NAVIGATION DEVICE & METHOD FOR PROVIDING PARKING INFORMATION

Field of the Invention

This invention relates to navigation devices and to methods for providing parking 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

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.

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.

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.

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.

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.

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.

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.

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).

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.

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.

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.

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 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 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 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.

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.

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.

Whilst navigation devices are able to direct users to car parks, which are often stored in or alongside map data as points of interest, often car parks, especially in busy cities, may be full. Furthermore, available on-street parking spaces are particularly difficult to find, especially in busy cities.

It is an aim of the present invention to address this problem, in particular to attempt to assist users in finding vehicle parking spaces.

Summary of the Invention

In pursuit of this aim, a presently preferred embodiment of the present invention provides: a navigation device comprising a parking place notification module wherein the navigation device is arranged to wirelessly receive a message indicating a location of a parking place and, in response, the parking place notification module is arranged to either display on a display device an indication of the location of the parking place, or to select as a destination location the location of the parking place.

A further preferred embodiment of the invention provides a method for use in a navigation device comprising receiving a message indicating a location of an available parking place; and displaying on a display device an indication of the location of the parking place, or selecting the location of the parking place as a destination location. The message may indicate a number of available parking places and the method may comprise displaying an indication of the number of available parking places based upon the indication in the message.

Another embodiment of the present invention provides a system, comprising: at least one in-vehicle device for determining a current location of a vehicle carrying the device and wirelessly transmitting data, characterised in that the in-vehicle device is arranged to determine the vehicle leaving a parking place and, in response, to transmit a message indicating a location of the parking place; and at least one navigation device comprising a parking place notification module, wherein the navigation device is arranged to wirelessly receive a message indicating the location of the parking place and, in response, the parking place notification module is arranged to either display on a display device an indication of the location of the parking place, or to select as a destination location the location of the parking place.

Another embodiment of the present invention relates to a navigation device comprising a processor, a receiver for wirelessly receiving data and a display; characterised in that the receiver is arranged to receive a parking place available message indicating a location of an available parking place; and the navigation devices comprises a parking place notification module arranged to either display on a display device an indication of the location of the parking place, or to select as a destination location the location of the parking place.

A further embodiment of the present invention relates to a method for use in a navigation device, characterised by: receiving a message indicating a location of an available parking place; either displaying on a display device an indication of the location of the parking place, or selecting as a destination location the location of the parking place.

Yet another embodiment of the present invention relates to computer software comprising one or more software modules operable, when executed in an execution environment, to cause a processor to receive a message indicating a location of an available parking place; and either display on a display device (240) an indication of the location of the parking place, or select as a destination location the location of the parking place.

Advantages of these embodiments 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.

Brief Description of the Drawings

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:

Fig. 1 is a schematic illustration of a Global Positioning System (GPS);

Fig. 2 is a schematic illustration of electronic components arranged to provide a navigation device;

Fig. 3 is a schematic illustration of the manner in which a navigation device may receive information over a wireless communication channel;

Figs. 4A and 4B are illustrative perspective views of a navigation device;

Fig. 5 is a schematic representation of the software employed by the navigation device;

Fig. 6 is an example screenshot taken from a display of a navigation device according to an embodiment of the present invention;

Fig. 7 is a graphical item displayed on a display of a navigation device according to an embodiment of the invention;

Fig. 8 is a schematic diagram illustrating a system according to an embodiment of the present invention;

Fig. 9 is a schematic diagram illustrating a system according to an embodiment of the present invention;

Fig. 10 is a schematic diagram illustrating a system according to an embodiment of the present invention;

Fig. 11 is a flow diagram illustrating a method according to an embodiment of the invention; and

Fig. 12 is a schematic diagram illustrating a system according to an embodiment of the present invention.

Detailed Description of Preferred Embodiments

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.

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.

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.

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.

As shown in Figure 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.

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.

Figure 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.

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.

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.

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.

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.

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.

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.

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.

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.

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).

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.

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.

For GPRS 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.

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.).

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

Figs 4A and 4B are perspective views of a navigation device 200. As shown in

Fig. 4A, 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.).

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.

As shown in Fig. 4B, 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. 4B. 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.

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. In accordance with the preferred embodiment of the present invention, part of this functionality comprises a parking notification module 490, the function of which will now be described in detail in connection with the following figures.

