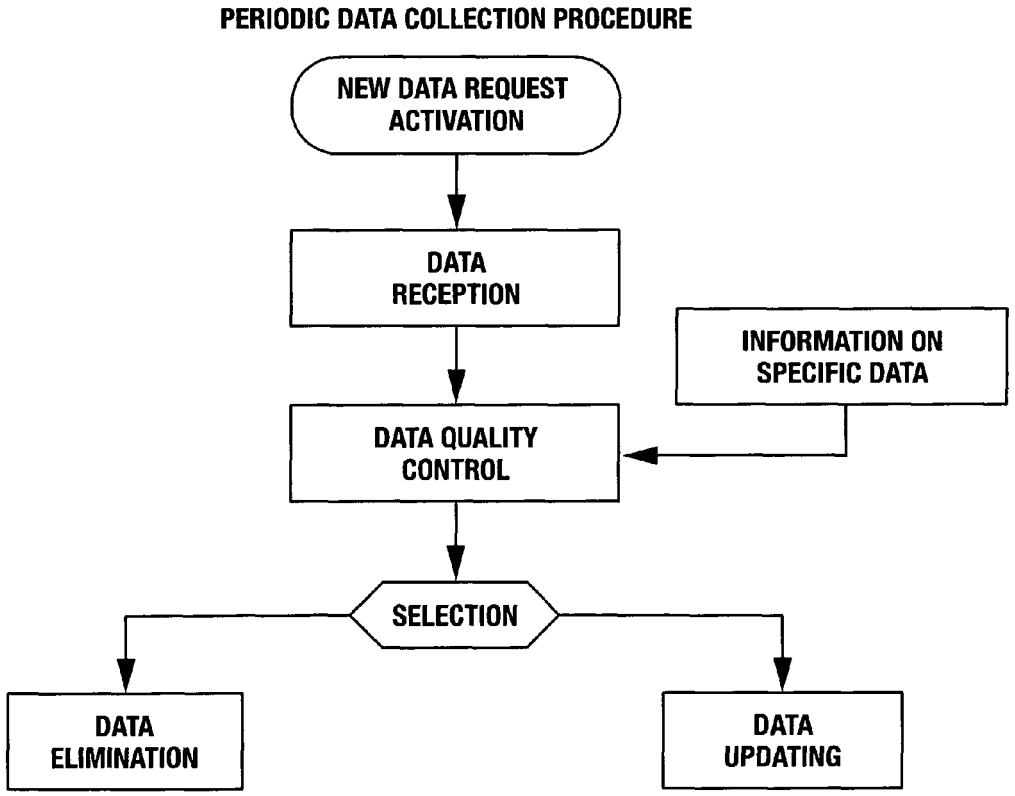
PERIODIC DATA COLLECTION PROCEDURE
NEW DATA REQUEST ACTIVATION
DATA RECEPTION
INFORMATION ON SPECIFIC DATA
DATA QUALITY CONTROL
SELECTION
DATA ELIMINATION
DATA UPDATING

