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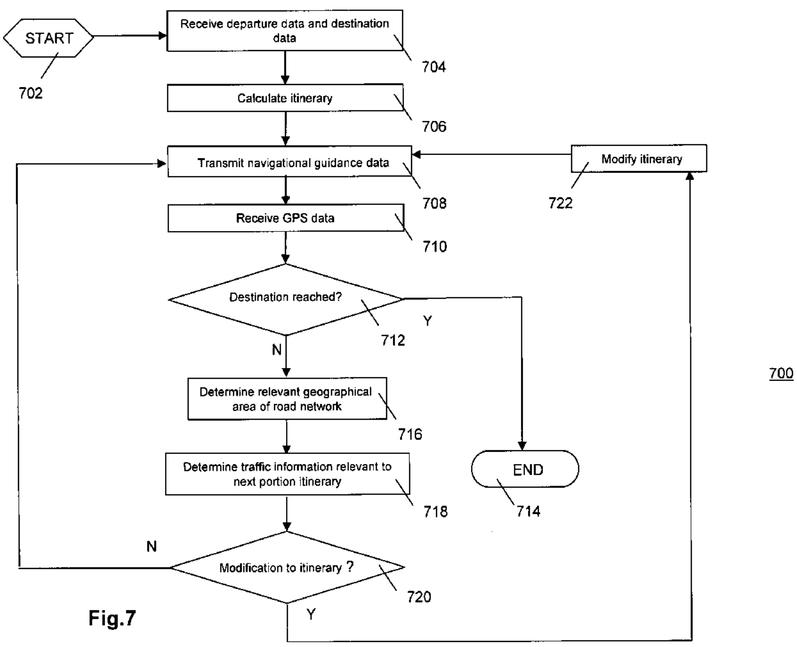


Fig.7

**(57) Abstract:** A navigation device has a GPRS receiver for receiving real-time information about slow traffic flow or slow average speed on a stretch of motorway, indicating congestion. The device calculates a new itinerary to avoid the congestion, based on historically recorded speeds on secondary roads weighed by the current average speed in the congestion area.

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# NAVIGATION DEVICE ASSISTING ROAD TRAFFIC CONGESTION MANAGEMENT

## FIELD OF THE INVENTION

The invention relates to a mobile electronic navigation device, software for implementing a functionality of the device, and, a method of providing a service to a user of such as device.

## BACKGROUND ART

Advances in technology and the increasing pressures of congested road environments have encouraged the development and adoption of Personal Navigation Devices (PND). The abbreviation PND is sometimes used to refer to a “portable navigation device”, but in this specification will be given its more expansive definition, covering any kind of personal navigation device that is either portable (e.g., can be fixed to an auto windscreen using a suction mount), or embedded (e.g. permanently fixed into an automobile). PNDs can be dedicated navigation devices (e.g., a device whose primary function is navigation) or can have multiple other applications (e.g., media players) or can have a primary function other than navigation (e.g., a mobile telephone). PNDs are used predominantly, but not exclusively, in cars and other motor vehicles. PNDs incorporate geographical map databases including road information and points of interest. They generally include software which allows the user to input a destination and to be provided with one or more routes; driving instructions are issued to guide the driver along the selected route to the destination. The PND may include a mount attachable to an automotive windscreen.

The selection of the route along which to guide the driver can be very sophisticated, and the selected route may take into account existing and predicted traffic and road conditions, historical information about road speeds, and the driver's own preferences for the factors determining road choice. In addition, the device may continually monitor road and traffic conditions, and offer to or choose to change the route over which the remainder of the journey is to be made due to changed conditions.

Road travel is a major part of everyday life for businesses, for other organizations, and for private individuals. The costs of traffic delays can be very large. The purely financial cost has been estimated as billions of pounds in the UK alone. In view of these costs, systems which can assist drivers to optimize their travel, for instance by selecting the best route and by avoiding congestion delays, are of significant value. In fact, a diverse array of driver information systems has grown up. The longest established are broadcast radio traffic reports which aggregate data from a number of sources such as the police, eye-in-the-sky, and more recently mobile phone calls from drivers stuck in traffic jams, to provide subjective advice about incidents and delays. Radio Data System (RDS) radios make these systems more effective by automatically cutting to traffic reports from normal radio programs. Static route planning systems are provided on the websites of major motoring organizations such as the Automobile Association (AA) and RAC in the UK. These allow a driver to enter the points of a journey and to be given a route and driving instructions for that route.

In the recent past, in-vehicle personal navigation devices have been introduced based on Global Positioning System (GPS) technology. Examples of these are the TomTom GO™ series of PNDs. Personal navigation devices use the GPS system to discover the exact position of the vehicle on the road network and to plot the location of the vehicle on an on-screen road map. PNDs contain a mechanism for computing best or good routes between two or more points on the road network and can direct the driver along the chosen route, continually monitoring their position on that route. Personal navigation devices have begun to incorporate traffic information into their services, and in some, traffic information is integrated into the route selection process: the PND will route around congested roads. Where traffic information is provided by the PND, the user can observe delays where they impact the selected route, and guide the device to re-plan a route avoiding the delayed sections of road if they consider this necessary. Real-time traffic monitoring systems, based on various technologies (e.g. mobile phone calls, fixed cameras, GPS fleet tracking) are being used to identify traffic delays and to feed the information into notification systems.

As mentioned above, road traffic can be monitored in real-time on the basis of mobile phone calls as follows. In a mobile phone system, subscribers carry handsets. When the subscriber initiates or receives a call or text message or data session, radio communication takes place between the handset and a base transceiver station (BTS), the familiar mast on the modern landscape. As well as transmitting an encoding of the message passing between caller and call recipient, the handset and BTS transmit a large amount of control information between themselves for the purposes of reliably and efficiently supporting the communication; for example the system must choose when to pass the call to another BTS as the subscriber moves about. The control information in a Global System for Mobile Communications (GSM) system or in a Universal Mobile Telecommunications System (UMTS), contains information on the signal strength of neighboring BTSes, timing advance information to instruct handsets further from the BTS to transmit earlier in order to match their time slot, transmission error rates and much more. Other technologies, such as code division multiple access (CDMA), use different information to achieve the same purposes of reliable and efficient communication. Collectively, these parameters are being referred to as the mobile phone control parameters. A location parameter database (LPDB) correlates mobile phone control parameters with geographical locations of handsets. LPDBs can be constructed and maintained by one of several means, and can map one of several useful subsets of control parameters to geographical locations.

For more background information on such PNDs and above services, see, e.g., US patent application publications US 20070225902; US 20070185648; US 20070118281; and US 20070117572, all owned by TomTom International B.V. and herein incorporated by reference.

For more background information on monitoring road traffic through monitoring usage of mobile telecommunication devices onboard road vehicles see, e.g., WO200245046 ("Traffic monitoring system"); and WO2007017691 ("Method of finding a physical location of mobile telephone at a given time"), incorporated herein by reference.

## SUMMARY OF THE INVENTION

The inventors aim at improving navigational guidance to an individual user of a road vehicle. The inventors further intend to improve traffic management so as to avoid or reduce traffic congestion.

The invention relates, among other things, to a mobile electronic navigation device configured for providing navigation information to a mobile user on a road network, depending on a geographic position of the device and upon being programmed to guide the mobile user to a pre-determined destination via an itinerary. The device comprises: a storage for storing information, e.g., roadmap information, about a segment of the road network, including historical data representative of respective historical traffic progress (e.g., average speeds or average traffic flow) on respective roads in the segment; a wireless receiver for receiving data indicative of a current traffic progress (e.g., current average speed or current traffic flow) on a stretch of a specific road in the segment; and a data processor coupled to the receiver. The processor is further operative to carry out following tasks. The processor determines if the stretch is included in a portion of the itinerary yet to be traveled. If the processor has determined that the stretch is not included, the itinerary is being used for determining the navigational guidance. If the processor has determined that the stretch is included, the processor uses the historical data to determine an alternative itinerary to the destination based on comparing a first expected travel time for the itinerary, given the current traffic progress, to a second expected travel time for the alternative itinerary. Depending on a result of the comparing, the processor starts to provide the navigation information with respect to the alternative itinerary.

Accordingly, the navigation device in the invention provides navigational guidance according to an alternative itinerary upon receipt of real-time information about the current traffic progress on a stretch of road in the upcoming leg of the original itinerary that may indicate that the alternative itinerary has a shorter expected travel time. The data received via the receiver may indicate an emerging or existing traffic jam in the upcoming leg of the trip. The device in the invention then seeks an alternative to the original itinerary for the part to be traveled. If the traffic jam has disappeared before the user has to be guided according to the alternative itinerary, the receiver receives data indicating an improved traffic progress (e.g., increased traffic flow or increased average speed) on the stretch and the device determines in a similar way that the original itinerary is to be taken as a basis for guidance.

In an embodiment of the device in the invention, the second expected travel time is calculated based on scaling the historical traffic progress (e.g., average speed or average traffic flow) on a further road in the alternative itinerary with a quantity representative of the current traffic progress (current average speed or current traffic flow) on the specific road. The scaling finds its origin that congestion on one road may lead to heavier traffic on connecting roads. That is, the congestion affects traffic flow and average speeds in the vicinity. By means of taking into consideration this phenomenon through the scaling, alternative routes are calculated that more reliably approximate the shortest overall travel time to the destination.

In addition to the current traffic progress conditions, current or expected weather conditions may also affect the travel time or, more generally, may also affect the itinerary. Real-time information about weather conditions is therefore preferably also taken into account when calculating modifications to the current itinerary. For the purpose of the invention, weather conditions such as fog, rain, snowfall, black ice, etc., can be translated into quantities representative of the (virtual) traffic progress. In case of hazardous road conditions due to bad weather, the expected travel time to cover the itinerary's stretch affected by the weather is scaled up. The scaling factor can be determined, e.g., based on historical data (see the historical data extracted from GPS traces further below) or can be determined by experiment or roughly estimated. This scaling up of the travel time is the quantity considered in the data processing in the invention regardless of the origin: whether originating from traffic congestion or from hazardous road conditions. Accordingly, the concept "current traffic progress" is also understood herein as to cover "current or expected weather conditions" for the purpose of the invention.

Another embodiment of the invention relates to software for a mobile navigation device configured for providing navigation information to a mobile user on a road network, depending on a geographic position of the device and upon being programmed to guide the mobile user to a pre-determined destination via an itinerary. The device comprises: a storage for storing information about a segment of the road network, including historical data representative of respective historical traffic progress on respective roads in the segment; a wireless receiver for receiving data indicative of a current traffic progress on a stretch of a specific road in the segment; and a data processor coupled to the receiver. The software comprises instructions for control of the processor to: determine if the stretch is included in a portion of the itinerary to be traveled; if the stretch is not included, to keep using the itinerary; if the stretch is included, using the historical data to determine an alternative itinerary to the destination based on comparing a first expected travel time for the itinerary, given the current traffic progress, to a second expected travel time for the alternative itinerary; depending on a result of the comparing, starting to provide the navigation information with respect to the alternative itinerary. Preferably, the software comprises further instructions for the processor to calculate the second expected travel time based on scaling the historical traffic progress on a further road in the alternative itinerary with a quantity representative of the current traffic progress on the specific road.

Accordingly, the software can be provided as an after-market add-on or as an upgrade to an installed base of electronic navigation devices that have a wireless receiver. A separate wireless receiver can optionally be mounted to a conventional electronic navigation device so as to make use of the service enabled by the supply data representative of real-time traffic conditions as specified above.

The wireless receiver introduces above includes, e.g., a General Packet Radio Service (GPRS) receiver. As known, GPRS is a packet-oriented Mobile Data Service available to users of GSM mobile telephones. The expression "packet oriented" refers to the way data packets are multiplexed. GPRS data communication can be unidirectional or bi-directional. Alternatively, the wireless receiver comprises a Radio Data System (RDS) receiver. The RDS technology uses conventional FM radio broadcasts to send data. RDS technology is typically used to implement a Traffic Message Channel (TMC) for delivering traffic information to drivers. Other implementations of the wireless receiver are based on, e.g., Digital Audio Broadcasting (DAB) technology, or satellite radio, the latter using a communications satellite that covers a larger geographical area than do transmissions using a terrestrial technology.

The GPRS technology enables a bi-directional data communication. This can be used in an embodiment of the invention, wherein the PND has a GPRS receiver and a GPRS transmitter and wherein the PND is configured as a thin-client that delegates to a server the calculation and/or re-calculation of the itinerary to the predetermined destination.

Accordingly, the inventors further propose a method of providing navigation information to a user of a mobile navigation device, depending on a geographic position of the device, for guiding the user to a pre-determined destination via an itinerary. The method comprises following steps. Data is received from the device representative of the geographical position. A segment of a road network is determined relevant to the itinerary given the device's current geographical position. Information is determined about the segment, including historical data representative of respective historical traffic progress on respective roads in the segment. Current traffic progress is determined of traffic on a stretch of a specific road in the segment. Then it is determined whether or not the stretch is included in a portion of the itinerary to be traveled. If the stretch is not included, then the itinerary is used. If the stretch is included, the historical data is used to determine an alternative itinerary to the destination based on comparing a first expected travel time for the itinerary, given the current traffic progress, to a second expected travel time for the alternative itinerary. Depending on a result of the comparing, navigation information is provided with respect to the alternative itinerary.

Preferably, the second expected travel time is calculated based on scaling the historical traffic progress on a further road in the alternative itinerary with a quantity representative of the current traffic progress on the specific road.

An advantage of the thin-client approach or of having the processing delegated to a server, resides in the fact that the server has available traffic information and weather information about multiple geographic areas, including the area wherein the user is advancing. This enables dynamically optimizing the itinerary on a scale larger than only locally within a single one of the geographic areas.

## BRIEF DESCRIPTION OF THE DRAWING

The invention is explained in further detail, by way of example and with reference to the accompanying drawing, wherein:

Fig.1 is a block diagram of a system in the invention;

Figs.2 and 3 give formulae explaining aspects of the invention;

Fig.4 is a block diagram of a first example of a navigation device in the invention;

Figs.5 and 6 are block diagrams of further examples of a navigation device in the invention; and

Fig.7 is a flow diagram of a method of providing navigational guidance to users of the devices of Figs. 5 and 6.

Throughout the Figures, similar or corresponding features are indicated by same reference numerals.

## DETAILED EMBODIMENTS

According to some studies, about 25% of traffic monitored on a specific road or highway consists of vehicles driving a longer, inter-regional route. This is a significant group which could take quite easily an alternative to the specific road or highway. The question is how to inform of the alternative? Authorities could inform all drivers driving in the region north of the city of Amsterdam that today it is better to use the Enkhuizen - Lelystad dike road if they intend to go to Flevoland or beyond. Drivers coming from the Amstelveen/Schiphol region could be advised to drive via the city of Utrecht. However, it is extremely difficult to inform these drivers and even more so to convince them that they should take the advice. The drivers need more detailed information in order to be able to accept the alternative route.

The system in the invention proposes the alternative routes to a driver via the mobile navigation device onboard the driver's vehicle. The alternative routes are proposed together with a clarification of the expected advantage of taking these alternative routes. Accordingly, when traffic gets congested in a certain geographical region, the system of the invention advises the drivers, driving within this region or traveling towards this region, to proceed according to the directions being currently given via the mobile navigational device in order to avoid the congestion automatically. The system in the invention thus helps the drivers to reach their destination sooner. In addition, the system also contributes to reducing the volume of traffic passing through the congested area by means of spreading it across the rest of the road network in the vicinity of the congested region.

The majority of the cars in traffic jams turn out to be on a short intra-regional trip. An example of drivers on an intra-regional trip is people living in the town of Almere who intend to do some shopping in the nearby city of Amsterdam. The system of the invention enables these drivers to be informed, before starting their trip, about expected travel times. If delays are to be expected due to traffic congestion, these people may want to reconsider their trip. They may decide to do some local shopping instead, to drive to another town or city, or to take one of the proposed alternative routes or use public transport. Again, traffic volume passing through the congested area will be reduced.

There always remains a group of drivers who, despite the congestion, decide to enter the congested area. It is a common misunderstanding that in this situation, driving through small villages and city centers instead, so as to bypass the congestion, is an acceptable solution. Studies have confirmed that such driving is completely ineffective. Reasons for this are, among others, that the maximum allowed road speeds are low and that, because of traffic lights and non-efficient routes, the average speed attainable is not higher than 15 km/hr to 25 km/hr. In most cases the driver's destination is reached much faster by just staying the traffic jam or using the regional roads. All devices from TomTom, the current Assignee, use by default these settings of the fastest route so as to avoid guidance via inefficient routes. However, the lack of reliable, up-to-date travel time information causes people to find there own routes, however inefficient. The system of the invention aims at convincing these people to accept the navigational information to their own benefit.

Accordingly, the system in the invention provides more reliable and efficient guidance directions to people on the move. Based on excellent travel time estimation, people can consider and easier accept alternative routes. The system of the invention improves the utilization of the main road network and contributes to reducing traffic congestion. Drivers on inter-regional trips are re-routed so as to bypass the congested area. Regional drivers will be advised to use regional alternatives or just accept the delay caused by the congestion.

The system of the invention generates high-quality traffic information for the entire road network. The system enables to propose alternative routes that better exploit the road network available around congested areas. The system uses a multi-source strategy. The system combines traffic information from existing sources, e.g., as supplied by the road authorities and other public services, with traffic information generated based on data supplied by mobile telephone network operators and traffic information supplied by users of GPS-enabled mobile navigation devices. As a consequence, a detailed overview of congestion bottlenecks is created. This detailed overview can then be used to generate navigation information about alternative routes.

Fig.1 is a block diagram of a system 100 in the invention. System 100 comprises a data collection and acquisition sub-system 102 that receives data from transportation departments, road operators or road authorities, local government, etc., all referred to here as "authorities" 104, data from mobile telephone network operator(s) 106 and data from users of GPS-enabled mobile navigation devices 108.

The data received from authorities 104 is representative of, e.g., conventional traffic information obtained via traffic monitoring equipment on the roadside. Such equipment includes, e.g., live cameras and other road sensors such as inductive loops integrated in the road surface. Other data received from authorities 104 may include roadwork reports. Yet other data received from authorities 104 include, e.g., weather forecasts or real-time weather radar data. The real-time weather radar data enables to, e.g., scale up expected travel times on roads in regions with heavy precipitation, with reduced visibility as a result of fog or drizzle, or with strong gusts of winds in order to account for slower traffic.

