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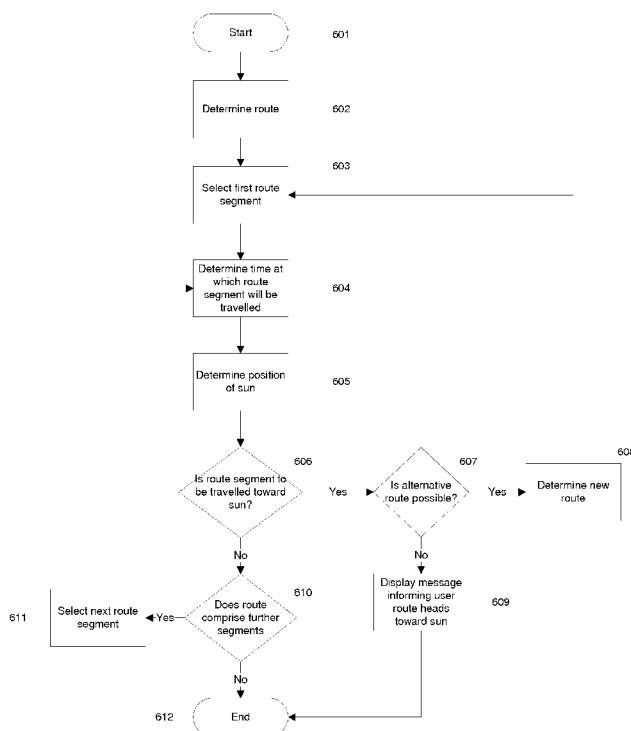


FIG. 6

(57) Abstract: A navigation apparatus (200) comprises a processor (202) arranged to determine a route between at least first and second locations and, for at least a part of the route, an amount of sun-view which would be experienced by a user travelling the route.

NAVIGATION APPARATUS AND METHOD OF DETERMINING A ROUTE THEREFOR

Field of the Invention

5 The present invention relates to a navigation apparatus of the type that determines a route. The present invention also relates to a method of determining a route. In particular, although not exclusively, the present invention relates to a navigation apparatus of the type that, for example, determines a route between first and second locations according to user preferences and a method of determining a route
10 between first and second locations.

Background to the Invention

 Portable computing devices, for example Portable Navigation Devices (PNDs) that include GPS (Global Positioning System) signal reception and processing
15 functionality are well known and are widely employed as in-car or other vehicle navigation systems.

 In general terms, a modern PND 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
20 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.

 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
25 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
30 microphone for detecting user speech. In one particular arrangement, the output interface display may be configured as a touch sensitive display (by means of a touch sensitive overlay or otherwise) additionally to provide an input interface by means of which a user can operate the device by touch.

 Devices of this type will also often include one or more physical connector
35 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 Bluetooth, Wi-Fi, Wi-Max, GSM, UMTS and the like.

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

The PND 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
10 which it is mounted. Typically, such features are most commonly provided in in-vehicle navigation systems, but may also be provided in PNDs if it is expedient to do so.

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
15 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.

Typically, the PND is enabled by software for computing a "best" or "optimum"
20 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
25 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).

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
30 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.

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
35 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.

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 with which the user's computing resource is communicating 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.

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.

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.

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
5 alternately by steering column mounted remote control, by voice activation or by any other suitable method.

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
10 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.

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
15 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
20 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.

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
25 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.

Devices of the type described above, for example the 920T model manufactured
30 and supplied by TomTom International B.V., provide a reliable means for enabling users to navigate from one position to another. Such devices are of great utility when the user is not familiar with the route to the destination to which they are navigating.

It has been noted that, particularly at certain times of the year such as in winter months, it may be inconvenient or difficult for a user to drive along a road due to a
35 relative position of the sun in relation to a direction in which the user is travelling. For example, during winter months when a declination of the sun is low, a driver may be

easily distracted or even partially blinded by driving toward the sun. Embodiments of the present invention aim to reduce this problem.

Summary of the Invention

5 According to a first aspect of the present invention, there is provided a navigation apparatus comprising a processor arranged to determine a route between at least first and second locations; wherein the processor is arranged to determine, for at least a part of the route, an amount of sun-view which would be experienced by a user travelling the route.

10 According to a second aspect of the present invention, there is provided a method of determining a route, comprising determining a route between at least first and second locations; and determining, for at least a part of the route, a level of sun-view to be experienced by a user when travelling the route.

It is thus possible to provide an apparatus and method capable of determining
15 whether a user is likely to experience an unacceptable level of sun-view when navigating a determined route.

The term sun-view may indicate the level to which a user's vision is directed toward the sun whilst navigating a route. The level of sun-view may be dependent upon a relative angle between a user's direction of travel and the position of the sun. Further,
20 the level of sun view may be dependent upon an altitude of the sun.

Brief Description of the Drawings

At least one embodiment of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

25 Figure 1 is a schematic illustration of an exemplary part of a Global Positioning System (GPS) usable by a navigation device;

Figure 2 is a schematic diagram of a communications system for communication between a navigation device and a server;

30 Figure 3 is a schematic illustration of electronic components of the navigation device of Figure 2 or any other suitable navigation device;

Figure 4 is a schematic diagram of an arrangement of mounting and/or docking a navigation device;

Figure 5 is a schematic representation of an architectural stack employed by the navigation device of Figure 3;

35 Figure 6 is an illustration of a method according to an embodiment of the invention;

Figure 7 is an illustration of another method according to an embodiment of the invention;

Figure 8 is an illustration of a layout of an area of map data showing two possible parts of a route;

5 Figure 9 is a an illustration of an example screenshot of a display device of a PND; and

Figure 10 is a further example screenshot of a display device of a PND.

Detailed Description of Preferred Embodiments

10 Throughout the following description identical reference numerals will be used to identify like parts.

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
15 type of processing device that is configured to execute navigation software in a portable manner 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 vehicle such as an automobile, or indeed a
20 portable computing resource, for example a portable personal computer (PC), a mobile telephone or a Personal Digital Assistant (PDA) executing route planning and navigation software.

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
25 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
30 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.

With the above provisos in mind, the Global Positioning System (GPS) of Figure 1 and the like are used for a variety of purposes. In general, the GPS is a satellite-radio based navigation system capable of determining continuous position, velocity, time, and
35 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.

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 allows 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.

As shown in Figure 1, the GPS system 100 comprises a plurality of satellites 102 orbiting about the earth 104. A GPS receiver 106 receives spread spectrum GPS satellite data signals 108 from a number of the plurality of satellites 102. The spread spectrum data signals 108 are continuously transmitted from each satellite 102, the spread spectrum data signals 108 transmitted each comprise a data stream including information identifying a particular satellite 102 from which the data stream originates. The GPS receiver 106 generally requires spread spectrum data signals 108 from at least three satellites 102 in order to be able to calculate a two-dimensional position. Receipt of a fourth spread spectrum data signal enables the GPS receiver 106 to calculate, using a known technique, a three-dimensional position.

