Figure 3
NAVIGATION APPARATUS AND METHOD FOR PROVIDING INSTRUCTIONS

Field of the Invention

The present invention relates to a navigation apparatus that is configured to provide instructions to a user, particularly instructions concerning the navigation of a route.

Background to the Invention

Portable computing devices, for example 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 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 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 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 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...
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 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 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.

PNDs of this type may 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.

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.

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 920T model manufactured
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.

During navigation along a calculated route, it is usual for 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 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.

Known PNDs select instructions to be provided to a user based upon static,
geometric map data. In the case where the PND is installed in a vehicle it is known to select the timing of instructions in dependence upon the speed of the vehicle. However, users currently always receive the same number of instructions at the same locations for the corresponding speed based on map geometry.

For example, a known navigation device may display a visual message or play an audio message to a user when the navigation device is within a fixed distance or a set of fixed distances from a turning. So, when approaching a right turn a known navigation system may provide a series of three instructions based upon the distance from the turning: "turn right in 100 metres", "turn right in 50 metres", "turn right now".

The number of instructions that are provided on approaching a turning is fixed, typically to be three, but the distances at which the instructions are provided may vary in dependence upon the speed. For example, the furthest distance at which an instruction is given may be varied in dependence upon the speed at which the vehicle is travelling.

In some cases, it has been found that instructions are not sufficient, superfluous or not distinctive enough for a particular situation.

**Summary of the Invention**

According to a first aspect of the present invention, there is provided a navigation apparatus comprising:- a processing resource configured to select at least one instruction to be provided to a user; and a location determination device for determining a location of the apparatus, wherein the processing resource is configured to select the at least one instruction in dependence upon the location and upon at least one aspect of the user environment.

It has been realised pursuant to the present invention that the environment experienced by a user at the time of receiving instructions can have a significant effect on the ease with which the user can receive, understand and comply with instructions, and the chances of instructions being misunderstood or ignored. By selecting instructions in dependence upon at least one aspect of the user environment, instructions may be provided to the user in a more effective manner, with reduced risk of misunderstanding, error or non-compliance.

The apparatus may comprise an environmental determination device for determining at least one aspect of the user environment.

The determination of at least one aspect of the user environment may comprise determining a parameter representative of at least one aspect of the user environment. The user environment parameter may be representative of an environmental
measurement or may be based upon stored data associated with the location. The
stored data may represent the results of earlier environmental measurements or may be
representative of previous user experiences at the location.

The determination of the parameter representative of at least one aspect of the
user environment may comprise assigning a value to one or more data items. The value
may be a numerical value, for example a numerical value that directly represents a
physical quantity (for example temperature). Alternatively the determination of the
parameter may comprise selecting one or more of a predetermined set of values or
states (for example, a low alert or high alert state). The selection of the at least one
instruction may comprise comparing the or each value to one or more thresholds and
selecting the instruction in dependence upon whether the or each parameter exceeds
the one or more thresholds. Alternatively, the selection of the at least one instruction
may comprise matching the value or state of the or each parameter to a set of
predetermined set of values or states, and selecting an instruction in dependence upon
the match.

The navigation apparatus may be a portable navigation device.

The apparatus may be for installation in a vehicle and the selection of the
instruction may be performed in dependence upon the location, the speed of the vehicle,
and the at least one aspect of the user environment.

The apparatus may be configured to communicate with a speed measurement
device or a central processing unit of the vehicle, and to receive speed data
representative of the speed of the vehicle from the speed measurement device or the
central processing unit.

The at least one aspect of the user environment may comprise or be
representative of an aspect of the user environment that affects the attention of the user.
Thus, the form or content of instructions may be selected in dependence upon the
attention that the user may be able to pay to the instructions. For example, if it is likely
that a user may be able to pay little attention to instructions the instructions could be
selected to have greater emphasis either by varying their form (for instance, the volume
with which they are provided) or content (for instance, to provide only essential
information).

The aspect of the user environment may comprise at least one of noise,
temperature, weather conditions, traffic conditions and ambient light. Each of those
aspects of the environment may affect the attention that a user may be able to pay to
instructions, or may affect the capability or speed of the user to comply with the
instructions correctly. For example, in adverse weather conditions a user may receive
instructions correctly but may have difficulty complying with the instructions in a timely fashion due to the greater difficulty in controlling his or her vehicle safely.

