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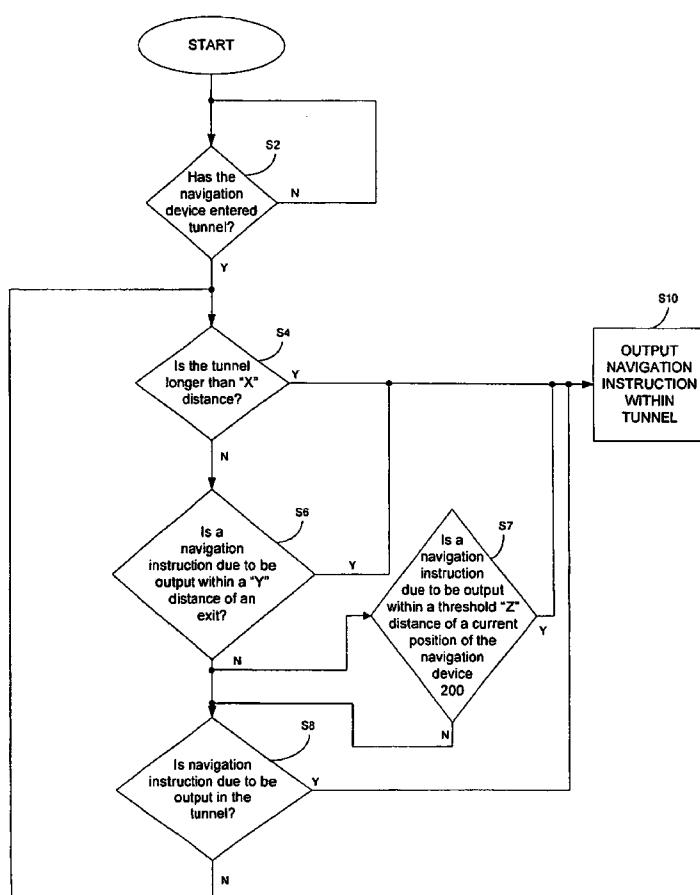
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(54) Title: A NAVIGATION DEVICE AND METHOD FOR EARLY INSTRUCTION OUTPUT



(57) Abstract: A navigation device includes means for performing a method that includes determining by a processor, during a route of travel, entry into a tunnel; and outputting a navigation instruction by an output device to a user of the navigation device within the tunnel, for travel along the travel route, upon determining by the processor, subsequent to determining entry into the tunnel, at least one of the tunnel being longer than a first threshold distance, a navigation instruction being due to be output within a second threshold distance of an exit of the tunnel and the navigation instruction being due to be output within the tunnel.



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A NAVIGATION DEVICE AND METHOD FOR EARLY INSTRUCTION OUTPUT**Field**

The present application generally relates to navigation methods and devices.

Background

Navigation devices were traditionally utilized mainly in the areas of vehicle use, such as on cars, motorcycles, trucks, boats, etc. Alternatively, if such navigation devices were portable, they were further transferable between vehicles and/or useable outside the vehicle, for foot travel for example. These devices are typically tailored to produce a route of travel based upon an initial position of the navigation device and a selected/input travel destination (end position), noting that the initial position could be entered into the device, but is traditionally calculated via GPS Positioning from a GPS receiver within the navigation device. To aid in navigation of the route, instructions are output along the route to a user of the navigation device. These instructions may be at least one of audible and visual.

SUMMARY

The inventors discovered that in certain known areas, or under certain conditions, triggers for output of instructions useable to navigate the travel route may be blocked. Thus, they have discovered that it would be helpful to the user if these areas or conditions can be either anticipated or detected, to permit early output of navigation instructions.

In at least one embodiment of the present application, a method includes determining, during a route of travel of a navigation device, entry of the navigation device into a tunnel; and outputting a navigation instruction to a user of the navigation device within the tunnel, for travel along the travel route, upon determining, subsequent to determining entry of the navigation device into the tunnel, at least one of the tunnel being longer than a first threshold distance, a navigation instruction being due to be output within a second

threshold distance of an exit of the tunnel and the navigation instruction being due to be output within the tunnel.

