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(54) **NAVIGATION DEVICE AND METHOD**

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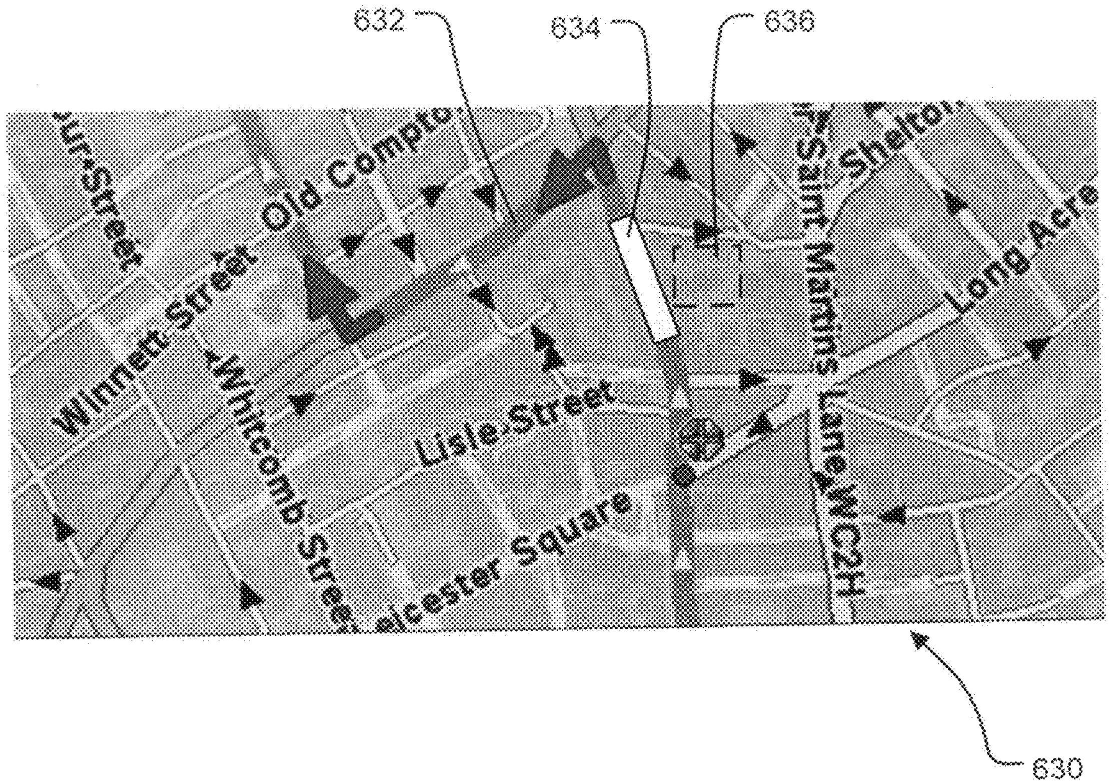
(57) **ABSTRACT**

A navigation device is disclosed which is operable to generate an output indication representing whether or not journey conditions are favourable. In at least one embodiment, the navigation device includes a processing resource configured to: calculate for a navigation route, expected journey time information indicating an expected time duration for completing the route; compare the expected journey time with an average journey time for the route; and generate, responsive to the result of said comparison, said output indication representing whether or not journey conditions are favourable.



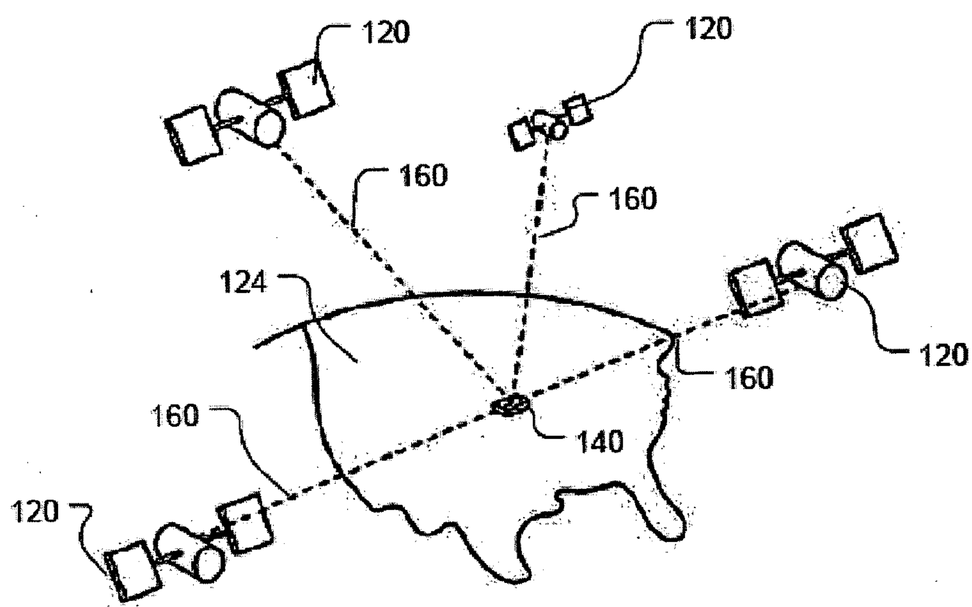

120
120
160
160
124
120
160
140
160
120

FIG. 1

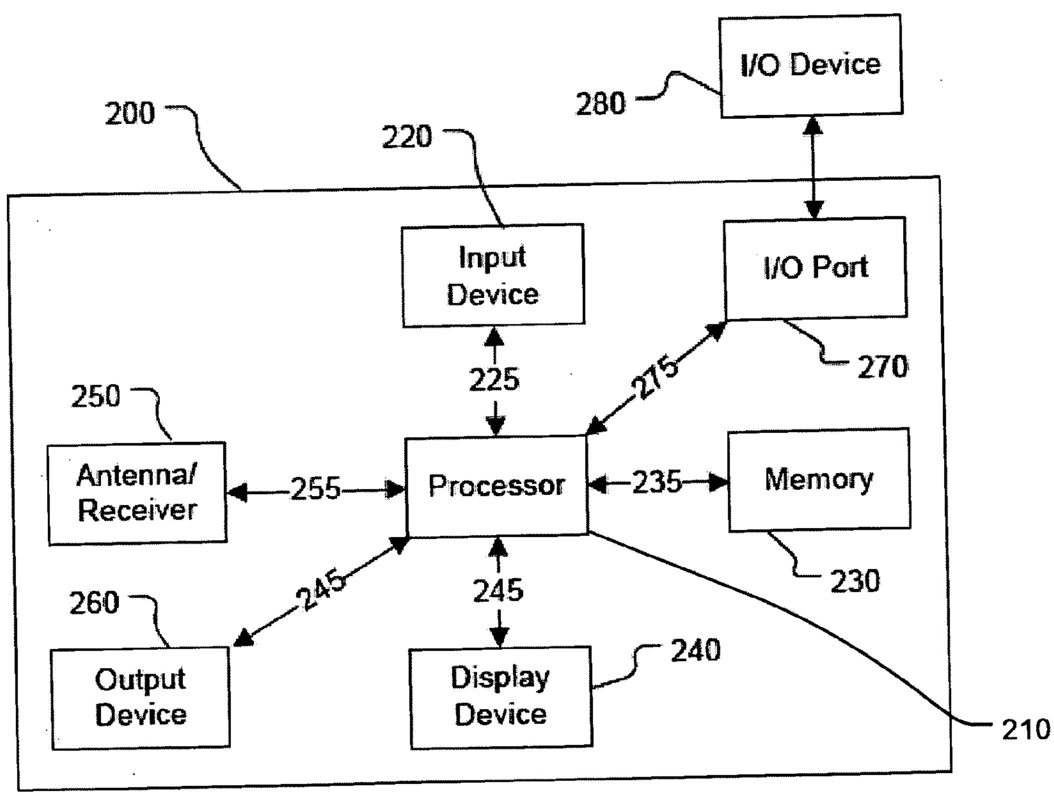

I/O Device
280
200
220
Input
Device
I/O Port
270
225
275
250
Antenna/
Receiver
255
Processor
235
Memory
230
245
245
260
Output
Device
Display
Device
240
210

FIG. 2

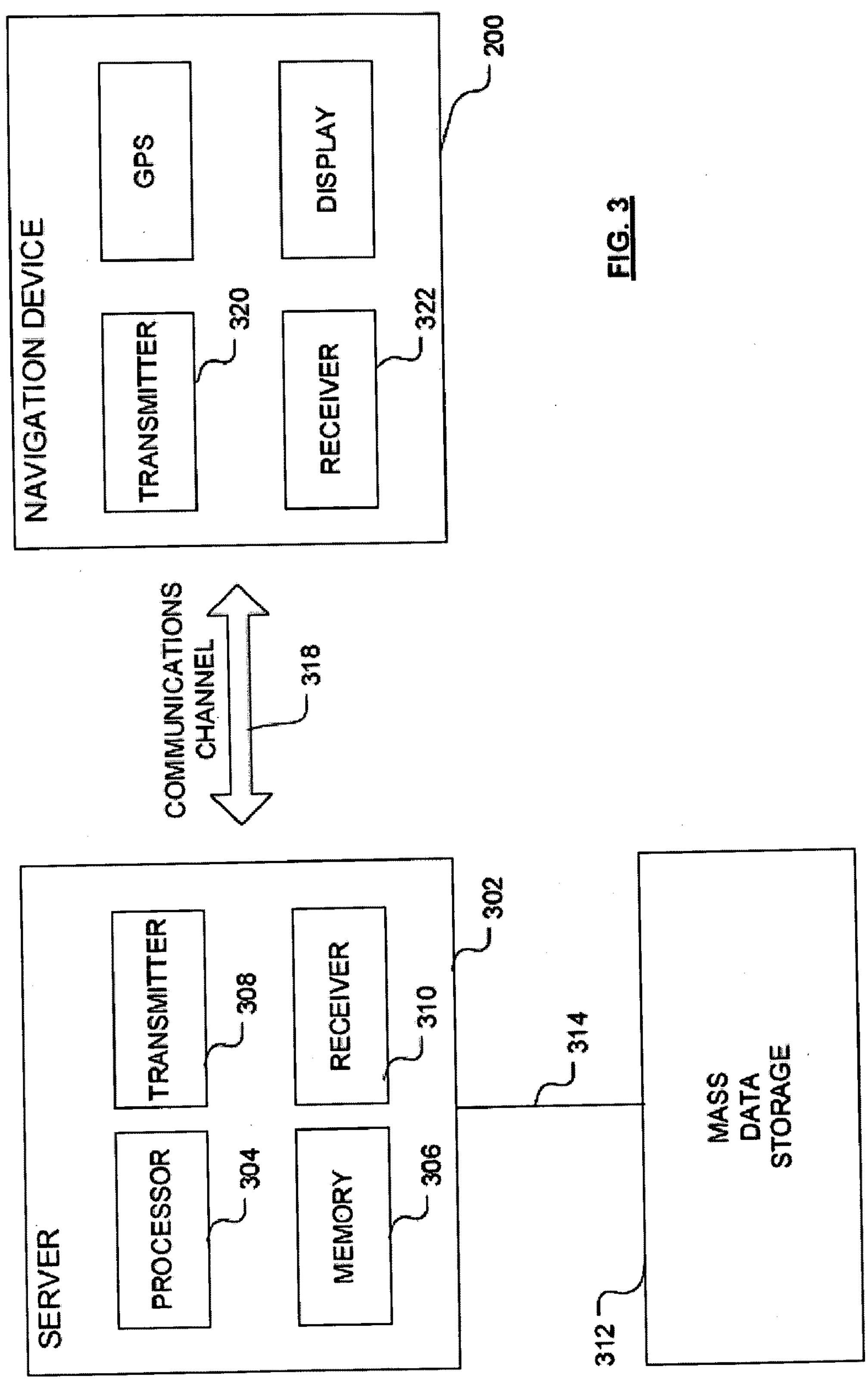

NAVIGATION DEVICE
GPS
DISPLAY
TRANSMITTER
RECEIVER
320
322
200
COMMUNICATIONS CHANNEL
318
SERVER
PROCESSOR
MEMORY
TRANSMITTER
RECEIVER
304
306
308
310
302
314
MASS DATA STORAGE
312