Fig. 3A

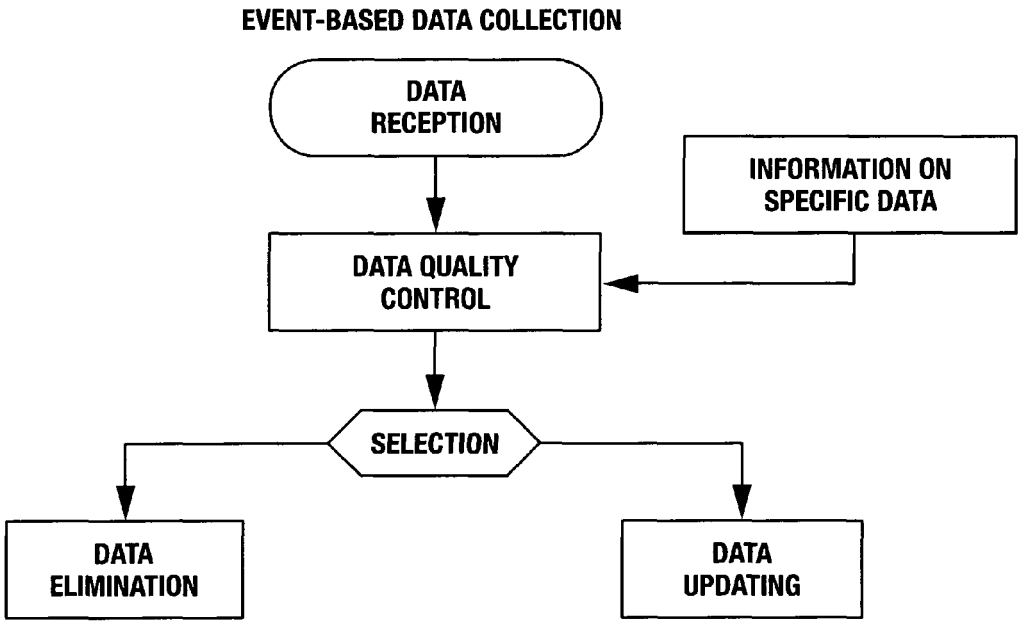
EVENT-BASED DATA COLLECTION
DATA RECEPTION
INFORMATION ON SPECIFIC DATA
DATA QUALITY CONTROL
SELECTION
DATA ELIMINATION
DATA UPDATING

Fig. 3B

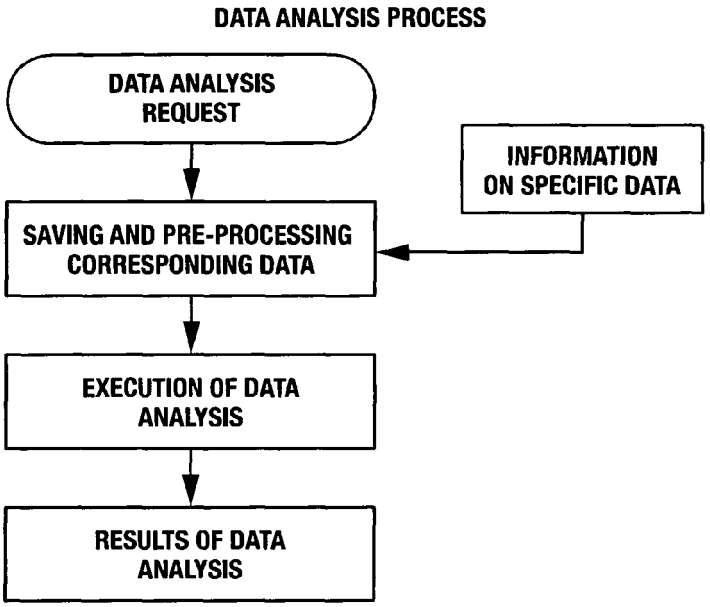
DATA ANALYSIS PROCESS
DATA ANALYSIS REQUEST
INFORMATION ON SPECIFIC DATA
SAVING AND PRE-PROCESSING CORRESPONDING DATA
EXECUTION OF DATA ANALYSIS
RESULTS OF DATA ANALYSIS