The data received from operator 106 is representative of road traffic monitored in real-time on the basis of mobile phone calls as explained above and in, e.g., WO200245046 and WO2007017691, mentioned above.

The data received from users of GPS-enabled mobile devices 108 is based on the following. Device 108 is configured for recording GPS traces. When device 108 is in operational use, device 108 repeatedly records its geographic location and a time stamp in a file. The records in file enable to reconstruct the trips taken with this particular device. An example of such device

108 is made by the Assignee. Device 108 cooperates with a software program ("TomTom Home") installed on the user's home PC or laptop PC. The software program enables the user to update, personalize and otherwise manage device 108. For example, if the user wants to install a new map, a custom points-of-interest database, or have device 108 give directions in another voice, the user can simply download these and other components from a server via the Internet and have them installed on device 108. The program also allows planning one's trip in advance from home. When connected to the server, the server will upload the file of records. The records are collected from all devices 108 and stored in sub-system 102.

Accordingly, system 100 has real-time data available through mobile telephone network operator 106 and historic data available through the download of GPS traces. These data now are processed in data processing sub-system 110 for generating traffic information stored in storage 114.

Data processing sub-system 110 processes the historic data (e.g., as represented by the GPS traces from devices 108) is processed to generate traffic information, including mean speeds for roads that are not, or not adequately, covered by real-time data from operator 106 for the purposes of the invention. In order to explain the processing, consider the following scenario.

Consider the situation at an arterial route bypassing an urban environment. This urban environment can be a small town, bypassed by a national motorway or a heavily used big urban main road which goes around a major city, or crosses suburbs or the city's center. When the arterial route is not congested, the GSM-based data received from operator 106 and the GPS-based data from devices 108 indicate normal transit times on the main roads. But, during rush hour, the transit time might increase sharply. The data received from operator 106 and devices 108 indicate this increase in transit time during rush hour. An increase in transit time is equivalent in a decrease of the average road speed. For example, normally the average speed lies between, say, 100 km/hr and 120 km/h, but during rush hour the average speed is around 30 km/h. During rush hour, the average speed on the urban network of secondary roads decreases as well, e.g., from around 35 km/h to around 15 km/h. The real-time data received from operators 106 does not enable to reliably measure real-time travel times on the urban smaller roads owing to the low volume of traffic; only on the urban arterials the measured travel-times are useable owing to, among other things, the higher traffic volume. Therefore, if the mobile navigation device of a user does not consider these varying average road speeds on the secondary roads, it may lead the user into the congestion or slow-moving traffic on the secondary roads, as these are not associated with the average speed of 15 km/hr during rush hour, but erroneously with the static average speed of 35 km/hr, which is still faster than the current average speed of 30 km/hr on the congested arterial route.

In order to improve navigational guidance to the drivers, the inventors therefore propose to use both the real-time GSM-based data and the historical GPS-based data in order to provide an estimate of the average speed or travel time on the secondary roads as is explained further below in detail.

Now consider the following scenario. System 100 determines via, e.g., the data from operator 106, that a certain stretch of a specific motorway is congested. That is, the average speed on this stretch is dramatically lower than during normal traffic flow. It is plausible to assume that the congestion also affects the average speeds on the secondary roads leading into, or exiting from, the congested stretch of the motorway. The traffic information generated and stored as data in storage 112 relates to the average speed on the congested stretch and/or expected travel time to cover this stretch under current circumstances. Via a server 114, this data is sent via a data network 116, which includes a GPRS infrastructure, to users of electronic navigational devices 118 in the relevant geographic area. GPRS is a known technology enabling to receive data packets via a mobile data service available to users of GSM mobile telephones. As mentioned above, wireless data communication technologies other than GPRS can be used to communicate data from server 114 to device 118. GPRS is mentioned here as a practical example. Note also that in addition to traffic information in terms of current average speeds on the roads considered, server 114 may also communicate to devices 118 data representative of weather conditions existing or being expected in the relevant geographical area. The data could refer to, e.g., strong gusts of wind, fog, black ice, etc. Devices 118 are preferably configured to process this data to generate information conveyed to the users of devices 118 via their display monitor and/or loudspeaker.

Navigational devices 118 are configured to process this data as follows, and as is explained in further detail below. The congestion may affect the travel times of one or more users of devices 118, given their destinations and given their original itinerary as first calculated by devices 118. Device 118 now recalculates the itinerary by taking into account the expected speeds or travel times on the secondary roads in the congested area, given the speed on the congested motorway stretch. To this end, device 118 has available the required information, e.g., from its local storage. Device 118 thus can make an educated guess about what routes to take in the detour in order to optimize, e.g., travel time, in the presence of traffic congestion ahead.

Details of the approach taken are as follows. The inventors introduce the concept of a virtual real-time speed (VRS). In an embodiment of the invention, the VRS is computed within the PND in situations wherein real-time data is not available for the relevant road. The VRS is computed based on the historic average speed information for that road. The VRS is computed for secondary road sections in a certain geographic area with traffic affected by congestion on the main motorway or main arterial route in that area. The VRS is determined by the speed of the real-time traffic on the main motorway. The VRS on a secondary road is assumed to depend on the real-time speed on the neighboring main motorway under some circumstances. The invention now exploits this dependence to improve accuracy of navigational guidance to the individual user of device 118.

Several approaches can be taken to determining a VRS: a line-based approach and an area-based approach, as explained in detail below. Preferably, the area-based VRS is used. However, in case the area-based VRS cannot be computed, the line-based approach is used.

For the line-based approach, one proceeds as follows. The real-time speed on a section of the relevant motorway, as determined from the GSM-based data, has a value $V_{real\text{-}mot}$. The historical average speed on this section, as determined from the GPS-traces, has a value $V_{hist\text{-}mot}$. Now consider a road segment in the road network surrounding the section of the motorway. For this segment, labeled "i", the VRS is assigned a value $V_{i,VRS\text{-}seg}$ by means of, e.g., scaling the historical average speed of the segment $V_{i,hist\text{-}seg}$ with a function $F_{line}$ according to expression (202) of Fig.2. The historical average speed of the segment $V_{i,hist\text{-}seg}$ is determined on the basis of the GPS traces mentioned above. Scaling function $F_{line}$ depends on a first quantity $V_{real\text{-}mot\text{-}line}$ and on a second quantity $V_{hist\text{-}mot\text{-}line}$ according to expression (204) in Fig.2. First quantity $V_{real\text{-}mot\text{-}line}$ is defined as the average of the real-time speeds, as measured from the GSM-based data, on N sections of the relevant motorway according to expression (206). The sections are identified on the basis of, e.g., traffic message channel (TMC) codes known in the art. Second quantity $V_{hist\text{-}mot\text{-}line}$ is defined as the average of the historical speeds, as recorded from the GPS traces, on the N sections of the relevant motorway according to expression (208). An example of a useable scaling factor F is given in expression (210) of Fig.2, but other dependences are possible as well.

Expression (210) implies for expression (202) that the ratio of $V_{i,VRS\text{-}seg}$ to $V_{real\text{-}mot\text{-}line}$ is assumed to be equal to the ratio of $V_{i,hist\text{-}seg}$ to $V_{hist\text{-}mot\text{-}line}$. This is interpreted, roughly, as that the ratio of the number of vehicles, assumed to be currently present on secondary road segment "i", to the number of vehicles, currently present on the N sections of the motorway, equals the ratio of the number of vehicles, present in the past on segment "i" according to the GPS traces in the considered time window, to the number of vehicles, present in the past on the N sections of the motorway in the same time window. That is, the traffic on the secondary roads is scaled to the traffic on the main motorway.

Above examples of scaling factors in expressions (202), (204) and (210) give rise to relatively simple models that are, nevertheless, useful in modeling traffic flow in practice for purposes of the invention. The scaling factor signifies the phenomenon that congestion on the motorway leads to slower speeds on the connecting secondary roads in the neighboring part of the road network. In general, the relationship between speed and traffic flow is a complicated one, and may take into account many other quantities, in addition to speed, for modeling traffic flow, such as, e.g., response time, acceleration and deceleration of individual vehicles, the time-derivative of speed and/or traffic volume, the location-derivative of speed and/or traffic volume, etc . Shock waves may form in the traffic flow resulting in the notorious traffic jam or pile-up collisions. See, e.g., G.B. Whitham, "Linear and Nonlinear Waves", chapter 3.1 "Traffic Flows", Wiley-Interscience 1999.

Instead of using expression (202), one could use, e.g., a set of values for the quantity $V_{i,VRS\text{-}seg}$, e.g., a set of two values wherein one pre-set value represents normal speed (when the corresponding main motorway is not congested), and the other pre-set value represents the flow in case the main motorway is congested. The latter value could be determined by scaling the normal speed by a factor representative of the real-time speed at the connected stretch of the congested motorway. Other dependencies can be considered so as to determine a quantity representative of an expected travel time along a certain route, given the historical data about the route's average speed and/or traffic volume, while taking into account the effect of congestion on roads nearby.

The scaling factor of expression (210) uses the ratio of speeds. Alternatively, a scaling factor $M_{line}$ could be used with expression (202) that includes the ratio of a first quantity $TF_{real\text{-}mot\text{-}line}$ to a second quantity $TFhist_{\text{-}mot\text{-}line}$ as given in expression (212). First quantity $TF_{real\text{-}mot\text{-}line}$ is defined as the average of the real-time traffic flow (i.e., the number of vehicles passing a location per unit of time), as measured through, e.g., loop sensors in the road surface, on one or more sections of the relevant motorway. Second quantity $TF_{hist\text{-}mot\text{-}line}$ is defined as the average of the historical traffic flows on the one or more sections of the relevant motorway.

Note that the historical data taken into account in these calculations should preferably have time stamps in time slots corresponding to the current moment. For example, the VRS calculated at a moment being 17:00 GMT on a certain Wednesday should take into account data from GPS traces generated around the same time of the day and also on past Wednesdays.

The line-based approach has turned out to be less accurate than the area-based approach. The line-based approach is therefore preferably used only when the area-based approach does produce an appropriate VRS. The area-based approach is discussed below in detail, followed by describing a scenario wherein the line-based approach should preferably be used.

For the area-based approach one proceeds as follows. The real-time speed on a section of the motorway is referred to as $V_{real\text{-}mot}$ and is determined on the basis of the GSM data. The historic average speed on this section is referred to as $V_{hist\text{-}mot}$ as determined on the basis of the GPS traces In case the real-time speed $V_{real\text{-}mot}$ on the motorway drops below a certain threshold level $V_{real\text{-}mot\text{-}threshold}$ (as an indication of a serious unusual blockage of the motorway), the area-based virtual real-time speed is computed.

Threshold speed $V_{real\text{-}mot\text{-}threshold}$ can be derived from the historic speed data using a threshold factor $G_{threshold}$. The historic speed data has been stored in the speed profile of that particular motorway section in storage 102 and the threshold factor $G_{threshold}$ has to be determined experimentally. Above considerations regarding time stamps in the line-based approach apply as well in the area-based approach. Expression (302) of Fig.3 conveys the meaning of $G_{threshold}$. If $V_{real\text{-}mot}$ drops below the threshold speed $G_{threshold}$, then the VRS on the secondary roads in the area around the motorway section need to be used.

This VRS calculation is similar to the one discussed above under the line-based approach. The scaling factor $H_{area}$, however, is now computed for an area instead of for a line, assuming that enough real-time data is available for the roads in the area. The scaling factor $H_{area}$ per section of the motorway is computed by dividing, the averaged real-time speed of the roads in the relevant area by the averaged historic speeds of these roads where real-time speed is measured. Real-time speed measurements as extracted from the GSM-based data supplied by operator 106 discriminates in traffic on a road going in one direction and traffic on the same road going into the other direction. See, e.g., WO200245046 and WO2007017691, mentioned above.

Preferably, upon receipt of this real-time data by navigation device 118, device 118 only considers those measurements that relate to traffic flow in those directions and on those roads that lay in a routing corridor from the user's current location towards the pre-determined destination. Here, a routing corridor is that part of the road network around the congested area to be avoided, that comprises routes which are candidates for being included into the alternative itinerary. A route in this sense is a directed graph. By taking into account the routing corridor, one prevents, among others things, that traffic flowing into the direction opposite to the direction of travel of the user of device 118 and on the same route, is taken into account when determining the detour. Accordingly, scaling factor $H_{area}$ depends in general on the predetermined destination.

Another difference is that it will be scaled to the set of real-time measured speeds on the secondary road network instead of to the set of real-time measured speeds on the motorway stretch. The above is further explained as follows.

Expression (304) corresponds to expression (202) of Fig.2, differing in the scaling factor. Scaling factor $H_{area}$ is specified in expression (306) of Fig.3 as depending on a first quantity $V_{real-area}$ and a second quantity $V_{hist-area}$. First quantity $V_{real-area}$ is defined in expression (308) as being the average of all real-time speeds measured on the secondary roads, j= 1, ..., M in the road network segment around the congestion on the main road or motorway stretch. Second quantity $V_{hist-area}$ is defined in expression (310) as being the average of all historical speeds measured on the secondary roads, j= 1, ..., M in the road network segment around the congestion on the main road or motorway stretch. Preferably, only those real-time speeds and historical speeds are considered that belong to the routing corridor, as mentioned above. A simple example of scaling factor $H_{area}$ is given in expression (312) as the ratio of quantity $V_{real-area}$ to quantity $V_{hist-area}$. As mentioned above under the line-based approach, other dependencies may be considered in the area-based approach as well. Likewise, instead of basing the scaling factor $H_{area}$ on measured speeds (real-time and historical) one could instead take real-time traffic flow and historical traffic flow to determine scaling factor $H_{area}$.

The above calculation and recalculation of the itinerary has been illustrated with a scenario with a user of device 118 being on the road and receiving via GPRS updates about the traffic conditions ahead. A similar scenario is applicable to a user who is still at home and is planning his trip just before departing. The user now uses dedicated software 120 on his/her PC 124 in Fig.1 for downloading the itinerary onto his/her mobile navigation device 118. Similarly, the current and expected traffic conditions give rise to a certain itinerary, that is downloaded to device 118 and that again may be changed dynamically while the user is driving. Further, the relevant data as provided by server 114 may be supplied to authorities 124 so as to be able to respond to the traffic situation. Authorities 124 may include those introduces under authorities 104, but may also include personnel of ambulances, fire engines, exceptional road transport operators, railway operators, bus operators, etc.

As mentioned above, the information gathered in storage 102 may also include information about current or expected weather conditions, e.g., as inferred from the weather radar. Note that hazardous weather may affect the road conditions similarly to traffic congestion from the point of view of traffic flow. That is, the average speed attainable in fog, heavy rain, during a snow storm, or in the presence of black ice will be lower than under more favorable weather conditions. In an embodiment of the invention, hazardous weather conditions can be mapped onto a quantity that represents an equivalent traffic flow for purposes of calculating the itinerary as described above. That is, the GPRS data are interpreted by device 118 as representative of traffic flow conditions or average speeds, whereas the data has originated directly from weather conditions.

In order to explain the use of the traffic information generated in system 100, consider mobile navigation device 118 in more detail. Reference is now made to Fig.4

Navigation device 118 comprises: a GPS receiver 402, a wireless receiver 404, a database 406 storing map information, user controls 412 to enable a user to control device 120, a rendering sub-system 408, trace storage 410 and a data processor 414 executing under control of software 416. Processor 414 takes care of processing of data and of controlling the other components of device 118 for the purpose of delivering navigational service to the user of device 118. Wireless receiver 404 includes, e.g., a GPRS modem.

GPS receiver 402 is configured to determine the current geographic location of device 118. The information about the current location is used by processor 414 to determine in database 406 the road map and other location-dependent information relevant to the user of device 118 given the current location. Given the destination of the journey and the road information from the map, software 414 enables to generate navigational guidance and have it played out via rendering sub-system 408. As in conventional mobile navigation devices, the user enters the destination and other control information (e.g., preference with regard to playing out the guidance information via user controls 412, preference to avoid motorways, etc.). User controls include, e.g., hard buttons and/or soft keys implemented on a touch screen in conjunction with an ergonomic menu of control options, voice input and/or any other suitable means for letting the user interact with device 118.

Sub-system 408 preferably includes a display monitor (not shown) and a loudspeaker (not shown). The display monitor provides the guidance as graphical and text information, and the loudspeaker supplies the guidance in the form of pre-recorded or synthesized speech. As is clear, rendering sub-system 408 can be implemented as being partly or completely external to device 118. In that case, device 118 comprises suitable interfaces for communicating to sub-system 408. For example, rendering sub-system 408 comprises a projection system for a head-up display to project the relevant information onto the windscreen of the car (or on the visor of the helmet worn by a motorcycle rider). The car's projection system is usually physically integrated with the dashboard. The projection system for the motorcycle rider is integrated in the helmet, and is powered through a battery or a cord connecting the helmet to the motorcycle's power supply. The relevant data is then communicated wirelessly, e.g., via a Bluetooth interface, or wired. As another example, rendering sub-system 408 comprises a loudspeaker that is a component of the car's built-in sound system or, in the case of the motorcycle rider, is built into the rider's helmet.

During the trip, the geographic positions, based on the GPS information are stored in trace storage 410, together with time stamps. When device 118 is connected to the user's home PC, e.g., in order to receive updates to roadmaps or an update to software 416 from the service provider via the Internet, the data stored in storage 410 is sent to the service provider where it is processed anonymously, i.e., without being associated with the individual user of device 118.

GPRS is a known technology. GPRS modem 404 enables device 118 to receive data packets via a mobile data service available to users of GSM mobile telephones. The data rates are in the order of 56 kbps to 114 kbps. Generally, data services provided via GPRS can be point-to-point services (i.e., data communication between two users), and point-to-multipoint (or: multicast, i.e., from one user to many users). With regard to the multicast GPRS service, data packets can be broadcast within a certain geographical area. An identifier in the broadcast indicates whether the data packets are intended for all users in the geographical area or to a specific group of users. Within the context of the invention, this type of service enables to send updates with regard to traffic information relevant to users of device 118 within a certain geographical area.