The at least one aspect of the user environment may comprise or be representative of a difficulty of navigation for a user at the determined location. If a user is likely to find navigation difficult at a particular location, then greater emphasis may be provided to instructions, by variation of their form or content, and instructions may be provided earlier and/or more often.

The difficulty of navigation may be determined based upon historical data. For example, the historical data may be representative of previous users, or previous experiences of the user, at a particular location. For example, the historical data may represent the number of mistakes in following instructions made at or near the location in the past.

The at least one aspect of the user environment may comprise or be representative of the familiarity of the user with the location or a route. Instructions may be suppressed or reduced if a user is familiar with a location or route. The familiarity of the user with a location or route may be determined in dependence upon at least one of distance to a home location of the user, distance to previously visited locations, and similarity of a route to previously taken routes.

The selecting of the at least one instruction may comprise selecting the content of the at least one instruction. The selection of content of the at least one instruction may comprise selection of the information content of the instructions and/or the wording by which the instructions is expressed. In particular the selection of content may comprise selection of the length and/or complexity of the instruction. The selection of content may also comprise the selection of additional warning messages, for example, an alarm signal such as a beep preceding a spoken instruction to attract a user's attention, or a warning message concerning road or weather conditions.

The selecting of the at least one instruction may comprise selecting the form of the at least one instruction. The selection of the form of an instruction may comprise the selection of at least one of the timing, volume, repetition rate or number, graphical form, highlighting, tone, emphasis (for example emphasis of particular words in an audio instruction), and the use of graphical symbols or highlighting.

The apparatus may further comprise at least one measurement device for measuring the at least one aspect of the user environment. The processing resource may be configured to receive measurement data from the measurement device and to determine the at least one aspect of the user environment in dependence upon the measurement data.
Alternatively or additionally, the navigation apparatus may be configured to receive user environment data from a server and/or the navigation apparatus may comprise a data store for storing user environment data. The environmental determination module may determine the at least one aspect of the user environment in dependence upon the user environment data.

In a further independent aspect of the invention there is provided a method of selecting at least one instruction to be provided to a user by a navigation apparatus; determining at least one aspect of the user environment; and selecting the at least one instruction in dependence upon the location and upon the user environment parameter.

In another independent aspect of the invention there is provided a computer program product comprising computer readable instructions executable to put into effect a method as claimed or described herein.

The apparatus may provide an instruction set that is based on the environment experienced by a user and/or on the outcome of actions taken by previous users following an instruction.

The number of instructions may be automatically adjusted to adapt to the current environment of a user or to the behaviour of previous users at a given location.

Any feature in one aspect of the invention may be applied to other aspects of the invention, in any appropriate combination. In particular, apparatus features may be applied to method features and vice versa.

**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:

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;

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;

Figure 6 is a schematic illustration of aspects of the processor included in the navigation device of Figure 3;
Figure 7 is a schematic illustration of a display screen of a navigation device; and Figure 8 is a flow chart illustrating the selection by a navigation device of instructions to be provided to a user.

5 **Detailed Description of Preferred Embodiments**

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 type of processing device. 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 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 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, 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 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 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.

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 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.

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/manufacturer 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 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 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 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.

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.

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 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 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 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 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 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. 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 view generation module 288.

It is a feature of the described embodiments that instructions that are provided to a user are selected in dependence upon parameters in addition to the location of a user and, in the case of a vehicle mounted navigation device, the speed of the vehicle. Certain aspects of the navigation device 200 that relate to the selection of instructions for provision to a user are shown in Figure 6, which illustrates the processor 202 of Figure 3 in more detail.

The processor 202 includes a location determination module 300 that is operable to determine the current location of the navigation device 200 from signals received from the antenna/receiver 224. The location determination module 300 is operably connected to an environmental determination module 302 that is operable to determine a parameter representative of at least one aspect of a user environment.

The environmental determination module 302 is connected to the memory 214, and to at least one measurement device 304. The environmental determination module 302 is also able to communicate with the server 150 and to receive data from and transmit data to the mass data storage device 160 and/or memory 156 via communications channel 152 using transmitter 166 and receiver 168.

The environmental determination module 302 and the location determination module 300 are both linked to an instruction control module 306, that is operable to select or generate instructions to be provided to a user in dependence upon the location of the vehicle.