The parking notification module 490 operatively notifies a user of available parking places or selects an available parking place as a destination based upon wirelessly received information. The parking notification module 490 may operatively provide a visual indication of a location of a recently vacated parking place, for example on a map which is displayed on the display device 240. In some embodiments the visual indication may comprise an indication of how recently the parking place was vacated. The indication may be in the form a textual indication and/or a colour indicating how recently the parking place became available. Alternatively or additionally, the parking

place notification module 490 may select as a destination location the location of the recently vacated parking place. The parking place notification module may select location of the recently vacated parking place as the destination location when it is within a predetermined distance of a current location of the navigation device.

Information on vacated parking places may be provided from in-vehicle devices, such as navigation devices, or from systems including sensors for detecting when vehicles vacate parking places.

An in-vehicle device is arranged to determine when the vehicle in which it is located leaves a parking space. In response thereto, the in-vehicle device notifies one or more navigation devices of the available parking space. In some embodiments, the in-vehicle device is a navigation device 200. However, the in-vehicle device may also be another type of device, such as a vehicle monitoring device, a road-toll monitoring device, or any other device capable of monitoring the vehicle's location and having access to a communications resource. The in-vehicle device may also be a portable device located in the vehicle, such as a portable navigation device. A parking notification module 490 of the device is arranged to determine when the vehicle vacates, or has recently vacated, a parking place. When the parking place has been vacated, the parking notification module 490 is arranged to notify at least one navigation device 200. The notification may be communicated to a server 302 via the communications channel 318, or may be communicated directly to one or more navigation devices 200. The notification may be sent to all navigation devices 200 communicative with the device transmitting the notification, either via the server or directly. Alternatively, the notification may be sent to a subset of the communicative navigation devices 200. The subset may be those navigation devices 200 within a predetermined distance of the device transmitting the notification. Alternatively, the subset may be one or more predetermined navigation devices 200.

A parking management system may comprise one or more sensors for detecting when a vehicle is parking in a corresponding parking place. A control unit of the system receives information from each sensor indicating whether a vehicle is parked in the corresponding parking place. In response to a vehicle leaving a parking place or the system determining that parking places are available, the control unit is arranged to transmit a signal indicating the availability of a parking place. The signal may be received by or communicated to the parking place notification module of one or more navigation devices which, in response thereto, may provide a visual indication of a location of a recently vacated parking place or select as a destination location the location of the recently vacated or available parking place.

Operation of embodiments of the parking notification module 490 will now be explained in detail. The parking notification module 490 is operative to aid a user of the navigation device 200 to find an available parking place. Available parking places are determined by the parking notification module 490 from received parking place available messages which indicate a geographical location of one or more parking places. The parking place available messages may be directly received from in-vehicle devices, such as navigation devices or from a server computer, as will be explained.

Referring to Figure 6, there is shown a screenshot of the display device 240 of the navigation device 200 operative in a first embodiment of a parking mode to display indications of available parking places. In the parking mode, the navigation device 200 is arranged to display on the display device 240 map information 610 which is representative of a current location of the device 200. An icon 620 denotes the current location of the navigation device 200, and is centred with the map information 610 of current and surrounding roads in the vicinity of the current device location and other map features also being displayed. Navigation information 630 is displayed in a status bar below the displayed map information. The navigation information 630 includes a distance to the next deviation from the current road required to be taken by the user, an icon suggestive of the particular type of deviation, for example a left or right turn, a name of the current road and various other information relating to the current journey and an indication of a strength of satellite-broadcast signals being received by the navigation device 200. The display 240 further indicates, using a plurality of symbols 640, 650, 660, 670, a location of available parking places in the vicinity of the current location of the navigation device 200. Each symbol 640, 650, 660, 670 comprises an indication that it is notifying the availability of a parking place, which in the example is provided by a letter P, and an indication of the time since that parking place became available. In Figure 6 the indication of the time since that parking place became available is provided by means of a textual label identifying a period of time since that parking place became available. However, it is envisaged that this indication may be provided in other ways, such as by varying a colour of the symbol. For example, parking places which recently became available may be indicated in a green colour which fades or changes to a red colour as time elapses. The indication of the time since that parking place became available is useful to assist the user establishing how likely that parking place is still to be available. Symbols indicating the availability of parking places may be removed from the display 240 after a predetermined time to prevent the display from becoming cluttered and because it may be assumed that the parking place would no longer be available. The predetermined time may depend upon the current location of the

navigation device. For example, in a city the predetermined time may be relatively low, such as 5 minutes, whereas in small town the predetermined time may be higher, such as 10 or 15 minutes. As further shown in Figure 6, the display provides visual instructions 680 to guide the user along a route to one of the available parking places 640. The available parking place 640 to which the route has been planned may be automatically determined by the parking notification module 490, or may be selected by the user by appropriate user input being received, such as a touch being received on the display device 240 selecting one of the displayed parking notifications 640, 650, 660, 670.