FIG. 3

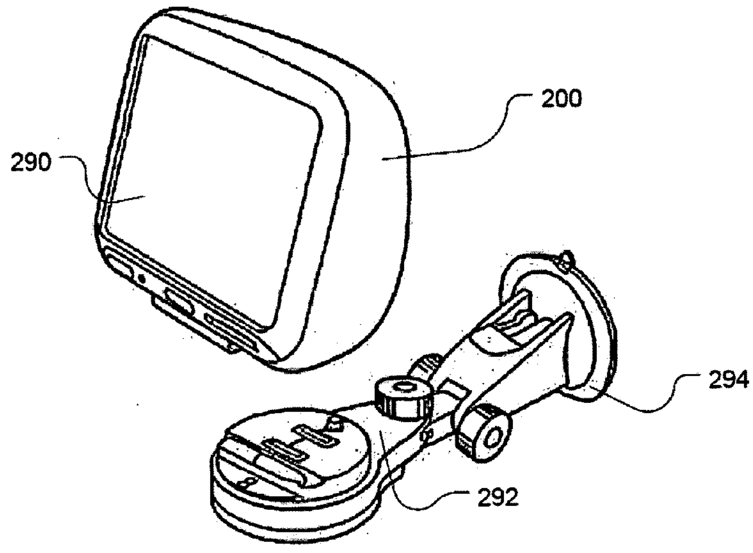


FIG. 4a

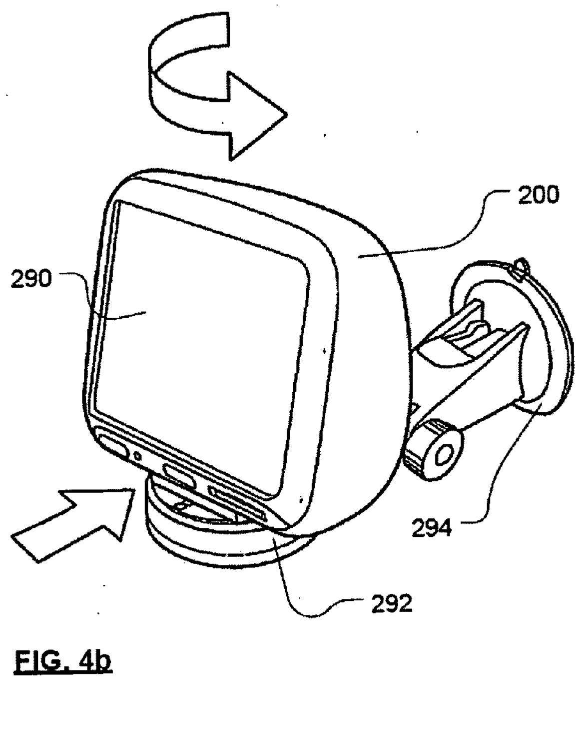


FIG. 4b

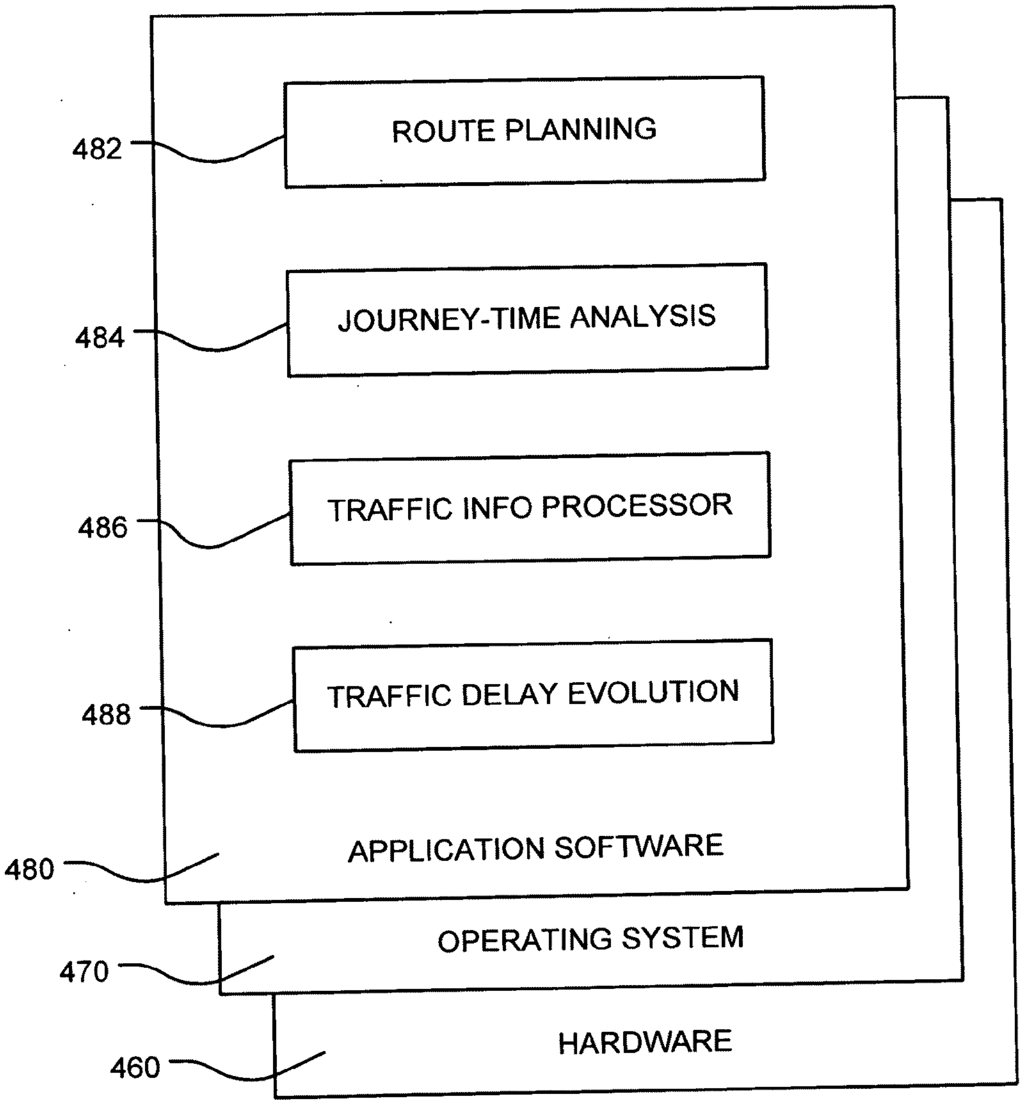

482
ROUTE PLANNING
484
JOURNEY-TIME ANALYSIS
486
TRAFFIC INFO PROCESSOR
488
TRAFFIC DELAY EVOLUTION
480
APPLICATION SOFTWARE
470
OPERATING SYSTEM
460
HARDWARE

Fig. 5

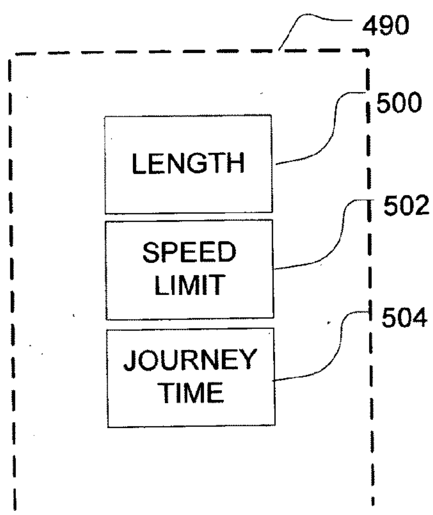


FIG. 6a

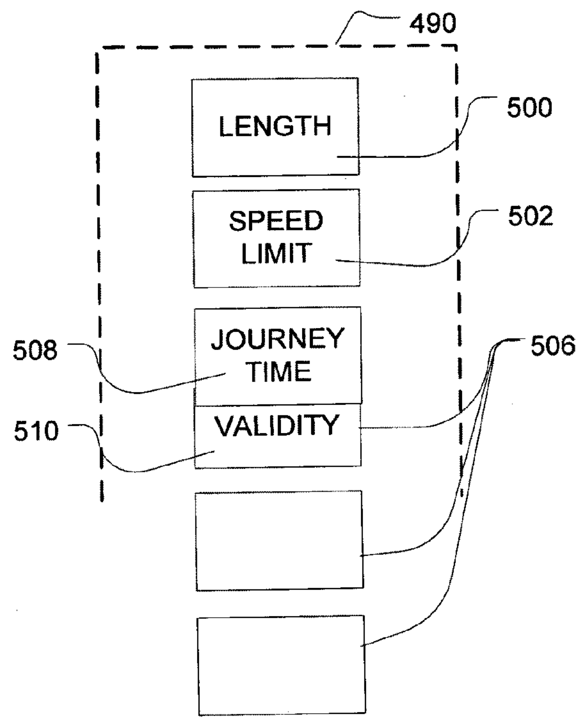


FIG. 6b

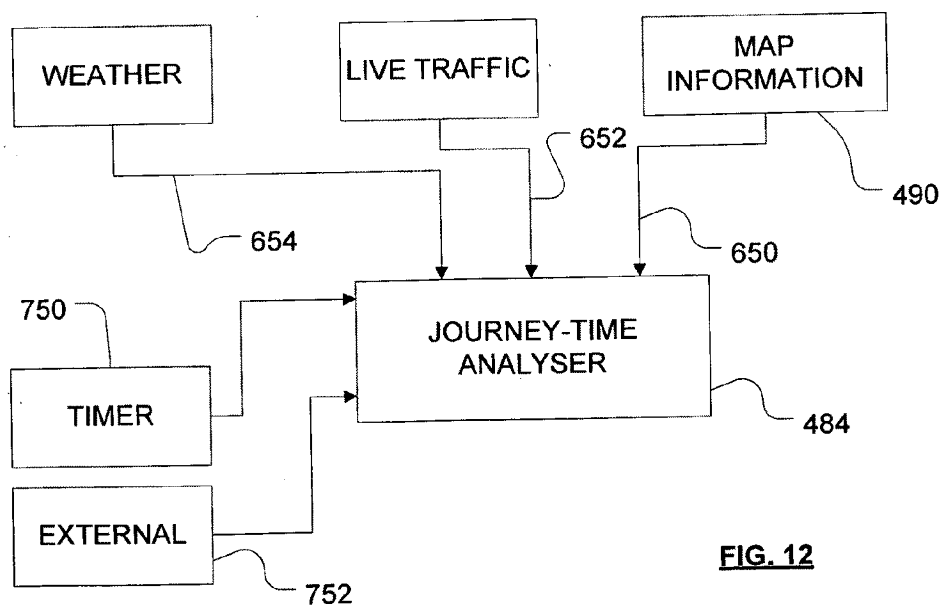


FIG. 12

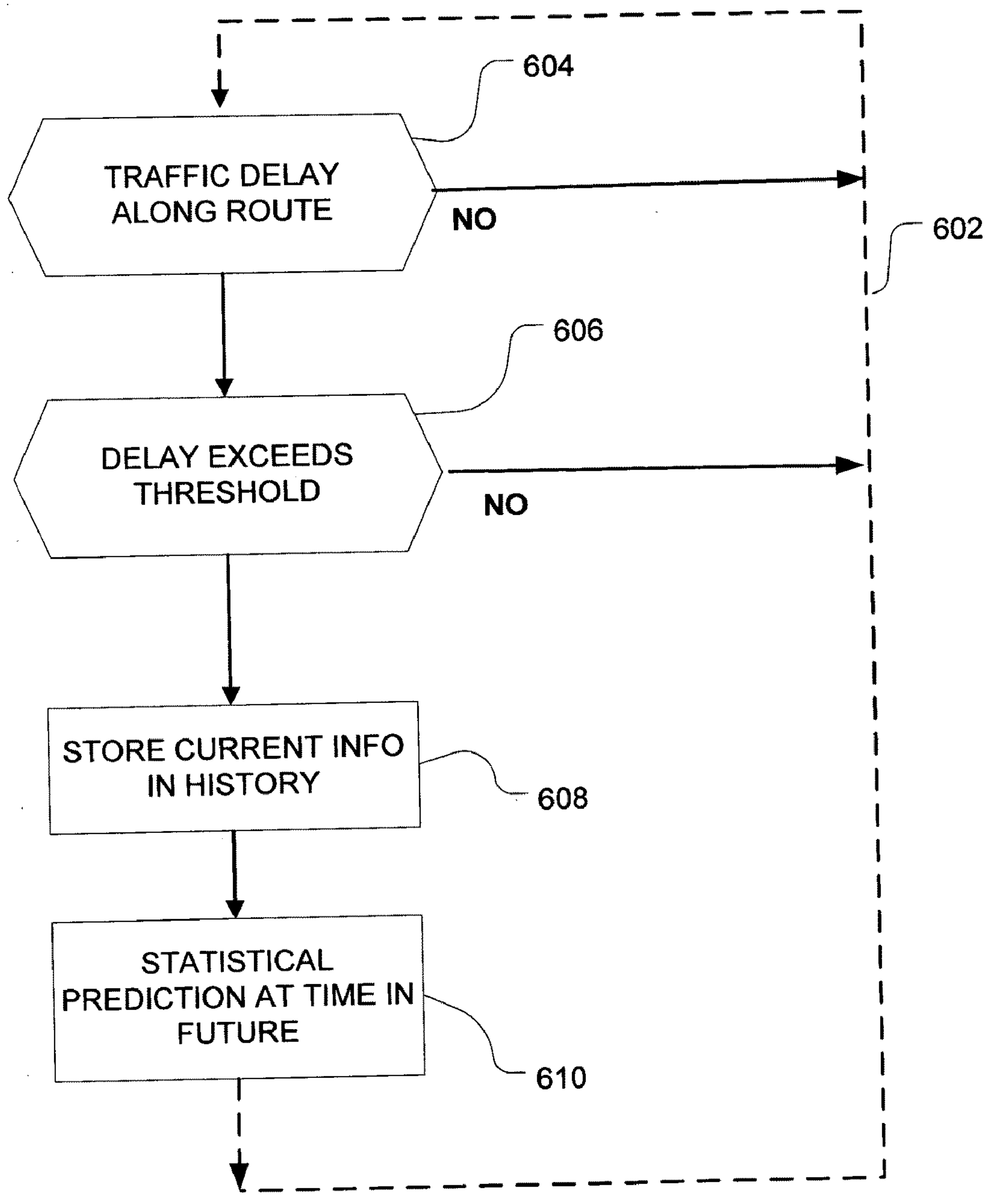

604
TRAFFIC DELAY ALONG ROUTE
NO
602
606
DELAY EXCEEDS THRESHOLD
NO
STORE CURRENT INFO IN HISTORY
608
STATISTICAL PREDICTION AT TIME IN FUTURE
610