In at least one embodiment of the present application, a navigation device includes a processor to determine, during a route of travel of a navigation device, entry of the navigation device into a tunnel; and an output device to output a navigation instruction to a user of the navigation device within the tunnel, for travel along the travel route, upon the processor determining, subsequent to determining entry of the navigation device into the tunnel, at least one of the tunnel being longer than a first threshold distance, a navigation instruction being due to be output within a second threshold distance of an exit of the tunnel and the navigation instruction being due to be output within the tunnel.

In at least one other embodiment of the present application, a method includes determining, during travel of a navigation device along a travel route, when a GPS signal is received by a navigation device and determining when a GPS signal was not received by the navigation device for a period of time exceeding a threshold; and outputting a navigation instruction to a user of the navigation device, for travel along the route, upon determining that a GPS signal was not received by the navigation device for a period of time exceeding a threshold.

In at least one other embodiment of the present application, a device includes a processor to determine, during travel of a navigation device along a travel route, when a GPS signal is received by a navigation device and to determine when a GPS signal was not received by the navigation device for a period of time exceeding a threshold; and an output device to output a navigation instruction to a user of the navigation device, for travel along the route, upon the processor determining that a GPS signal was not received by the navigation device for a period of time exceeding a threshold.

BRIEF DESCRIPTION OF THE DRAWINGS

The present application will be described in more detail below by using example embodiments, which will be explained with the aid of the drawings, in which: Figure 1 illustrates an example view of a Global Positioning System (GPS);

Figure 2 illustrates an example block diagram of electronic components of a navigation device of an embodiment of the present application;

Figure 3 illustrates an example block diagram of a server, navigation device and connection therebetween of an embodiment of the present application;

Figures 4A and 4B are perspective views of an implementation of an embodiment of the navigation device;

Figures 5A and 5B illustrate example flow charts of embodiments of the present application;

Figures 6A-C illustrate example flow charts of other embodiments of the present application.

DETAILED DESCRIPTION OF THE EXAMPLE EMBODIMENTS

The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the present invention. As used herein, the singular forms “a”, “an”, and “the” are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms “includes” and/or “including”, when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

In describing example embodiments illustrated in the drawings, specific terminology is employed for the sake of clarity. However, the disclosure of this patent specification is not intended to be limited to the specific terminology so selected and it is to be understood that each specific element includes all technical equivalents that operate in a similar manner.

Referencing the drawings, wherein like reference numerals designate identical or corresponding parts throughout the several views, example embodiments of the present patent application are hereafter described. Like numbers refer to like elements throughout. As used herein, the term “and/or” includes any and all combinations of one or more of the associated listed items.

Figure 1 illustrates an example view of Global Positioning System (GPS), usable by navigation devices, including the navigation device of embodiments of the

present application. 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 work with 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, usable in embodiments of navigation devices of the present application, 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 illustrates an example block diagram of electronic components of a navigation device 200 of an embodiment of the present application, 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 utilized to input information; and the display screen 240 can include any type of display screen such as an LCD display, for example. In at least one embodiment of the present application, the input device 220 and display screen 240 are integrated into an integrated input and display device, including a touchpad or touchscreen input wherein 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.

In addition, other types of output devices 250 can also include, including but not limited to, an audible output device. As output device 241 can produce audible information to a user of the navigation device 200, it is equally understood that input device 240 can also 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 240 via a connection 225, and operatively connected to at least one of display screen 240 and output device 241, via output connections 245, to output information thereto. Further, the processor 210 is operatively connected to memory 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 external I/O device 270 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.

The navigation device 200, in at least one embodiment, may establish a "mobile" network connection with the server 302 via a mobile device 400 (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 400 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 400 (via a service provider) and another device such as the server 302, using the internet 410 for example, can be done in a known manner. This can include use of TCP/IP layered protocol for example. The mobile device 400 can utilize any number of communication standards such as CDMA, GSM, WAN, etc. As such, an internet connection may be utilized 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 400, and eventually with the internet 410 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, wherein the internal antenna of the navigation device 200 can further alternatively be used). The mobile phone technology within the navigation device 200 can include internal components as specified above, and/or can include an insertable 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 410 for example, in a manner similar to that of any mobile device 400.

For GRPS phone settings, the Bluetooth enabled 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 a manner discussed in any of the embodiments, previous and subsequent.

Figure 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 Figure 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 Figure 2 are considered within the scope of the present application. For example, in one embodiment, the components shown in Figure 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 Figure 2 can be connected or “docked” in a known manner to a motorized vehicle such as a car or boat for example. Such a navigation device 200 is then removable from the docked location for portable or handheld navigation use.