Fig. 4

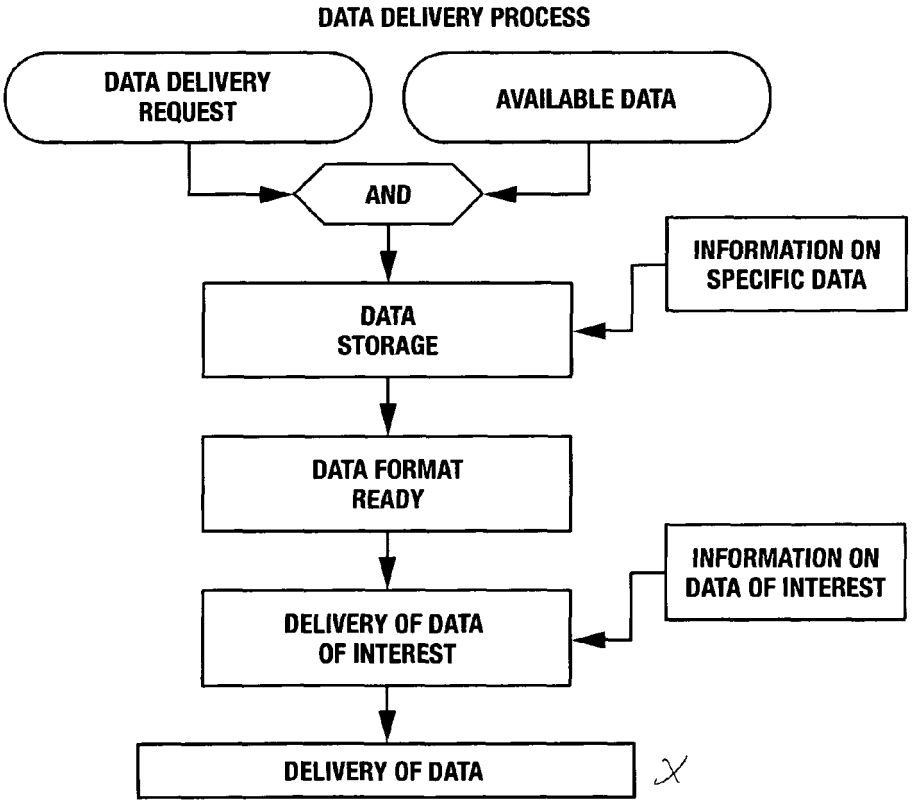
DATA DELIVERY PROCESS
DATA DELIVERY REQUEST
AVAILABLE DATA
AND
INFORMATION ON SPECIFIC DATA
DATA STORAGE
DATA FORMAT READY
INFORMATION ON DATA OF INTEREST
DELIVERY OF DATA OF INTEREST
DELIVERY OF DATA
X