FIG. 7

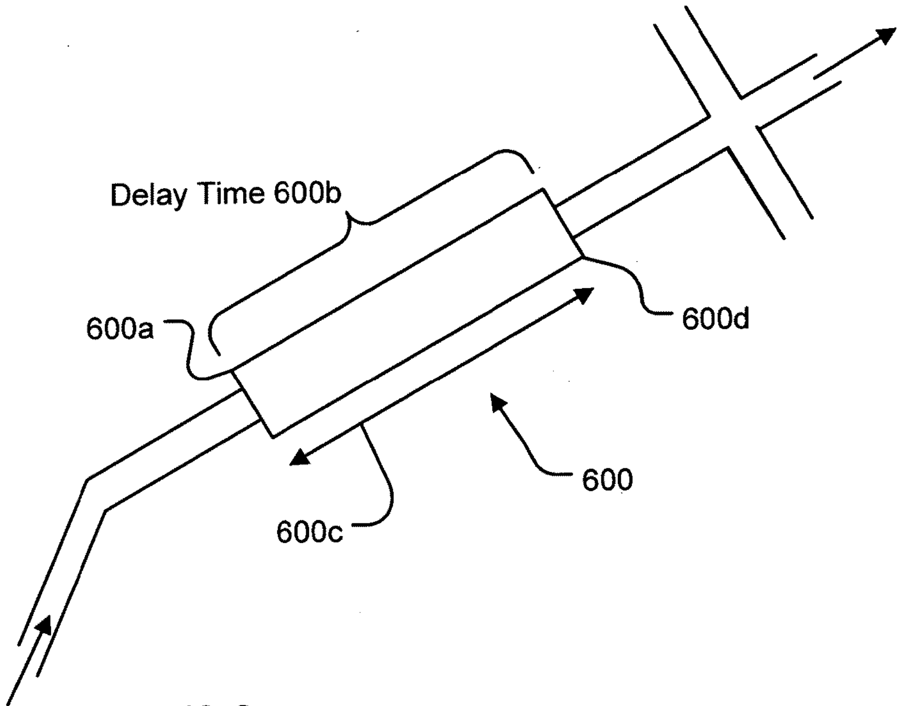

Delay Time 600b
600a
600d
600
600c

FIG. 8

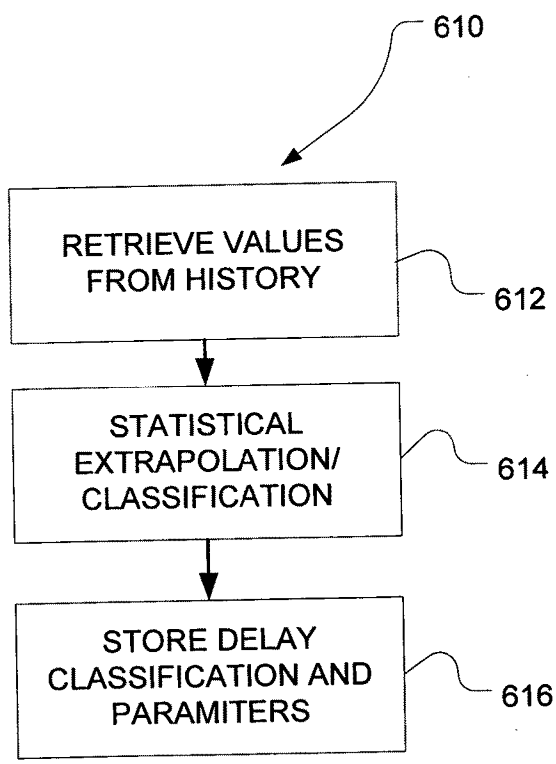

610
RETRIEVE VALUES FROM HISTORY
612
STATISTICAL EXTRAPOLATION/ CLASSIFICATION
614
STORE DELAY CLASSIFICATION AND PARAMITERS
616

FIG. 9

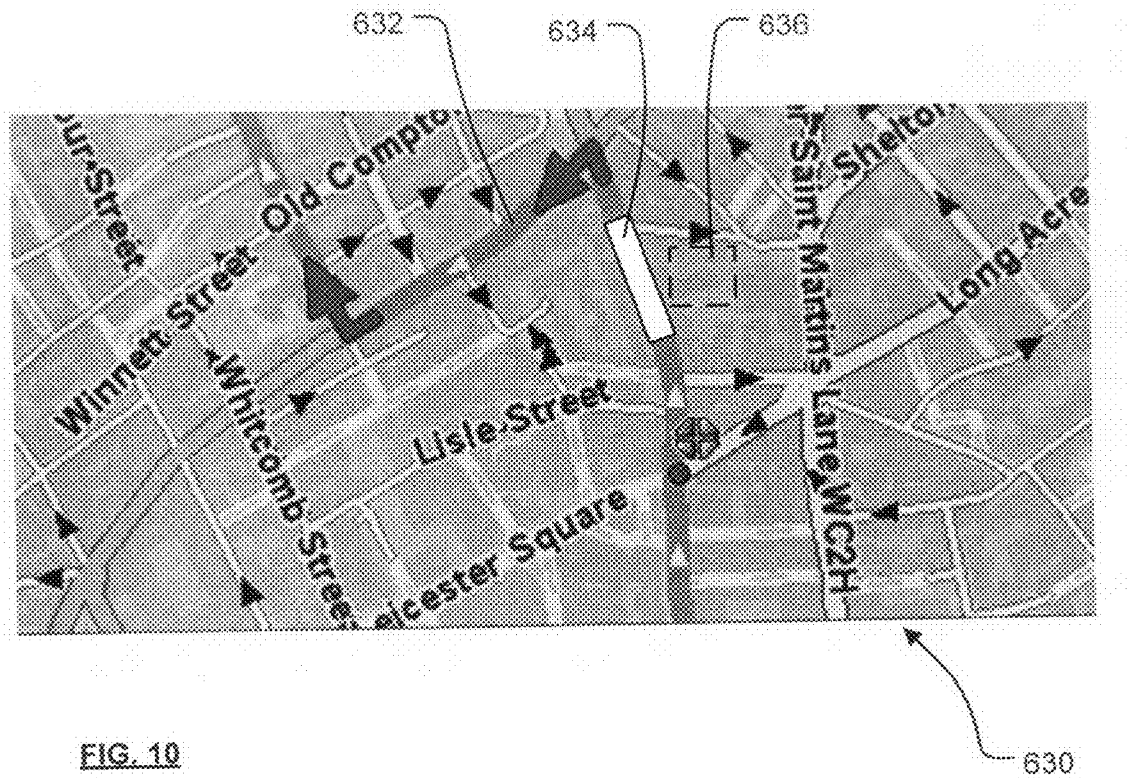

632
634
636
Old Compto
Winnett Street
Whitcomb Street
Lisle Street
Leicester Square
Saint Martins Lane
WC2H
Shelton
Long Acre
630

FIG. 10

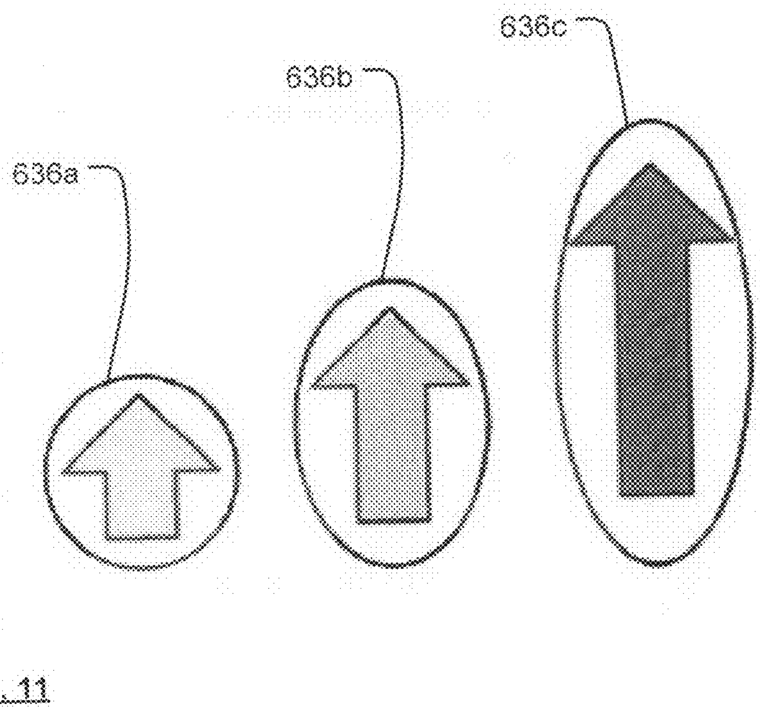

636a
636b
636c

FIG. 11

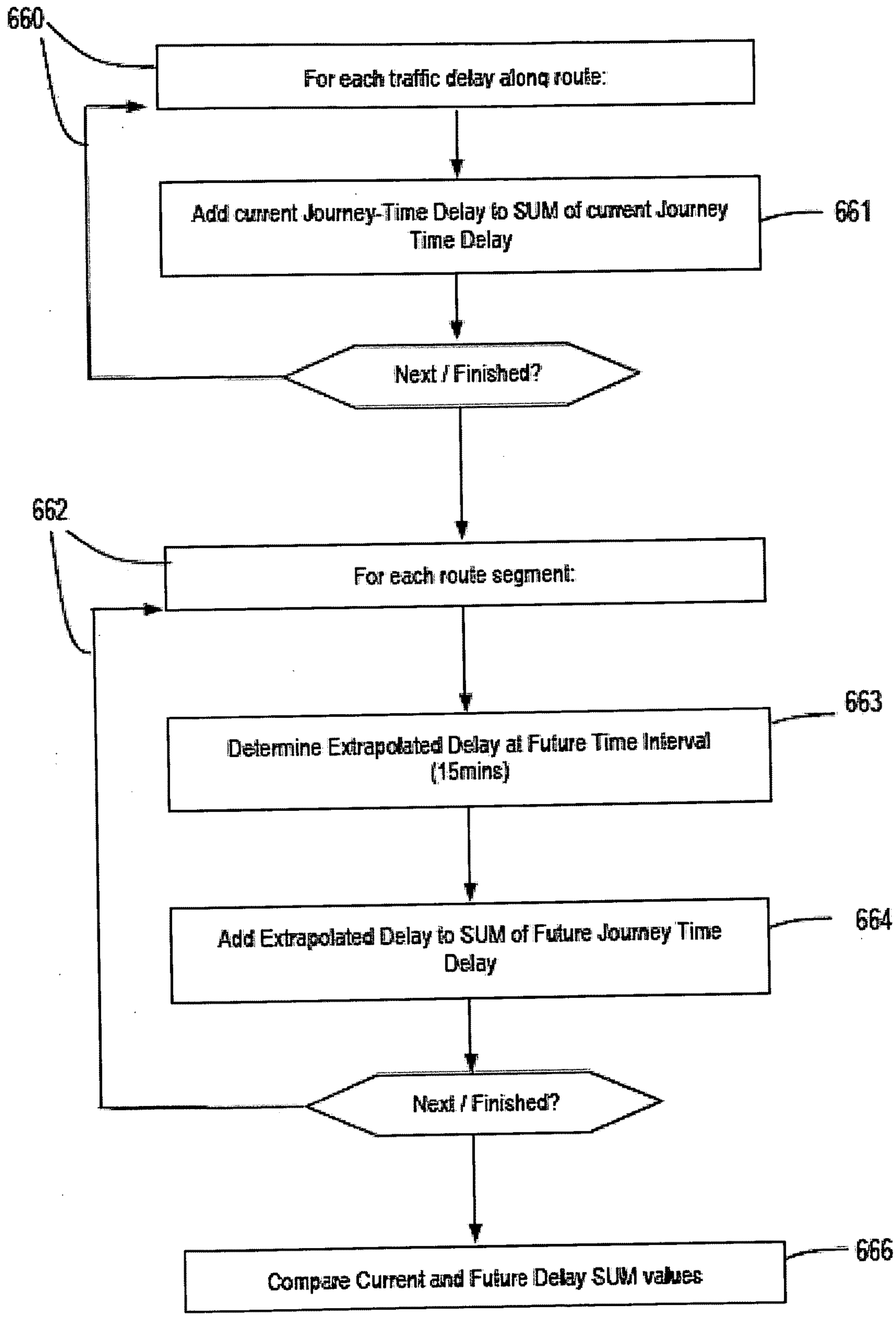
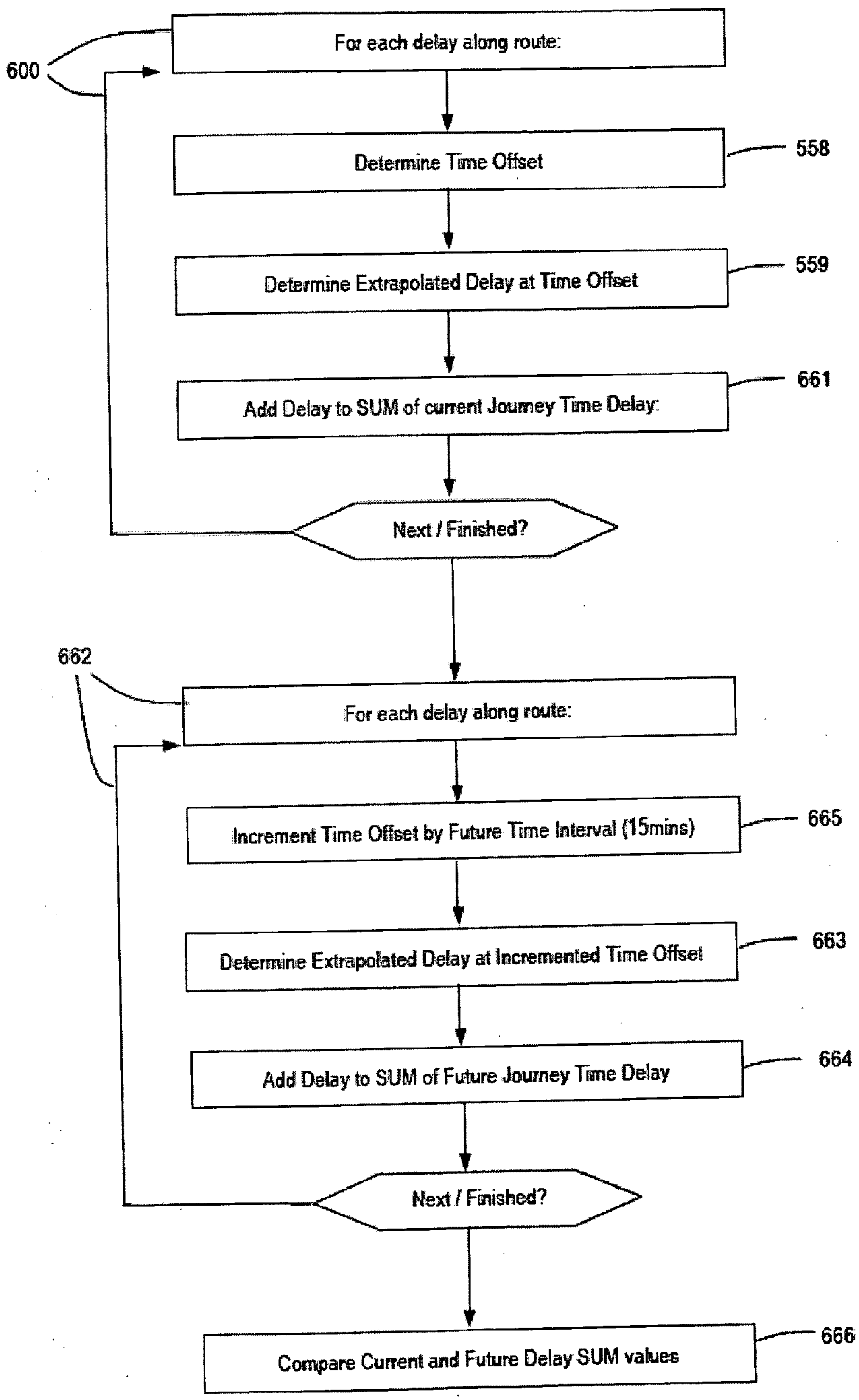