In the above embodiments, the (re-)calculation of the itinerary is carried out by device 118 itself which, for this purpose, accommodates processor 414, database 406 and software 416. Device 118 only receives from server 114 the real-time traffic updates via GPRS modem 404 and then processes them to modify the itinerary and to generate navigational guidance on the basis of the modified itinerary and its current position according to the onboard GPS receiver.

Fig.5 is a diagram of a PND 502 in the invention, as an example of an alternative to device 118. Device 502 is implemented as a thin-client cooperating with server 114. Device 502 now comprises also a wireless transmitter 504 for communicating data to server 114. For example, transmitter 504 communicates to server 114 information about the destination of the journey to server 114 as entered through user controls 412, preferably together with the user's preferences (e.g., modality of supply of the navigational guidance such as male or female voice; avoid motorways; avoid toll booths; etc.). The preferences can be either selected by the user per individual journey or can have been pre-set as a default mode of operation. Transmitter 504 further communicates to server 114 data representative of the geographical position of device 502, as determined via GPS receiver 402.

Server 114 (re-)calculates the itinerary, similarly as discussed above, based on the current position of device 502, on the real-time traffic information gathered from GSM operator 106 and from GPS traces 108. If a large enough number of vehicles are using a PND configured as thin-client 502, then server 114 has real-time information about the geographical position of these vehicles that can be taken into account at system 100 as well to generate traffic information 112. Note that also for this reason, device 502 need not have trace storage 410 as the geographic positions of device 502 are being communicated in real-time to server 114.

An advantage of this implementation is that device 502 can be implemented as a lean data processing device. Another advantage is that server 114 can put navigational guidance to the user of device 502 into a broader context. This is explained as follows. Server 114 has traffic information and weather information 112 not only relating to the geographical area wherein the user of device 502 is currently present, but also relating to other geographical areas. This means that navigational guidance to the user of device 502 can be calculated so as to be optimized with regard to the entire region of the current journey from departure to destination. That is, a global optimization is possible. Note that, in contrast, device 118 receives only traffic information about local traffic conditions and that the modifications to the itinerary represent a local optimization. For example, consider the scenario wherein, in order to guide the user of device 118 around local, moderate traffic congestion in a specific area, device 118 provides guidance for a detour that happens to bring the user into a neighboring area wherein heavy congestion as a result of a massive pile-up has occurred as a result of a massive traffic accident. If the user had stayed with the original itinerary to ride out the moderate inconvenience he/she had not encountered the heavy congestion on the detour. Such bad luck, however, may be incidental and rare, depending on the density of the roads in the areas.

Depending on the bandwidth available at server 114 and in the wireless communication from server 114 to receiver 404, server 114 can be configured to carry out all data processing operations that were carried out in device 118 in the previous embodiment. That is, all data processing is delegated to server 114. Then, processor 414 in device 502 now mainly takes care of the control of rendering sub-system 408 to render the navigational guidance information. The navigational guidance information includes map data received from server 114 on an as-needed basis to be rendered on a display monitor of sub-system 408, and includes directions received from server 114 to be rendered as speech via loudspeaker in sub-system 408 and/or as graphical icons via the display monitor. In this case, device 502 itself does not need database storage 406 for storing road map data and other geographically related data, as everything is being communicated to device 502.

Note however, that, in order to receive data from server 114 for detailed navigational guidance, e.g., for rendering detailed roadmaps on the display monitor, receiver 404 and server 114 need to have sufficiently large bandwidth. GPRS-technology could in practice be inadequate for implementing the download of data from server 114 to device 502. GPRS technology can still be used for uploading of the GPS to server 114. Television technology, including a dedicated television channel can be used, in principle, for the download from server 114 to device 502.

Fig.6 is a block diagram of an embodiment 602 of a PND in the invention, whose configuration can be considered to lie halfway between the configuration of device 118 and the configuration of device 502. Similar to device 502, device 602 uses a wireless bi-directional data communication technology to communicate with sever 114, e.g., using GPRS technology in both receiver 404 and transmitter 504. Device 602 stores the road map data and other relevant geographic information in database 406, similar to device 118. Database 406, however, does not need to store the data representative of the historical averaged speeds recorded per individual road segment. Transmitter 504 uploads intermittently (for example, periodically or selectively depending on e.g., the changes in the direction of traveling) GPS data to server 114. As a result, server 114 is kept informed about the current geographical position of device 602. Server 114 downloads to device 602, via receiver 404, navigational guidance data. This data is calculated on the basis of the user's destination and the user's current geographic position, and on the basis of the historical and real-time traffic information and weather information created in storage 112. The creation process has been discussed above, e.g., with reference to Figs. 2 and 3. As with embodiment 502, an advantage resides in the fact that server 112 has available traffic information and weather information about multiple geographic areas, including the area wherein the user is driving or riding. This enables an optimization of the itinerary on a scale larger than only locally within a single one of the geographic areas. Processor 414 processes the navigational guidance data received from server 114, under control of software 604, to generate guidance information suitable for the user of device 602. For example, processor 414 generates visual and/or auditory instructions on rendering sub-system 408, and combines the guidance information with the relevant road map data retrieved from database 406.

As to user interface aspects of a PND in the invention, such as devices 118, 502 or 602, the following features may contribute to perceived user-friendliness of the device in operational use.

A first feature relates to device 118, 502 or 602 configured or programmed to notify the user of the current update to the recent itinerary based on traffic conditions or weather conditions as discussed above. The user is notified through, e.g., synthesized voice via a loudspeaker of sub-system 408 and/or via graphical indications on a display monitor in sub-system 408.

A second feature relates to the graphical representation of the navigational guidance on the display monitor in sub-system 408 of device 118, 502 or 602. For example, a portion of the currently relevant roadmap is rendered on the display monitor, and the corresponding portion of the currently used itinerary is projected onto the displayed map portion. The user then forms a mental picture of that part of the itinerary and its geographic environment. At a given moment, the current itinerary is modified as a result of undesirable traffic conditions and/or weather condition in the upcoming leg of the current itinerary, as discussed above. The user then has to re-adjust his/her mental picture so as to correspond to the modified itinerary. Device 118, 502 or 602 now graphically indicates both the relevant portion of the previous itinerary and the relevant currently valid portion of the modified itinerary. For example, the previous portion is indicated in the color red and the currently valid portion is indicated in the color green. Alternatively, the previous portion and the currently valid portion are graphically indicated in, e.g., different dash styles. The previous portion is indicated as a string of dashes ("- - - - - ") and the currently valid portion is indicated as a string of plus signs ("+ + + + + + + "). The latter option is preferable if the user is color-blind. A configuration menu, accessible through user controls 412, enables the user to select a preferred way of indicating the previous and currently valid portions in operational use of device 118, 502 or 602.

A third option relates to providing information to the user of device 118, 502 or 602 as to the reason for the current modification to the itinerary. For example, the data received from server 114 includes an identifier processed by processor 414 to select one of multiple pre-defined icons or texts to be rendered in sub-system 408, the icons and texts being representative of the reason. For example, if the reason is heavy congestion due to a traffic accident, an icon is selected that shows a car lying on its side. As another example, an icon corresponding to a traffic sign conventionally used to indicate a slippery road can be used to indicate inclement weather conditions being the reason for the itinerary. As yet another example, icons can be selected to indicate rush hour traffic, a draw bridge, etc.

A fourth option relates to navigational guidance to drivers, e.g., daily commuters, who know they will encounter the usual unavoidable heavy traffic on their trip. These users of devices 118, 502 or 602 need not to be guided via a detour nor need they be informed about the usual congestion. The commuter can then, e.g., turn off device 118, 502 or 602, or ignore the guidance. A more user-friendly option is then to have the guidance operate in a mode, wherein only unusually severe congestion (i.e., out of the ordinary compared to the daily heavy congestion) gives rise to a modified itinerary. Server 114 has information about real-time average speeds or traffic volume and device 118 and/or server 114 have information about the historical average speeds or traffic volume. The operational mode can then be selected wherein device 118 or server 114 differentiates between usual congestion and unusual congestion so as to enable to selectively modify the itinerary.

Fig.7 is a flow diagram of an example of a method executed by server 114 of providing navigational guidance to devices 502 or 602 as discussed above. The method is initialized in a step 702. In a step 704, server 114 receives from device 502 or 602 information about its location of departure its destination. The location of departure can be determined by server 114 from the GPS data received from device 502 or device 602, or can be received as text data via GPRS as a result of the user entering or otherwise selecting the name of the destination through user controls 412. In a step 706, server 114 calculates an itinerary, optionally taking into account the user's preferences and traffic information and/or weather information available at storage 112. In a step 708, server 114 transmits, to device 502 or device 602, data representative of the navigational guidance. The data transmission is established via GPRS. Device 502 or 602 submits, e.g., via GPRS, data representative of the device's current geographic position, e.g., as determined via a GPS technology (or another technology). For convenience, this data is referred to as GPS data in this text. In a step 710, server 114 receives GPS data. In a step 712, server 114 determines if the destination has been reached. If the destination has been reached, the process of the method ends in a step 714. If the destination has not been reached, server 114 determines in a step 716 the geographic area corresponding to the position of device 502 or 602 according to the GPS data received. In a step 718, server 114 determines the traffic information and/or weather information relevant to the portion of the currently valid itinerary yet to be covered, i.e., the itinerary between the current geographic position and the destination. Based on this information, server 114 calculates in a step 720 candidate modifications to the currently valid itinerary to determine if travel time (or distance to be traveled or a weighted sum of these and other quantities) can be optimized. If server 114 determines that a modification to the currently valid itinerary is not needed, the process returns to step 708. If server 114 decides that a modification is needed, server 114 creates a modified itinerary in a step 722. The process returns to step 708 to supply navigational guidance data based on the modified itinerary.

CLAIMS

1. A mobile navigation device (118) configured for providing navigation information to a mobile user on a road network, depending on a geographic position of the device and upon being programmed to guide the mobile user to a pre-determined destination via an itinerary, wherein the device comprises:

a storage (406) for storing information about a segment of the road network, including historical data representative of respective historical traffic progress on respective roads in the segment;

a wireless receiver (404) for receiving data indicative of current traffic progress on a stretch of a specific road in the segment;

a data processor (414) coupled to the receiver and operative to:

determine if the stretch is included in a portion of the itinerary to be traveled;

if the stretch is not included, to keep using the itinerary;

if the stretch is included, using the historical data to determine an alternative itinerary to the destination based on comparing a first expected travel time for the itinerary, given the current traffic progress, to a second expected travel time for the alternative itinerary; and

depending on a result of the comparing, starting to provide the navigation information with respect to the alternative itinerary.

2. The device of claim 1, wherein:

the second expected travel time is calculated by the processor based on scaling the historical traffic progress on a further road in the alternative itinerary with a quantity representative of the current traffic progress on the specific road.

3. Software (416) for a mobile navigation device (118) configured for providing navigation information to a mobile user on a road network, depending on a geographic position of the device and upon being programmed to guide the mobile user to a pre-determined destination via an itinerary, wherein the device comprises:

a storage (406) for storing information about a segment of the road network, including historical data representative of respective historical traffic progress on respective roads in the segment;

a wireless receiver (404) for receiving data indicative of a current traffic progress on a stretch of a specific road in the segment; and

a data processor (414) coupled to the receiver;

and wherein the software comprises instructions for control of the processor to:

determine if the stretch is included in a portion of the itinerary to be traveled;

if the stretch is not included, to keep using the itinerary;

if the stretch is included, using the historical data to determine an alternative itinerary to the destination based on comparing a first expected travel time for the itinerary, given the current traffic progress, to a second expected travel time for the alternative itinerary; and

depending on a result of the comparing, starting to provide the navigation information with respect to the alternative itinerary.

4. The software of claim 3, comprising further instructions for the processor to calculate the second expected travel time based on scaling the historical traffic progress on a further road in the alternative itinerary with a quantity representative of the current traffic progress on the specific road.

5. A method of providing navigation information to a user of a mobile navigation device (118), depending on a geographic position of the device, for guiding the user to a pre-determined destination via an itinerary, wherein the method comprises:

accessing a storage (406) storing information about a segment of a road network, including historical data representative of respective historical traffic progress on respective roads in the segment;

receiving via a wireless receiver (404) data indicative of a current traffic progress on a stretch of a specific road in the segment;

determining if the stretch is included in a portion of the itinerary to be traveled;

if the stretch is not included, using the itinerary;

if the stretch is included, using the historical data to determine an alternative itinerary to the destination based on comparing a first expected travel time for the itinerary, given the current traffic progress, to a second expected travel time for the alternative itinerary; and

depending on a result of the comparing, starting to provide the navigation information with respect to the alternative itinerary.

6. The method of claim 5, wherein the second expected travel time is calculated based on scaling the historical traffic progress on a further road in the alternative itinerary with a quantity representative of the current traffic progress on the specific road.

7. A method of providing navigation information to a user of a mobile navigation device (502; 602), depending on a geographic position of the device, for guiding the user to a pre-determined destination via an itinerary, wherein the method comprises:

receiving (710) data from the device representative of the geographical position;

determining (716) a segment of a road network relevant to the itinerary;

determining (718) information about the segment, including historical data representative of respective historical traffic progress on respective roads in the segment;

determining current traffic progress on a stretch of a specific road in the segment;

determining if the stretch is included in a portion of the itinerary to be traveled;

if the stretch is not included, using the itinerary;

if the stretch is included, using the historical data to determine (720) an alternative itinerary (722) to the destination based on comparing a first expected travel time for the itinerary, given the current traffic progress, to a second expected travel time for the alternative itinerary; and

depending on a result of the comparing, starting to provide the navigation information with respect to the alternative itinerary.

8. The method of claim 7, wherein the second expected travel time is calculated based on scaling the historical traffic progress on a further road in the alternative itinerary with a quantity representative of the current traffic progress on the specific road.

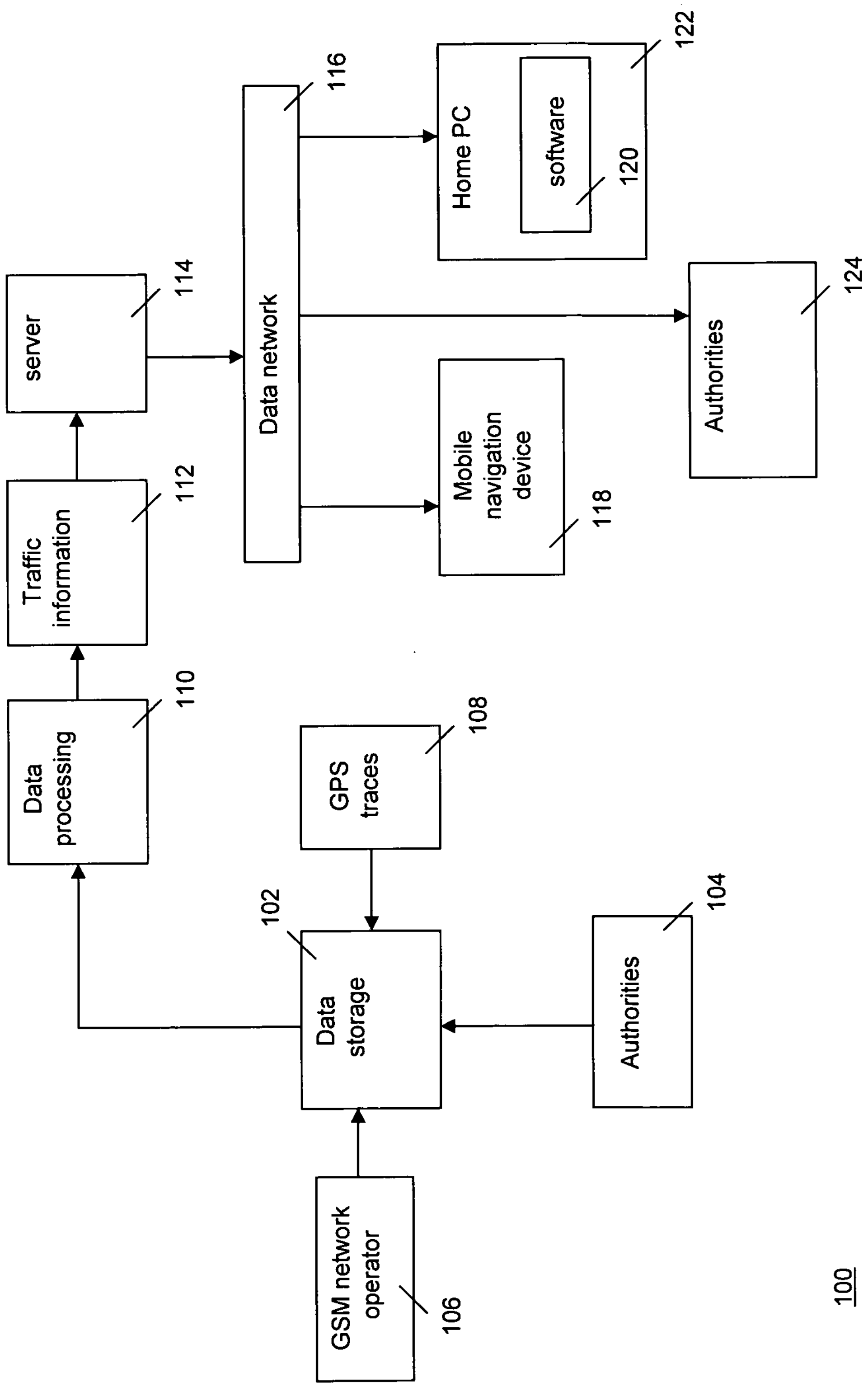

GSM network operator
106
Data storage
102
Authorities
104
GPS traces
108
Data processing
110
Traffic information
112
server
114
Data network
116
Mobile navigation device
118
Authorities
124
Home PC
software
120
122
100

Fig.1

(202) $V_{i,VRS\text{-}seg} = F_{line} \cdot V_{i,hist\text{-}seg}$

(204) $F_{line} = F_{line}\,(V_{real\text{-}mot\text{-}line}, V_{hist\text{-}mot\text{-}line})$