In operation, when the user switches on the navigation device 200, the device 200 acquires a GPS fix and calculates (in a known manner) the current location of the navigation device 200. The user is then presented on the display device 206 with a display showing the local environment in which the navigation device 200 is determined to be located, using map data stored in the memory 214.

The user is then able to select using the input device 204 a destination to which he or she wishes to navigate. The user may select a stored destination, for example a home location or a favourite location that has been previously stored by the user, or a point of interest (for instance, a petrol station, ATM, tourist attraction, shop, restaurant or hotel) that has been pre-stored on or downloaded to the device. Alternatively the user can enter an address or set of co-ordinates to which he wishes to navigate.

The navigation device 200 then calculates a route between the current location and the selected destination and displays that route on the display device 206. The user is able to instruct the navigation device 200 is calculate an alternative route if desired.
If the calculated route is accepted by the user, a two- or three-dimensional view of the current location for the navigation device is displayed to the user on the display device 206. The user then commences their journey and the navigation device 200 guides the user by updating the map in accordance with determined changes in location of the navigation device 200 and by providing the user with visual and/or audible navigation instructions via the display device 206 and/or the output device 208.

During the journey, the environmental determination module 302 receives data from one or more of the measurement device 304, the memory 214 or the server 150 and determines the value of at least one environmental parameter in dependence upon the received data, and passes the value of the environmental parameter to the instruction control module 306.

The position 402 of the vehicle on a selected route 404 is tracked using the location determination module 300 and displayed on a display screen 400 forming part of the display device 206, as shown in Figure 7. The processor 202 monitors when the vehicle approaches a point in the route where instructions may be required (for instance approaching a turning 406). The instruction control module 306 receives the value of the environmental parameter from the environmental determination module 302 and the location of the vehicle from the location determination module 300 and selects at least one of the form and content of instructions to be provided to a user in dependence upon the value of the environmental parameter and the location.

Data representative of the instructions to be provided is then selected under control of the instruction control module 306 from a library of instructions stored in the memory 214 and is processed by the instruction control module to ensure that the instructions have the selected form and content and the data is passed to the output device 208 and processed to provide audible instructions or the data is passed to the display device 206 and processed to provide visible instructions.

It is a feature of the described embodiments that the form and/or content of the navigation instructions are selected in dependence on at least one aspect of the environment experienced by the user instead of or in addition to the location of the navigation device and/or the speed of travel.

The instruction control module 306 is able to control various aspects of the form and content of the instructions, including for example the number of instructions (for example the number of separate turn instructions to be provided on the approach to a turning), the level of detail provided in each instruction (for instance, specifying a sharp or narrow turn), the inclusion of additional warning messages (for instance an alarm signal or beep preceding a spoken instruction to attract a user’s attention, or a warning
message concerning weather or road conditions), frequency or repetition (for example the number of times an instruction is spoken), tone of voice or emphasis of particular words used for spoken instructions (for instance, "take the SECOND left"), inclusion of additional wording or other information (for example, "Take extra care, you really need to take the first exit"), volume of instructions, the use of graphical symbols or highlighting (for example highlighting elements on a moving map displayed to a user).

A parameter representative of at least one aspect of the environment experienced by the user is determined by the environmental determination module 302 in dependence upon data received from one or more of the measurement device 304 the memory 214 and the server 150.

In the embodiment of Figure 6, the measurement device 304 is a sound meter that measures the level of in-vehicle sound. In variants of the embodiment, the measurement device 304 can be of any type and measures at least one environmental parameter to which the user or vehicle is subject, such as temperature, other weather or external conditions such as rainfall, snowfall, visibility, light level, or traffic conditions.

The server 150 is able to provide data concerning environmental parameters, such as weather or other external conditions, for example traffic conditions, that are provided from an external source or that have been previously been obtained from another navigation device in communication with the server 150. Thus, environmental data does not need to be measured by the measurement device 304 but may be obtained from an external source.

The server is also able to provide data concerning the previous experience of other users navigating through a location of the navigation device 200. Such data can provide an indication of aspects of the environment likely to be experienced by the user at a particular location, or of a user's subjective experience of that environment. For example, data received from other navigation devices may provide an indication that a high level of attention may be required from a user at a location if, for instance, that data shows that a significant number of users had previously followed instructions incorrectly at that location. In another example, the server can provide data indicating that previous users had experienced problems with GPS coverage in a particular area.