660
For each traffic delay along route:
Add current Journey-Time Delay to SUM of current Journey Time Delay
661
Next / Finished?
662
For each route segment:
Determine Extrapolated Delay at Future Time Interval (15mins)
663
Add Extrapolated Delay to SUM of Future Journey Time Delay
664
Next / Finished?
Compare Current and Future Delay SUM values
666

FIG. 13



600
For each delay along route:
Determine Time Offset
558
Determine Extrapolated Delay at Time Offset
559
Add Delay to SUM of current Journey Time Delay:
661
Next / Finished?
662
For each delay along route:
Increment Time Offset by Future Time Interval (15mins)
665
Determine Extrapolated Delay at Incremented Time Offset
663
Add Delay to SUM of Future Journey Time Delay
664
Next / Finished?
Compare Current and Future Delay SUM values
666

FIG. 14

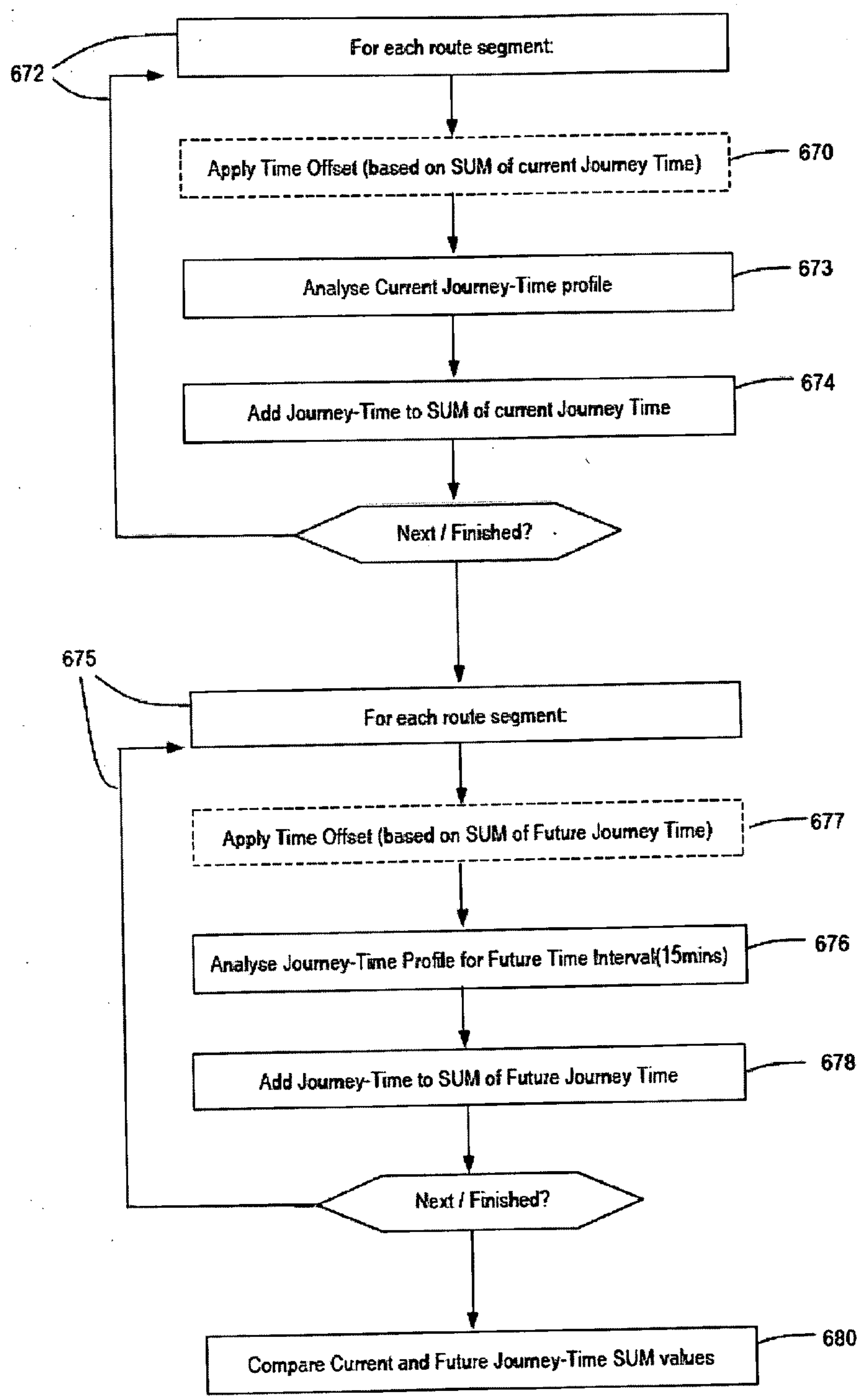

For each route segment:
672
Apply Time Offset (based on SUM of current Journey Time)
670
Analyse Current Journey-Time profile
673
Add Journey-Time to SUM of current Journey Time
674
Next / Finished?
675
For each route segment:
Apply Time Offset (based on SUM of Future Journey Time)
677
Analyse Journey-Time Profile for Future Time Interval(15mins)
676
Add Journey-Time to SUM of Future Journey Time
678
Next / Finished?
Compare Current and Future Journey-Time SUM values
680

FIG. 15

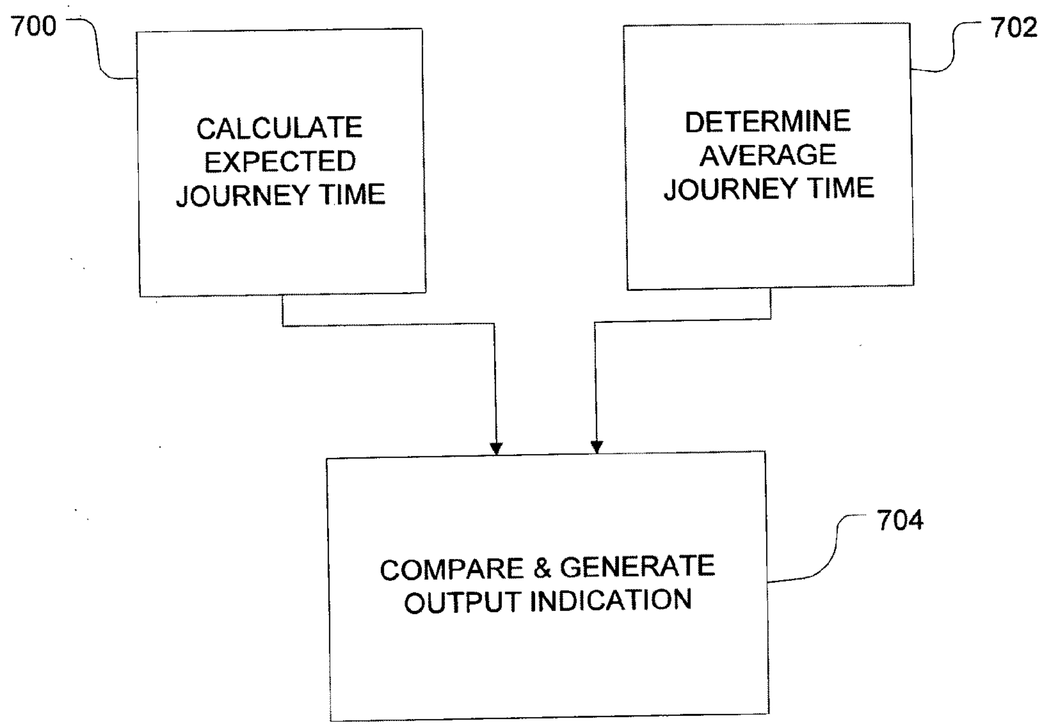

700
CALCULATE EXPECTED JOURNEY TIME
702
DETERMINE AVERAGE JOURNEY TIME
704
COMPARE & GENERATE OUTPUT INDICATION

FIG. 16

NAVIGATION DEVICE AND METHOD

FIELD OF THE INVENTION

[0001] This invention relates to navigation devices and to methods for presenting navigation information. Illustrative embodiments of the invention relate to portable navigation devices (so-called PNDs), in particular PNDs that include Global Positioning System (GPS) signal reception and processing functionality. Other embodiments relate, more generally, to any type of processing device that is configured to execute navigation software so as to provide route planning, and preferably also navigation, functionality.

BACKGROUND TO THE INVENTION

[0002] Portable navigation devices (PNDs) that include GPS (Global Positioning System) signal reception and processing functionality are well known and are widely employed as in-car or other vehicle navigation systems.

[0003] In general terms, a modern PNDs comprises a processor, memory (at least one of volatile and non-volatile, and commonly both), and map data stored within said memory. The processor and memory cooperate to provide an execution environment in which a software operating system may be established, and additionally it is commonplace for one or more additional software programs to be provided to enable the functionality of the PND to be controlled, and to provide various other functions.

[0004] Typically these devices further comprise one or more input interfaces that allow a user to interact with and control the device, and one or more output interfaces by means of which information may be relayed to the user. Illustrative examples of output interfaces include a visual display and a speaker for audible output. Illustrative examples of input interfaces include one or more physical buttons to control on/off operation or other features of the device (which buttons need not necessarily be on the device itself but could be on a steering wheel if the device is built into a vehicle), and a microphone for detecting user speech. In a particularly preferred arrangement the output interface display may be configured as a touch sensitive display (by means of a touch sensitive overlay or otherwise) to additionally provide an input interface by means of which a user can operate the device by touch.

[0005] Devices of this type will also often include one or more physical connector interfaces by means of which power and optionally data signals can be transmitted to and received from the device, and optionally one or more wireless transmitters/receivers to allow communication over cellular telecommunications and other signal and data networks, for example Wi-Fi, Wi-Max GSM and the like.

[0006] PND devices of this type also include a GPS antenna by means of which satellite-broadcast signals, including location data, can be received and subsequently processed to determine a current location of the device.

[0007] The PND device may also include electronic gyroscopes and accelerometers which produce signals that can be processed to determine the current angular and linear acceleration, and in turn, and in conjunction with location information derived from the GPS signal, velocity and relative displacement of the device and thus the vehicle in which it is mounted. Typically such features are most commonly provided in in-vehicle navigation systems, but may also be provided in PND devices if it is expedient to do so.

[0008] The utility of such PNDs is manifested primarily in their ability to determine a route between a first location (typically a start or current location) and a second location (typically a destination). These locations can be input by a user of the device, by any of a wide variety of different methods, for example by postcode, street name and house number, previously stored “well known” destinations (such as famous locations, municipal locations (such as sports grounds or swimming baths) or other points of interest), and favourite or recently visited destinations.

[0009] Typically, the PND is enabled by software for computing a “best” or “optimum” route between the start and destination address locations from the map data. A “best” or “optimum” route is determined on the basis of predetermined criteria and need not necessarily be the fastest or shortest route. The selection of the route along which to guide the driver can be very sophisticated, and the selected route may take into account existing, predicted and dynamically and/or wirelessly received traffic and road information, historical information about road speeds, and the driver’s own preferences for the factors determining road choice (for example the driver may specify that the route should not include motorways or toll roads).