(206) $V_{real\text{-}mot\text{-}line} = \frac{1}{N} \sum V_{real\text{-}mot\text{-}sec\ j}$

(208) $V_{hist\text{-}mot\text{-}line} = \frac{1}{N} \sum V_{hist\text{-}mot\text{-}sec\ j}$

(210) $F_{line} = V_{real\text{-}mot\text{-}line} / V_{hist\text{-}mot\text{-}line}$

(212) $M_{line} = TF_{real\text{-}mot\text{-}line} / TF_{hist\text{-}mot\text{-}line}$

**Fig.2**

(302) $V_{real\text{-}mot\text{-}threshold} = G_{threshold} \cdot V_{hist\text{-}mot}, \quad 0 < G_{threshold} < 1$

(304) $V_{i,VRS\text{-}seg} = H_{area} \cdot V_{i,hist\text{-}seg}$

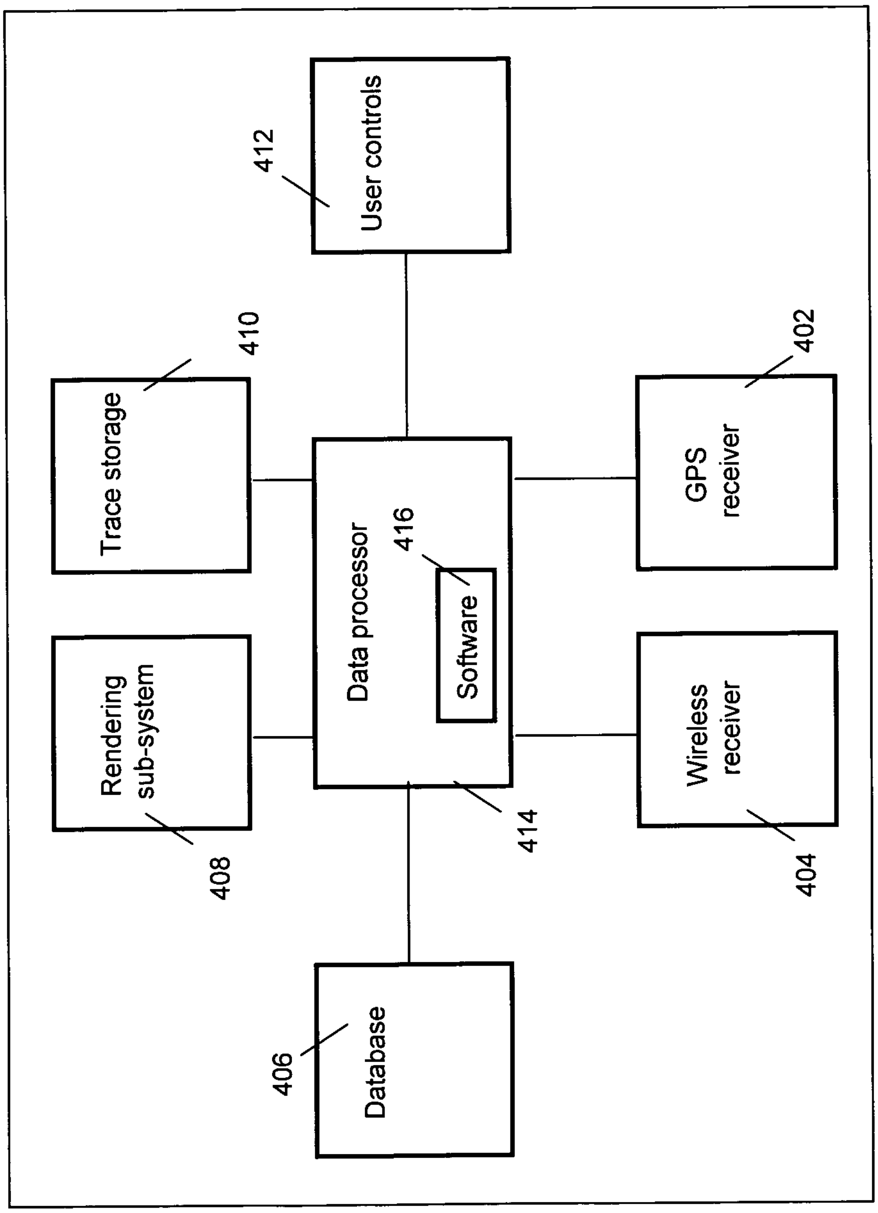
(306) $H_{area} = H_{area}\,(V_{real\text{-}area}, V_{hist\text{-}area})$

(308) $V_{real\text{-}area} = \frac{1}{M} \Sigma\ V_{j,\,real}$

(310) $V_{hist\text{-}area} = \frac{1}{M} \Sigma\ V_{j,\,hist}$

(312) $H_{area} = V_{real\text{-}area} / V_{hist\text{-}area}$

**Fig.3**


User controls
412
Trace storage
410
Data processor
416
Software
414
GPS receiver
402
Rendering sub-system
408
Wireless receiver
404
Database
406

118

Fig.4

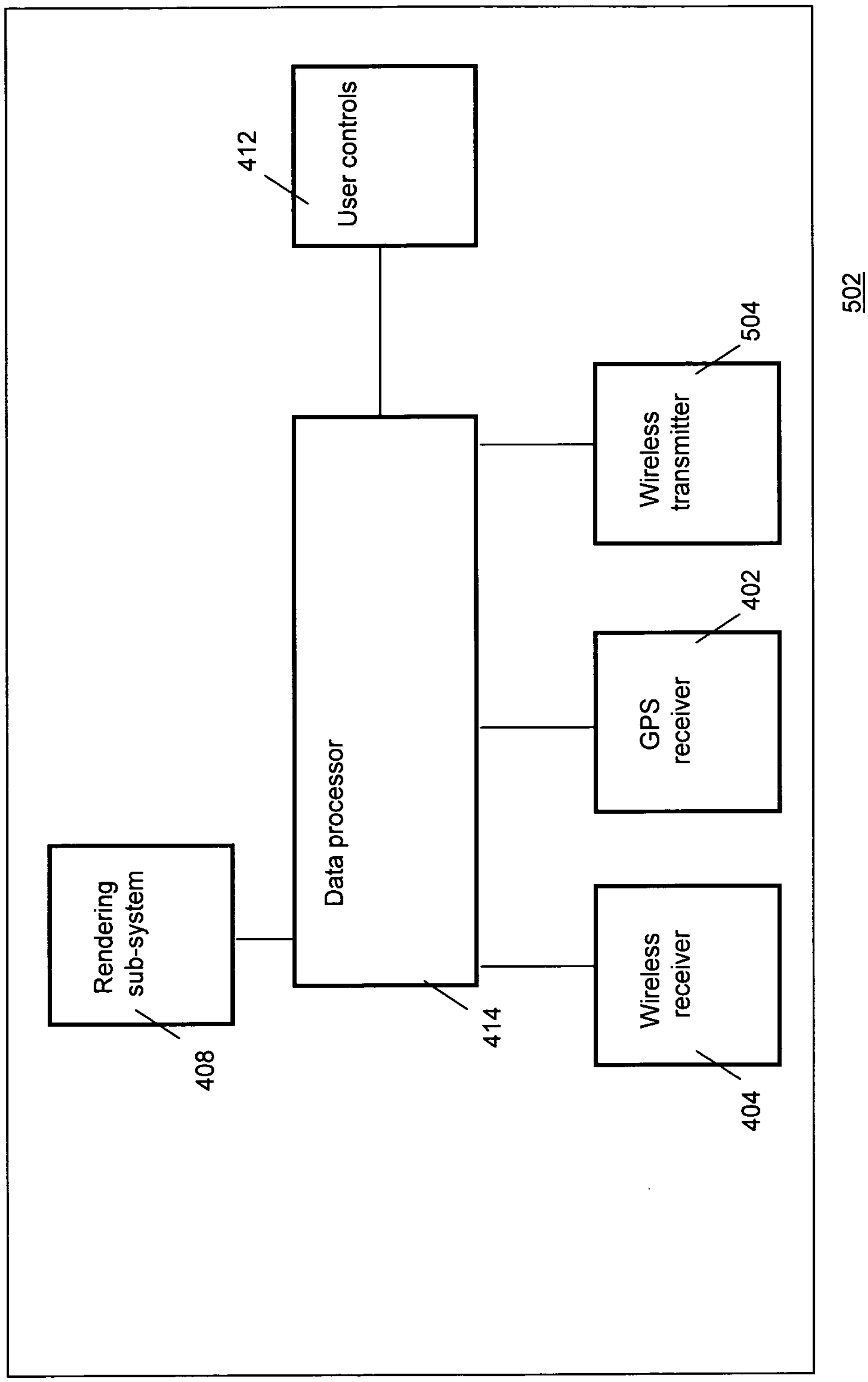
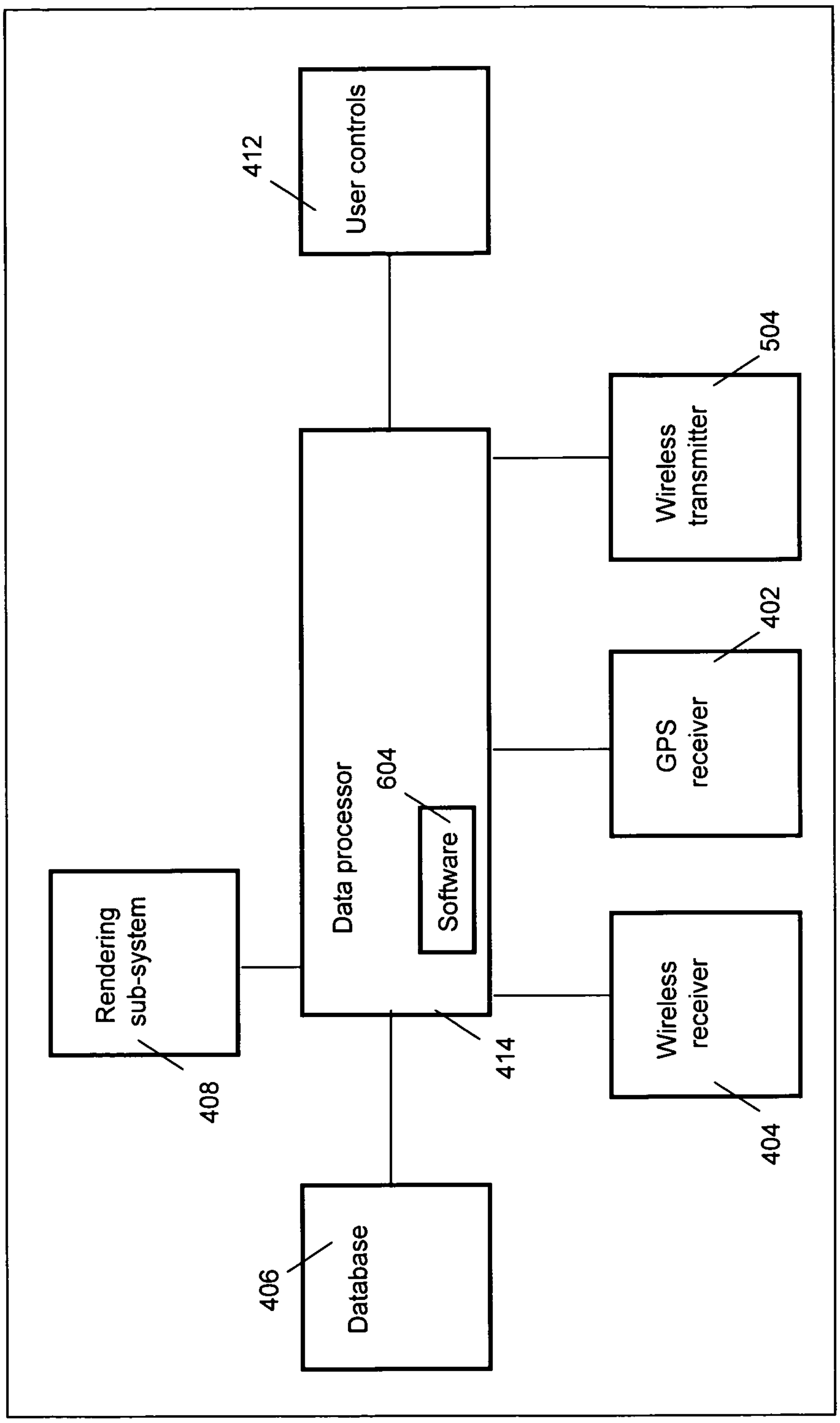



Fig.5

Docket No.: 132/TW


User controls
412
Wireless transmitter
504
GPS receiver
402
Wireless receiver
404
Data processor
Software
604
414
Rendering sub-system
408
Database
406

602

Fig.6

700

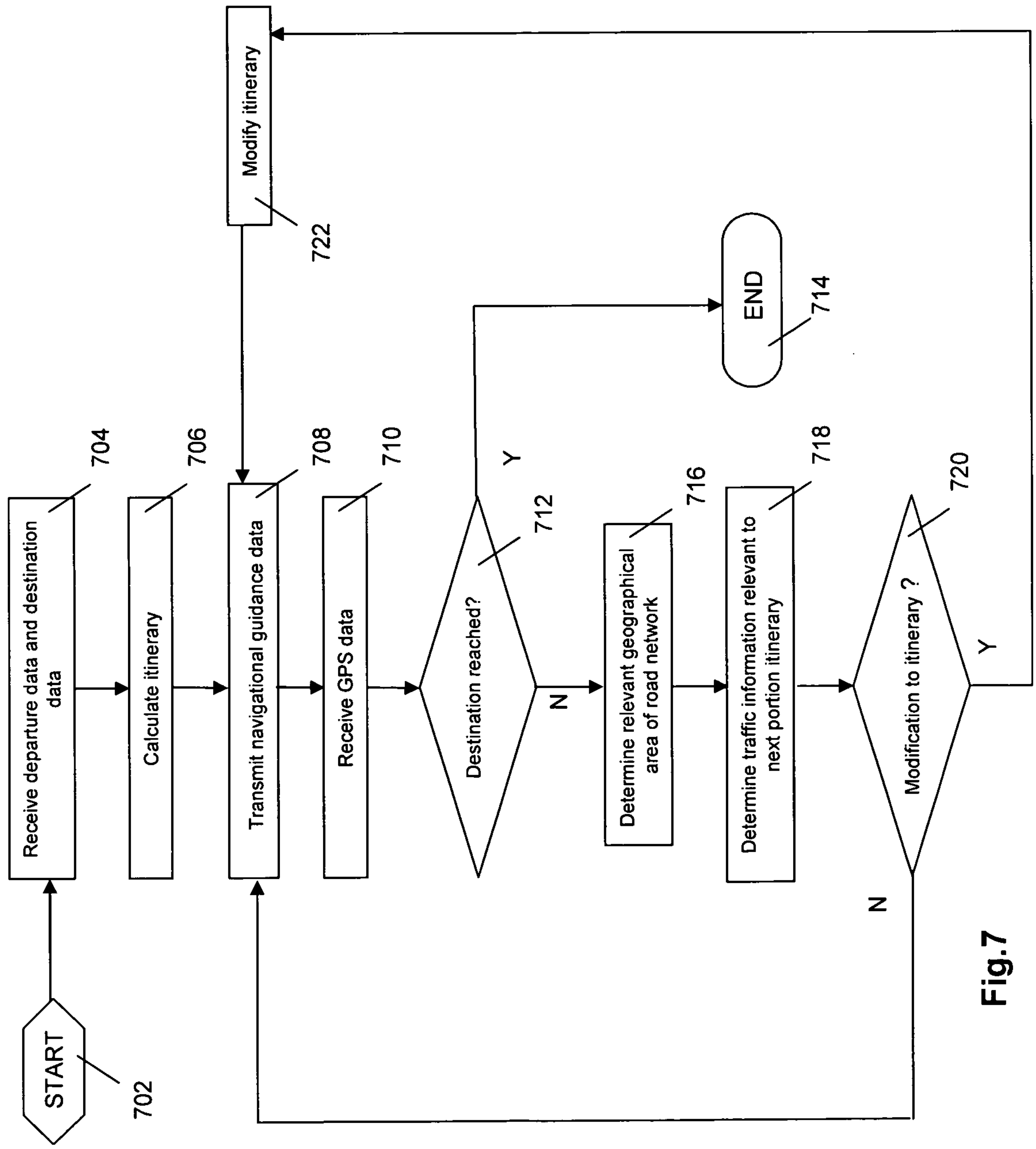

START
702
Receive departure data and destination data
704
Calculate itinerary
706
Transmit navigational guidance data
708
Receive GPS data
710
Destination reached?
712
Y
N
END
714
Determine relevant geographical area of road network
716
Determine traffic information relevant to next portion itinerary
718
Modification to itinerary ?
720
Y
N
Modify itinerary
722

Fig.7

# INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2008/001880

**A. CLASSIFICATION OF SUBJECT MATTER**
INV. G01C21/34 G08G1/0968

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)
G01C G08G

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

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X<br>Y | DE 101 31 526 A1 (DAIMLER CHRYSLER AG [DE]) 23 January 2003 (2003-01-23)<br>column 10, paragraph 37 - column 11, paragraph 40<br>figure 3 | 1,3,5,7<br>2,4,6,8 |
| X<br>Y | US 2002/128766 A1 (PETZOLD BERND [DE] ET AL) 12 September 2002 (2002-09-12)<br>page 1, paragraph 10<br>page 2, paragraph 23<br>page 4, paragraph 35<br>figures 1,8 | 1,3,5,7<br>2,4,6,8 |

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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# INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2008/001880

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| Y | US 6 222 836 B1 (SEKIYAMA HIROAKI [JP] ET AL) 24 April 2001 (2001-04-24)<br>column 1, line 39 - line 56<br>column 2, line 13 - line 35<br>column 3, line 40 - column 4, line 27<br>column 5, line 60 - column 6, line 26<br>figures 1,3,4,7<br>----- | 2,4,6,8 |
| Y | US 2006/206256 A1 (KUMAGAI MASATOSHI [JP] ET AL) 14 September 2006 (2006-09-14)<br>the whole document<br>----- | 2,4,6,8 |

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2008/001880

| Patent document cited in search report | | Publication date | Patent family member(s) | | | Publication date |
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| | | | JP | 2006251941 | A | 21-09-2006 |