Turning to Figure 2, a navigation device 200 comprising or coupled to the GPS receiver device 106, is capable of establishing a data session, if required, with network hardware of a "mobile" or telecommunications network via a mobile device (not shown), for example a mobile telephone, PDA, and/or any device with mobile telephone technology, in order to establish a digital connection, for example a digital connection via known Bluetooth technology. Thereafter, through its network service provider, the mobile device can establish a network connection (through the Internet for example) with a server 150. As such, a "mobile" network connection can be 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 150 to provide a "real-time" or at least very "up to date" gateway for information.

The establishing of the network connection between the mobile device (via a service provider) and another device such as the server 150, using the Internet for example, can be done in a known manner. In this respect, any number of appropriate data communications protocols can be employed, for example the TCP/IP layered
5 protocol. Furthermore, the mobile device can utilize any number of communication standards such as CDMA2000, GSM, IEEE 802.11 a/b/c/g/n, etc.

Hence, it can be seen that the internet connection may be utilised, which can be achieved via data connection, via a mobile phone or mobile phone technology within the navigation device 200 for example.

10 Although not shown, the navigation device 200 may, of course, include its own mobile telephone 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, and/or can include an insertable card (e.g. Subscriber Identity
15 Module (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 150, via the Internet for example, in a manner similar to that of any mobile device.

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

In Figure 2, the navigation device 200 is depicted as being in communication with
25 the server 150 via a generic communications channel 152 that can be implemented by any of a number of different arrangements. The communication channel 152 generically represents the propagating medium or path that connects the navigation device 200 and the server 150. The server 150 and the navigation device 200 can communicate when a connection via the communications channel 152 is established between the server 150
30 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.).

The communication channel 152 is not limited to a particular communication technology. Additionally, the communication channel 152 is not limited to a single communication technology; that is, the channel 152 may include several communication
35 links that use a variety of technology. For example, the communication channel 152 can be adapted to provide a path for electrical, optical, and/or electromagnetic

communications, etc. As such, the communication channel 152 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, free space, etc. Furthermore, the communication channel 152 can include intermediate devices such as routers, repeaters, buffers, transmitters, and receivers, for example.

In one illustrative arrangement, the communication channel 152 includes telephone and computer networks. Furthermore, the communication channel 152 may be capable of accommodating wireless communication, for example, infrared communications, radio frequency communications, such as microwave frequency communications, etc. Additionally, the communication channel 152 can accommodate satellite communication.

The communication signals transmitted through the communication channel 152 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 152. These signals may be modulated, encrypted and/or compressed signals as may be desirable for the communication technology.

The server 150 includes, in addition to other components which may not be illustrated, a processor 154 operatively connected to a memory 156 and further operatively connected, via a wired or wireless connection 158, to a mass data storage device 160. The mass storage device 160 contains a store of navigation data and map information, and can again be a separate device from the server 150 or can be incorporated into the server 150. The processor 154 is further operatively connected to transmitter 162 and receiver 164, to transmit and receive information to and from navigation device 200 via communications channel 152. The signals sent and received may include data, communication, and/or other propagated signals. The transmitter 162 and receiver 164 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 162 and receiver 164 may be combined into a single transceiver.

As mentioned above, the navigation device 200 can be arranged to communicate with the server 150 through communications channel 152, using

transmitter 166 and receiver 168 to send and receive signals and/or data through the communications channel 152, noting that these devices can further be used to communicate with devices other than server 150. Further, the transmitter 166 and receiver 168 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 166 and receiver 168 may be combined into a single transceiver as described above in relation to Figure 2. Of course, the navigation device 200 comprises other hardware and/or functional parts, which will be described later herein in further detail.

Software stored in server memory 156 provides instructions for the processor 154 and allows the server 150 to provide services to the navigation device 200. One service provided by the server 150 involves processing requests from the navigation device 200 and transmitting navigation data from the mass data storage 160 to the navigation device 200. Another service that can be provided by the server 150 includes processing the navigation data using various algorithms for a desired application and sending the results of these calculations to the navigation device 200.

The server 150 constitutes a remote source of data accessible by the navigation device 200 via a wireless channel. The server 150 may include a network server located on a local area network (LAN), wide area network (WAN), virtual private network (VPN), etc.

The server 150 may include a personal computer such as a desktop or laptop computer, and the communication channel 152 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 150 to establish an internet connection between the server 150 and the navigation device 200.

The navigation device 200 may be provided with information from the server 150 via information downloads which may be periodically updated automatically or upon a user connecting the navigation device 200 to the server 150 and/or may be more dynamic upon a more constant or frequent connection being made between the server 150 and navigation device 200 via a wireless mobile connection device and TCP/IP connection for example. For many dynamic calculations, the processor 154 in the server 150 may be used to handle the bulk of processing needs, however, a processor (not shown in Figure 2) of the navigation device 200 can also handle much processing and calculation, oftentimes independent of a connection to a server 150.

Referring to Figure 3, 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. The navigation device 200 is located within a housing (not shown). The navigation device 200 includes a processing resource comprising, for example, the processor 202 mentioned above, the processor 202 being coupled to an input device 204 and a display device, for example a display screen 206.

5 Although reference is made here to the input device 204 in the singular, the skilled person should appreciate that the input device 204 represents any number of input devices, including a keyboard device, voice input device, touch panel and/or any other known input device utilised to input information. Likewise, the display screen 206 can include any type of display screen such as a Liquid Crystal Display (LCD), for example.

10 In one arrangement, one aspect of the input device 204, the touch panel, and the display screen 206 are integrated so as to provide an integrated input and display device, including a touchpad or touchscreen input 250 (Figure 4) to enable both input of information (via direct input, menu selection, etc.) and display of information through the touch panel screen so that a user need only touch a portion of the display screen 206 to
15 select one of a plurality of display choices or to activate one of a plurality of virtual or "soft" buttons. In this respect, the processor 202 supports a Graphical User Interface (GUI) that operates in conjunction with the touchscreen.

In the navigation device 200, the processor 202 is operatively connected to and capable of receiving input information from input device 204 via a connection 210, and
20 operatively connected to at least one of the display screen 206 and the output device 208, via respective output connections 212, to output information thereto. The navigation device 200 may include an output device 208, for example an audible output device (e.g. a loudspeaker). As the output device 208 can produce audible information for a user of the navigation device 200, it is should equally be understood that input
25 device 204 can include a microphone and software for receiving input voice commands as well. Further, the navigation device 200 can also include any additional input device 204 and/or any additional output device, such as audio input/output devices for example.

The processor 202 is operatively connected to memory 214 via connection 216 and is further adapted to receive/send information from/to input/output (I/O) ports 218 via
30 connection 220, wherein the I/O port 218 is connectible to an I/O device 222 external to the navigation device 200. The external I/O device 222 may include, but is not limited to an external listening device, such as an earpiece for example. The connection to I/O device 222 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
35 example, for connection to an earpiece or headphones, and/or for connection to a mobile telephone for example, wherein the mobile telephone connection can 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.

Figure 3 further illustrates an operative connection between the processor 202 and an antenna/receiver 224 via connection 226, wherein the antenna/receiver 224 can be a GPS antenna/receiver for example. It should be understood that the antenna and receiver designated by reference numeral 224 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.