[0010] 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. Real time traffic monitoring systems, based on various technologies (e.g. mobile phone data exchanges, fixed cameras, GPS fleet tracking) are being used to identify traffic delays and to feed the information into notification systems.

[0011] PNDs of this type may typically be mounted on the dashboard or windscreen of a vehicle, but may also be formed as part of an on-board computer of the vehicle radio or indeed as part of the control system of the vehicle itself. The navigation device may also be part of a hand-held system, such as a PDA (Portable Digital Assistant) a media player, a mobile phone or the like, and in these cases, the normal functionality of the hand-held system is extended by means of the installation of software on the device to perform both route calculation and navigation along a calculated route.

[0012] Route planning and navigation functionality may also be provided by a desktop or mobile computing resource running appropriate software. For example, the Royal Automobile Club (RAC) provides an on-line route planning and navigation facility at http://www.rac.co.uk, which facility allows a user to enter a start point and a destination whereupon the server to which the user’s PC is connected calculates a route (aspects of which may be user specified), generates a map, and generates a set of exhaustive navigation instructions for guiding the user from the selected start point to the selected destination. The facility also provides for pseudo three-dimensional rendering of a calculated route, and route preview functionality which simulates a user travelling along the route and thereby provides the user with a preview of the calculated route.

[0013] In the context of a PND, once a route has been calculated, the user interacts with the navigation device to select the desired calculated route, optionally from a list of proposed routes. Optionally, the user may intervene in, or guide the route selection process, for example by specifying that certain routes, roads, locations or criteria are to be avoided or are mandatory for a particular journey. The route calculation aspect of the PND forms one primary function, and navigation along such a route is another primary function.

[0014] During navigation along a calculated route, it is usual for such PNDs to provide visual and/or audible instructions to guide the user along a chosen route to the end of that route, i.e. the desired destination. It is also usual for PNDs to display map information on-screen during the navigation, such information regularly being updated on-screen so that the map information displayed is representative of the current location of the device, and thus of the user or user's vehicle if the device is being used for in-vehicle navigation.

[0015] An icon displayed on-screen typically denotes the current device location, and is centred with the map information of current and surrounding roads in the vicinity of the current device location and other map features also being displayed. Additionally, navigation information may be displayed, optionally in a status bar above, below or to one side of the displayed map information, examples of navigation information include a distance to the next deviation from the current road required to be taken by the user, the nature of that deviation possibly being represented by a further icon suggestive of the particular type of deviation, for example a left or right turn. The navigation function also determines the content, duration and timing of audible instructions by means of which the user can be guided along the route. As can be appreciated a simple instruction such as "turn left in 100 m" requires significant processing and analysis. As previously mentioned, user interaction with the device may be by a touch screen, or additionally or alternately by steering column mounted remote control, by voice activation or by any other suitable method.

[0016] A further important function provided by the device is automatic route re-calculation in the event that: a user deviates from the previously calculated route during navigation (either by accident or intentionally); real-time traffic conditions dictate that an alternative route would be more expedient and the device is suitably enabled to recognize such conditions automatically, or if a user actively causes the device to perform route re-calculation for any reason.

[0017] It is also known to allow a route to be calculated with user defined criteria; for example, the user may prefer a scenic route to be calculated by the device, or may wish to avoid any roads on which traffic congestion is likely, expected or currently prevailing. The device software would then calculate various routes and weigh more favourably those that include along their route the highest number of points of interest (known as POIs) tagged as being for example of scenic beauty, or, using stored information indicative of prevailing traffic conditions on particular roads, order the calculated routes in terms of a level of likely congestion or delay on account thereof. Other POI-based and traffic information-based route calculation and navigation criteria are also possible.

[0018] Although the route calculation and navigation functions are fundamental to the overall utility of PNDs, it is possible to use the device purely for information display, or "free-driving", in which only map information relevant to the current device location is displayed, and in which no route has been calculated and no navigation is currently being performed by the device. Such a mode of operation is often applicable when the user already knows the route along which it is desired to travel and does not require navigation assistance.

[0019] Devices of the type described above, for example the 720T model manufactured and supplied by TomTom International B.V., provide a reliable means for enabling users to navigate from one position to another.

[0020] As well as being of great utility when a user is not familiar with the route to be navigated, many users still use a navigation device to aid route selection on a familiar journey, such as between the user's home and place of work. Circumstances such as accidents, and changes in traffic flow at different times of day, mean that a navigation device can be of substantial benefit in aiding selection of an optimum route to avoid delays and congestion.

[0021] For example, in some countries, digital information concerning traffic delays may be transmitted to in-vehicle navigation devices wirelessly. One example is the radio-data-system-traffic-message-channel (RDS-TMC) which enables a limited quantity of digital traffic information to be multiplexed as part of an FM radio broadcast. Such information may be demultiplexed by a suitable FM receiver, and processed by a navigation device. Another example uses the techniques described in the following PCT applications, published under numbers WO 2007/057696, WO 2007/057694, WO 2007/042796, WO 2007/017691 and WO 02/45046, to provide a large quantity of up-to-date digital traffic information in a dedicated information channel. Such a system is implemented by TomTom International BV under the trade name of HD Traffic (High Definition Traffic).

[0022] As an alternative to receiving information about delays, a further technique is to include, in the digital map information, journey-time profiles for different times of day that take account of habitual traffic patterns. These journey-time profiles are based on a historical average of different vehicles using a road at different times of day. Including such journey-time profiles in the digital map information enables a navigation device to plan a route in accordance with habitual traffic patterns. The journey-time profiles may be derived by any suitable method, a specific technique being described, for example, in PCT/EP2008/057694. Such a technique is implemented by TomTom International BV under the trade name of IQ Routes.

[0023] Each technique has it advantages and disadvantages. Real-time traffic information is more accurate because it is based on actual traffic and road conditions. However, real-time traffic information only provides information for the current moment, without any indication of how the traffic flow will evolve in the future. In contrast, pre-stored journey-time profiles for different times of day do provide a pattern of how journey-times and habitual delays evolve, because they are based on analysis of historical journeys. However, pre-store journey-time profiles are merely statistical in nature, they do not provide an accurate snapshot of a current traffic situation, which may be affected by unpredictable accidents, broken-down vehicles, or other delays caused by roadworks or faulty traffic-lights.

[0024] A further problem is that, as the quantity of traffic flow information accessible by a navigation device increases (whether real-time traffic information, or pre-stored journey-time profiles), it becomes increasingly difficult to present such information to the user in a simple yet meaningful way. When used in-vehicle, it is important not to distract the user's attention from driving the vehicle, as this increases the driver's stress and increases the risk of accident.

[0025] The present invention has been devised bearing the above issues in mind.

SUMMARY OF THE INVENTION

[0026] Aspects of the invention are defined in the claims.

[0027] In one aspect, the preferred embodiment illustrates a technique for generating an output indication representing whether or not journey conditions are favourable, the technique comprising:

[0028] calculating for a navigation route, expected journey time information indicating an expected time duration for completing the route;

[0029] comparing the expected journey time with an average journey time for the route; and

[0030] generating, responsive to the result of said comparison, the output indication representing whether or not journey conditions are favourable.

[0031] In another aspect, the preferred embodiment illustrates a technique for generating an output indication representing whether or not journey conditions are favourable, the technique comprising one or more features selected from:

[0032] determining first journey time information for traversing at least one segment of a navigation route at a first predetermined time;

[0033] determining second journey time information for traversing said at least one segment of the navigation route at a second predetermined time different from said first predetermined time;

[0034] determining from said first and second journey time information a journey time parameter representative of variation in journey time; and

[0035] generating the output indication responsive to the journey time parameter.

[0036] In another aspect, the preferred embodiment illustrates a technique for processing live traffic information to predict future evolution of the live traffic information, the technique comprising one or more features selected from:

[0037] receive an item of live traffic information representing a traffic journey-time delay, at a respective time of incidence;

[0038] store information indicating the journey-time delay and the respective time in a memory, to create a history of variation of the respective journey-time delay with respect to incidence time; and

[0039] determine from the history at least one characteristic of the journey-time delay indicative of predicted evolution into the future of the journey-time delay from time of incidence of a most recent item of live traffic information.

[0040] As used herein, the term "traffic information" or "live traffic information" refers to traffic information received from an external source and providing information from observed current traffic data. The information is "live" in the sense that it is based on current observations, although it will be appreciated that processing and transmission may delay the information throughput. Examples of live traffic information include the aforementioned RDS-TMC and HD-Traffic.

[0041] Features and advantages of the invention in its various aspects and embodiments include at least one selected from: (i) the presentation of an indication of whether journey conditions are favourable, in an intuitive and easy to understand manner; (ii) ability to monitor journey conditions for one or more pre-stored routes, and to generate a prompt to advise or warn about journey conditions; (iii) ability to derive a prediction of how journey-time delays indicated by live traffic information may evolve in the future; (iv) using a history of the live traffic information to predict how traffic delays may evolve based on extrapolation of the history; (v) ability to bridge the usability information gap between live traffic information and pre-stored journey-time profiles.

[0042] Further feature and advantages are set out hereafter, and further details and features of each of these embodiments are defined in the accompanying dependent claims and elsewhere in the following detailed description. Protection is claimed for any novel feature or idea described herein and/or illustrated in the drawings, whether or not emphasis has been placed thereon.

BRIEF DESCRIPTION OF THE DRAWINGS

[0043] Various aspects of the teachings of the present invention, and arrangements embodying those teachings, will hereafter be described by way of illustrative example with reference to the accompanying drawings, in which:

[0044] FIG. **1** is a schematic illustration of a Global Positioning System (GPS);

[0045] FIG. **2** is a schematic illustration of electronic components arranged to provide a navigation device;

[0046] FIG. **3** is a schematic illustration of the manner in which a navigation device may receive information over a wireless communication channel;

[0047] FIGS. **4**A and **4**B are illustrative perspective views of a navigation device;

[0048] FIG. **5** is a schematic representation of the software employed by the navigation device;

[0049] FIGS. **6**A and **6**B are schematic representations of journey time information for a digital map database.

[0050] FIG. **7** is a schematic flow diagram illustrating process steps for predicting evolution of a traffic delay.

[0051] FIG. **8** is a schematic representation of a delay occurring along a planned navigation route.

[0052] FIG. **9** is a schematic flow diagram illustrating in more detail a step of FIG. **7**.

[0053] FIG. **10** is a schematic illustration of a map view showing the position of a traffic delay.

[0054] FIG. **11** depicts three forms of display icon for representing traffic delay information.

[0055] FIG. **12** is a schematic block diagram showing implementation of a journey-time analyser.

[0056] FIG. **13** is a schematic flow diagram illustrating an example technique for processing live traffic information;

[0057] FIG. **14** is a schematic flow diagram illustrating a modification of the example technique of FIG. **13**.

[0058] FIG. **15** is a schematic flow diagram illustrating an example technique for processing journey-time profiles.

[0059] FIG. **16** is a schematic flow diagram illustrating a further example implementable by the journey-time analyser.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0060] Preferred embodiments of the present invention will now be described with particular reference to a PND. It should be remembered, however, that the teachings of the present invention are not limited to PNDs but are instead universally applicable to any type of processing device that is configured to execute navigation software so as to provide route planning and navigation functionality. It follows therefore that in the context of the present application, a navigation device is intended to include (without limitation) any type of route planning and navigation device, irrespective of whether that device is embodied as a PND, a navigation device built into a vehicle, or indeed a computing resource (such as a desktop or portable personal computer (PC), mobile telephone or portable digital assistant (PDA)) executing route planning and navigation software.

[0061] It will also be apparent from the following that the teachings of the present invention even have utility in circumstances where a user is not seeking instructions on how to navigate from one point to another, but merely wishes to be provided with a view of a given location. In such circumstances the "destination" location selected by the user need not have a corresponding start location from which the user wishes to start navigating, and as a consequence references herein to the "destination" location or indeed to a "destination" view should not be interpreted to mean that the generation of a route is essential, that travelling to the "destination" must occur, or indeed that the presence of a destination requires the designation of a corresponding start location.

[0062] With the above provisos in mind, FIG. **1** illustrates an example view of Global Positioning System (GPS), usable by navigation devices. Such systems are known and are used for a variety of purposes. In general, GPS is a satellite-radio based navigation system capable of determining continuous position, velocity, time, and in some instances direction information for an unlimited number of users. Formerly known as NAVSTAR, the GPS incorporates a plurality of satellites which orbit the earth in extremely precise orbits. Based on these precise orbits, GPS satellites can relay their location to any number of receiving units.

[0063] The GPS system is implemented when a device, specially equipped to receive GPS data, begins scanning radio frequencies for GPS satellite signals. Upon receiving a radio signal from a GPS satellite, the device determines the precise location of that satellite via one of a plurality of different conventional methods. The device will continue scanning, in most instances, for signals until it has acquired at least three different satellite signals (noting that position is not normally, but can be determined, with only two signals using other triangulation techniques). Implementing geometric triangulation, the receiver utilizes the three known positions to determine its own two-dimensional position relative to the satellites. This can be done in a known manner. Additionally, acquiring a fourth satellite signal will allow the receiving device to calculate its three dimensional position by the same geometrical calculation in a known manner. The position and velocity data can be updated in real time on a continuous basis by an unlimited number of users.