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代理人 刘国伟

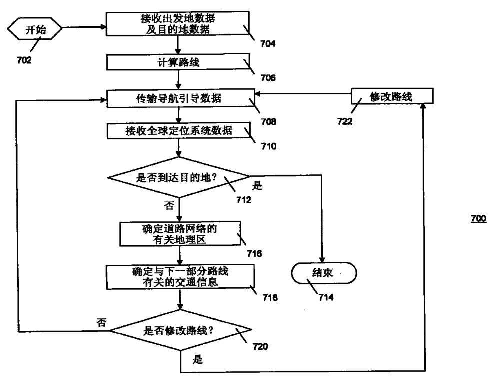
权利要求书 3 页 说明书 17 页 附图 7 页

[54] 发明名称

辅助道路交通堵塞管理的导航装置

[57] 摘要

本发明提供一种导航装置，其具有 GPRS 接收器，所述 GPRS 接收器用于接收关于汽车道路段上的缓慢交通流量或缓慢平均速度的指示堵塞的实时信息。 所述装置基于由堵塞区中的当前平均速度加权的二级道路上的历史记录的速度来计算新路线以避开所述堵塞。



1. 一种移动导航装置（118），其经配置以用于依据所述装置的地理位置向道路网络上的移动用户提供导航信息且在经编程后经由路线引导所述移动用户到预定目的地，其中所述装置包含：

存储装置（406），其用于存储关于所述道路网络的区段的信息，所述信息包括表示所述区段中的相应道路上的相应历史交通进展的历史数据；

无线接收器（404），其用于接收指示所述区段中的特定道路的路段上的当前交通进展的数据；

数据处理器（414），其耦合到所述接收器且操作以：

确定所述路段是否包括于所述路线的待行进的部分中；

如果不包括所述路段，则继续使用所述路线；

如果包括所述路段，则使用所述历史数据来基于在已知所述当前交通进展的情况下将所述路线的第一预计行进时间与到所述目的地的替代路线的第二预计行进时间进行比较来确定所述替代路线；以及

依据所述比较的结果，开始提供关于所述替代路线的所述导航信息。

2. 根据权利要求1所述的装置，其中：

所述第二预计行进时间由所述处理器基于用表示所述特定道路上的所述当前交通进展的量缩放所述替代路线中的另一道路上的所述历史交通进展来计算。

3. 一种用于移动导航装置（118）的软件（416），所述移动导航装置（118）经配置以用于依据所述装置的地理位置向道路网络上的移动用户提供导航信息且在经编程后经由路线引导所述移动用户到预定目的地，其中所述装置包含：

存储装置（406），其用于存储关于所述道路网络的区段的信息，所述信息包括表示所述区段中的相应道路上的相应历史交通进展的历史数据；

无线接收器（404），其用于接收指示所述区段中的特定道路的路段上的当前交通进展的数据；以及

数据处理器（414），其耦合到所述接收器；

且其中所述软件包含用于控制所述处理器以执行以下操作的指令：

确定所述路段是否包括于所述路线的待行进的部分中；

如果不包括所述路段，则继续使用所述路线；

如果包括所述路段，则使用所述历史数据来基于在已知所述当前交通进展的情

况下将所述路线的第一预计行进时间与到所述目的地的替代路线的第二预计行进时间进行比较来确定所述替代路线；以及

依据所述比较的结果，开始提供关于所述替代路线的所述导航信息。

4. 根据权利要求3所述的软件，其进一步包含用于所述处理器执行以下操作的指令：基于用表示所述特定道路上的所述当前交通进展的量缩放所述替代路线中的另一道路上的所述历史交通进展来计算所述第二预计行进时间。

5. 一种依据移动导航装置（118）的地理位置向所述装置的用户提供导航信息以用于经由路线引导所述用户到预定目的地的方法，其中所述方法包含：

存取存储关于道路网络的区段的信息的存储装置（406），所述信息包括表示所述区段中的相应道路上的相应历史交通进展的历史数据；

经由无线接收器（404）接收指示所述区段中的特定道路的路段上的当前交通进展的数据；

确定所述路段是否包括于所述路线的待行进的部分中；

如果不包括所述路段，则使用所述路线；

如果包括所述路段，则使用所述历史数据来基于在已知所述当前交通进展的情况下将所述路线的第一预计行进时间与到所述目的地的替代路线的第二预计行进时间进行比较来确定所述替代路线；以及

依据所述比较的结果，开始提供关于所述替代路线的所述导航信息。

6. 根据权利要求5所述的方法，其中基于用表示所述特定道路上的所述当前交通进展的量缩放所述替代路线中的另一道路上的所述历史交通进展来计算所述第二预计行进时间。

7. 一种依据移动导航装置（502；602）的地理位置向所述装置的用户提供导航信息以用于经由路线引导所述用户到预定目的地的方法，其中所述方法包含：

从所述装置接收（710）表示所述地理位置的数据；

确定（716）道路网络的与所述路线有关的区段；

确定（718）关于所述区段的信息，所述信息包括表示所述区段中的相应道路上的相应历史交通进展的历史数据；

确定所述区段中的特定道路的路段上的当前交通进展；

确定所述路段是否包括于所述路线的待行进的部分中；

如果不包括所述路段，则使用所述路线；

如果包括所述路段，则使用所述历史数据基于在已知所述当前交通进展的情况下

将所述路线的第一预计行进时间与到所述目的地的替代路线（722）的第二预计行进时间进行比较来确定（720）所述替代路线；以及

依据所述比较的结果，开始提供关于所述替代路线的所述导航信息。

8. 根据权利要求7所述的方法，其中基于用表示所述特定道路上的所述当前交通进展的量缩放所述替代路线中的另一道路上的所述历史交通进展来计算所述第二预计行进时间。

# 辅助道路交通堵塞管理的导航装置

## 技术领域

本发明涉及一种移动电子导航装置、用于实施所述装置的功能性的软件及一种向此装置的用户提供服务的方法。

## 背景技术

技术的进步及堵塞道路环境的不断增加的压力已促使发展及采用个人导航装置（PND）。缩写PND有时用于指代“便携型导航装置”，但在本说明书中将赋予其更宽泛的定义：其涵盖任何种类的个人导航装置，所述装置是便携型（例如，可使用吸附式安装件固定到汽车挡风玻璃）或是嵌入式（例如，永久地固定到汽车中）。PND 可为专用导航装置（例如，主要功能为导航的装置）或可具有多个其它应用（例如，媒体播放器）或可具有不同于导航的主要功能（例如，移动电话）。PND 主要（但并非排他地）用于汽车及其它机动车辆中。PND 并入有包括道路信息及兴趣点的地图数据库。其大体上包括用于执行以下操作的软件：允许用户输入目的地且为用户提供一个或一个以上路径；发出驾驶指令以引导驾驶员沿着选定的路径到目的地。PND 可包括一可附着到汽车挡风玻璃的安装件。

用以沿其引导驾驶员的路径的选择可能非常复杂，且选定的路径可能会考虑现有的及预测的交通及道路条件、关于道路速度的历史信息及驾驶员本身的偏好作为确定道路选择的因素。另外，装置可能不断地监视道路及交通条件，且因条件改变而提议或选择改变进行旅程的剩余部分的路径。

道路行进是企业、其它组织及私人个体的日常生活的重要部分。交通延迟的成本可能非常大。仅在英国，纯粹的财务成本就已估计为数十亿英镑。鉴于这些成本，可（例如）通过选择最佳路径及通过避开堵塞延迟而辅助驾驶员最佳化其行进的系统具有重要价值。事实上，已逐渐形成大批多样的驾驶员信息系统。最早建立的是聚集来自多个来源如警察、侦察卫星及（更近些时候）来自陷于交通阻塞中的驾驶员的移动电话呼叫的数据以提供关于事故及延迟的主观建议的广播无线电交通报导。无线电数据系统（RDS）无线电通过从正常无线电节目自动切播到交通报导而使这些系统更有效。在大型汽车运输组织（例如，英国的汽车协会（AA）及 RAC）的网站上提供静态路径计划系统。这些静态路径计划系统允许驾驶员输入旅程点且为驾驶员提供路径及用于所述路径的驾

驶指令。

在最近的过去，已基于全球定位系统（GPS）技术引入车载个人导航装置。这些车载个人导航装置的实例为TomTom GO™系列的PND。个人导航装置使用GPS系统来发现车辆在道路网络上的准确位置，且在屏幕上的道路图上绘制车辆的位置。PND含有用于计算道路网络上的两个或两个以上点之间的最佳或优良路径的机构且可沿着选定的路径指引驾驶员，并不断地监视驾驶员在所述路径上的位置。个人导航装置已开始将交通信息并入到其服务中，且在一些装置中，将交通信息整合到路径选择过程中：PND将在堵塞道路周围安排路径。在由PND提供交通信息的情况下，用户可观察影响到选定路径的延迟，且在用户认为必要时引导装置重新计划一条避开道路的延迟部分的路径。人们正使用基于各种技术（例如，移动电话呼叫、固定相机、GPS车队追踪）的实时交通监视系统来识别交通延迟且将信息馈入到通知系统中。

如上文所提及，可在移动电话呼叫的基础上如下实时监视道路交通。在移动电话系统中，订户携带手机。当订户起始或接收呼叫或文本消息或数据会话时，在手机与基地收发站（BTS）（现代景观上熟悉的发射天线）之间发生无线电通信。手机与BTS既传输在主叫方与被叫方之间传递的消息的编码，也在其自身之间传输大量控制信息以用于可靠地且有效地支持通信的目的；例如，随着订户四处移动，系统必须选择何时将呼叫传递到另一BTS。全球移动通信系统（GSM）系统中或通用移动电信系统（UMTS）中的控制信息含有关于相邻BTS的信号强度的信息、用以指令离BTS较远的手机较早传输以便匹配其时隙的时序提前信息、传输错误率及更多的信息。例如码分多址（CDMA）等其它技术使用不同的信息来实现可靠且有效的通信的相同目的。这些参数被统称为移动电话控制参数。位置参数数据库（LPDB）使移动电话控制参数与手机的地理位置相关。LPDB可通过若干方式中的一者来建构及维护，且可将控制参数的若干有用子集中的一者映射到地理位置。

关于所述PND及以上服务的更多背景信息，见（例如）美国专利申请公开案US 20070225902；US 20070185648；US 20070118281；及US 20070117572，所有这些专利申请公开案由汤姆汤姆国际公司（TomTom International B.V.）拥有且以引用的方式并入本文中。

关于通过监视道路车辆上携带的移动电信装置的使用来监视道路交通的更多背景信息，见（例如）WO200245046（“交通监视系统”("Traffic monitoring system"))；及WO2007017691（“在给定时间找到移动电话的物理位置的方法”("Method of finding a physical location of mobile telephone at a given time"))，所述文件以引用的方式并入本文

中。

## 发明内容

发明人旨在改进对道路车辆的个别用户的导航引导。发明人进一步意图改进交通管理以便避开或减少交通堵塞。

本发明尤其涉及一种移动电子导航装置，其经配置以用于依据装置的地理位置向道路网络上的移动用户提供导航信息，且在经编程后即经由路线引导所述移动用户到预定目的地。所述装置包含：存储装置，其用于存储关于道路网络的区段的信息（例如，道路图信息），所述信息包括表示所述区段中的相应道路上的相应历史交通进展（例如，平均速度或平均交通流量）的历史数据；无线接收器，其用于接收指示所述区段中的特定道路的路段上的当前交通进展（例如，当前平均速度或当前交通流量）的数据；及数据处理器，其耦合到所述接收器。所述处理器进一步操作以实行以下任务。所述处理器确定所述路段是否包括于路线的仍待行进的部分中。如果处理器已确定不包括所述路段，则使用所述路线来确定导航引导。如果处理器已确定包括所述路段，则处理器使用历史数据来基于在已知当前交通进展的情况下将路线的第一预计行进时间与到目的地的替代路线的第二预计行进时间进行比较来确定所述替代路线。依据所述比较的结果，处理器开始提供关于替代路线的导航信息。

因此，在接收到关于原始路线的即将到来的分支中的道路路段上的当前交通进展的可能指示替代路线具有较短的预计行进时间的实时信息后，本发明中的导航装置根据替代路线提供导航引导。经由接收器接收的数据可能指示行程的即将到来的分支中的新出现的或现有的交通阻塞。本发明中的装置接着搜寻用于待行进的部分的对原始路线的替代路线。如果在必须根据替代路线引导用户之前交通阻塞已消失，则接收器接收指示所述路段上的经改进的交通进展（例如，增加的交通流量或增加的平均速度）的数据且装置以类似方式确定将把原始路线视为引导的基础。

在本发明中的装置的一实施例中，基于用表示特定道路上的当前交通进展（当前平均速度或当前交通流量）的量缩放替代路线中的另一道路上的历史交通进展（例如，平均速度或平均交通流量）来计算第二预计行进时间。所述缩放的起因在于一条道路上的堵塞可能会导致连接道路上的较拥挤的交通。亦即，堵塞影响附近的交通流量及平均速度。借助于通过缩放而考虑到此现象，计算较可靠地接近到目的地的最短总行进时间的替代路径。

除当前交通进展条件以外，当前或预计的天气条件也可能会影响行进时间，或更一

般地也可能会影响路线。因此，当计算对当前路线的修改时，优选也考虑关于天气条件的实时信息。出于本发明的目的，可将例如雾、雨、降雪、黑冰等等的天气条件转变成表示（虚拟）交通进展的量。在因恶劣天气而造成的危险道路条件的情况下，按比例增加覆盖路线的受天气影响的路段的预计行进时间。比例因子可（例如）基于历史数据（见下文进一步从 GPS 轨迹中提取的历史数据）来确定或可通过实验来确定或粗略地估计。不管起源如何——无论是源自交通堵塞还是源自危险的道路条件，行进时间的此按比例增加均为本发明中的数据处理中考虑的量。因此，出于本发明的目的，在本文中概念“当前交通进展”也被理解为涵盖“当前或预计的天气条件”。

本发明的另一实施例涉及用于移动导航装置的软件，所述移动导航装置经配置以用于依据装置的地理位置向道路网络上的移动用户提供导航信息，且在经编程后经由路线引导所述移动用户到预定目的地。所述装置包含：存储装置，其用于存储关于道路网络的区段的信息，所述信息包括表示所述区段中的相应道路上的相应历史交通进展的历史数据；无线接收器，其用于接收指示所述区段中的特定道路的路段上的当前交通进展的数据；及数据处理器，其耦合到所述接收器。所述软件包含用于控制所述处理器执行以下操作的指令：确定所述路段是否包括于路线的待行进的部分中；如果不包括所述路段，则继续使用所述路线；如果包括所述路段，则使用历史数据来基于在已知当前交通进展的情况下将路线的第一预计行进时间与到目的地的替代路线的第二预计行进时间进行比较来确定所述替代路线；依据所述比较的结果，开始提供关于替代路线的导航信息。优选地，所述软件包含用于处理器执行以下操作的其它指令：基于用表示特定道路上的当前交通进展的量缩放替代路线中的另一道路上的历史交通进展来计算第二预计行进时间。

因此，所述软件可作为售后市场附加品（after-market add-on）或作为具有无线接收器的电子导航装置的安装基础的升级来提供。可任选地将单独的无线接收器安装到常规电子导航装置以便使用如上文所指定由表示实时交通条件的供应数据实现的服务。

上文引入的无线接收器包括（例如）通用分组无线电服务（GPRS）接收器。如已知的，GPRS 是可供 GSM 移动电话的用户使用的分组导向的移动数据服务。词语“分组导向的”指代数据分组被多路复用的方式。GPRS 数据通信可为单向的或双向的。或者，无线接收器包含无线电数据系统（RDS）接收器。RDS 技术使用常规 FM 无线电广播来发送数据。RDS 技术通常用于实施用于将交通信息传送给驾驶员的交通消息频道（TMC）。无线接收器的其它实施方案是基于（例如）数字音频广播（DAB）技术或卫星无线电，后者使用通信卫星，所述通信卫星覆盖的地理区比使用陆上技术的传输所覆盖

的地理区大。

GPRS 技术实现双向数据通信。此可用于本发明的一实施例中，其中 PND 具有 GPRS 接收器及 GPRS 发射器，且其中 PND 配置为将到预定目的地的路线的计算及/或重新计算委托给服务器的轻型客户端（thin-client）。

因此，发明人进一步提议一种依据移动导航装置的地理位置向所述装置的用户提供导航信息以用于经由路线引导用户到预定目的地的方法。所述方法包含以下步骤。从所述装置接收表示地理位置的数据。在已知装置的当前地理位置的情况下，确定道路网络的与所述路线有关的区段。确定关于所述区段的信息，所述信息包括表示所述区段中的相应道路上的相应历史交通进展的历史数据。确定所述区段中的特定道路的路段上的交通的当前交通进展。接着确定所述路段是否包括于路线的待行进的部分中。如果不包括所述路段，则使用所述路线。如果包括所述路段，则使用历史数据来基于在已知当前交通进展的情况下将路线的第一预计行进时间与到目的地的替代路线的第二预计行进时间进行比较来确定所述替代路线。依据所述比较的结果，提供关于替代路线的导航信息。

优选地，基于用表示特定道路上的当前交通进展的量缩放替代路线中的另一道路上的历史交通进展来计算第二预计行进时间。

轻型客户端方法或将处理委托给服务器的优点在于以下事实：服务器具有关于包括其中用户正前进的区的多个地理区的可用交通信息及天气信息。这一点能实现在比仅局部地在所述地理区中的单个一者内的规模大的规模上动态地最佳化路线。

## 附图说明

借助于实例且参看附图更详细地解释本发明，其中：

图 1 是本发明中的系统的框图；

图 2 及图 3 提供解释本发明的方面的公式；

图 4 是本发明中的导航装置的第一实例的框图；

图 5 及图 6 是本发明中的导航装置的其它实例的框图；及

图 7 是向图 5 及图 6 的装置的用户提供导航引导的方法的流程图。

贯穿诸图，类似或对应特征由相同参考数字指示。

## 具体实施方式

根据一些研究，在特定道路或公路上监视的交通的大约 25%由驾驶较长、区域间路径的车辆组成。这是可非常容易地采用到特定道路或公路的替代路径的重要群体。问题在于如何通知替代路径？管理机构可通知所有在阿姆斯特丹（Amsterdam）市北部的区