The memory 214 is able to provide data which may be used to determine aspects of the user environment or the user's experience of that environment, in particular the familiarity of a user with a particular location or route, which in turn may determine the level of attention or instruction required by the user.

Each of the measurements and types of data discussed in the preceding paragraphs are used in various modes of operation by the environmental determination
module 302 in co-operation with the processor 202 to select the content and/or form of instructions that are provided to the user at a particular location. Each of the measurements and types of data affect or are representative of the attention that the user is able to give to instructions at a particular location and time, and/or the level of instruction that is likely to be required by the user at a particular location and time.

An example of one mode of operation of the system of Figure 6 is illustrated in overview in the flow chart of Figure 8.

Various specific examples of the selection of the form or content of instructions in dependence upon an aspect of the user environment using the system of Figure 6 are now described.

In one embodiment, the measurement device 304 measures one or more weather conditions (for example, fog, rain, snow or temperature) and the environmental determination module 304 determines the value of a parameter representative of the weather condition in dependence upon data from the measurement device. If the value of the parameter exceeds one or more predetermined thresholds then the number of instructions provided to a user when approaching a turning is increased (for example from three to four) as the user's attention may be occupied more than normal in coping with the weather conditions. In a variant of the embodiment, data concerning weather conditions is provided by the server 150 instead of by the measurement device 304. In that case, additional instructions are provided warning the user that they are approaching an area of adverse weather.

In another embodiment, the measurement device 304 measures ambient light and the environmental determination module 302 determines the value of a parameter representative of the ambient light. The parameter may have two (for instance representative of night and day) or more (for instance representative of:- night time - unlit road, night time - lit road; twilight; daytime) values. The number of instructions provided to a user concerning the route (for example upon approach to a turning) is set by the instruction control module 306 in dependence upon the value of the ambient light parameter. For example, in low light conditions more instructions may be provided. In variants of the embodiment, a plurality of measurement devices 304 (for example a light sensor of the navigation device 200 and light sensors of the car) are provided and the direction of light is determined from the measurement devices. For example, it may be determined by the environmental determination module 302 that the user will be driving into direct sunlight.

The instruction control module 306 can issue general instructions or warnings (for example, "wear sunglasses", "switch headlights on") as well as varying the number
of instructions concerning the route. Data concerning light conditions can also be obtained from the server 150 instead of or in addition to from the measurement device 304. In that case a user can be pre-warned concerning light conditions that may be encountered. For example, the user could be pre-warned that they will be encountering direct sunlight on their route and be instructed to place their sunglasses within easy reach.

In other embodiments, the measurement device 304 comprises an in-vehicle sound measurement device that measures the in-vehicle noise. The instruction control module 306 controls the volume at which instructions are provided and/or precedes instructions with an additional sound or warning tone to draw the attention of the user, in dependence upon the measured level of noise. In variants of such embodiments, the sound measurement device is configured to detect conversation, for example in dependence upon sound patterns and frequencies. The device may be configured such that when a voice or conversation is detected a user is able to temporarily turn down/off voice instruction by voice command or screen tap.

In another embodiment, the server 150 provides data to the navigation device 200 when the navigation device 200 is approaching a location where users have made mistakes (for example missing turns) in the past. The data is based on log files of data obtained from previous journeys by users of navigation devices, in particular upon indications that a navigation device has had to replan a route at the point in the past. The environmental determination module 302 determines the value of a parameter that represents the likelihood of user error based upon the received data. If the value of the parameter exceeds a predetermined threshold then the instruction determination module 306 alters the instructions to be provided to the user in the vicinity of the location, for example by warning the user earlier of an approaching turn, zooming the display (either out or in or by a lesser or greater extent, earlier or later) when approaching a turn to draw attention to the turn, or by increasing the number or volume of instructions on approach to the turn.

In other embodiments, the environmental determination module 302 provides a value of a parameter that is representative of the familiarity of a user with a location or route.

In one such embodiment, the environmental determination module 302 determines how close the navigation device 200 is to the home location of the user (which is stored in the data store 214). The environmental determination module determines the value of a home distance parameter that represents the distance from the home location and provides the value of the parameter to the instruction control
module 306. The instruction control module 306 determines whether the value of the home distance parameter is below a predetermined threshold and if it is suppresses most or all instructions to the user, as instructions are unlikely to be needed if the user is close to his or her home address.