[0064] As shown in FIG. **1**, the GPS system is denoted generally by reference numeral **100**. A plurality of satellites **120** are in orbit about the earth **124**. The orbit of each satellite **120** is not necessarily synchronous with the orbits of other satellites **120** and, in fact, is likely asynchronous. A GPS receiver **140** is shown receiving spread spectrum GPS satellite signals **160** from the various satellites **120**.

[0065] The spread spectrum signals **160**, continuously transmitted from each satellite **120**, utilize a highly accurate frequency standard accomplished with an extremely accurate atomic clock. Each satellite **120**, as part of its data signal transmission **160**, transmits a data stream indicative of that particular satellite **120**. It is appreciated by those skilled in the relevant art that the GPS receiver device **140** generally acquires spread spectrum GPS satellite signals **160** from at least three satellites **120** for the GPS receiver device **140** to calculate its two-dimensional position by triangulation. Acquisition of an additional signal, resulting in signals **160** from a total of four satellites **120**, permits the GPS receiver device **140** to calculate its three-dimensional position in a known manner.

[0066] FIG. **2** is an illustrative representation of electronic components of a navigation device **200** according to a preferred embodiment of the present invention, in block component format. It should be noted that the block diagram of the navigation device **200** is not inclusive of all components of the navigation device, but is only representative of many example components.

[0067] The navigation device **200** is located within a housing (not shown). The housing includes a processor **210** connected to an input device **220** and a display screen **240**. The input device **220** can include a keyboard device, voice input device, touch panel and/or any other known input device utilised to input information; and the display screen **240** can include any type of display screen such as an LCD display, for example. In a particularly preferred arrangement the input device **220** and display screen **240** are integrated into an integrated input and display device, including a touchpad or touchscreen input so that a user need only touch a portion of the display screen **240** to select one of a plurality of display choices or to activate one of a plurality of virtual buttons.

[0068] The navigation device may include an output device **260**, for example an audible output device (e.g. a loudspeaker). As output device **260** can produce audible information for a user of the navigation device **200**, it is should equally be understood that input device **240** can include a microphone and software for receiving input voice commands as well.

[0069] In the navigation device **200**, processor **210** is operatively connected to and set to receive input information from input device **220** via a connection **225**, and operatively connected to at least one of display screen **240** and output device **260**, via output connections **245**, to output information thereto. Further, the processor **210** is operably coupled to a memory resource **230** via connection **235** and is further adapted to receive/send information from/to input/output (I/O) ports **270** via connection **275**, wherein the I/O port **270** is connectible to an I/O device **280** external to the navigation device **200**. The memory resource **230** comprises, for example, a volatile memory, such as a Random Access Memory (RAM) and a non-volatile memory, for example a digital memory, such as a flash memory. The external I/O device **280** may include, but is not limited to an external listening device such as an earpiece for example. The connection to I/O device **280** can further be a wired or wireless connection to any other external device such as a car stereo unit for hands-free operation and/or for voice activated operation for example, for connection to an ear piece or head phones, and/or for connection to a mobile phone for example, wherein the mobile phone connection may be used to establish a data connection between the navigation device **200** and the internet or any other network for example, and/or to establish a connection to a server via the internet or some other network for example.

[0070] FIG. **2** further illustrates an operative connection between the processor **210** and an antenna/receiver **250** via connection **255**, wherein the antenna/receiver **250** can be a GPS antenna/receiver for example. It will be understood that the antenna and receiver designated by reference numeral **250** are combined schematically for illustration, but that the antenna and receiver may be separately located components, and that the antenna may be a GPS patch antenna or helical antenna for example.

[0071] Further, it will be understood by one of ordinary skill in the art that the electronic components shown in FIG. **2** are powered by power sources (not shown) in a conventional manner. As will be understood by one of ordinary skill in the art, different configurations of the components shown in FIG. **2** are considered to be within the scope of the present application. For example, the components shown in FIG. **2** may be in communication with one another via wired and/or wireless connections and the like. Thus, the scope of the navigation device **200** of the present application includes a portable or handheld navigation device **200**.

[0072] In addition, the portable or handheld navigation device **200** of FIG. **2** can be connected or "docked" in a known manner to a vehicle such as a bicycle, a motorbike, a car or a boat for example. Such a navigation device **200** is then removable from the docked location for portable or handheld navigation use.

[0073] Referring now to FIG. **3**, the navigation device **200** may establish a "mobile" or telecommunications network connection with a server **302** via a mobile device (not shown) (such as a mobile phone, PDA, and/or any device with mobile phone technology) establishing a digital connection (such as a digital connection via known Bluetooth technology for example). Thereafter, through its network service provider, the mobile device can establish a network connection (through the internet for example) with a server **302**. As such, a "mobile" network connection is established between the navigation device **200** (which can be, and often times is mobile as it travels alone and/or in a vehicle) and the server **302** to provide a "real-time" or at least very "up to date" gateway for information.

[0074] The establishing of the network connection between the mobile device (via a service provider) and another device such as the server **302**, using an internet (such as the World Wide Web) for example, can be done in a known manner. This can include use of TCP/IP layered protocol for example. The mobile device can utilize any number of communication standards such as CDMA, GSM, WAN, etc.

[0075] As such, an internet connection may be utilised which is achieved via data connection, via a mobile phone or mobile phone technology within the navigation device **200** for example. For this connection, an internet connection between the server **302** and the navigation device **200** is established. This can be done, for example, through a mobile phone or other mobile device and a GPRS (General Packet Radio Service)-connection (GPRS connection is a high-speed data connection for mobile devices provided by telecom operators; GPRS is a method to connect to the internet).

[0076] The navigation device **200** can further complete a data connection with the mobile device, and eventually with the internet and server **302**, via existing Bluetooth technology for example, in a known manner, wherein the data protocol can utilize any number of standards, such as the GSRM, the Data Protocol Standard for the GSM standard, for example.

[0077] The navigation device **200** may include its own mobile phone technology within the navigation device **200** itself (including an antenna for example, or optionally using the internal antenna of the navigation device **200**). The mobile phone technology within the navigation device **200** can include internal components as specified above, and/or can include an insertable card (e.g. Subscriber Identity Module or SIM card), complete with necessary mobile phone technology and/or an antenna for example. As such, mobile phone technology within the navigation device **200** can similarly establish a network connection between the navigation device **200** and the server **302**, via the internet for example, in a manner similar to that of any mobile device.

[0078] For GRPS phone settings, a Bluetooth enabled navigation device may be used to correctly work with the ever changing spectrum of mobile phone models, manufacturers, etc., model/manufacturer specific settings may be stored on the navigation device **200** for example. The data stored for this information can be updated.

[0079] In FIG. **3** the navigation device **200** is depicted as being in communication with the server **302** via a generic communications channel **318** that can be implemented by any of a number of different arrangements. The server **302** and a navigation device **200** can communicate when a connection via communications channel **318** is established between the server **302** and the navigation device **200** (noting that such a connection can be a data connection via mobile device, a direct connection via personal computer via the internet, etc.).

[0080] The server **302** includes, in addition to other components which may not be illustrated, a processor **304** operatively connected to a memory **306** and further operatively connected, via a wired or wireless connection **314**, to a mass data storage device **312**. The processor **304** is further operatively connected to transmitter **308** and receiver **310**, to transmit and send information to and from navigation device **200** via communications channel **318**. The signals sent and received may include data, communication, and/or other propagated signals. The transmitter **308** and receiver **310** may be selected or designed according to the communications requirement and communication technology used in the communication design for the navigation system **200**. Further, it should be noted that the functions of transmitter **308** and receiver **310** may be combined into a signal transceiver.

[0081] Server **302** is further connected to (or includes) a mass storage device **312**, noting that the mass storage device **312** may be coupled to the server **302** via communication link **314**. The mass storage device **312** contains a store of navigation data and map information, and can again be a separate device from the server **302** or can be incorporated into the server **302**.

[0082] The navigation device **200** is adapted to communicate with the server **302** through communications channel **318**, and includes processor, memory, etc. as previously described with regard to FIG. **2**, as well as transmitter **320** and receiver **322** to send and receive signals and/or data through the communications channel **318**, noting that these devices can further be used to communicate with devices other than server **302**. Further, the transmitter **320** and receiver **322** are selected or designed according to communication requirements and communication technology used in the communication design for the navigation device **200** and the functions of the transmitter **320** and receiver **322** may be combined into a single transceiver.

[0083] Software stored in server memory **306** provides instructions for the processor **304** and allows the server **302** to provide services to the navigation device **200**. One service provided by the server **302** involves processing requests from the navigation device **200** and transmitting navigation data from the mass data storage **312** to the navigation device **200**. Another service provided by the server **302** includes processing the navigation data using various algorithms for a desired application and sending the results of these calculations to the navigation device **200**.

[0084] The communication channel **318** generically represents the propagating medium or path that connects the navigation device **200** and the server **302**. Both the server **302** and navigation device **200** include a transmitter for transmitting data through the communication channel and a receiver for receiving data that has been transmitted through the communication channel.

[0085] The communication channel **318** is not limited to a particular communication technology. Additionally, the communication channel **318** is not limited to a single communication technology; that is, the channel **318** may include several communication links that use a variety of technology. For example, the communication channel **318** can be adapted to provide a path for electrical, optical, and/or electromagnetic communications, etc. As such, the communication channel **318** includes, but is not limited to, one or a combination of the following: electric circuits, electrical conductors such as wires and coaxial cables, fibre optic cables, converters, radio-frequency (RF) waves, the atmosphere, empty space, etc. Furthermore, the communication channel **318** can include intermediate devices such as routers, repeaters, buffers, transmitters, and receivers, for example.

[0086] In one illustrative arrangement, the communication channel **318** includes telephone and computer networks. Furthermore, the communication channel **318** may be capable of accommodating wireless communication such as radio frequency, microwave frequency, infrared communication, etc. Additionally, the communication channel **318** can accommodate satellite communication.

[0087] The communication signals transmitted through the communication channel **318** include, but are not limited to, signals as may be required or desired for given communication technology. For example, the signals may be adapted to be used in cellular communication technology such as Time Division Multiple Access (TDMA), Frequency Division Multiple Access (FDMA), Code Division Multiple Access (CDMA), Global System for Mobile Communications (GSM), etc. Both digital and analogue signals can be transmitted through the communication channel **318**. These signals may be modulated, encrypted and/or compressed signals as may be desirable for the communication technology.

[0088] The server **302** includes a remote server accessible by the navigation device **200** via a wireless channel. The server **302** may include a network server located on a local area network (LAN), wide area network (WAN), virtual private network (VPN), etc.

[0089] The server **302** may include a personal computer such as a desktop or laptop computer, and the communication channel **318** may be a cable connected between the personal computer and the navigation device **200**. Alternatively, a personal computer may be connected between the navigation device **200** and the server **302** to establish an internet connection between the server **302** and the navigation device **200**. Alternatively, a mobile telephone or other handheld device may establish a wireless connection to the internet, for connecting the navigation device **200** to the server **302** via the internet.

[0090] The navigation device **200** may be provided with information from the server **302** via information downloads which may be periodically updated automatically or upon a user connecting navigation device **200** to the server **302** and/or may be more dynamic upon a more constant or frequent connection being made between the server **302** and navigation device **200** via a wireless mobile connection device and TCP/IP connection for example. For many dynamic calculations, the processor **304** in the server **302** may be used to handle the bulk of the processing needs, however, processor **210** of navigation device **200** can also handle much processing and calculation, oftentimes independent of a connection to a server **302**.

[0091] As indicated above in FIG. **2**, a navigation device **200** includes a processor **210**, an input device **220**, and a display screen **240**. The input device **220** and display screen **240** are integrated into an integrated input and display device to enable both input of information (via direct input, menu selection, etc.) and display of information through a touch panel screen, for example. Such a screen may be a touch input LCD screen, for example, as is well known to those of ordinary skill in the art. Further, the navigation device **200** can also include any additional input device **220** and/or any additional output device **241**, such as audio input/output devices for example.

[0092] FIGS. **4**A and **4**B are perspective views of a navigation device **200**. As shown in FIG. **4**A, the navigation device **200** may be a unit that includes an integrated input and display device **290** (a touch panel screen for example) and the other components of FIG. **2** (including but not limited to internal GPS receiver **250**, microprocessor **210**, a power supply, memory systems **230**, etc.).

[0093] The navigation device **200** may sit on an arm **292**, which itself may be secured to a vehicle dashboard/window/etc. using a suction cup **294**. This arm **292** is one example of a docking station to which the navigation device **200** can be docked.

[0094] As shown in FIG. **4**B, the navigation device **200** can be docked or otherwise connected to an arm **292** of the docking station by snap connecting the navigation device **292** to the arm **292** for example. The navigation device **200** may then be rotatable on the arm **292**, as shown by the arrow of FIG. **4**B. To release the connection between the navigation device **200** and the docking station, a button on the navigation device **200** may be pressed, for example. Other equally suitable arrangements for coupling and decoupling the navigation device to a docking station are well known to persons of ordinary skill in the art.

[0095] Referring now to FIG. **5** of the accompanying drawings, the memory resource **230** stores a boot loader program (not shown) that is executed by the processor **210** in order to load an operating system **470** from the memory resource **230** for execution by functional hardware components **460**, which provides an environment in which application software **480** can run. The operating system **470** serves to control the functional hardware components **460** and resides between the application software **480** and the functional hardware components **460**. The application software **480** provides an operational environment including the GUI that supports core functions of the navigation device **200**, for example map viewing, route planning, navigation functions and any other functions associated therewith. Amongst other modules, the application software **480** may include a route-planning module **482**, a journey-time analyzer module **484**, a traffic-information processing module **486**, and a traffic delay evolution analyzer **488**. Although these modules are indicated to be distinct, it will be appreciated that such representation is merely to aid understanding. Functionality may overlap between modules, and/or one module may comprise one or more of the other modules.