Figure 7 illustrates a graphical item 700 displayed on the display device 240 of a navigation device 200 operative in a second embodiment of the parking mode in response to a received parking place available message. As discussed above, the parking place available message indicates the location of the vacated parking place and the time at which the parking place was vacated. In this embodiment of the invention, the parking notification module 490 is arranged to display on the display device a visual indication that a new parking place available message has been received by the navigation device 200. The visual indication is in the form of a "pop-up" or dialogue box 700 indicating the reception of the parking place available message. In this embodiment, the indication 700 contains information conveying to the user that the parking place available message has been received, for example with the text "New Parking Place Available!". In some embodiments, the dialogue box 700 further comprises distance information 710 indicating a distance from the current location of the navigation device 200 to the parking place identified in the parking place available message and/or time information 720 indicating how long ago the parking place was vacated. In some embodiments, a graphical control 730 may be included in the dialogue box by which is operable by the user to select the parking place as a destination location for route guidance, such that the navigation device 200 directs the user to the parking place. However, in other embodiments, the parking place may be automatically selected as the destination location by the parking place notification module 490 if the parking place meets one or more predetermined criteria e.g. the parking place is within a predetermined distance or travelling time of the current location, or is closer to the current location than a previously selected parking place.

Figure 8 illustrates a system 800 for notifying navigation devices of available parking places according to an embodiment of the present invention. The system comprises a server 810 communicatively coupled to a first navigation device 820 via a communications channel as described in detail above. The server 810 is also

communicatively coupled to one or more additional navigation devices 831-836. The first navigation device 820 comprises a parking notification module 490 and may be identical to those navigation devices 831-836 forming the group of navigation devices.

The parking notification module 490 of the first navigation device 820 is arranged to determine when the first navigation device 820 is located within a vehicle which is leaving, or has recently left, a parking space. The determination of when the navigation device 820 is located in a vehicle which is leaving a parking space may be achieved in a number of different ways, as will be described.

In one embodiment, the parking notification module 490 may determine that the navigation device 820 is in a vehicle when it is turned-on at a location which is identical to a location at which the navigation device 820 was shut-down. This would indicate that the navigation device 820 is in a vehicle which was parked, the navigation device 820 shut-down and then turned-on at the same location in advance of the vehicle commencing a journey. In addition, the parking notification module 490 may support this by determining that the navigation device 820 previously travelled to that location at greater than a predetermined speed, for example $20kmh^{-1}$, prior to being shut-down. In another embodiment, the navigation device 820 may comprise means, such as a pressure switch, to detect when it is docked to the arm 292 of the docking station, indicating that it is mounted to a vehicle windscreen. In another embodiment, the parking notification module 490 may compare the current location of the navigation device 820 against stored map data to determine that its current location is in a parking area. In yet another embodiment, the parking notification module 490 may determine when the navigation device 820 is supplied with power from an external source, indicating that it is mounted in a vehicle. In a further embodiment, the parking notification module 490 is arranged to determine when a route has been planned on the navigation device 820 by a user and the navigation travels away from the location at which the route was planned by greater than a predetermined speed, such as $20kmh^{-1}$, indicating that it is in a vehicle which has commenced a journey. In a still further embodiment, parking notification module 490 is arranged to determine that the navigation device 820 is in a vehicle when it is able to communicate with an electronic system of the vehicle, such as a Bluetooth audio device of the vehicle, or an information bus, e.g. CAN bus, of the vehicle. In the latter case, the parking notification module 490 may determine that the navigation device is located in a parked vehicle from information received over the CAN bus, such as information indicative of engine start/stop, doors locked/unlocked, handbrake on/off etc. Such information may be useful in discriminating when the vehicle is parked or is simply stopped waiting e.g. in traffic or at traffic lights, a

bridge, etc. In a further embodiment, audio data received from a microphone 220 of the navigation device 200 is analysed to determine when the navigation device is located in a vehicle having a running engine. Any of the above embodiments may be combined to increase a confidence level of determining when the navigation device 820 is in a vehicle. Advantageously, the parking notification module 490 determining that the navigation device 200 is leaving, or has left, the parking space allows the availability of parking spaces which are not equipped with physical sensors to determine the presence of a vehicle in that parking space to be notified to users.