It will, of course, be understood by one of ordinary skill in the art that the electronic components shown in Figure 3 are powered by one or more 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 Figure 3 are contemplated. For example, the components shown in Figure 3 may be in communication with one another via wired and/or wireless connections and the like. Thus, the navigation device 200 described herein can be a portable or handheld navigation device 200.

In addition, the portable or handheld navigation device 200 of Figure 3 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.

Referring to Figure 4, the navigation device 200 may be a unit that includes the integrated input and display device 206 and the other components of Figure 2 (including, but not limited to, the internal GPS receiver 224, the microprocessor 202, a power supply (not shown), memory systems 214, etc.).

The navigation device 200 may sit on an arm 252, which itself may be secured to a vehicle dashboard/window/etc. using a suction cup 254. This arm 252 is one example of a docking station to which the navigation device 200 can be docked. The navigation device 200 can be docked or otherwise connected to the arm 252 of the docking station by snap connecting the navigation device 200 to the arm 252 for example. The navigation device 200 may then be rotatable on the arm 252. To release the connection between the navigation device 200 and the docking station, a button (not shown) on the navigation device 200 may be pressed, for example. Other equally suitable arrangements for coupling and decoupling the navigation device 200 to a docking station are well known to persons of ordinary skill in the art.

Turning to Figure 5, the processor 202 and memory 214 cooperate to support a BIOS (Basic Input/Output System) 282 that functions as an interface between functional

hardware components 280 of the navigation device 200 and the software executed by the device. The processor 202 then loads an operating system 284 from the memory 214, which provides an environment in which application software 286 (implementing some or all of the above described route planning and navigation functionality) can run.

5 The application software 286 provides an operational environment including the GUI that supports core functions of the navigation device, for example map viewing, route planning, navigation functions and any other functions associated therewith. In this respect, part of the application software 286 comprises a direct sun view (DSV) module 288. Operation of embodiments of the direct sun view module 288 will now be explained.

10 In some embodiments of the present invention, the DSV module 288 is arranged to determine sun position information with respect to a given location at a particular time of day on a given date.

The sun position information may comprise an azimuth of the sun or may
15 comprise an azimuth and altitude of the sun relative to the given location and temporal (time & date) information. A given location may correspond to a location for which respective longitude and latitude may be obtained. Altitude may be understood as a vertical angle with respect to the current location, wherein 0 degrees is level with the horizon and 90 degrees is directly overhead. Azimuth may be understood as an angle
20 along the horizon with 0 degrees corresponding to north and increasing in a clockwise manner. Those skilled in the art will understand how to calculate the position of the sun for given location and temporal information. Further information may be obtained from sources such as the US Naval Observatory (www.usno.navy.mil/).

A method of determining a route which a user may navigate without having to
25 directly view the sun according to an embodiment of the invention will now be described with reference to Figures 6 and 7.

The method begins in step 601. In step 602 a route is determined according to one or more criteria. For example, a route may be determined between first and second locations having a shortest travelling time. Such a route is likely to include more route
30 segments having a higher average or predicted speed. Alternatively, a route may be calculated which avoids certain types of road and/or has a shortest distance.

In step 603 a first route segment is selected for consideration of whether that route segment is likely to require a user to drive whilst having a direct view of the sun. A route segment may be an entire road, or may be a section of road which does not
35 deviate more than a predetermined amount from a general direction, for example a section of road following a general heading. The road may be divided into route

segments when the road deviates from the general heading.

A time at which the route segment will be travelled is determined in step 604. If the route is to be travelled immediately, then the time at which the first route segment will be travelled may be determined as the current time. For following route segments, the time at which they are to be travelled may correspond to a sum of travelling times of all preceding route segments in addition to the current time. Alternatively, if the route is being determined in advance for later travel, a user may be requested to input a journey start time at which the journey is to begin. The time at which each route segment is to be travelled may then be calculated based upon the journey start time. It will be understood that if the route is not being planned for travel during the current day then time may also include a date on which the route is to be travelled.

The determined time at which the selected route segment is to be travelled is used in step 605, along with location information relating to the location of the route segment, to determine a position of the sun when the route segment is to be travelled. In some embodiments, an altitude and azimuth of the sun at the time when the route segment is to be travelled is determined in step 605. The position of the sun is calculated for the location of the route segment. In some embodiments, the location of the route segment may be taken as a location of a start of the route segment, a mid-point of the route segment or another appropriately chosen location along the route segment.

In step 606 it is determined whether the selected route segment is to be travelled with a user having a direct view toward the sun, based upon the position of the sun determined in step 605. An embodiment of a method of determining whether the route segment is to be travelled whilst having a direct view toward the sun will now be described with reference to Figure 7. It will be recognised that, for a given route segment, portions of the route segment will vary in direction. That is, portions of a route segment are likely to have a variation in heading, even for a route segment selected to include one or more roads, or a portion of a road, having less than a predetermined deviation from a general heading of the route segment. Therefore, in some embodiments, an average heading of the route segment may be determined for consideration as to whether the average heading is toward the sun. The average heading may be determined by calculating a heading of straight line which best fits the route segment.

If it is determined in step 606 that the route segment is to be travelled with a direct view of the sun, then in step 607 it is determined whether an alternative route is possible. An alternative route is a route which does not include the route segment

determined in step 606 to be driven with a direct view of the sun. If an alternative route exists, then in step 608 the alternative route is determined and processing returns to step 603 where the first route segment of the alternative route is selected. However, if it is determined that no alternative routes which have not been previously considered exist, in other words that all possible routes include a route segment having a direct view of the sun, then in step 609 a message may be displayed to a user indicating that the route includes a route segment which will require travelling whilst having a direct view of the sun. Following display of the message the method ends in step 612.

If, in step 606, it is determined that the route segment is not to be travelled toward the sun, then the method moves to step 610 where it is determined whether the route comprises further segments. If the route does comprise further segments, then the next route segment is selected in step 611 and the method returns to step 604 for consideration of the following route segment. If the route does not comprise any further route segments, then the method ends in step 612.

A method of determining whether a route segment has a direct view of the sun according to an embodiment of the invention will now be described with reference to Figure 7. The method shown in Figure 7 may be performed in step 606 of Figure 6.

The method begins in step 701 and in step 702 it is determined whether the altitude of the sun is below a predetermined threshold. It will be recalled that the altitude of the sun may be a value indicating an angle of the sun with respect to the viewer's horizon level. If the value is between 0 and 90 then the sun is visible in viewer's sky. If the sun is above, or equal to, a threshold value then it is determined that the user will not have a direct view into the sun because it is above a direct viewing angle. The threshold value may be 10, 20, 30, 40 or 45 degrees, although it will be realised that other threshold values may be selected according to a user's preference. If in step 702 it is determined that the sun is below the threshold altitude then the method moves to step 703, otherwise the method moves to step 705 where it is determined that the route segment does not have a direct view of the sun and the method ends in step 707. The method may then return to that shown in Figure 6.