Figure 3 illustrates an example block diagram of a server 302 and a navigation device 200 of the present application, via a generic communications channel 318, of an embodiment of the present application. The server 302 and a navigation device 200 of the present application 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 Figure 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. According to at least one embodiment of the present application, 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. According to at least one embodiment of the present application, 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, according to at least one embodiment, 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, fiber optic cables, converters, radio-frequency (rf) waves, the atmosphere, empty space, etc. Furthermore, according to at least one various embodiment, the communication channel 318 can include intermediate devices such as routers, repeaters, buffers, transmitters, and receivers, for example.

In at least one embodiment of the present application, for example, the communication channel 318 includes telephone and computer networks. Furthermore, in at least one embodiment, the communication channel 318 may be capable of accommodating wireless communication such as radio frequency, microwave frequency, infrared communication, etc. Additionally, according to at least one embodiment, 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. According to at least one embodiment, these signals may be modulated, encrypted and/or compressed signals as may be desirable for the communication technology.

The mass data storage 312 includes sufficient memory for the desired navigation applications. Examples of the mass data storage 312 may include magnetic data storage media such as hard drives for example, optical storage media such as CD-Roms for example, charged data storage media such as flash memory for example, molecular memory, etc.

According to at least one embodiment of the present application, the server 302 includes a remote server accessible by the navigation device 200 via a wireless channel. According to at least one other embodiment of the application, the

server 302 may include a network server located on a local area network (LAN), wide area network (WAN), virtual private network (VPN), etc.

According to at least one embodiment of the present application, 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 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.

The mass storage device 312 connected to the server 302 can include volumes more cartographic and route data than that which is able to be maintained on the navigation device 200 itself, including maps, etc. The server 302 may process, for example, the majority of the devices of a navigation device 200 which travel along the route using a set of processing algorithms. Further, the cartographic and route data stored in memory 312 can operate on signals (e.g. GPS signals), originally received by the navigation device 200.

As indicated above in Figure 2 of the application, a navigation device 200 of an embodiment of the present application includes a processor 210, an input device 220, and a display screen 240. In at least one embodiment, 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.

Figures 4A and 4B are perspective views of an implementation of an embodiment of the 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 figure 2 (including but not limited to internal GPS receiver 250, microprocessor 210, a power supply, memory systems 220, etc.).

The navigation device 200 may sit on an arm 292, which itself may be secured to a vehicle dashboard/window/etc. using a large 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 (this is only one example, as other known alternatives for connection to a docking station are within the scope of the present application). 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 (this is only one example, as other known alternatives for disconnection to a docking station are within the scope of the present application).

In at least one embodiment, a method of the present application includes determining, during a route of travel of the navigation device 200, entry of the navigation device into a tunnel; and outputting a navigation instruction to a user of the navigation device 200 within the tunnel, for travel along the route, upon determining, subsequent to determining entry of the navigation device 200 into the tunnel, at least one of the tunnel being longer than a first threshold distance, a navigation instruction being due to be output within a

second threshold distance of an exit of the tunnel and the navigation instruction being due to be output within the tunnel.

In at least one embodiment of the present application, a navigation device 200 includes a processor 210 to determine, during a route of travel of the navigation device 200, entry of the navigation device 200 into a tunnel; and an output device 241 to output a navigation instruction to a user of the navigation device within the tunnel, for travel along the travel route, upon the processor 210 determining, subsequent to determining entry of the navigation device 200 into the tunnel, at least one of the tunnel being longer than a first threshold distance, a navigation instruction being due to be output within a second threshold distance of an exit of the tunnel, and the navigation instruction being due to be output within the tunnel.

With regard to at least one embodiment, the inventors discovered that in certain known areas, or under certain conditions, triggers for output of instructions useable to navigate the travel route may be blocked. Thus, they have discovered that it is helpful to the user if these areas or conditions can be either anticipated or detected, to permit early output of navigation instructions.