Once the parking notification module 490 determines that the navigation device 820 is in a vehicle and the current location of the navigation device 820 begins to change, the parking notification module 490 is arranged to transmit a parking place available message 825 to the server 810 indicating that a parking place has become available. The message 825 may comprise information identifying a location of the available parking place, for example a location at which the parking notification module 490 determined that the navigation device 820 was located in a parked vehicle, and may also indicate a time at which the parking place became available. Furthermore, in some embodiments the message may indicate a number of parking places which are available. In the present example, the message would indicate that a single parking place had been vacated or is available.

Upon receiving the parking place available message 825 from the navigation device 820, the server 810 is arranged to notify the group of navigation devices 831-836 of the parking place that has become available by sending a parking place available message 830 to each navigation device 831-836 via the communications channel 318. The parking place notification message 830 may be a copy of that generated by the first navigation device 820 and received by the server 810. The parking place available message 830 sent to the navigation devices 831-836 indicates the location of the parking place and may also indicate the time at which it became available.

In response to receiving the parking place available notification message 830, each of the navigation devices 831-836 stores the information contained in the received parking place notification message in memory 230. In some embodiments, if the location of the available parking place is more than a predetermined distance from the current location of the navigation device 831-836, then the parking place available message 830 may be discarded by the navigation device. If a user subsequently activates the parking mode of the navigation device 831-836, the parking notification module 490 is arranged to display an indication of available parking places in the vicinity of the navigation device, as described with reference to Figure 6. If the parking

notification module 490 is configured to only display indications of parking places which became available within a predetermined amount of time, the information in the parking place available message indicating the time at which each parking place became available may be used to identify those parking places to be indicated on the display device 240.

Whilst the embodiment described with reference to Figure 8 includes a server 810 through which parking place available messages are distributed to navigation devices 831-836, embodiments of the present invention may be envisaged which do not require a server 810. In these embodiments, each navigation device 820, 831-836 is capable of wirelessly transmitting and receiving data to/from other navigation devices 820, 831-836. For example, each navigation device may include a WiMax transmitter/receiver unit. In this case, the first navigation device 820 is arranged to transmit the parking place available message directly to other navigation devices 831-836 in the local area using the transmitter/receiver unit. Advantageously, this ensures that parking place available messages 830 are only communicated to navigation devices 831-836 which are relatively local to the parking place.

Figure 9 shows a system comprising a server 910, a first navigation device 920, a communications channel 925 between the server and the first navigation device 920, and a plurality of other navigation devices 931-936 in communication with server via communications channel 930, as previously described with reference to Figure 8. As previously described, the parking place notification module 490 of the first navigation device 920 is arranged to determine when the navigation device 920 is located in a vehicle which leaves a parking place and to send a parking place available message to the server 910. However, in these embodiments, only some of the navigation devices 931-936 communicatively coupled to the server 910 are notified of the available parking place.

In one embodiment, the server 910 determines which of the plurality of navigation devices 931-936 are sent the parking place available message 930, based upon a current location of each navigation device 931-936. Each of the group of navigation devices 931-936 is arranged to periodically communicate location information indicating their current location to the server 910 to, for example, enable the provision of traffic information relevant to the vicinity of each navigation device 931-936. Using the location information, the server 910 is arranged to determine a relative distance between each of the navigation devices 931-936 and the location of the parking place identified in the parking place available message received by the server from the first navigation device 920. If the distance is less than a predetermined distance, then the server 910 is

arranged to transmit a parking place available message to that navigation device, such that only those navigation devices within a predetermined distance of the parking place are notified. As shown in Figure 9, navigation devices 931, 934 and 935 have been determined by the server 910 to be within the predetermined distance of the available parking place and thus the server 910 communicates the parking place available message 830 to only those navigation devices, but not the other navigation devices 932, 933, 936 which are more than the predetermined distance from the available parking place.

Again referring to Figure 9, further embodiments of the present invention in which the parking place available message 930 is transmitted by the server 910 to only a subset of navigation devices 931-936 will now be described.

In one embodiment, the parking place available message 925 transmitted by the first navigation device 920 to the server 910 further comprises a private parking group identification number (PPGID). The PPGID is used by the server 910 to identify one or more navigation devices to which the parking place available message 930 should be sent by the server 910. The server 910 stores a navigation device group database identifying one or more navigation devices with a PPGID. Upon receiving the parking place available message 925 from the first navigation device 920, the server 910 is arranged to determine the navigation devices belonging to that PPGID from the navigation device group database and to transmit the parking place available message to only those navigation devices 931, 934, 935. This is useful, for example, where the parking place is a private parking place used by a plurality of users. Once one user leaves the private parking place, its availability is only communicated to other legitimate users of the parking place. Map data stored in the first navigation device 920 may identify the parking place as private and, in response to the vehicle in which the first navigation device 920 is located leaving the private parking place, the parking place notification module 490 is arranged to transmit the parking place available message containing the PPGID appropriate to that parking place.