In step 704 the azimuth of the sun and the general heading of the route segment are compared to determine a difference there between. For example, the route segment may be determined to have a general heading of 97 degrees whereas the sun is determined to have an azimuth of 93 degrees. In this example, the difference between the azimuth of the sun and the heading of the route segment is 4 degrees.

In step 704 it is determined whether the difference in route segment heading and azimuth of the sun is less than a predetermined threshold angle. For example, it may be

determined whether the difference is below a predetermined threshold of 5 degrees, although it will be noted that other values may be chosen. If the difference is below the threshold angle, then it is determined in step 706 that the route segment has a direct view of the sun. That is, a user driving the route in the direction of the general heading would have a direct view of the sun, and the method ends in step 707. The method may then return to that shown in Figure 6.

It will be realised that various changes may be made to the methods shown in Figures 6 and 7, and the combination thereof, which have the same effect as the shown arrangement of method steps. For example, steps 702 and the combination of steps 703 and 704 may be re-ordered, such that consideration of the angular difference between the sun and route segment is made before consideration of the altitude of the sun.

Figures 8-10 illustrate an example of the operation of embodiments of the present invention. Figure 8 shows a layout of an area of map data comprising a plurality of roads. A route is determined comprising a route segment 810 which runs along a road "Kempenbaan" from the crossing of that road with "De Run" to a crossing of that road with "De Plank". A general heading of the route segment 810 is indicated with the arrow shown. A determined position of the sun 820 for the time and date on which the route segment will be travelled is also shown. It is determined in step 606 that the route segment 810 will be travelled with the user having a direct view of the sun 820. That is, the sun 820 has an altitude within a user's viewing angle and the general heading of the route segment is within a predetermined angle of the azimuth of the sun 820. Figure 9 shows a screenshot 900 of a PND display device 206 which shows the route segment 810 and the sun 820. It will be noted that the sun has a low altitude, such that it is within the user's viewing angle and below the threshold angle in step 702. Therefore, in step 608 a new route is determined which includes an alternative route segment 830 which runs along a road "Heiberg" between "De Run" and "De Plank". Whilst the altitude of the sun 820 for the locations of both route segments 810, 830 will be very similar, since both route segments are in close proximity, a difference exists in a general heading of both route segments 810, 830. Therefore in steps 703 and 704 a greater difference exists between the general heading of the alternative route segment 830 and the azimuth of the sun 820, which may exceed the threshold angle in step 704 and thus the alternative route segment is determined not to require a user to directly view the sun 820. A screen shot 910 of display device 206 when travelling along the alternative route segment 830 is shown in Figure 10, illustrating a difference between the general heading of route segment 830 and the azimuth of the sun 820. Thus embodiments of the present

invention can determine a route which does not require a user to directly view the sun.

A further embodiment of the present invention will now be described.

In the second embodiment, the DSV module 288 uses stored sun information to determine whether a user travelling in a given direction along a route segment will have
5 a direct view of the sun. In some embodiments, the sun information is stored as part of the map data for at least some roads in the map data. In embodiments of the invention, each road in the map data having stored sun information comprises associated sun data which indicates a date and time dependent value for an amount of direct view of the sun which the user would experience when driving the road in each direction. The sun data
10 may be a range of values, such as between 0 and 1, wherein 1 indicates a direct head-on view of the sun at 0 degrees altitude and 0 indicates that there is no direct view of the sun. For example, the sun data for a given direction of travel along a road may indicate that the user would experience a direct sun view of 0.9. It will of course be realised that other ranges of values may be used. When determining a route, the PND may obtain
15 from the sun data the direct sun view (DSV) value for a route segment with respect to a given direction of travel at a time and date at which the route segment will be travelled. The PND may then compare the obtained DSV value against a predetermined threshold value. If the DSV equals or exceeds the threshold value, then the route segment may be discarded from the route and a different route determined which avoids the discard
20 route segment, if possible. Advantageously, by using stored sun data it may it may be determined whether a user would experience a direct view of the sun whilst determining the route and route segments chosen appropriately during the determination.

It will also be appreciated that whilst various aspects and embodiments of the present invention have heretofore been described, the scope of the present invention is
25 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.

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
30 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.

35 Alternative embodiments of the invention can be implemented as a computer program product for use with a computer system, the computer program product being,

for example, a series of computer instructions stored on a tangible data recording medium, such as a diskette, CD-ROM, ROM, or fixed disk, or embodied in a computer data signal, the signal being transmitted over a tangible medium or a wireless medium, for example, microwave or infrared. The series of computer instructions can constitute
5 all or part of the functionality described above, and can also be stored in any memory device, volatile or non-volatile, such as semiconductor, magnetic, optical or other memory device.

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
10 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.

Lastly, it should also be noted that whilst the accompanying claims set out
15 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.

CLAIMS

1. A navigation apparatus comprising:
a processor (202) arranged to determine a route between at least first and
5 second locations;
characterised in that:
the processor (202) is arranged to determine, for at least a part of the route, an
amount of sun-view which would be experienced by a user travelling the route.
- 10 2. The apparatus of claim 1, wherein the amount of sun-view is proportional to the
user having a direct view of the sun (820).
3. The apparatus of claim 1 or 2, wherein the route comprises one or more route
segments (820, 830) and the processor (210) is arranged to determine, for each route
15 segment (820, 830), a position of the sun (810) relative to a location of the route
segment (820, 830), and temporal information indicating when the route segment (820,
830), will be travelled.
4. The apparatus of claim 3, wherein the processor (210) is arranged to determine a
20 relative angle of the sun (820) and the route segment (820, 830),
5. The apparatus of claim 4, wherein the processor (210) is arranged to determine
that a user travelling the route segment would have a direct view of the sun in response
to the relative angle of the sun (820) and the route segment (820, 830), being less than a
25 predetermined value.
6. The apparatus of claim 3, 4 or 5, wherein the processor (210) is arranged to
determine an elevation of the sun (820) and that the user would have a direct view of the
sun (820) in response to the altitude being less than a predetermined value and the
30 relative angle of the sun (820) and the route segment (820, 830), being less than a
predetermined value.
7. The apparatus of claim 1, 2 or 3 wherein the amount of sun-view is determined
from map data having sun information associated therewith which indicates the amount
35 of sun-view for one or more roads in the map data.

8. The apparatus of any preceding claim, wherein the processor (210) is arranged to determine an alternative route when the amount of sun-view exceeds a predetermined threshold.

- 5 9. A method of determining a route, comprising:
determining a route between at least first and second locations;
characterised by:
determining, for at least a part of the route (810), a level of sun-view to be experienced by a user when travelling the route.

10

10. The method of claim 9, comprising:
determining, for at least the part of the route (820, 830), a position of the sun (820) with respect to a location of the part of the route and temporal information indicating when the route is to be travelled.