[0096] The memory resource **230** also stores a map database or digital map **490**, that is an electronic representation of information used for (i) generating a visual map display, and (ii) the positions of roads and junctions needed for route-planning and navigation. The digital map **490** may be organised as a single collection of data, or it may be organised as a plurality of distinct information components. For each road segment represented in the digital map **490**, the digital map includes supplementary information about the road segment. For example, referring to FIG. **6***a*, in a simple form, the supplementary information may include one or more of a road segment length **500**, a speed limit **502** for the road segment and/or a typical journey time **504** for travelling along the road segment. The journey-time information is significant, because it enables the route-planning software to predict the duration of journey along the route from departure point to destination point, and to optimise selection of the route to minimise the journey time.

[0097] Note that, in FIG. **6***a*, not all items of information need be represented explicitly. One item of information may be derived implicitly from another. For example, the typical journey time might not be included explicitly. It might instead be calculated assuming that the average speed for the road segment is a fixed fraction of the speed limit, such as 0.8 times the speed limit. The typical journey time may then be calculated by dividing the road segment length by the average speed (e.g. typical journey time=length/(0.8×speed limit)).

[0098] Referring to FIG. **6***b*, in a more advanced form, the supplementary information for a road segment may include the road segment length **500**, the speed limit **502**, and plural journey-time profiles **506** for different times of day and/or different days. Each profile **506** includes a journey-time indicator **508**, which may be represented in time, or any other parameter for calculating a journey time. For example, the journey-time indicator **508** could be in the form of a fraction representing the average vehicle speed as a fraction of the speed limit, in the same manner as explained above. When the journey is slow, the fraction is small. When the journey is relatively fast, the fraction increases in magnitude towards unity. Each journey-time profile **506** may be associated with a time and/or day validity window **510** indicating the time and/or day when the profile is valid. For example, for a weekday morning peak-time profile, the time and/or day window may be represented as Monday-to-Friday, from 08:00 to 10:00. The validity window **510** may be expressly indicated with the profile, or the same window may be applied for a local area of a map (such as a town), or for the entire map, in which case the validity window **510** is implied and does not need to be represented explicitly. The journey-time indicator **508** may itself be sub-divided according to different criteria, such as weather (e.g. good, poor) or vehicle category (e.g. car, goods).

[0099] In addition to the digital map **490**, the memory resource **230** may also store a planned navigation route that has been devised by the route planning module **482**, and/or one or more pre-planned routes that have previously been planned, and have been selected by the user for storage. For example, such pre-planned routes may be referred to as "favourite routes". Storing these routes enables the route details to be retrieved without having to re-input the route details such as departure point, destination point, and route selection criteria.

[0100] In one form, the navigation device **200** is able to process live traffic information. As used herein, the term "live traffic information" means traffic information received from an external source and providing information from observed traffic data. The information is "live" in the sense that it is based on current observations, although it will be appreciated that processing and transmission may delay the information throughput. Examples of live traffic information include the aforementioned RDS-TMC and HD-Traffic data. RDS-TMC information may be delayed by up to 30-60 minutes, because the information capacity of an RDS-TMC channel limits the throughput of information, and it can take up to 30-60 minutes to refresh an entire frame of information. HD-Traffic data is much more up to date, and the transmission less affected by the transmission channel capacity. The navigation device **200** may include a receiver for receiving and decoding the live traffic information, or the navigation device **200** may be coupled via the I/O port **270** to a separate receiver for receiving the live traffic information. The separate receiver could, for example, be an FM radio, or cellular telephone equipment. The live traffic information is decoded if necessary by the traffic information processing module **486**.

[0101] One optional aspect of the preferred embodiment is the traffic delay evolution analyzer **488**. The analyzer **488** processes the live traffic information to predict how a traffic delay may evolve in the future. FIG. **7** illustrates schematically the general steps for such a process, with respect to a traffic delay **600** indicated in FIG. **8**. The process includes a loop **602** that is executed for each traffic delay **600**. Step **604** is an optional step for limiting processing and/or data storage burden, by selecting only traffic delays that occur along a route of interest. The term "along" includes traffic delays on the route of interest, and optionally near the route of interest (in case such delay may spill on to the route of interest in the future, or may be significant in case re-planning of the route of interest is required). The route of interest may be a currently selected route, or it may include also one or more pre-stored ("favourite") routes, so that information for such routes can be maintained up to date even when not currently selected by a user. If step **604** is not implemented, the processing proceeds for all delays.

[0102] Step **606** applies a second optional selection test, by determining whether the respective delay to journey time exceeds a time threshold. The threshold is selected so that minor delays can be skipped. The threshold may be, for example, about 5 minutes. Step **606** may be implemented optionally in combination with step **604** or, as an alternative, both steps **604** and **606** could be omitted if desired.

[0103] Step **608** stores the current traffic delay information, and a time-stamp representing an time of incidence of the traffic delay information, to create a time-indexed or time-ordered history of the delay information for the respective delay over time. The traffic delay information may include one or more of a delay start point **600***a* on the map, a journey-time delay **600***b* for traversing the delay, a jam length **600***c* (a physical length), and a delay end point **600***d* on the map.

[0104] Step **610** analyses the history of the delay information, and uses statistical extrapolation to predict how the delay to journey time will evolve in the future, based on the time delay history. Various extrapolation techniques are known in the art of statistical analysis for predicting future change based on current and historical values. Step **610** may also classify the delay according to, for example, whether the delay is stable, growing or shrinking, and/or whether the delay is itself advancing along the route (for example, if caused by a slow-moving vehicle). The loop **602** is then repeated for the next traffic delay awaiting processing.

[0105] FIG. **9** illustrates in more detail sub-steps in the analysis step **610**. At sub-step **612**, values of the delay are retrieved from the history stored by step **606**, at intervals of t**1**, for a period extending back in time t**2**. The number of data samples is t**2**/t**1**. The value of the intervals t**1** may, for example, be about 1 second, or about 2 seconds, or about 5 seconds, or about 10 seconds, or more or any value in between. The value of t**2** may optionally be about 100-150 times greater than t**1** (thus yielding about 100-150 samples for processing). Additionally or alternatively, the value of t**2** may be about 500 seconds, 55 seconds, 600 seconds, 700 seconds, or 1000 seconds, or greater or any value in between. Typical values may be t**1**=5 seconds, and t**2**=600 seconds, yielding 120 samples for processing. At step **614**, the statistical extrapolation is applied to these discrete values, to classify the type of delay and define delay parameters. The classification and associated parameters may include one or more of the following:

[0106] (a) Whether the delay to journey time is stable, increasing or decreasing. If increasing or decreasing, the rate of change (and optionally the rate of acceleration of change);

[0107] (b) Whether the delay is moving or is stationary. A moving delay might be indicated by the start and end points both advancing in the same direction. If moving, the speed of motion (and optionally the rate of acceleration of change).

[0108] (c) Whether the delay is increasing/decreasing at the start (e.g. the first point encountered along the route), and a respective rate of increase/decrease.

[0109] (d) Whether the delay is increasing/decreasing at the end (e.g. the final point encountered along the route), and a respective rate of increase/decrease.

[0110] (e) Classification of the delay to journey time as being small, medium or large, depending on the magnitude of the delay time with respect to predetermined thresholds.

[0111] At step **616**, the classification and parameters are stored in the memory resource.

[0112] The above technique enables prediction of how a traffic delay may evolve in the future based on storing and analysing the delay history. This makes up for a significant difference between live traffic information and pre-stored journey-time profiles. Even when live traffic information does not contain any historical content, nor future prediction information, the above technique can enable traffic delay evolution to be predicted.

[0113] The above technique has been described as being used by a navigation device **200** processing received live traffic information. As an alternative, such prediction processing could be applied on the transmission side before the live traffic information is transmitted or broadcast. For example, an additional data field could be included in the live traffic information. The additional data field could represent one or more of the above classifications and parameters. This may enable the processing burden to be reduced in each navigation device **200**. It may also increase the value of live traffic information, as well as ensuring harmonisation of prediction.

[0114] The use of predicted delay times from (or for) live traffic information is extremely valuable for aiding route planning and analysis. Such information can fill current information gap between live traffic information

[0115] Referring to FIG. **10**, in one form, the navigation device **200** is operable to generate a map view **630** indicating a navigation route **632**, and any traffic delays **634**. The traffic delay **634** may be indicated in any suitable alerting manner, for example, by means of a solid line (for example coloured red). The length of the line may correspond to the jam length projected on the map view **630**. Characteristics of the delay may be displayed alongside, or in openable/collapsible sub-window, or represented by an icon **636**.

[0116] In a preferred form, the navigation device **200** generates an icon **636** in the map view. Referring to FIG. **11**, the icon **636** has a magnitude (e.g. length) corresponding to the magnitude of the delay to journey time. The icon **636** may take the form of an arrow, either on its own, or contained within a surrounding line or ring. The icon **636** may also be coloured, depending on either (i) the magnitude of the delay to journey time, or (ii) whether the delay is currently increasing, decreasing, or stable. For example, a red icon may indicate that the delay is currently increasing, a yellow icon may indicate that the delay is stable, or a green icon may indicate that the delay is currently shrinking.

[0117] If a traffic delay is determined to be increasingly at a rate greater than a pre-determined threshold, an additional alert may be generated to alert the user to the delay being a rapidly increasing perturbation to the journey along this route. The additional alert may, for example, be an alert sound.

[0118] If a traffic delay is of medium size, and is determined to be stable for a relatively long time and/or shows little or no motion, the delay may represent a standing traffic jam caused by road works and/or an accident. Such a traffic delay may remain present for a long time, and so a different display representation and/or icon may be used.

[0119] Referring to FIG. **12**, a second optional aspect of the preferred embodiment is the journey-time analyzer **484** for analyzing the journey time for a route, and generating an output indication of whether conditions for travel are currently favourable. In order to perform the analysis, the journey-time analyzer **484** receives one or more of the following information inputs: a map information input **650** from the digital map **490**; a live traffic information input **652** of received live traffic information; weather information **654** received from an external weather information source, or sensed by suitable sensors, such as an in-vehicle rainfall sensor (not shown).

[0120] In one form, the journey-time analyzer **484** is configured to generate an output indication of whether the journey time along a route is currently in a state of increase, decrease, or is stable. Such information is an effective way of indicating to the user whether, were the user to wait a short while, the journey time will be longer, shorter, or the same, compared to the user starting the journey now. This provides a simple yet highly intuitive indication to the user whether he should start the journey now, or wait a short while if the journey time would be shorter.

[0121] In another form, the journey-time analyzer **484** may additionally, or alternatively, be configured to generate a warning signal indicative of whether or not the journey time along a route is "worse than average", i.e. greater than average. Additionally or alternatively, a positive indication may be generated if the expected journey time is less than average (and/or at least not greater than average). If the driver wishes to avoid congestion or delay, this may enable the user to decide whether he should start the journey, or wait longer.

[0122] The processing to implement such functionality is now described.

[0123] In the form in which the journey-time analyzer analyses whether the journey time is currently in a state of increase, decrease or stable, reference is made to FIGS. **13**-**15**. The most accurate calculation of journey time may be obtained from live traffic information input **652**. The journey-time analyzer **484** may invoke the traffic delay evolution analyzer **488** to predict how traffic delays affecting a route will evolve. In a simple implementation, the traffic delays along a route are analysed in time synchronisation with each other, i.e. as if the delays are encountered at the same time, and without consideration of how distant a respective traffic delay is from the current vehicle position. Referring to FIG. **13**, the steps executed by the journey-time analyzer include a first loop **660** of summing, at step **661**, current journey time delays for each traffic delay along the route, in order to generate a progressive or running total current journey-time delay (meaning a running total of the delays on the route if starting the journey with the current delays). This is followed by a second loop **662** of invoking at step **663** the delay evolution analyzer **488** to predict the journey-time delay evolution for each traffic delay a certain time interval into the future. The future time interval may be at least about 5 minutes, more preferably at least about 10 minutes. The future time interval may be less than about 30 minutes, preferably less than about 20 minutes. For example, the future time interval may be about 15 minutes. Step **664** sums, along the route, the predicted journey time delays to generate a total future journey-time delay (meaning a running total of the delays on the route if starting the journey with delays at future predicted values). Step **666** compares the total current journey-time delay obtained by the first loop **660**, with the total future journey-time delay obtained by the second loop **662**, and generates an information output signal indicative of a respective state:

[0124] (a) Current delay is less than Future delay (delay state is increasing);

[0125] (b) Current delay is equal to Future delay (delay state is stable);

[0126] (c) Current delay is greater than Future delay (delay state is decreasing).

[0127] If desired, the comparison may be quantised by a predetermined quantisation value (e.g. 5 minutes) or a predetermined fraction of the total journey time (e.g. 5%), such that only differences in magnitude greater than the quantisation value will indicate states (a) or (c). Differences in magnitude less than the quantisation value are deemed to be equal and indicate state (b).

[0128] The output indication may again be indicated using an icon, such as the arrow icon of FIG. **11**. The icon may be accompanied by time information concerning the delay. The time information may, for example, indicated the difference in journey times and/or one or both of the current and future journey times. The output signal is an effective way of indicating to the user whether, were the user to wait a short while (e.g. 15 minutes), the journey time will be longer, shorter, or the same, as were the user to start the journey now. This provides a simple yet highly intuitive indication to the user whether he should start the journey now, or wait a short while such as 15 minutes.