In an alternative embodiment, the first navigation device 920 is arranged to transmit the parking place available message 925 to the server 810 irrespective of whether the parking place is private, as in previous embodiments. The server 810 stores map data in memory 306 which indicates a location private parking places and one or more navigation devices 931, 934, 935 corresponding to each parking place. Upon receiving the parking place available message 925 from the first navigation device 920, the server 910 is arranged to determine from the stored map data whether the location indicated in the message 925 corresponds to a private parking place. If the

location is a private parking place, the parking place available message 925 is transmitted by the server 910 only to those navigation devices 931, 934, 935 corresponding to that private parking place.

Figure 10 shows a further embodiment of the present invention, similar to that shown in Figure 8. A system 1000 comprises a server 1010, an in-vehicle device 1020 and a plurality of navigation devices 1031-1036. The in-vehicle device 1020 is a device capable of determining its current location and transmitting a parking place available message 1025 to the server 1010. Such an in-vehicle device may, for example, be a vehicle security device, such as that used for alerting a vehicle owner or security service of the vehicle's location when it has been stolen, or for road charging purposes. The device 1020 is arranged to determine when the vehicle in which it is mounted leaves a parking place in the same way as the parking notification module 490 previously described and to transmit the parking place notification message 1025 to the server 1010. The server 1010, upon receiving the notification message 1025 from the device 1020, is arranged to transmit a parking place notification message 1030 to either all communicatively coupled navigation devices 1031-1036 as shown in Figure 10, or to only some of the navigation devices as previously described with reference to Figure 9.

Figure 11 shows a method 1100 according to a further embodiment of the present invention. In this embodiment, a user wishing to park activates a parking mode on their navigation device 200. In response, the navigation device 200 is arranged to notify a server 810, 910, 1010 of the parking mode being activated, signalling the user of the navigation device's intention to park, by sending a parking request message to the server 810, 910, 1010 including a current location of the navigation device 200. The server 810, 910, 1010 is arranged to receive parking place available messages from navigation devices 200, as in previously described embodiments. However, in this embodiment, the server 810, 910, 1010 is arranged to select a parking place to be notified to the navigation device 200 of the user wishing to park. That is, the server 810, 910, 1010 selectively notifies navigation devices 200 of available parking places, thus not all navigation devices 200 are notified of every parking place. The server 810, 910, 1010 selects the parking place to be notified to avoid a number of vehicles converging on a single parking place. That is, the server 810, 910, 1010 is arranged to select the parking place to be notified such that vehicles wishing to park in a geographical area are distributed over available parking places. The method begins in step 1110 and in step 1120 the server 810, 910, 1010 receives a parking place available message from a navigation device leaving a parking place. In step 1130, the server 810, 910, 1010 receives a parking request message from another navigation device 200 whose user

wishes to park. In step 1140 the server 810, 910, 1010 determines whether any navigation devices 200 are to be notified of the available parking place. A navigation device 200 is notified of the available parking place if it is within a predetermined distance of the parking place. If a number of navigation devices 200 within the predetermined distance of the parking place have sent parking place request messages to the server 810, 910, 1010, the server 810, 910, 1010 may only notify a sub-set, i.e. less than a predetermined number determined on a first-com-first served basis, of those navigation devices 200 in order to prevent too many vehicles arriving at the parking place. The method ends in step 1160.