域中驾驶的驾驶员：如果其打算去弗列弗兰（Flevoland）或更远的地方，则今天最好使用恩克华生一莱利斯达（Enkhuizen-Lelystad）堤道路。可建议来自阿姆斯特尔芬（Amstelveen）/史基辅（Schiphol）区域的驾驶员经由乌特列支（Utrecht）市驾驶。然而，通知这些驾驶员乃至更多驾驶员以便使其相信其应采纳所述建议是极端困难的。驾驶员需要更多详细信息以便能够接受替代路径。

本发明中的系统经由驾驶员的车辆上携带的移动导航装置向驾驶员提议替代路径。除提议替代路径以外，还阐明采用这些替代路径的预计的优点。因此，当在特定地理区域中发生交通堵塞时，本发明的系统建议在此区域内驾驶或朝此区域行进的驾驶员根据当前正经由移动导航装置提供的指引前进以便自动地避开堵塞。本发明中的系统因此帮助驾驶员较早到达其目的地。此外，所述系统还有助于借助于在堵塞区域附近的道路网络的其余部分上扩展交通量而减少通过堵塞区的交通量。

事实证明，交通阻塞中的大多数汽车是在进行短的区域内行程。进行区域内行程的驾驶员的实例为居住在阿梅尔（Almere）镇打算在阿姆斯特丹附近的城市中购物的人。本发明的系统能够在这些驾驶员开始其行程前通知这些驾驶员预计的行进时间。如果预计会因交通拥塞而发生延迟，则这些人可能想重新考虑其行程。其可能会决定改为在本地购物、驾驶到另一个镇或城市，或采用所提议的替代路径中的一者或使用公共运输。同样，将减少通过堵塞区的交通量。

总有一群驾驶员尽管堵塞还是决定进入堵塞区。人们常常误认为在此情形下改为通过小乡村及城市中心驾驶以便绕过堵塞是可接受的解决方案。研究已证实，此驾驶完全无效。出现此情形的原因尤其在于所允许的最大道路速度低，且由于交通灯及非有效路径而使得可达到的平均速度不高于 15 km/hr 到 25 km/hr。在大多数情况下，通过仅停留在交通阻塞或使用区域道路会更快地到达驾驶员的目的地。来自当前受让人汤姆汤姆的所有装置均默认使用这些最快路径设定以便避开经由无效路径的引导。然而，缺乏可靠的最新行进时间信息使得人们虽自己找到路径但却无效。本发明的系统旨在说服这些人出于其自身的利益而接受导航信息。

因此，本发明中的系统为正在移动的人提供更可靠且有效的引导指引。基于极好的行进时间估计，人们可考虑且较容易接受替代路径。本发明的系统改进主要道路网络的利用且有助于减少交通堵塞。为正进行区域间行程的驾驶员重新安排路径以便绕过堵塞区。将建议区域驾驶员使用区域替代路径或就接受由堵塞引起的延迟。

本发明的系统产生整个道路网络的高质量的交通信息。所述系统能够提议更好地利用堵塞区周围的可用道路网络的替代路径。所述系统使用多来源策略。所述系统组合来

自现有来源的交通信息（例如，由道路管理机构及其它公共服务供应）与基于由移动电话网络经营商供应的数据产生的交通信息及由具备 GPS 功能的移动导航装置的用户供应的交通信息。因此，创建对堵塞瓶颈的详细概述。可接着使用此详细概述来产生关于替代路径的导航信息。

图 1 是本发明中的系统 100 的框图。系统 100 包含数据收集及获取子系统 102，所述数据收集及获取子系统 102 接收来自运输部门、道路经营商或道路管理机构、地方政府等等（所有这些在此被称作“管理机构”104）的数据、来自移动电话网络经营商 106 的数据及来自具备 GPS 功能的移动导航装置 108 的用户的数据。

从管理机构 104 接收的数据表示（例如）经由路旁的交通监视设备获得的常规交通信息。所述设备包括（例如）现场相机及集成在道路表面中的例如感应环路等其它道路传感器。从管理机构 104 接收的其它数据可包括道路工程报导。从管理机构 104 接收的另外其它数据包括（例如）天气预报或实时天气雷达数据。实时天气雷达数据能够（例如）按比例增加具有大量降雨、由于雾或细雨而导致具有降低的可见度、或具有强阵风的区域中的道路上的预计行进时间，以便考虑到较慢的交通。

从经营商 106 接收的数据表示如上文及在（例如）上文所提及的 WO200245046 及 WO2007017691 中所解释的在移动电话呼叫的基础上实时地监视的道路交通。

从具备 GPS 功能的移动装置 108 的用户接收的数据是基于以下。装置 108 经配置以用于记录 GPS 轨迹。当装置 108 在操作使用中时，装置 108 将其地理位置及时戳重复地记录于文件中。文件中的所述记录能够用此特定装置重建所采用的行程。此装置 108 的一实例由本案受让人制作。装置 108 与安装于用户的家用 PC 或膝上型 PC 上的软件程序（“TomTom Home”（汤姆汤姆家用版））协作。所述软件程序使用户能够更新、个人化及以其它方式管理装置 108。举例来说，如果用户想要安装新地图、定制的兴趣点数据库或使装置 108 以另一语音提供指引，则用户可简单地经由因特网从服务器下载这些及其它组件且将其安装于装置 108 上。所述程序还允许从家中预先计划个人的行程。当连接到服务器时，服务器将上载记录的文件。从所有装置 108 收集记录且将记录存储于子系统 102 中。

因此，系统 100 具有可通过移动电话网络经营商 106 得到的实时数据及可通过下载 GPS 轨迹得到的历史数据。现在于数据处理子系统 110 中处理这些数据以用于产生存储于存储装置 114 中的交通信息。

数据处理子系统 110 处理历史数据（例如，由来自装置 108 的 GPS 轨迹表示）以产生交通信息，出于本发明的目的，所述交通信息包括未（或未充分地）被来自经营商 106

的实时数据覆盖的道路的平均速度。为了解释所述处理，考虑以下情境。

考虑绕过市区环境的主干路径处的情形。此市区环境可为被国家汽车道绕过的小城镇或围绕大城市或穿越郊区或城市中心的大量使用的大型市区主要道路。当主干路径未堵塞时，从经营商 106 接收的基于 GSM 的数据及从装置 108 接收的基于 GPS 的数据指示主要道路上的正常穿行时间。但在高峰时间期间，穿行时间可能急剧地增加。从经营商 106 及装置 108 接收的数据指示在高峰时间期间穿行时间的此增加。穿行时间的增加相当于平均道路速度的降低。举例来说，一般平均速度介于大约 100 km/hr 与 120 km/h 之间，但在高峰时间期间，平均速度大约为 30 km/h。在高峰时间期间，二级道路的市区网络上的平均速度也降低，（例如）从大约 35 km/h 降低到大约 15 km/h。由于低交通量而使得从经营商 106 接收的实时数据不能够可靠地测量市区较小道路上的实时行进时间；尤其由于较高交通量而使得仅在都市主干上所测量的行进时间可用。因此，如果用户的移动导航装置不考虑二级道路上的这些变化的平均道路速度，则其可能导致用户进入二级道路上的堵塞或缓慢移动的交通中，因为这些不是与高峰时间期间的平均速度 15 km/hr 相关联，而是错误地与静态平均速度 35 km/hr 相关联，静态平均速度 35 km/hr 仍然比堵塞的主干路径上的当前平均速度 30 km/hr 快。

为了改进对驾驶员的导航引导，发明人因此提议使用基于 GSM 的实时数据与基于 GPS 的历史数据两者以便提供对二级道路上的平均速度或行进时间的估计，如下文进一步详细解释。

现在考虑以下情境。系统 100 经由（例如）来自经营商 106 的数据确定特定汽车道的特定路段是否堵塞。亦即，此路段上的平均速度显著低于正常交通流量期间的平均速度。假定堵塞也影响通向汽车道的堵塞路段或离开汽车道的堵塞路段的二级道路上的平均速度似乎是合理的。所产生且作为数据存储于存储装置 112 中的交通信息与堵塞路段上的平均速度及/或用以在当前环境下覆盖此路段的预计行进时间有关。经由服务器 114，经由包括 GPRS 基础设施的数据网络 116 将此数据发送给有关地理区中的电子导航装置 118 的用户。GPRS 为能够经由可供 GSM 移动电话的用户使用的移动数据服务接收数据分组的已知技术。如上文所提及，可使用不同于 GPRS 的无线数据通信技术将数据从服务器 114 传递到装置 118。GPRS 在此处作为一实际实例而提及。还请注意，除了关于所考虑的道路上的当前平均速度的交通信息以外，服务器 114 还可将表示有关地理区中现有的或预计的天气条件的数据传递到装置 118。所述数据可指代（例如）强阵风、雾、黑冰等等。装置 118 优选经配置以处理此数据来产生经由其显示监视器及/或扬声器传达给装置 118 的用户的信息。

导航装置 118 经配置以如下且如下文更详细解释处理此数据。在已知装置 118 的一个或一个以上用户的目的地且已知所述用户的首先由装置 118 计算的原始路线的情况下，堵塞可能会影响所述用户的行进时间。在已知堵塞汽车道路段上的速度的情况下，装置 118 现在通过考虑堵塞区中的二级道路上的预计速度或行进时间而重新计算路线。为此目的，装置 118 使（例如）来自其本地存储装置的所需信息可用。装置 118 因此可在前方存在交通堵塞的情况下做出关于绕道采用哪些路径以便最佳化（例如）行进时间的有根据的推测。

采用的方法的细节如下。发明人引入虚拟实时速度（VRS）的概念。在本发明的一实施例中，在其中实时数据不可用于有关道路的情形下在 PND 内计算 VRS。基于所述道路的历史平均速度信息来计算 VRS。计算特定地理区中具有受主要汽车道或所述区中的主要主干路径上的堵塞影响的交通的二级道路部分的 VRS。通过主要汽车道上的实时交通的速度来确定 VRS。在一些环境下，假定二级道路上的 VRS 取决于相邻主要汽车道上的实时速度。本发明现在利用此相关性来改进对装置 118 的个别用户的导航引导的准确性。

可采用若干方法来确定 VRS：基于线的方法及基于区的方法，如下文详细解释。优选地，使用基于区的 VRS。然而，在无法计算基于区的 VRS 的情况下，使用基于线的方法。

对于基于线的方法如下进行。从基于 GSM 的数据确定的有关汽车道的一部分上的实时速度具有值 $V_{real\text{-}mot}$。从 GPS 轨迹确定的此部分上的历史平均速度具有值 $V_{hist\text{-}mot}$。现在考虑环绕汽车道的所述部分的道路网络中的一道路区段。对于此标记为“i”的区段，借助于(例如)根据图 2 的表达式(202)用函数 $F_{line}$ 缩放所述区段的历史平均速度 $V_{i,hist\text{-}seg}$ 而为 VRS 指派值 $V_{i,VRS\text{-}seg}$。在上文所提及的 GPS 轨迹的基础上确定所述区段的历史平均速度 $V_{i,hist\text{-}seg}$。根据图 2 中的表达式（204），缩放函数 $F_{line}$ 取决于第一量 $V_{real\text{-}mot\text{-}line}$ 及第二量 $V_{hist\text{-}mot\text{-}line}$。根据表达式（206）将第一量 $V_{real\text{-}mot\text{-}line}$ 界定为有关汽车道的 N 个部分上的从基于 GSM 的数据测量的实时速度的平均值。在（例如）此项技术中已知的交通消息频道(TMC)代码的基础上识别所述部分。根据表达式(208)将第二量 $V_{hist\text{-}mot\text{-}line}$ 界定为有关汽车道的 N 个部分上的从 GPS 轨迹记录的历史速度的平均值。在图 2 的表达式（210）中提供可用比例因子 F 的一实例，但其它相关性也是可能的。对于表达式（202），表达式（210）暗示假定 $V_{i,VRS\text{-}seg}$ 与 $V_{real\text{-}mot\text{-}line}$ 的比等于 $V_{i,hist\text{-}seg}$ 与 $V_{hist\text{-}mot\text{-}line}$ 的比。此粗略地解释为：假定当前存在于二级道路区段“i”上的车辆的数目与当前存在于汽车道的 N 个部分上的车辆的数目的比等于在所考虑的时窗中根据 GPS 轨迹在过去

存在于区段“i”上的车辆的数目与同一时窗中在过去存在于汽车道的 N 个部分上的车辆的数目的比。亦即，根据主要汽车道上的交通来缩放二级道路上的交通。

表达式（202）、（204）及（210）中的比例因子的以上实例产生相对简单的模型，然而，出于本发明的目的，所述相对简单的模型实际上在模型化交通流量时有用。比例因子表示汽车道上的堵塞导致道路网络的相邻部分中的连接的二级道路上的较缓慢速度的现象。大体而言，速度与交通流量之间的关系是一种复杂的关系，且除速度以外还可考虑用于模型化交通流量的许多其它量，例如响应时间、个别车辆的加速度及减速度、速度及/或交通量的时间导数、速度及/或交通量的位置导数等等。交通流量中可能会形成冲击波，从而导致臭名昭著的交通阻塞或连环碰撞。见（例如）G·B·惠瑟姆（G.B. Whitham）的“线性及非线性波”（"Linear and Nonlinear Waves"）第 3.1 章“交通流量”（"Traffic Flows"）（Wiley-Interscience 1999）。

替代于使用表达式（202），可使用（例如）用于量 $V_{i,VRS\text{-}seg}$ 的一组值，例如一组两个值，其中一个预设定值表示正常速度（当对应的主要汽车道不堵塞时），且另一预设定值表示主要汽车道堵塞的情况下的流量。后一值可通过用表示堵塞汽车道的连接路段处的实时速度的因子来缩放正常速度而确定。可考虑其它相关性以便在已知关于路径的平均速度及/或交通量的历史数据的情况下同时考虑到堵塞对附近道路的影响而确定表示沿着特定路径的预计行进时间的量。

表达式（210）的比例因子使用速度的比。或者，可与表达式（202）一起使用比例因子 $M_{line}$，比例因子 $M_{line}$ 包括表达式（212）中提供的第一量 $TF_{real\text{-}mot\text{-}line}$ 与第二量 $TFhist_{\text{-}mot\text{-}line}$ 的比。将第一量 $TF_{real\text{-}mot\text{-}line}$ 界定为有关汽车道的一个或一个以上部分上的通过（例如）道路表面中的环路传感器测量的实时交通流量（亦即，每一单位时间通过一位置的车辆的数目）的平均值。将第二量 $TF_{hist\text{-}mot\text{-}line}$ 界定为有关汽车道的所述一个或一个以上部分上的历史交通流量的平均值。

请注意，这些计算中所考虑的历史数据应优选具有对应于当前时刻的时隙中的时戳。举例来说，在某个星期三的 17:00 GMT 的时刻计算的 VRS 应考虑来自当天还有过去的星期三的大约相同时间产生的 GPS 轨迹的数据。

事实证明，基于线的方法不如基于区的方法准确。因此优选仅当基于区的方法确实产生适当 VRS 时使用基于线的方法。下文详细论述基于区的方法，随后描述其中应优选使用基于线的方法的情境。

对于基于区的方法如下进行。汽车道的一部分上的实时速度被称作 $V_{real\text{-}mot}$ 且在 GSM 数据的基础上确定。此部分上的历史平均速度被称作 $V_{hist\text{-}mot}$，其在 GPS 轨迹的基

础上确定。在汽车道上的实时速度 $V_{real-mot}$ 降低到特定阈值水平 $V_{real-mot-threshold}$ 以下（作为汽车道的严重不寻常堵塞的指示）的情况下，计算基于区的虚拟实时速度。

可使用阈值因子 $G_{threshold}$ 从历史速度数据导出阈值速度 $V_{real-mot-threshold}$。历史速度数据已存储于存储装置 102 中的所述特定汽车道部分的速度简档中，且必须用实验方法确定阈值因子 $G_{threshold}$。基于线的方法中关于时戳的以上考虑也适用于基于区的方法。图 3 的表达式（302）传达 $G_{threshold}$ 的意义。如果 $V_{real-mot}$ 降低到阈值速度 $G_{threshold}$ 以下，则需要使用汽车道部分周围的区中的二级道路上的 VRS。

此 VRS 计算类似于上文在基于线的方法下所论述的 VRS 计算。然而，现在针对区而非针对线计算比例因子 $H_{area}$，假定足够的实时数据可用于所述区中的道路。通过将有关区中的道路的平均实时速度除以这些计算实时速度的道路的平均历史速度来计算汽车道的每一部分的比例因子 $H_{area}$。从经营商 106 供应的基于 GSM 的数据中提取的实时速度测量区分道路上在一个方向上行进的交通与同一道路上往另一方向行进的交通。见（例如）上文所提及的 WO200245046 及 WO2007017691。

优选地，在导航装置 118 接收到此实时数据后，装置 118 仅考虑与处于从用户的当前位置朝向预定目的地的路径安排通道（routing corridor）中的那些方向中及那些道路上的交通流量有关的那些测量。此处，路径安排通道是道路网络的在要避开的堵塞区周围的那个部分，其包含作为供包括于替代路线中的候选路径的路径。此意义上的路径是定向图。通过考虑路径安排通道，尤其防止了在确定绕道时考虑流入与装置 118 的用户的行进方向相反的方向且在同一路径上的交通。因此，比例因子 $H_{area}$ 大体上取决于预定目的地。