[0129] FIG. **14** shows a more refined version of the process based on FIG. **13**. Instead of using the current journey-time delay for each instance of traffic delay, a time offset is applied depending on the distance between the current vehicle position, and the traffic delay. The delay evolution predictor **488** is invoked each time, but with different future points in time representative of an expected point in time at which the vehicle would encounter the delay. For example, even if a hypothetical route journey is commenced at a current time, it might still take 10 minutes or so to reach a delay that is **10**km along the route. The time offset compensates for this. The time offset may be based on an accumulated journey time counter calculated by the route planning module **482**, or it may be an approximation based on the distance between the vehicle position and the traffic delay, divided by an approximate average speed over the route. In FIG. **14**, the step **661** of the first loop **600** is preceded by initial steps **558** of determining a respective time offset to apply to each incidence of traffic delay, as explained above, and step **559** of invoking the delay evolution predictor **488** based on the time offsets. Step **661** sums the respective time delays along the route, to generate the total current journey-time delay (meaning the total delay to journey time if commencing the journey at the current time). In the second loop **662**, an additional step **665** adds to the time offsets, the future time interval. For example, each offset may be incremented by 15 minutes into the future. Step **663** then invokes the delay evolution predictor **488** based on the incremented time offsets, and the method continues as described previously. This refined process may generate a more accurate pattern of delays at the respective times the traffic delays may be encountered along a route.

[0130] FIG. **15** illustrates an alternative technique for generating similar information based instead on the journey-time profiles **506** if provided as part of the digital map **490**. This alternative technique may be used where the navigation device is not equipped to process live traffic information, or where such live traffic information is not available. The journey-time profiles **506** are pre-stored with the digital map information **490**, and so do not rely on reception of an additional information stream. As in the previous technique, two similar methods may be used with and without time offsets.

[0131] Referring to FIG. **15**, the more simple method comprises a first loop **672** comprising, for each route segment along a navigation route, a first step **673** of analysing, based on a current time and day, the journey-time profile **506** for the route segment, and step **674** of summing the journey-times along the route to generate a running current journey time. In second loop **675**, for each route segment, step **676** analyses the journey-time profiles **506** corresponding to at a certain time interval into the future. The time interval into the future may be the same as that used in FIGS. **13** and **14**, with a value of about 15 minutes being typical. Step **678** sums the journey-times along the route at the future time interval, to generate a running future journey time. Step **680** compares the current journey time obtained from the first loop **672**, and the future journey time obtained from the second loop **675**, to generate an output signal in the same manner as step **666** described above.

[0132] In a more refined form, the method adds optional steps **670** and **677** of applying time offsets to reflect the length of time taken by a vehicle to reach a certain road segment. In the present method, the offset may be read directly from the rolling sum of journey time calculated at step **674** or **678**, respectively.

[0133] In a further alternative form, the journey-time analyzer **484** may use, in combination, both a technique based on live traffic information (e.g. FIG. **13** or **14**) and a technique based on journey-time profiles **506** (e.g. FIG. **15**). Such a combined method may be especially useful if, the live traffic information is limited to unusual, non-habitual traffic delays, for example, as might be caused by an accident, or faulty traffic lights, or a broken-down or slow moving vehicle. Information concerning habitual traffic delays may still be obtained from the journey-time profiles **506**. The above described methods may be executed one after the other, or in parallel, and the respective "current" and "future" time information summed together before a final comparison.

[0134] FIG. **16** illustrates the processing for the second form of output indicator from the journey-time analyzer **484**, namely, comparing the journey time along a route with an average value. Step **700** comprises calculating for the journey, the expected journey time assuming the journey starting at the current time. The journey time may be calculated by reference to any one or more of:

[0135] (a) pre-stored journey-time profiles **506**;

[0136] (b) received live traffic information; and

[0137] (c) weather information. The type of weather may be one of the characteristics by which pre-stored journey-time profiles are sub-categorised. Alternatively, the navigation device may increase journey times by a poor-weather multiplication factor, representing a statistical average by which journey times increase in poor weather.

[0138] Where the expected journey time is based on received live traffic information, a delay to journey time less than, or not exceeding, a predetermined threshold may optionally be ignored as insignificant, in order to reduce processing burden. The threshold may, for example, be similar to that used in step **606**. Typically the threshold is about 5 minutes. Optionally, the journey time delay evolution analyzer **188** may be invoked to extrapolate the delay time to a future point in time at which the vehicle is expected to arrive that the point of the traffic delay.

[0139] Step **702** comprises determining or calculating an average journey time for the journey. The information source for the average journey time may be different from the information source for the expected journey time. For example, if at step **700** the expected journey time is calculated using received live traffic information, step **702** may comprise obtaining the average journey time from the digital map information, for example, from the journey-time profiles **506**. The journey-time profiles **506** are already based on a historical average of collected vehicle journey data, and so no additional averaging function might be implemented.

[0140] Alternatively, the information source for the average journey time may be the same as that for calculating the expected journey time, for example, both based on pre-stored traffic profiles **506**. In such case, step **702** preferably comprises performing further averaging calculations to obtain an average value of the journey time, for example, by averaging the journey-time profiles **506** over an entire day, and/or by averaging the journey profiles for the same time of day, but different days of the week, month and/or year. Performing such averaging calculations (i) ensures some differentiation or independence between the expected journey time and the average journey time, and/or (ii) ensures that the average journey time represents a less fluctuating reference of journey time than the expected journey time.

[0141] At step **704**, the expected journey time and the average journey time are compared, and an indication is generated depending on whether the expected journey time is greater than the average. If desired, an additional threshold could also be used in the comparison, either:

[0142] (a) is (expected journey time)>(average journey time+threshold). This calculation increases the average journey time by the value of the threshold, thereby reducing the chance of generation of a "worse than average" warning indication when the expected journey time is similar to the average journey time; or

[0143] (b) is (expected journey time)>(average journey time−threshold). This calculation decreases the average journey time by the value of the threshold, thereby generating a worse than average indication unless the expected journey time beats the average journey time by at least the value of the threshold.

[0144] Also, at step **704**, three or more indication states could be used instead of merely two states. Three indication states could include: "better than average (less than average) "; "the same as average"; or "worse than average (greater than average)". The threshold could be used to quantise the comparison such that if the magnitude of difference between the expected journey time and the average journey time is less than the quantisation threshold, the output indication is "same as average".

[0145] In both of the above, the threshold may be a predetermined value, or it may be user settable or adjustable.

[0146] The indication of journey time at step **704** may comprises generation of a sound, such as a warning tone. Different sounds may be used to indicate different comparison states, and/or a special alert sound may be generated when the comparison state changes.

[0147] Referring to FIG. **12**, the journey-time analyzer **484** may be responsive to an external input **750** to trigger processing upon a user's command. Alternatively, the journey-time analyzer **484** may be configured to repeat processing autonomously or semi-autonomously, in order to provide background functionality, and act as a journey-time radar that monitors the expected journey time. For example, in addition to external input **750** being a user's command, external input **750** may be indicative of the user interacting with the navigation device **200**. After the user has stopped interacting with the device for a predetermined period of time, processing by the journey-time analyser may stop. Alternatively, the user may pre-program time criteria for operation of the journey-time analyzer **484**, and a timer module **752** may generate triggers at appropriate operation times. For example, the user may decide that he would like the journey time analyzer **484** to monitor the expected journey time for a current route (or a route stored as a "favourite") for a certain time window, for example from 08:00 to 10:00 every weekday morning. The start and finish times may be programmed into the timer module **752** which generates calculation triggers periodically when the current time is within the desired operation window. As a further alternative, the timer module **752** may be free running to generate periodic calculation triggers for the journey-time analyzer **484** whenever the navigation device is in operation.

[0148] The same principles of monitoring the journey time to provide time-related information for a certain route of interest may be extended to other traffic delay parameters, such as traffic flow. While many users typically desire route-planning for the fastest route, other users may desire a free flowing route, without congestion delays, even if this route might not be the fastest route to the destination. A free-flowing route may be less stressful for the user to drive.

[0149] The above techniques enable monitoring of journey-time information and generation of useful and intuitive indicators to a user concerning journey-times and/or traffic delays. The indicators are easy for a user to understand without having to divert attention to listen to, or read, large quantities of time-related information. If desired, the journey-time information may additionally be logged or calculated over a certain time period, and presented visually in a graphical form to the user, to enable the user to identify an optimum time of day to make the desired journey. The graphical form may be displayed on the display of the navigation device **200**, or it may be printed, for example, using a communication connection to an external computer equipped with a printer.

[0150] It will be appreciated that whilst various aspects and embodiments of the present invention have heretofore been described, the scope of the present invention is not limited to the particular arrangements set out herein and instead extends to encompass all arrangements, and modifications and alterations thereto, which fall within the scope of the appended claims.

[0151] For example, whilst embodiments described in the foregoing detailed description refer to GPS, it should be noted that the navigation device may utilise any kind of position sensing technology as an alternative to (or indeed in addition to) GPS. For example the navigation device may utilise using other global navigation satellite systems such as the European Galileo system. Equally, it is not limited to satellite based but could readily function using ground based beacons or any other kind of system that enables the device to determine its geographic location.

[0152] It will also be well understood by persons of ordinary skill in the art that whilst the preferred embodiment implements certain functionality by means of software, that functionality could equally be implemented solely in hardware (for example by means of one or more ASICs (application specific integrated circuit)) or indeed by a mix of hardware and software. As such, the scope of the present invention should not be interpreted as being limited only to being implemented in software.

[0153] Lastly, it should also be noted that whilst the accompanying claims set out particular combinations of features described herein, the scope of the present invention is not limited to the particular combinations hereafter claimed, but instead extends to encompass any combination of features or embodiments herein disclosed irrespective of whether or not that particular combination has been specifically enumerated in the accompanying claims at this time.

1. A navigation device operable to generate an output indication representing whether or not journey conditions are favourable, the navigation device comprising a processing resource configured to:

calculate for a navigation route, expected journey time information indicating an expected time duration for completing the route;

compare the expected journey time with an average journey time for the route; and

generate, responsive to the result of said comparison, said output indication representing whether or not journey conditions are favourable.

2. The navigation device of claim **1**, wherein the processing resource is configured to calculate the expected journey time based on one or more information sources selected from: weather information received from a communications channel; live traffic information received from a communications channel; and pre-stored journey time profiles for road segments in a digital map database.

3. The navigation device of claim **2**, wherein the processing resource is configured to calculate the expected journey time information based on a different information source from that used by for obtaining the average journey time.

4. The navigation device of claim **1**, wherein the processing resource is configured to calculate the average journey time based on a plurality of journey time profiles each representing a journey time on a respectively different occasion.

5. The navigation device of claim **4**, wherein the processing resource is configured to calculate the average journey time by averaging information from the journey time profiles.

6. The navigation device of claim **4**, wherein the processing resource is configured to calculate the expected journey time based on one or more journey time profiles.

7. The navigation device of claim **1**, wherein the processing resource is configured to generate a warning indication when the expected journey time exceeds the average journey time.

8. The navigation device of claim **1**, wherein the processing resource is configured to generate a warning indication when the expected journey time exceeds the average journey time, offset by a threshold.

9. The navigation device of claim **1**, wherein the processing resource is configured to repeat processing to refresh calculation of at least one selected from: the expected journey time; the average journey time.

10. The navigation device of claim **1**, wherein the processing device is configured to repeat processing in response to at least one of (i) user interaction with the navigation device, and (ii) inputting of a repeat processing command by a user.

11. The navigation device according to claim **9**, further comprising a timer, and wherein the processing resource is responsive to trigger signals from the timer, to repeat said processing.

12. The navigation device according to claim **11**, wherein the timer generates trigger signals within a time window corresponding to a desired window of use inputted by a user.

13. The navigation device according to claim **9**, wherein the timer is implemented by a portion of the processing resource.

14. The navigation device according to claim **1**, wherein the navigation device is a portable navigation device.

15. A method of operation for a navigation device, to generate an output indication representing whether or not journey conditions are favourable, the method comprising: calculating for a navigation route, expected journey time information indicating an expected time duration for completing the route; comparing the expected journey time with an average journey time for the route; and generating, responsive to the result of said comparison, said output indication representing whether or not journey conditions are favourable.

16. The method of claim **15**, wherein the step of calculating expected journey time comprises calculating the expected journey time based on one or more information sources selected from: weather information received from a communications channel; live traffic information received from a communications channel; and pre-stored journey time profiles for road segments in a digital map database.

17. The method of claim **16**, wherein the step of calculating expected journey time comprises calculating the expected journey time information based on a different information source from that used by for obtaining the average journey time.

18. The method of claim **15**, further comprising the step of calculating the average journey time based on a plurality of journey time profiles each representing a journey time on a respectively different occasion.

19. The method of claim **18**, wherein the step of calculating average journey time comprises averaging information from the journey time profiles.

20. A computer program which, when executed by a processor, implements a method for generating an output indication representing whether or not journey conditions are favourable, the method comprising:

calculating for a navigation route, expected journey time information indicating an expected time duration for completing the route;

comparing the expected journey time with an average journey time for the route; and

generating, responsive to the result of said comparison, said output indication representing whether or not journey conditions are favourable.

21. A non-transitory machine-readable record carrier carrying or implementing the computer program of claim **20**.

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