Figure 12 shows a system 1200 for notifying navigation devices of available parking places according to a further embodiment of the invention. The system 1200 comprises one or more detectors 1201, 1202 for detecting when a vehicle is parked in a corresponding parking place. The detectors 1201, 1202 may be any form of detector capable of detecting the presence of a vehicle. The detectors may be contact or non-contact detectors. For example, optical vehicle detectors or electromagnetic induction-based detectors may be used. The detectors 1201 1202 may be a combination of various detection technologies i.e. each detector 1201, 1202 does not have to be the same technology. Each detector 1201, 1202 is arranged to output a vehicle detection signal indicating whether a vehicle is present in a corresponding parking place. The vehicle detection signals are received by a parking-management server 1210. The server 1210 receiving the vehicle detection signals from the vehicle detectors 1201, 1202 determines if a parking place is available. The server 1210 may manage parking in one or more parking facilities, such as multi-storey car parks. In response to determining that a parking space is available, based upon the received vehicle detection signals, the server 1210 is arranged to transmit a parking place available 1220 message to one or more navigation devices 1231, 1232, 1233 as previously described. The parking place available message identifies the location of the parking place, e.g. in the parking facility managed by the server 1210, and may also identify the location of the parking place within the facility. Furthermore, the parking place available message may also identify a number of parking places available in the facility i.e. that X spaces are available. The server 1210 may re-transmit the message 1220 periodically if the parking places remain available, or may retransmit the message 1220 each time a parking place becomes occupied whilst some parking places remain available in the facility i.e. the newly transmitted message indicates that X-1 parking places remain available. In response thereto, the parking place notification module (490) of the one or more navigation devices is arranged to display on the display device a corresponding

indication of the number of available parking places. In some embodiments, the server 1210 utilises a relatively short-range communication e.g. WiMAX to transmit the parking place available message 1220 to only those navigation devices 1231, 1232, 1233 within a relatively short distance to the parking location. However, in other embodiments, the server 1210 communicates the parking place available message to a much larger number of navigation devices, such that each navigation device 1231, 1232, 1233 determines whether to respond to the parking place available message according to one or more criteria. In this way, users of navigation devices 1231, 1232, 1233 can be notified of parking places available in managed vehicle parking facilities.

It will be apparent from the foregoing that the teachings of the present invention provide an arrangement whereby a user is provided information concerning recently vacated parking spaces, and/or automatically directed to an available parking place.

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 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.

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.

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.

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.

CLAIMS

1. A navigation device (731, 831, 931) characterised by comprising a parking place notification module (490), wherein the navigation device is arranged to wirelessly receive a message (730, 830, 930) indicating a location of a parking place and, in response, the parking place notification module (490) is arranged to either display on a display device (240) an indication of the location of the parking place, or to select as a destination location the location of the parking place.

2. The navigation device (731, 831, 931) of claim 1, wherein:

the message indicates a time at which the parking place became available and the parking place notification module (490) is arranged to display on the display device (240) the indication of the location of the parking place and an indication of the time at which the parking place became available.

3. The navigation device (731, 831, 931) of claim 1 or 2, wherein the parking place notification module (490) is arranged to only display on the display device (240) one or more indications of parking places which became available less then a predetermined duration ago.

4. The navigation device (731, 831, 931) of any preceding claim, wherein the parking place notification module (490) is arranged to indicate the location of the parking place on a representation of map data displayed on the display device (240).

5. The navigation device (731, 831, 931) of claim 4, wherein the representation of the map is displayed on the display (240) in perspective and the indication of the location of the parking place is displayed on the map according to the perspective.

6. The navigation device (731, 831, 931) of any preceding claim, wherein the message (730, 830, 930) indicates a number of parking places available and the parking place notification module (490) is arranged to display on the display device (240) an indication of the number of parking places available.

7. The navigation device (731, 831, 931) of any preceding claim, wherein the indication of the location of the parking place is an indication of a distance from a current location of the navigation device.

8. The navigation device (731, 831, 931) of any preceding claim, wherein the indication of the location of the parking place is operable by a user to select the location of the parking place as a destination location for route guidance.

9. The navigation device (731, 831, 931) of any preceding claim, wherein parking place notification module is arranged to transmit a message indicating a current location of the navigation device (731, 831, 931) to request notification of the available parking place according to the current location.

10. A method for use in a navigation device (200), characterised by:

receiving a message indicating a location of an available parking place; and

displaying on a display device (240) an indication of the location of the parking place, or selecting the location of the parking place as a destination location.

11. The method of claim 10, wherein the message comprises time information for indicating when the parking place became available, and the method comprises providing an indication on the display device (240) representing a duration since the parking place became available based upon the time information.

12. The method of claim 11, wherein the indication representing the duration is one or more of textual or colour information indicating the duration since the parking place became available.

13. The method of claim 10, 11 or 12, comprising receiving a user input for selecting an available parking place as a destination location for route guidance.

14. The method of any of claims 10 to 13, comprising:

determining, according to a perspective applied to a map displayed on the display device (240), a size of the indication of the location of the parking place; and

displaying the indication on the display device (240) with the map.

15. The method of claim 10, comprising: selecting the location of the parking place as a destination location if a current location of the navigation device is within a predetermined distance of the parking place.