The environmental determination module 302 is also able to determine how close the navigation device 200 is to favourite locations often visited by the user (which are stored in the data store 214). The environmental determination module 302 determines the value of a distance parameter that represents the distance from nearest favourite location and provides the value of the parameter to the instruction control module 306. The instruction control module 306 determines whether the value of the distance parameter is below a predetermined threshold and if it is suppresses most or all instructions to the user, as the user is likely to know their way around without instruction near often-visited favourite locations.

In another embodiment, the data store 214 stores a profile of patterns of use by a user, based for example of time of day and day of week. For example, one pattern is that departures from between 7am and 9am (plus/minus 30 minutes) on a weekday usually mean that that the user is going to work. Upon departure by the user, the environmental determination module 302 requests profiles stored in the data store 214 that correspond to the departure time and day of week. If a profile matches the departure time, the environmental determination module 302 provides a value of a parameter to the instruction selection module 304 that indicates that the user is taking a familiar route. The instruction selection module 304 suppresses instructions to the user.

The environmental determination module 302 monitors the location of the vehicle from the output of the location determination module 300 and determines whether it matches the expected route (in this case to work). If the vehicle deviates from the expected route then the environmental determination module 302 informs the instruction selection module 306, which provides voice instructions to the user until the vehicle is back on the expected route, or until the user overrides the expected route or enters another route. In this example, the home-work route is also automatically displayed on the map (for example with a dotted line, or other line that is different to the usual route indicator) upon departure and the traffic condition of the route is also checked by the processor 202 in communication with the server 150. If the traffic conditions are bad then the instruction selection module 304 controls and audio or visual message to the user to that effect and provides instructions for an alternative route.

In another embodiment, the server 150 supplies the environmental determination module 302 with data (obtained for instance from logged data from other navigation
devices) that indicates that an area of the route has low GPS coverage. The environmental determination module 302 instructs the instruction control module 306 accordingly and the instruction control module 306 causes the user to be instructed concerning the route in the area of low GPS coverage (for example, concerning a turning) pre-emptively, earlier than would otherwise be the case, in case the navigation device loses its coverage.

It will be appreciated that in the examples above other variations in the form or content of user instructions may be provided as well as or instead of those described above, and any suitable combinations of those variations may also be provided.

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, although the present invention may be exemplified as a portable navigation device, it would be appreciated that 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.

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.

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
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
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.

It will be understood that the present invention has been described above purely
by way of example, and modifications of detail can be made within the scope of the
invention.

Each feature disclosed in the description, and (where appropriate) the claims and
drawings may be provided independently or in any appropriate combination.

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 apparatus (200) comprising:-
a processor (202) configured to select at least one instruction to be provided to a user; and
a location determination device (300) for determining a location of the apparatus, wherein the processor (202) is configured to select the at least one instruction in dependence upon the location and upon at least one aspect of the user environment.

2. Apparatus according to Claim 1, for installation in a vehicle, wherein the selection of the instruction is performed in dependence upon the location, the speed of the vehicle, and the at least one aspect of the user environment.

3. Apparatus according to Claim 1 or 2, wherein the at least one aspect of the user environment is an aspect that affects the attention of the user.

4. Apparatus according to Claim 3, wherein the at least one aspect of the user environment comprises at least one of noise, temperature, weather conditions, traffic conditions and ambient light.

5. Apparatus according to any preceding claim, wherein the at least one aspect of the user environment comprises or represents a difficulty of navigation for a user at the determined location.

6. Apparatus according to Claim 5, wherein the difficulty of navigation is determined based upon historical data.

7. Apparatus according to any preceding claim, wherein the at least one aspect of the user environment comprises the familiarity of the user with the location or a route.

8. Apparatus according to any preceding claim, wherein the familiarity of the user with a location or route is determined in dependence upon at least one of distance to a home location of the user, distance to previously visited locations, time, and similarity of a route to previously taken routes.

9. Apparatus according to any preceding claim, wherein the selecting of the at least
one instruction comprises selecting the content of the at least one instruction.

10. Apparatus according to any preceding claim, wherein the selecting of the at least one instruction comprises selecting the form of the at least one instruction.

11. Apparatus according to any preceding claim, further comprising at least one measurement device (304) for measuring the at least one aspect of the user environment.