Fig. 5

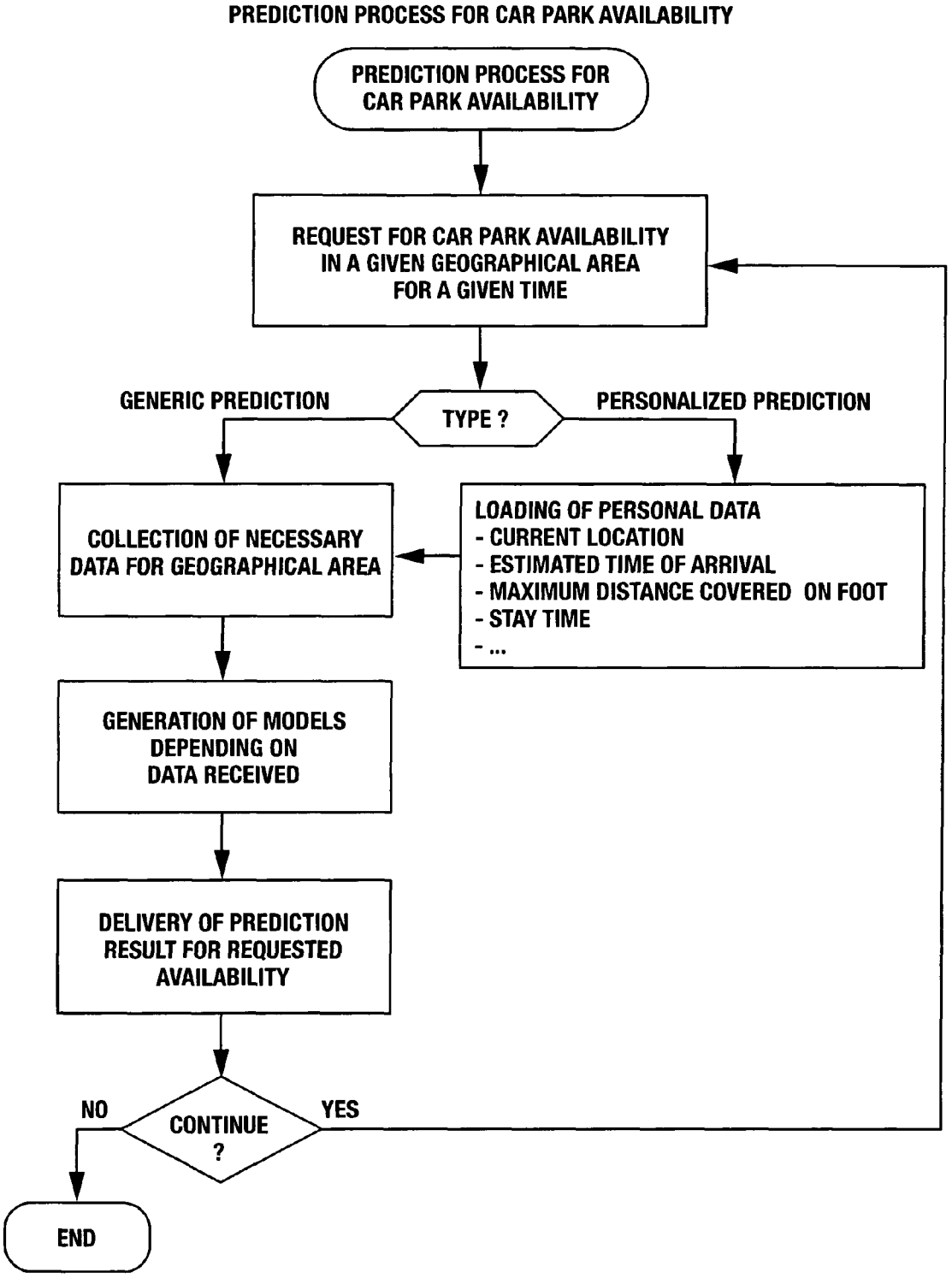
PREDICTION PROCESS FOR CAR PARK AVAILABILITY
PREDICTION PROCESS FOR CAR PARK AVAILABILITY
REQUEST FOR CAR PARK AVAILABILITY IN A GIVEN GEOGRAPHICAL AREA FOR A GIVEN TIME
GENERIC PREDICTION
TYPE ?
PERSONALIZED PREDICTION
COLLECTION OF NECESSARY DATA FOR GEOGRAPHICAL AREA
LOADING OF PERSONAL DATA
- CURRENT LOCATION
- ESTIMATED TIME OF ARRIVAL
- MAXIMUM DISTANCE COVERED ON FOOT
- STAY TIME
- ...
GENERATION OF MODELS DEPENDING ON DATA RECEIVED
DELIVERY OF PREDICTION RESULT FOR REQUESTED AVAILABILITY
NO
CONTINUE ?
YES
END