15

11. The method of claim 10, wherein the position of the sun (820) comprises an azimuth of the sun (820).

12. The method of claim 10 or 11, wherein the position of the sun comprising an elevation of the sun (820).

20

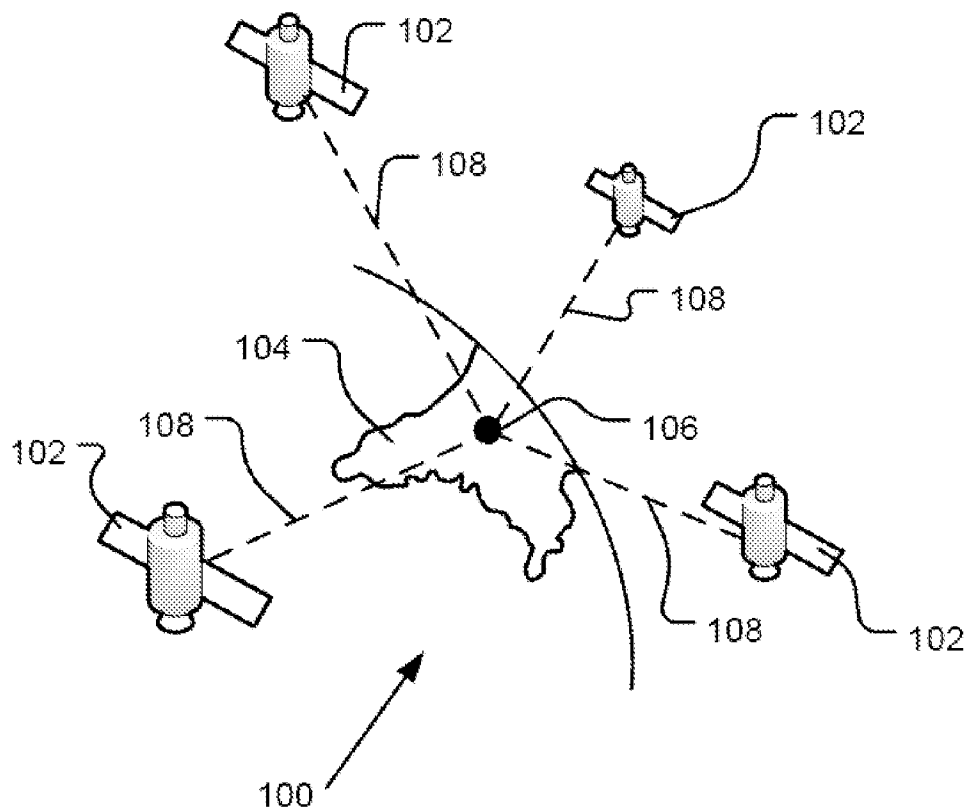
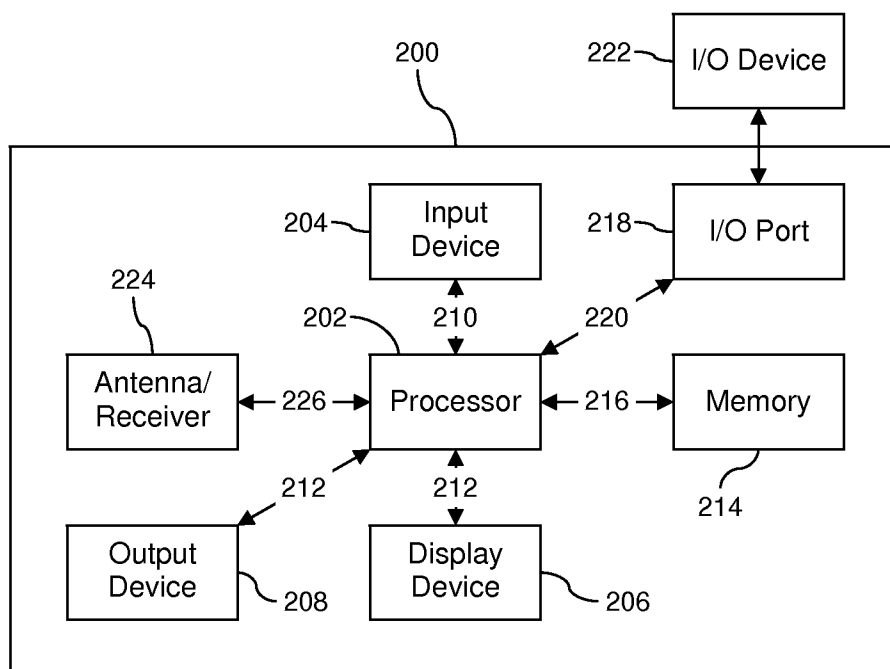
13. The method of claim 10 or 11, comprising:
comparing the position of the sun (820) against a heading of the at least part of the route; and
25 determining whether the user would have a direct view of the sun (820) in response thereto.

25

14. The method of claim 9 or 10, comprising:
determining the level of sun view by obtaining sun information relating to one or
30 more roads in map data.

30

15. The method of claim 14, wherein the sun information indicates the level of sun view with respect to a direction of travel and temporal information.