12. A method of selecting at least one instruction to be provided to a user by a navigation apparatus (200):
    determining the location of the navigation apparatus (200);
    determining at least one aspect of the user environment; and
    selecting the at least one instruction in dependence upon the location and upon
    the at least one aspect of the user environment.

13. A computer program product comprising computer readable instructions executable to put into effect a method according to Claim 12.
Set Destination

Determine current location

Determine user environment parameter

Select content and/or form of instruction to be provided to user in dependence upon user environment parameter.

Provide instruction to user

Reached Destination?

No

Yes

End

Figure 8
**INTERNATIONAL SEARCH REPORT**

**PCT/EP2008/063400**

---

### A. CLASSIFICATION OF SUBJECT MATTER

INV. G01C21/36

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)

GOIC G08G

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

---

### C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>WO 93/09510 A (MOTOROLA INC [US]) 13 May 1993 (1993-05-13) page 6, line 1 - line 27; figures 1,2 figure 4; table 1</td>
<td>1,2,12, 13</td>
</tr>
<tr>
<td>X</td>
<td>US 5 844 505 A (VAN RYZIN JOHN M [US]) 1 December 1998 (1998-12-01) column 4, line 47 - line 62</td>
<td>1,2,12, 13</td>
</tr>
<tr>
<td>X</td>
<td>US 5 146 219 A (ZECHNALL WOLF [DE]) 8 September 1992 (1992-09-08) column 2, line 34 - line 39 column 3, line 48 - line 50 column 4, line 50 - line 59; figure 2</td>
<td>1,2,12, 13</td>
</tr>
</tbody>
</table>

---

Further documents are listed in the continuation of Box C.

---

Date of the actual completion of the international search

25 June 2009

Date of mailing of the international search report

11/09/2009

Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL- 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016

Authorized officer

Jakob, Clemens

---

Form PCT/ISA/210 (second sheet) (April 2005)
<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>WO 2008/002126 A (TOMTOM INT BV [NL]; KHACHATURIAN ARSHAK [NL]) 3 January 2008 (2008-01-03) page 14, line 2 - line 11; figures 1,4 page 15, line 14 - line 17 page 17, line 21 - line 25</td>
<td>1, 2, 12, 13</td>
</tr>
</tbody>
</table>
This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. Claims Nos.: because they relate to subject matter not required to be searched by this Authority, namely:

2. Claims Nos.: because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. Claims Nos.: because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

see annex

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.
This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1, 2, 12, 13

   navigation apparatus taking into account the vehicle speed in addition to its location and to the user environment in the selection of an instruction to be provided to its user

2. claims: 1, 3, 4

   navigation apparatus taking account of conditions that affect the attention of the user in the selection of an instruction to be provided to its user

3. claims: 1, 5, 6

   navigation apparatus considering user environment aspects comprising or representing a difficulty of navigation for a user at a determined location in the selection of an instruction to be provided

4. claims: 1, 7, 8

   navigation apparatus selecting an instruction to be provided to its user dependent on the familiarity of the user with a location or with a route

5. claims: 1, 9, 10

   navigation apparatus selecting the content or the form of an instruction to be provided to its user in dependence of its location and of the user environment

6. claims: 1, 11

   navigation apparatus selecting an instruction to be provided to its user dependent upon an aspect of the user environment measured by at least one measurement device
<table>
<thead>
<tr>
<th>Patent document cited in search report</th>
<th>Publication date</th>
<th>Patent family member(s)</th>
<th>Publication date</th>
</tr>
</thead>
<tbody>
<tr>
<td>WO 9309510</td>
<td>A</td>
<td>13-05-1993</td>
<td>DE</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>DE</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>JP</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>US</td>
</tr>
</tbody>
</table>

| | | | | |
| | | | | |
| US 5844505 | A | 01-12-1998 | NONE | |

| | | | | |
| | | | | |
| | | | WO | 8805199 A1 | 14-07-1988 |
| | | | EP | 0331675 A1 | 13-09-1989 |
| | | | JP | 2501959 T | 28-06-1990 |
| | | | JP | 2798387 B2 | 17-09-1998 |

| | | | | |
| | | | | |
| WO 2008002126 | A | 03-01-2008 | AU | 2006345293 A1 | 03-01-2008 |
| | | | CA | 2646830 A1 | 03-01-2008 |
| | | | CN | 101405573 A | 08-04-2009 |
| | | | EP | 2032944 A1 | 11-03-2009 |