另一差异在于：将根据二级道路网络上的所述组实时测量的速度而非根据汽车道路段上的所述组实时测量的速度来缩放。进一步对上文解释如下。

表达式（304）对应于图 2 的表达式（202），不同之处在于比例因子。在图 3 的表达式（306）中依据第一量 $V_{real-area}$ 及第二量 $V_{hist-area}$ 指定比例因子 $H_{area}$。在表达式（308）中将第一量 $V_{real-area}$ 定义为在道路网络区段中在主要道路或汽车道路段上的堵塞周围的二级道路（j=1, ..., M）上测量的所有实时速度的平均值。在表达式（310）中将第二量 $V_{hist-area}$ 定义为在道路网络区段中在主要道路或汽车道路段上的堵塞周围的二级道路（j=1, ..., M）上测量的所有历史速度的平均值。优选地，如上文所提及，仅考虑属于路径安排通道的那些实时速度及历史速度。在表达式（312）中作为量 $V_{real-area}$ 与量 $V_{hist-area}$ 的比而提供比例因子 $H_{area}$ 的一简单实例。如上文在基于线的方法下所提及，也可在基于区的方法中考虑其它相关性。同样，替代于使比例因子 $H_{area}$ 基于所测量的速度（实时的

及历史的)，可改为采用实时交通流量及历史交通流量来确定比例因子 $H_{area}$。

已在装置 118 的用户正在道路上且经由 GPRS 接收关于前方的交通条件的更新的情境下说明对路线的以上计算及重新计算。类似情境可适用于仍在家中且就在出发之前计划其行程的用户。所述用户现在使用其 PC 124（图 1 中）上的专用软件 120 将路线下载到其移动导航装置 118 上。类似地，当前及预计的交通条件产生特定路线，将所述特定路线下载到装置 118 且当用户正在驾驶时可再次动态地改变所述特定路线。此外，可将服务器 114 提供的有关数据供应到管理机构 124 以便能够对交通情形做出响应。管理机构 124 可包括管理机构 104 下的那些介绍，但还可包括救护车、消防车、特殊道路运输经营商、铁路经营商、公共汽车经营商等等的人员。

如上文所提及，在存储装置 102 中收集的信息还可包括关于当前或预计的天气条件（例如，从天气雷达推断）的信息。请注意，从交通流量的角度来看，危险的天气可能会类似于交通堵塞而影响道路条件。亦即，在雾、大雨中、在暴风雪期间或在存在黑冰的情况下可达到的平均速度将低于较有利的天气条件下可达到的平均速度。在本发明的一实施例中，如上所述，出于计算路线的目的，可将危险的天气条件映射到表示等效交通流量的量上。亦即，装置 118 将 GPRS 数据解译为表示交通流量条件或平均速度，而所述数据直接源白天气条件。

为了解释在系统 100 中产生的交通信息的使用，更详细地考虑移动导航装置 118。现在参看图 4。

导航装置 118 包含：GPS 接收器 402、无线接收器 404、存储地图信息的数据库 406、用以使用户能够控制装置 120 的用户控制装置 412、再现子系统 408、轨迹存储装置 410 及在软件 416 的控制下执行的数据处理器 414。处理器 414 负责处理数据及控制装置 118 的其它组件以用于将导航服务传送给装置 118 的用户的目的。无线接收器 404 包括（例如）GPRS 调制解调器。

GPS 接收器 402 经配置以确定装置 118 的当前地理位置。处理器 414 使用关于当前位置的信息在已知当前位置的情况下在数据库 406 中确定与装置 118 的用户有关的道路图及其它与位置相关的信息。在已知旅程的目的地及来自地图的道路信息的情况下，软件 414 能够产生导航引导且经由再现子系统 408 将其播放出来。与在常规移动导航装置中一样，用户输入目的地及其它控制信息（例如，关于经由用户控制装置 412 将引导信息播放出来的偏好、避开汽车道的偏好等等）。用户控制装置包括（例如）硬按钮及/或结合控制选项的人类工程学菜单而实施于触摸式屏幕上的软键、用于使用户与装置 118 交互的语音输入及/或任何其它合适构件。

子系统 408 优选包括显示监视器（未图示）及扬声器（未图示）。显示监视器将引导提供为图形及文本信息，且扬声器以预先录制或合成的话音的形式供应引导。显然，可将再现子系统 408 实施为部分或完全在装置 118 的外部。在所述情况下，装置 118 包含用于连通到子系统 408 的合适接口。举例来说，再现子系统 408 包含用于平视显示器的投影系统，其用以将有关信息投影到汽车的挡风玻璃上（或投影在摩托车骑手戴的头盔的护目镜上）。汽车的投影系统通常以物理方式与仪表板集成。用于摩托车骑手的投影系统集成于头盔中，且通过电池或将头盔连接到摩托车的电源的软线供电。接着以无线方式（例如，经由蓝牙接口）或以有线方式传递有关数据。作为另一实例，再现子系统 408 包含扬声器，所述扬声器是汽车的内建式声音系统的组件，或在摩托车骑手的情况下建构于骑手的头盔中。

在行程期间，将基于 GPS 信息的地理位置连同时戳存储于轨迹存储装置 410 中。当装置 118 连接到用户的家用 PC（例如）以便经由因特网从服务提供商接收道路图的更新或软件 416 的更新时，将存储于存储装置 410 中的数据发送到服务提供商，在所述服务提供商处，不具名地处理所述数据，亦即，不与装置 118 的个别用户相关联。

GPRS 是一种已知技术。GPRS 调制解调器 404 使装置 118 能够经由可供 GSM 移动电话的用户使用的移动数据服务接收数据分组。数据速率大约为 56 kbps 到 114 kbps。大体而言，经由 GPRS 提供的数据服务可为点对点服务（亦即，两个用户之间的数据通信）及点对多点（或：多播，亦即，从一个用户到许多用户）。关于多播 GPRS 服务，可在特定地理区内广播数据分组。广播中的识别符指示数据分组是意图用于地理区中的所有用户还是用于特定用户群。在本发明的上下文内，此类型的服务能够发送关于与特定地理区内的装置 118 的用户有关的交通信息的更新。

在以上实施例中，由装置 118 自身来进行路线的（重新）计算，出于此目的，装置 118 容纳处理器 414、数据库 406 及软件 416。装置 118 仅经由 GPRS 调制解调器 404 从服务器 114 接收实时交通更新，且接着处理所述实时交通更新以修改路线并在经修改的路线及其根据车载 GPS 接收器的当前位置的基础上产生导航引导。

图 5 是本发明中的 PND 502 的图，PND 502 是作为装置 118 的替代装置的实例。装置 502 实施为与服务器 114 协作的轻型客户端。装置 502 现在还包含一用于将数据传递到服务器 114 的无线发射器 504。举例来说，发射器 504 将通过用户控制装置 412 输入的关于旅程的目的地的信息优选连同用户的偏好（例如，导航引导的供应形态，如男性或女性语音；避开汽车道；避开收费所等等）一起传递到服务器 114。可由用户针对每一个别旅程选择偏好，或者可能已将偏好预设定为默认操作模式。发射器 504 进一步将

表示经由 GPS 接收器 402 确定的装置 502 的地理位置的数据传递到服务器 114。

类似于上文所论述，服务器 114 基于装置 502 的当前位置、基于从 GSM 经营商 106 及从 GPS 轨迹 108 收集的实时交通信息（重新）计算路线。如果足够大数目的车辆正在使用配置为轻型客户端 502 的 PND，则服务器 114 具有关于这些车辆的地理位置的实时信息，也可在系统 100 处考虑所述实时信息以产生交通信息 112。请注意，也由于此原因，装置 502 不需要具有轨迹存储装置 410，因为装置 502 的地理位置正被实时地传递到服务器 114。

此实施方案的一优点在于装置 502 可实施为精简数据（lean data）处理装置。另一优点在于服务器 114 可将对装置 502 的用户的导航引导置于更广泛的情形中。对此解释如下。服务器 114 具有不仅与装置 502 的用户当前所在的地理区有关而且与其它地理区有关的交通信息及天气信息 112。这意味着可计算对装置 502 的用户的导航引导以便关于从出发地到目的地的当前旅程的整个区域而最佳化。亦即，全局最佳化是可能的。请注意，与此相反，装置 118 仅接收关于局部交通条件的交通信息且对路线的修改表示局部最佳化。举例来说，考虑以下情境：其中，为了在特定区中的局部的中等程度的交通堵塞周围引导装置 118 的用户，装置 118 提供对绕道的引导，所述绕道碰巧使用户进入由于重大交通事故而已发生因重大连环撞车引起的严重堵塞的相邻区中。假如用户停留在原始路线从而经受住中等程度的不便，则其不会遭遇绕道上的严重堵塞。然而，这样的坏运气可能是偶然且罕见的，这取决于所述区中的道路的密度。

依据在服务器 114 处及从服务器 114 到接收器 404 的无线通信中可用的带宽，服务器 114 可经配置以实行在先前实施例中在装置 118 中实行的所有数据处理操作。亦即，将所有数据处理委托给服务器 114。接着，装置 502 中的处理器 414 现在主要负责控制再现子系统 408 以再现导航引导信息。导航引导信息包括按照需要从服务器 114 接收的待再现于子系统 408 的显示监视器上的地图数据，且包括从服务器 114 接收的待作为话音经由子系统 408 中的扬声器再现及/或作为图形图标经由显示监视器再现的指引。在此情况下，装置 502 自身不需要用于存储道路图数据及其它地理上有关的数据的数据库存储装置 406，因为所有内容均正被传递到装置 502。

然而，请注意，为了从服务器 114 接收用于详细导航引导的数据（例如，用于在显示监视器上再现详细道路图），接收器 404 及服务器 114 需要具有足够大的带宽。GPRS 技术实际上可能对于实施将数据从服务器 114 下载到装置 502 而言不足。GPRS 技术仍可用于将 GPS 上载到服务器 114。包括专用电视频道的电视技术原则上可用于从服务器 114 到装置 502 的下载。

图 6 是本发明中的 PND 的实施例 602 的框图，可将所述 PND 的配置视为介于装置 118 的配置与装置 502 的配置之间。类似于装置 502，装置 602 使用无线双向数据通信技术与服务器 114 通信，例如，在接收器 404 与发射器 504 两者中均使用 GPRS 技术。类似于装置 118，装置 602 将道路图数据及其它有关地理信息存储于数据库 406 中。然而，数据库 406 并不需要存储表示针对每一个别道路区段记录的历史平均速度的数据。发射器 504 间歇地（例如，依据（例如）行进方向的改变而周期地或选择性地）将 GPS 数据上载到服务器 114。因此，服务器 114 始终知道装置 602 的当前地理位置。服务器 114 经由接收器 404 将导航引导数据下载到装置 602。在用户的目的地及用户的当前地理位置的基础上及在存储装置 112 中创建的历史及实时交通信息及天气信息的基础上计算此数据。上文已（例如）参看图 2 及图 3 论述了创建过程。与实施例 502 一样，一优点在于以下事实：服务器 112 具有关于包括用户正在其中驾驶或骑乘的区的多个地理区的可用交通信息及天气信息。这使得能够在比仅局部地在所述地理区中的单个地理区内的规模大的规模上使路线最佳化。处理器 414 在软件 604 的控制下处理从服务器 114 接收的导航引导数据，以产生适合用于装置 602 的用户的引导信息。举例来说，处理器 414 在再现子系统 408 上产生视觉及/或听觉指令，且将引导信息与从数据库 406 检索的有关道路图数据进行组合。

至于本发明中的 PND 的用户接口方面（例如，装置 118、502 或 602），以下特征可有助于装置在操作使用中的察觉到的用户友好性。

第一特征涉及如上所述的经配置或编程以基于交通条件或天气条件告知用户对新近路线的当前更新的装置 118、502 或 602。通过（例如）合成语音经由子系统 408 的扬声器及/或经由子系统 408 中的显示监视器上的图形指示告知用户。

第二特征涉及在装置 118、502 或 602 的子系统 408 中的显示监视器上的导航引导的图形表示。举例来说，将当前有关的道路图的一部分再现于显示监视器上，且将当前使用的路线的对应部分投影到所显示的地图部分上。用户接着在脑海里形成路线的所述部分及其地理环境的图片。如上所述，在给定时刻，由于当前路线的即将到来的分支中的不良交通条件及/或天气条件而修改当前路线。用户接着必须重新调整其脑海里的图片以便对应于经修改的路线。装置 118、502 或 602 现在用图形指示先前路线的有关部分及经修改的路线的有关的当前有效的部分两者。举例来说，以红色指示先前部分且以绿色指示当前有效的部分。或者，以（例如）不同的短划式样用图形指示先前部分及当前有效的部分。以一串短划（“-----”）指示先前部分且以一串加号（“+ + + + + + + +”）指示当前有效的部分。如果用户是色盲，则后一选项优选。可通过用户控制装置 412 存取的

配置菜单使用户能够在装置 118、502 或 602 的操作使用中选择指示先前及当前有效的部分的优选方式。

第三选项涉及向装置 118、502 或 602 的用户提供关于对路线的当前修改的原因的信息。举例来说，从服务器 114 接收的数据包括由处理器 414 处理以选择多个预定义的图标或文本中待在子系统 408 中再现的一者的识别符，所述图标及文本表示原因。举例来说，如果原因是因交通事故引起的严重堵塞，则选择展示侧翻的汽车的图标。作为另一实例，可使用对应于按照惯例用于指示打滑道路的交通符号的图标来指示作为路线的原因的恶劣天气条件。作为又一实例，可选择指示高峰时间交通、吊桥等等的图标。

第四选项涉及对知道在其行程中其将遭遇通常的不可避开的拥挤交通的驾驶员（例如，每日通勤者）的导航引导。不需要经由绕道引导装置 118、502 或 602 的这些用户，也不需要向其通知通常的堵塞。通勤者于是可（例如）关闭装置 118、502 或 602，或忽视所述引导。更用户友好的选项则是使引导以这样的模式操作：其中仅不寻常地严重的堵塞（亦即，与日常严重堵塞相比不平常）引起经修改的路线。服务器 114 具有关于实时平均速度或交通量的信息，且装置 118 及/或服务器 114 具有关于历史平均速度或交通量的信息。可接着选择这样的操作模式：其中装置 118 或服务器 114 区分通常的堵塞与不寻常的堵塞以便能够选择性地修改路线。

图 7 是由服务器 114 执行的如上所述向装置 502 或 602 提供导航引导的方法的一实例的流程图。在步骤 702 中起始所述方法。在步骤 704 中，服务器 114 从装置 502 或 602 接收关于其出发位置、其目的地的信息。出发位置可由服务器 114 从 GPS 数据（从装置 502 或装置 602 接收）确定，或可由于用户通过用户控制装置 412 输入或以其它方式选择目的地的名称而经由 GPRS 作为文本数据来接收。在步骤 706 中，服务器 114 任选地考虑到用户的偏好及在存储装置 112 处可用的交通信息及/或天气信息来计算路线。在步骤 708 中，服务器 114 将表示导航引导的数据传输到装置 502 或装置 602。经由 GPRS 建立数据传输。装置 502 或 602（例如）经由 GPRS 提交表示装置的当前地理位置的数据，所述当前地理位置（例如）是经由 GPS 技术（或另一技术）确定的。为方便起见，在此文中将此数据称作 GPS 数据。在步骤 710 中，服务器 114 接收 GPS 数据。在步骤 712 中，服务器 114 确定是否已到达目的地。如果已到达目的地，则所述方法的过程在步骤 714 中结束。如果尚未到达目的地，则服务器 114 在步骤 716 中根据接收到的 GPS 数据确定对应于装置 502 或 602 的位置的地理区。在步骤 718 中，服务器 114 确定与当前有效的路线的仍待覆盖的部分（亦即，当前地理位置与目的地之间的路线）有关的交通信息及/或天气信息。基于此信息，服务器 114 在步骤 720 中计算对当前有效的路线的

候选修改以确定是否可最佳化行进时间（或待行进的距离或这些及其它量的加权和）。如果服务器 114 确定不需要对当前有效的路线的修改，则过程返回到步骤 708。如果服务器 114 决定需要修改，则服务器 114 在步骤 722 中创建经修改的路线。过程返回到步骤 708 以基于经修改的路线供应导航引导数据。

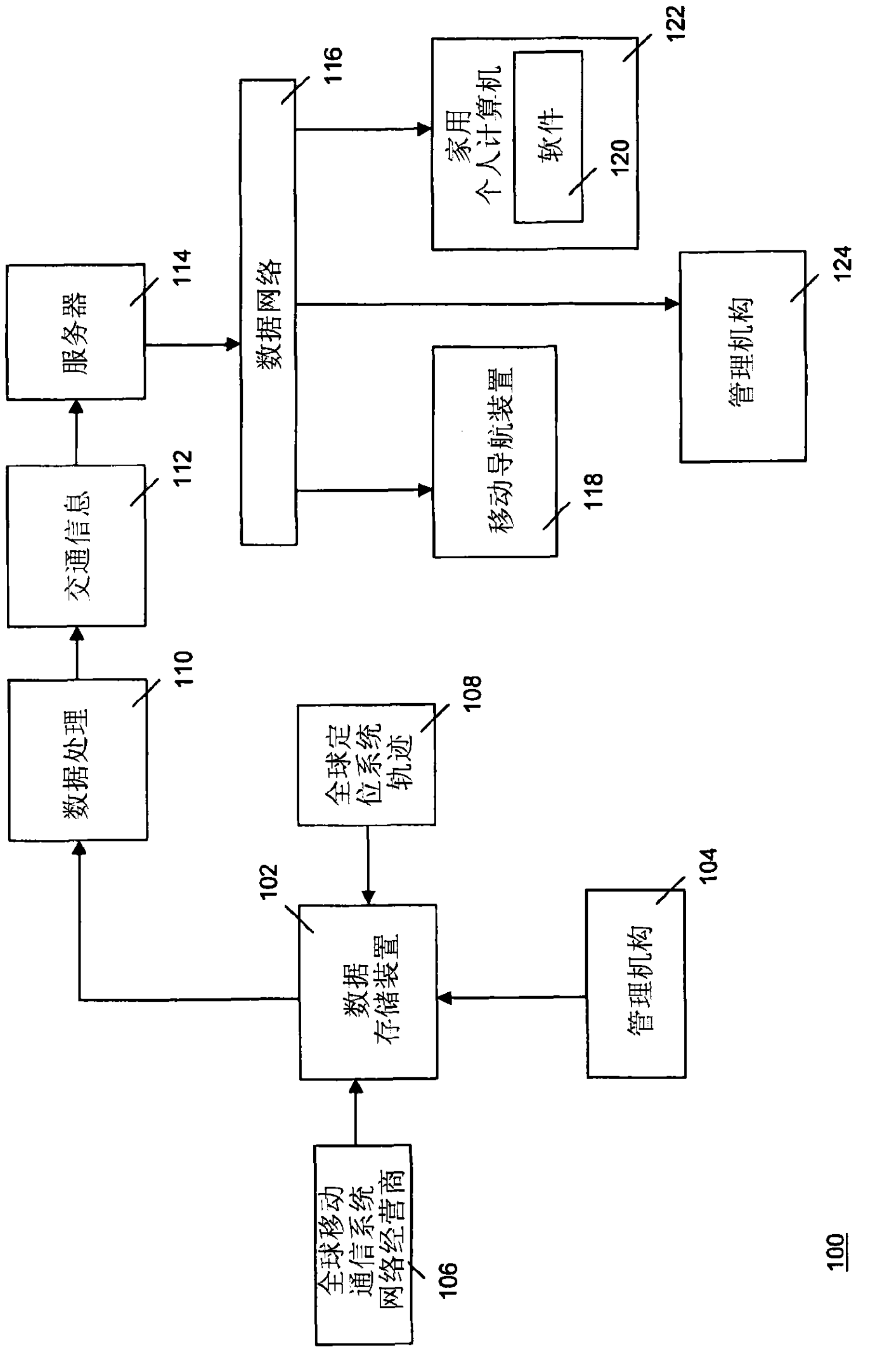

全球移动通信系统网络经营商
106
数据存储装置
102
管理机构
104
全球定位系统轨迹
108
数据处理
110
交通信息
112
服务器
114
数据网络
116
移动导航装置
118
管理机构
124
家用个人计算机
122
软件
120
100