**FIG. 1****FIG. 2**

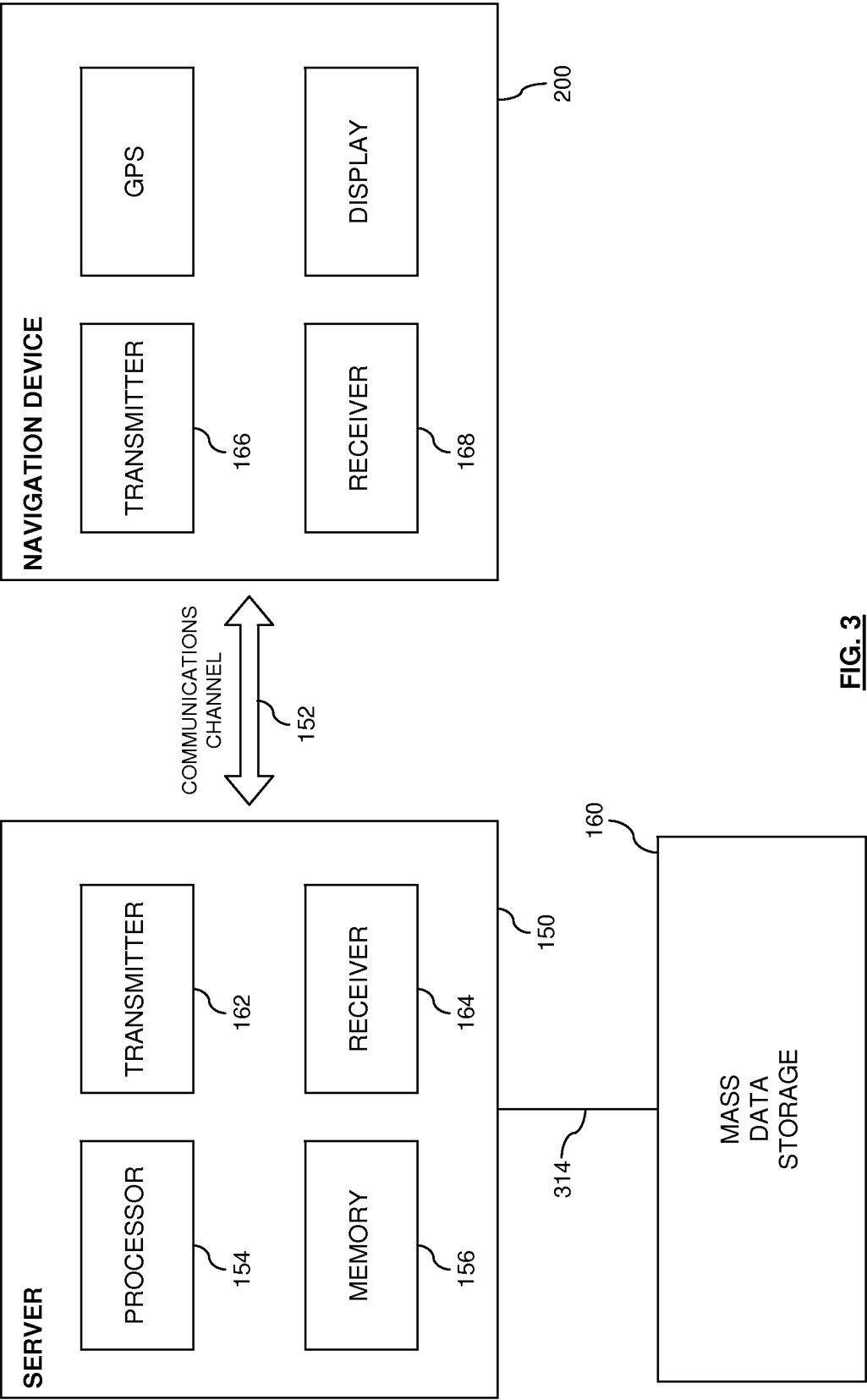
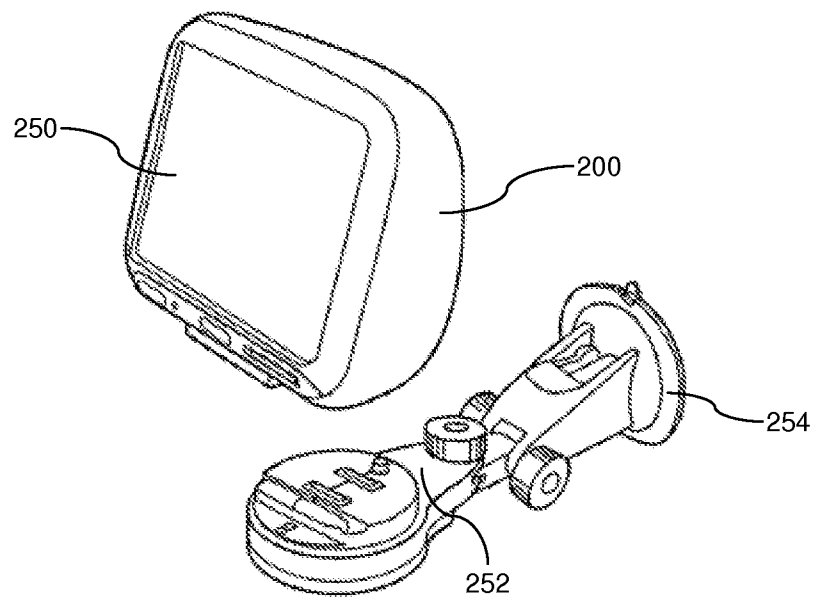