Fig. 6

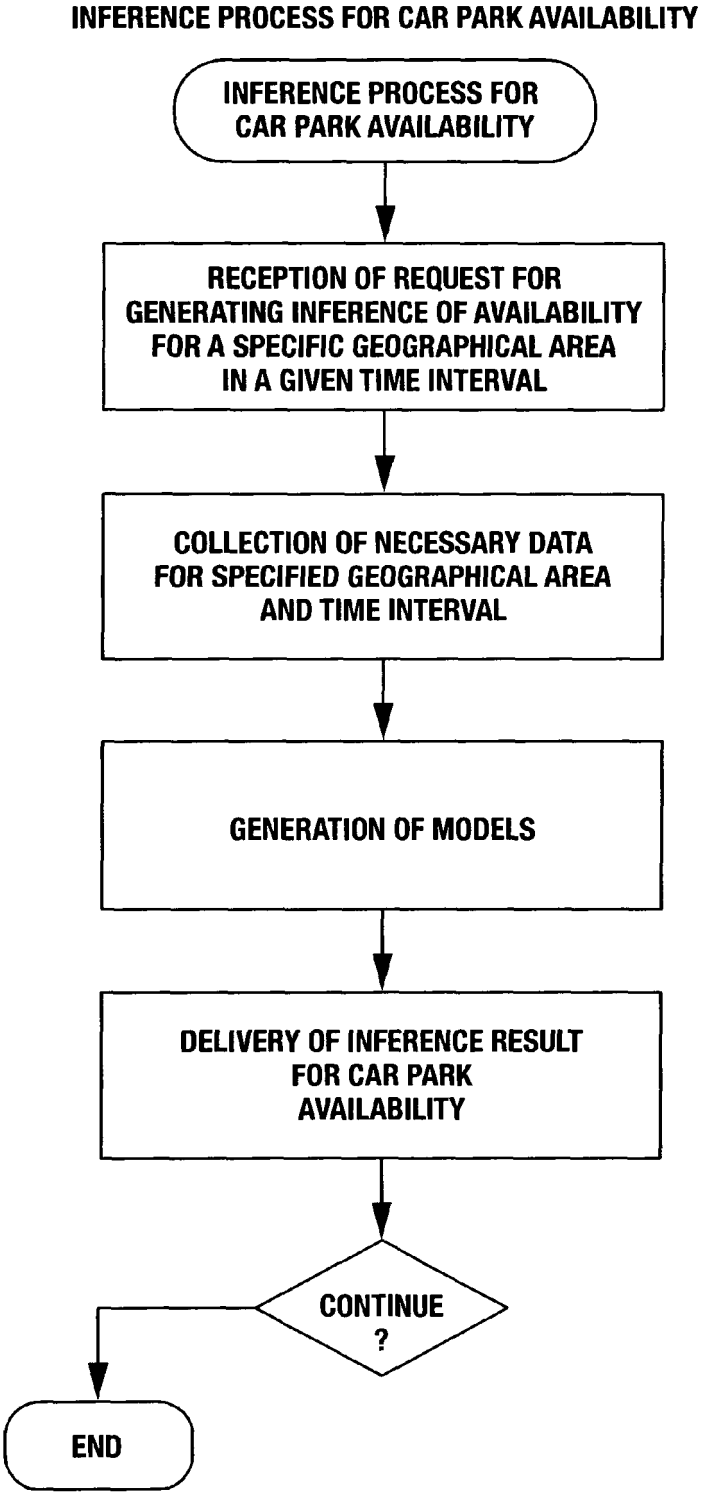
INFERENCE PROCESS FOR CAR PARK AVAILABILITY
INFERENCE PROCESS FOR CAR PARK AVAILABILITY
RECEPTION OF REQUEST FOR GENERATING INFERENCE OF AVAILABILITY FOR A SPECIFIC GEOGRAPHICAL AREA IN A GIVEN TIME INTERVAL
COLLECTION OF NECESSARY DATA FOR SPECIFIED GEOGRAPHICAL AREA AND TIME INTERVAL
GENERATION OF MODELS
DELIVERY OF INFERENCE RESULT FOR CAR PARK AVAILABILITY
CONTINUE ?
END

Fig. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 11 40 5347

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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X	FR 2 909 477 A1 (PEUGEOT CITROEN AUTOMOBILES SA [FR]) 6 June 2008 (2008-06-06) * page 3, line 8 - page 8, line 27; figures 2,3 *	1-18	
X	WO 2010/023571 A1 (WAZE MOBILE LTD [IL]; LEVINE URI [IL]; SHINAR AMIR [IL]; SHABTAI EHUD) 4 March 2010 (2010-03-04) * paragraph [0019] - paragraph [0024] *	1-18	
X	US 6 927 700 B1 (QUINN JOSEPH P [US]) 9 August 2005 (2005-08-09) * the whole document *	1-18	
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	24 January 2012	Créchet, Patrick

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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24-01-2012

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