图1

(202) $V_{i,VRS\text{-}seg} = F_{line} \cdot V_{i,hist\text{-}seg}$

(204) $F_{line} = F_{line}\,(V_{real\text{-}mot\text{-}line},\ V_{hist\text{-}mot\text{-}line})$

(206) $V_{real\text{-}mot\text{-}line} = \frac{1}{N} \sum V_{real\text{-}mot\text{-}sec\ j}$

(208) $V_{hist\text{-}mot\text{-}line} = \frac{1}{N} \sum V_{hist\text{-}mot\text{-}sec\ j}$

(210) $F_{line} = V_{real\text{-}mot\text{-}line} / V_{hist\text{-}mot\text{-}line}$

(212) $M_{line} = TF_{real\text{-}mot\text{-}line} / TF_{hist\text{-}mot\text{-}line}$

图2

(302) $V_{real\text{-}mot\text{-}threshold} = G_{threshold} \cdot V_{hist\text{-}mot}, \quad 0 < G_{threshold} < 1$

(304) $V_{i,VRS\text{-}seg} = H_{area} \cdot V_{i,hist\text{-}seg}$

(306) $H_{area} = H_{area}(V_{real\text{-}area}, V_{hist\text{-}area})$

(308) $V_{real\text{-}area} = \frac{1}{M} \Sigma\ V_{j,\,real}$

(310) $V_{hist\text{-}area} = \frac{1}{M} \Sigma\ V_{j,\,hist}$

(312) $H_{area} = V_{real\text{-}area} / V_{hist\text{-}area}$

图3

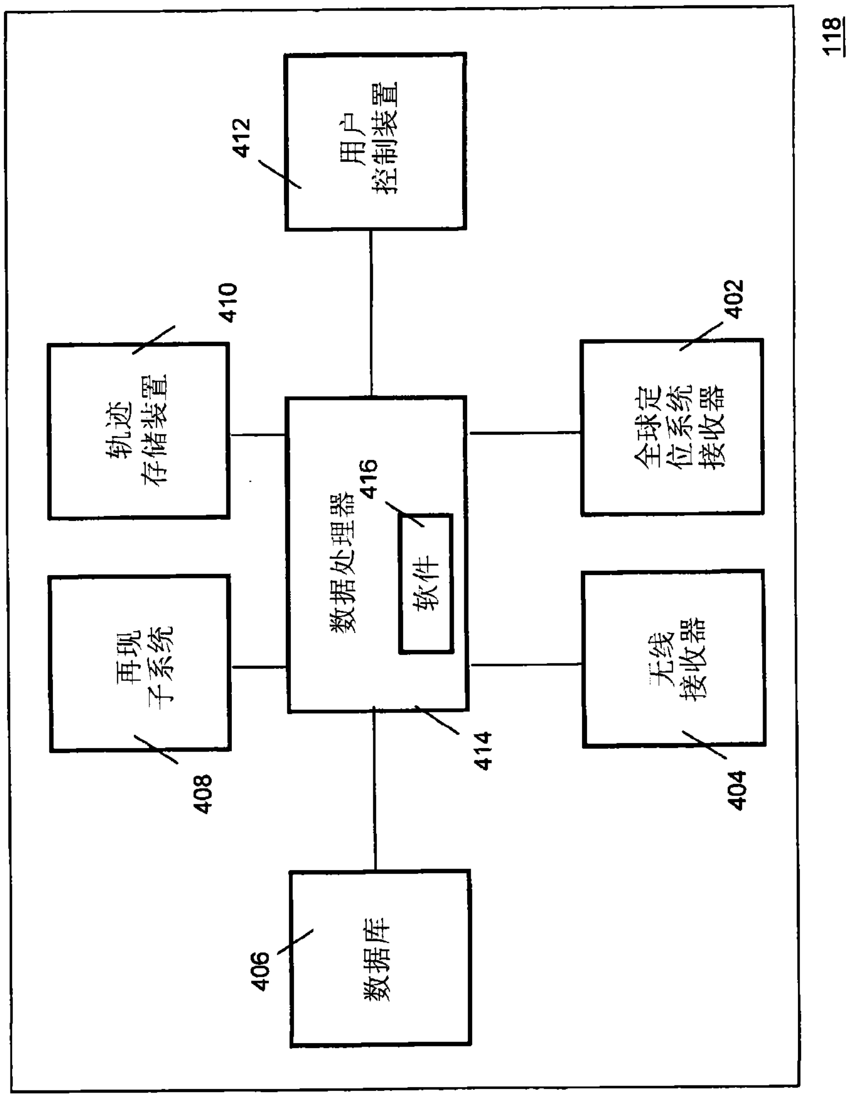

用户
控制装置
412
轨迹
存储装置
410
全球定位系统
接收器
402
数据处理器
416
软件
414
再现
子系统
408
无线
接收器
404
数据库
406
118

图4

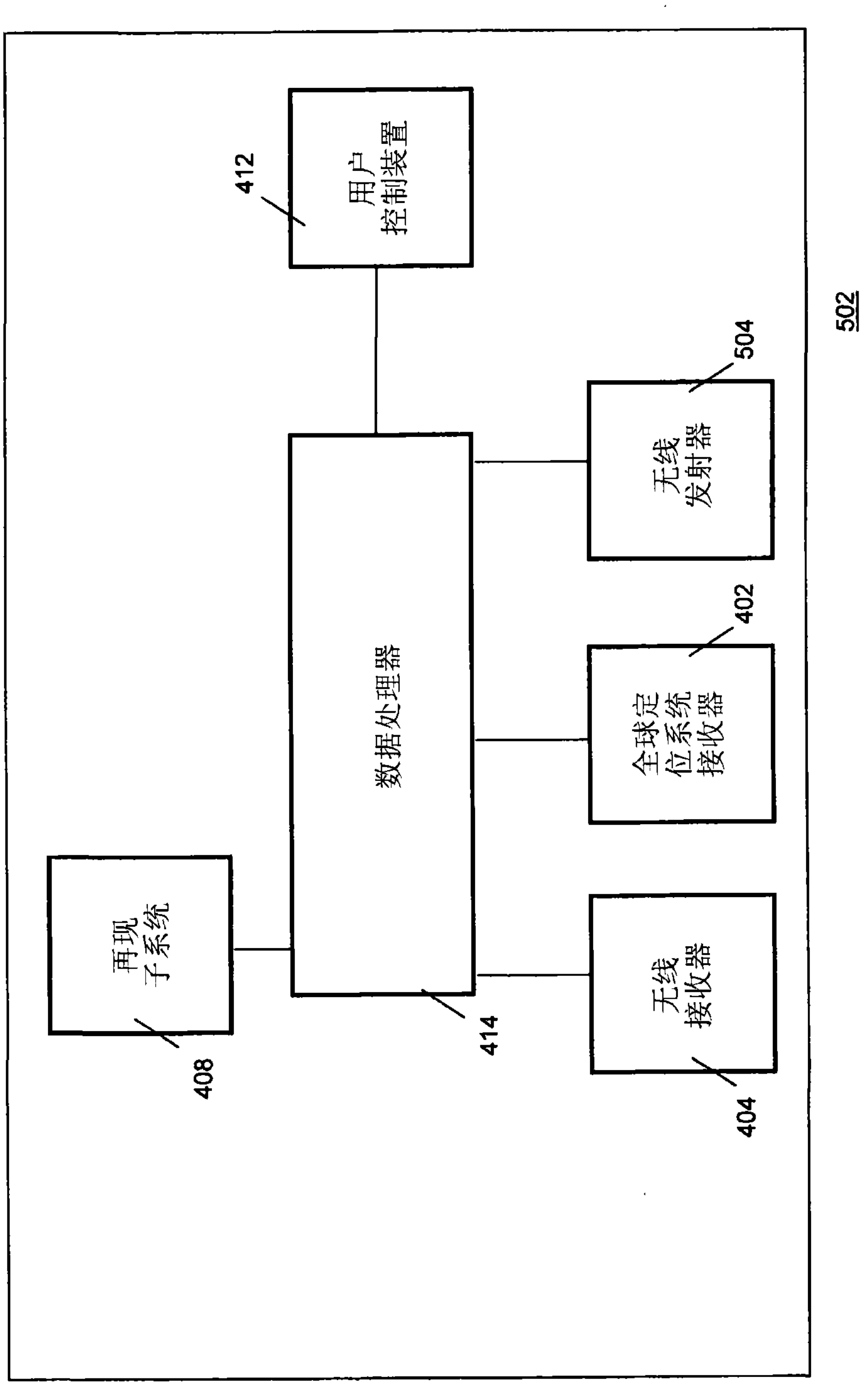

用户
控制装置
412
数据处理器
414
无线
发射器
504
全球定位系统
接收器
402
无线
接收器
404
再现
子系统
408
502

图5

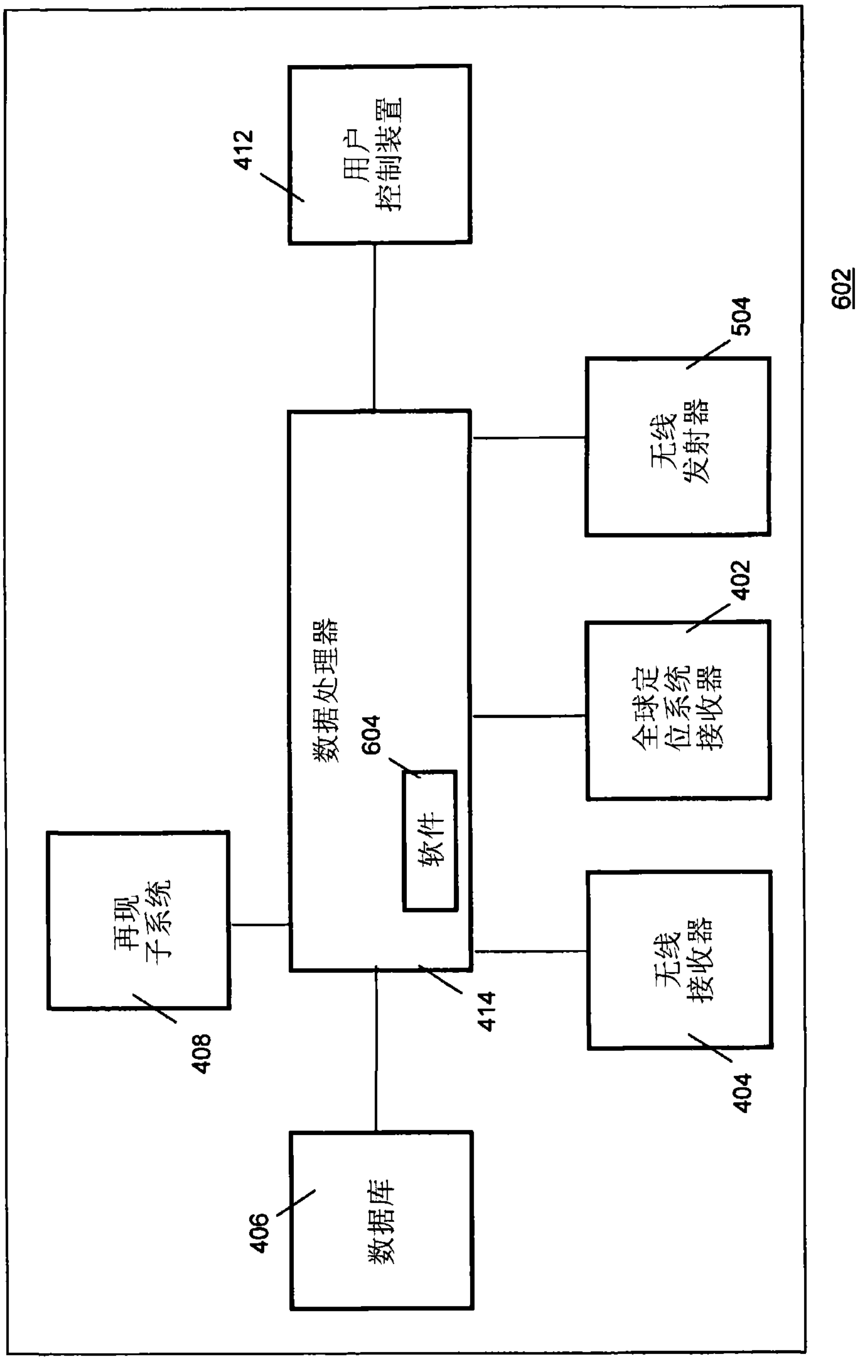

用户
控制装置
412
数据处理器
604
软件
414
无线
发射器
504
全球定位系统
接收器
402
无线
接收器
404
再现
子系统
408
数据库
406
602

图6

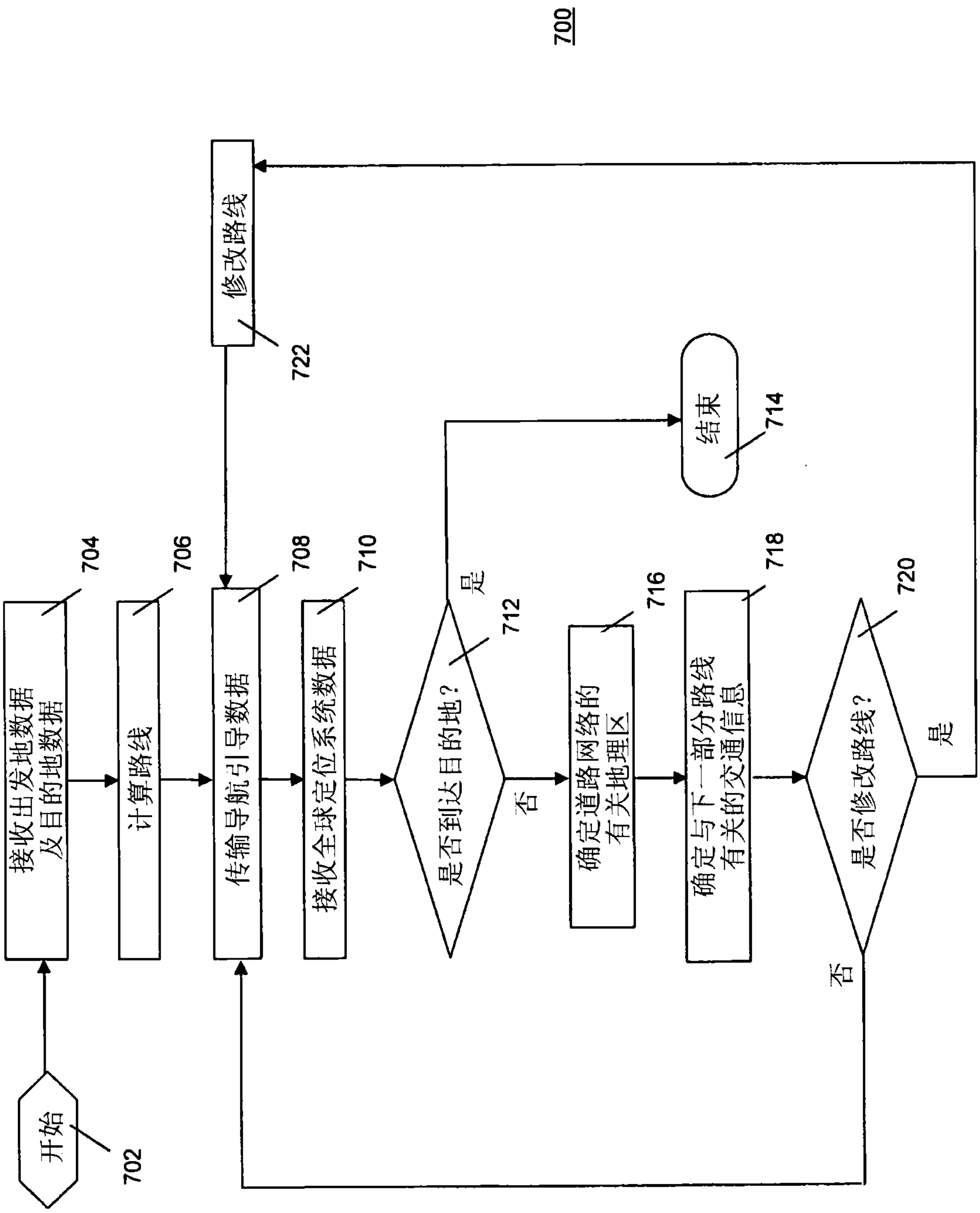

700
开始
702
接收出发地数据及目的地数据
704
计算路线
706
传输导航引导数据
708
接收全球定位系统数据
710
是否到达目的地？
712
是
否
结束
714
确定道路网络的有关地理区
716
确定与下一部分路线有关的交通信息
718
是否修改路线？
720
是
否
修改路线
722

图7