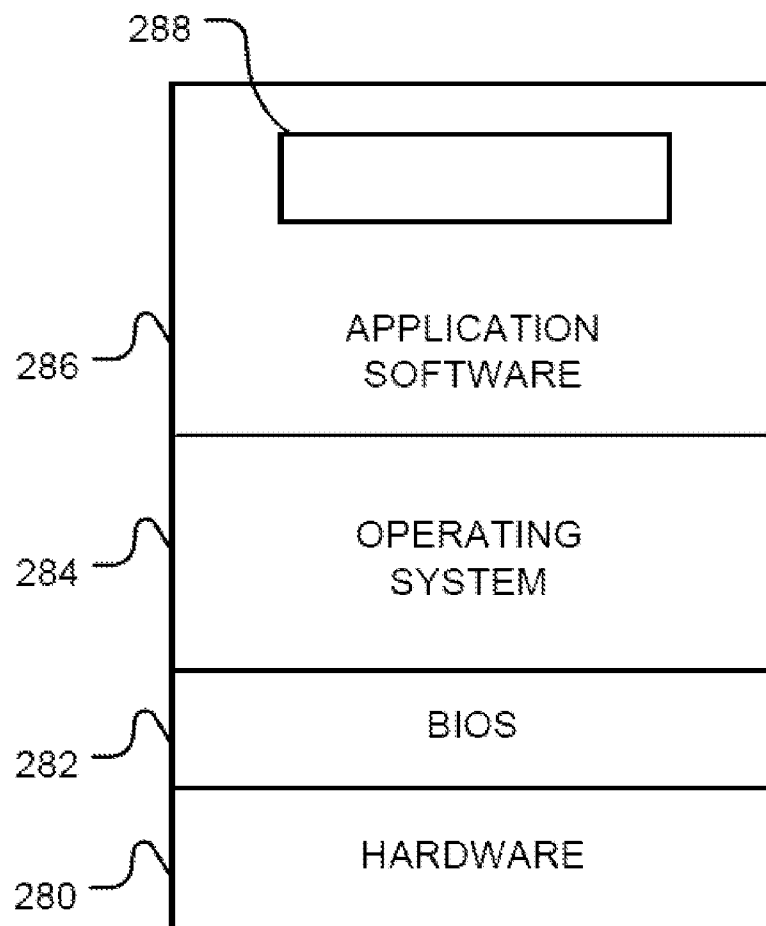
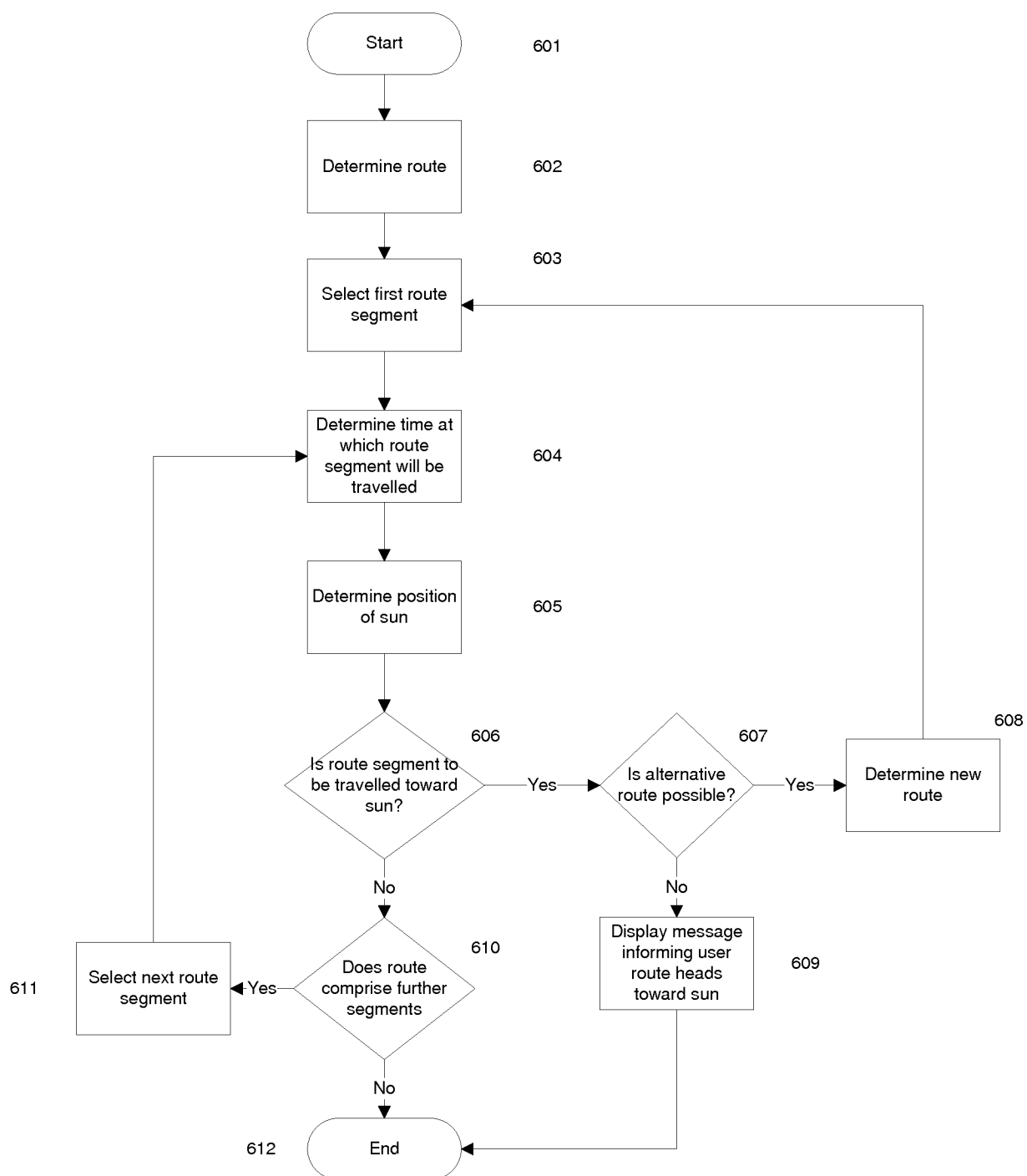
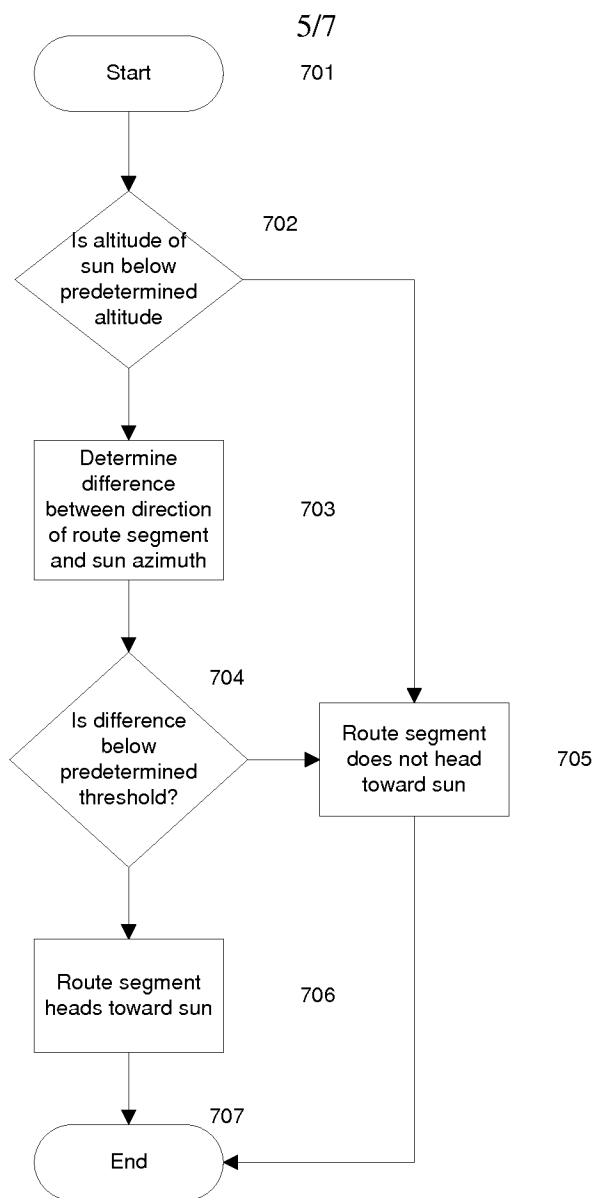


FIG. 3

**FIG. 4a****FIG. 5**

**FIG. 6**

**FIG. 7**

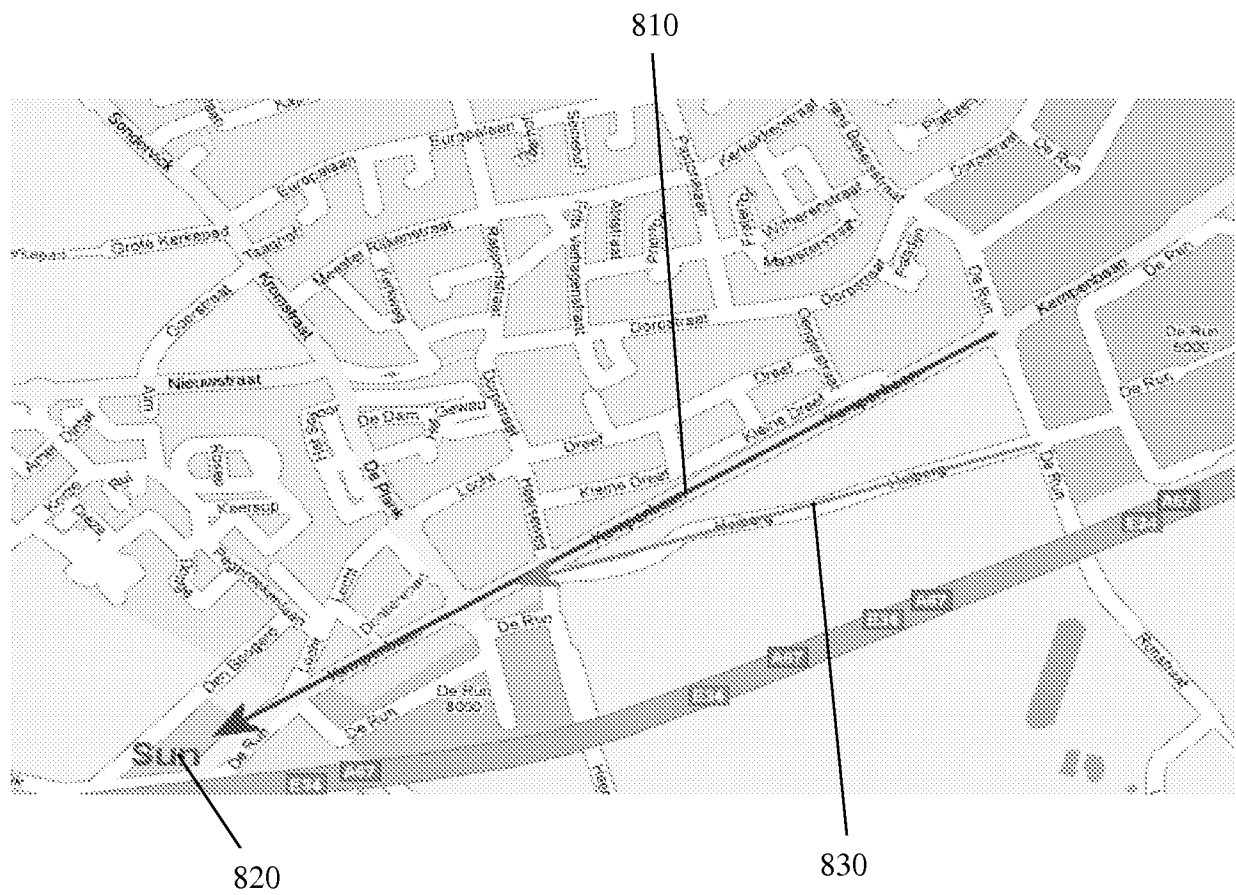


FIG. 8

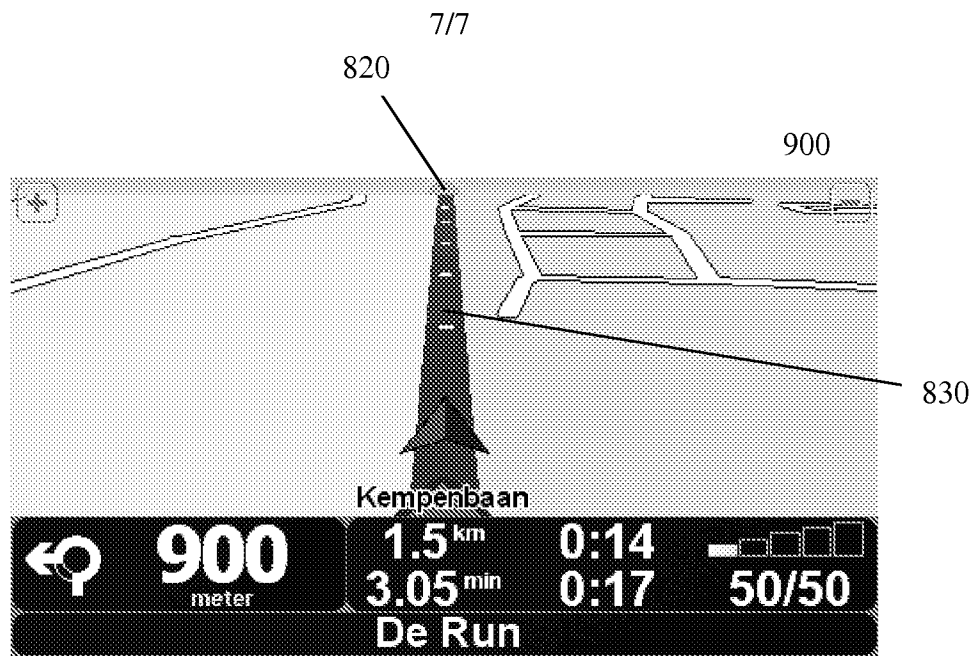


FIG. 9

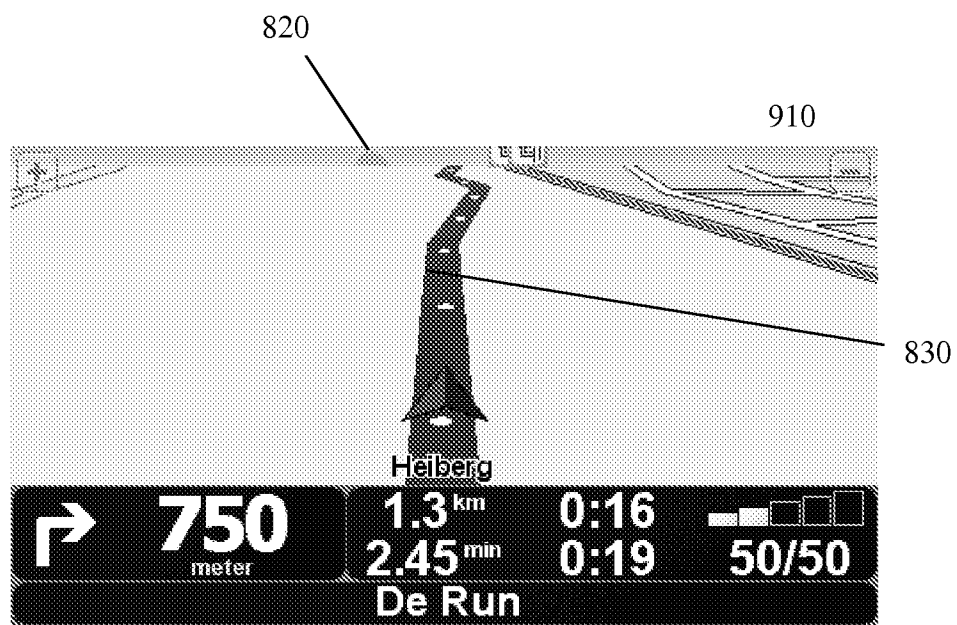


FIG. 10

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2008/063398

A. CLASSIFICATION OF SUBJECT MATTER
INV. G01C21/26 G01C21/34

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 08 159800 A (NIPPON DENSO CO) 21 June 1996 (1996-06-21)	1-6, 8-10, 13-15
Y	abstract	7, 11-12
X	JP 2008 134165 A (RENEAS TECH CORP) 12 June 2008 (2008-06-12)	1-6, 8-10, 13-15
Y	abstract	7, 11-12
Y	US 2003/066299 A1 (AOKI SHINJI [JP]) 10 April 2003 (2003-04-10)	7
A	page 7, paragraph 99 - page 8, paragraph 119; figure 6	1-6, 8-15
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☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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8 document member of the same patent family

Date of the actual completion of the international search

29 June 2009

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INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2008/063398

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	DE 102 53 507 A1 (BOSCH GMBH ROBERT [DE]) 27 May 2004 (2004-05-27)	11-12
A	page 2, paragraph 9 - page 4, paragraph 29 page 6, paragraph 59 - page 7, paragraph 69; figures 1-4	1-10, 13-15
A	JP 2007 315799 A (PIONEER ELECTRONIC CORP; INKURIMENTO P KK) 6 December 2007 (2007-12-06) abstract	1-15

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2008/063398

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JP 2008134165	A	12-06-2008	NONE	
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DE 10253507	A1	27-05-2004	NONE	
JP 2007315799	A	06-12-2007	NONE	