An example embodiment of the present application is shown in Figure 5A. As shown in Figure 5A, in step S2 a processor 210 of the navigation device 200, for example, determines whether or not the navigation device 200 has entered a tunnel. For example, a processor 210 initially receives an input or selected destination location from a user of the navigation device 200. From this, a route can be calculated in a known manner from map information stored in memory 230, the travel destination, and a GPS location of the navigation device 200. Before such route calculation, the map information in the memory 230 can be examined for tunnels and a tunnel marker or flag may be set for each tunnel (or the tunnel otherwise identified in the map data utilized by the processor 210 in determining the route) such that the processor 210 of the navigation device 200 can recognize, during route calculation for example, if a user will drive on a route including a tunnel. For example, points or nodes on the map information is traditionally marked, so for a tunnel, a line of travel between two nodes of the tunnel, on stored map information, may be "flagged" or otherwise marked. Nodes are usually marked at junctions and therefore an

entire stretch of map information between two junctions may be marked as a tunnel. Thus, during travel along the route, the processor 210 can determine if a user of the navigation device 200 is currently driving along a navigation route with a tunnel, based upon marker(s)/ flag(s) set.

Thereafter, in step S4, S6, S7 and S8, it may be determined, by the processor 210 for example, whether or not at least one other condition has been met. It should be noted that the order of steps S4, S6, S7 and S8 is not important, as the processor 210 can determine each of the various conditions in any order. In step S4, it may be determined, by the processor 210 for example, whether or not the tunnel is longer than a threshold "x" distance. For example, if the tunnel is only a short distance, then it is most likely that no output of instructions will be needed while the navigation device 200 is still located in the tunnel. Such a threshold distance can be set in the map information such that, for example, the tunnel is only flagged if it is longer than a certain threshold distance. Alternatively, the tunnel flag may be set for all tunnels, and then the length later compared to the threshold by the processor 210 during navigation. Such a threshold distance can be, for example, two miles. It should be noted that such a step S4 is optional, when at least one of steps S6 and S8 are utilized. Thus, if the processor 210 determines that the tunnel is longer than a threshold "x" distance, the processor 210 will instruct output of the instruction (likely within the tunnel for example) in step S10.

In step S6, it may be determined, by the processor 210 for example, whether or not a navigation instruction is due to be output within a threshold "y" distance after an exit of the tunnel. For example, the processor 210 knows when a next instruction is due to be output and normally outputs an instruction based upon a received GPS signal at a certain map location. This may be achieved in a known manner. As such, if the processor 210 knows an instruction is due to be output within, for example, one mile of (measured from or occurring after) an exit of the tunnel, and the processor 210 knows that the navigation device 200 is currently located in a tunnel wherein a GPS signal will likely be lost, the GPS signal may not be recovered in time for the processor 210 of the navigation device 200 to timely output the instruction. Thus, if a navigation instruction is due to be output within a threshold distance, such as one mile for example, of

an exit of the tunnel, the processor 210 will instruct output of the instruction within the tunnel in step S10, so that the user has adequate warning of an upcoming turn, merge, entry onto a highway, etc. which will occur after exit of the tunnel. It should be noted that such a step S6 is optional, when at least one of steps S4 and S8 are utilized.

Finally, in step S8, it may be determined, by the processor 210 for example, whether or not a navigation instruction is due to be output within the tunnel. For example, in some tunnels such as those in Brussels, Belgium for example, junctions may be included within the tunnel. If this is the case, then such an instruction needs to be output to the user within the tunnel itself in step S10. This condition can be detected in a manner similar to that set forth above regarding steps S4 and S6 by the processor 210, to provide output in step S10 upon the condition being met. It should be noted that such a step S8 is optional, when at least one of steps S4 and S6 are utilized.

Thus, in a method of an example embodiment of the present application, entry of the navigation device 200 into a tunnel can be determined in step S2 by the processor 210, during a route of travel of the navigation device 200, and a navigation instruction can be output within the tunnel in step S10, for travel along the route, upon the processor 210 determining, subsequent to determining entry of the navigation device 200 into the tunnel, at least one of the tunnel being longer than a first threshold distance in step S4, a navigation instruction being due to be output within a second threshold distance of an exit of the tunnel in step S6, and/or the navigation instruction being due to be output within the tunnel in step S8.

The output of the navigation instruction in step S10 can include at least one of a visual output of the navigation instruction, on an integrated input and display device 290 of the navigation device 200 for example, and/or an audible output of the navigation instruction, via a speaker within the navigation device 200 for example.

Figure 5B illustrates a further example embodiment of the present application. In step S12, the travel route of the navigation device 200 is initially determined, by processor 210 for example, upon receipt of a travel destination. For example, once the travel destination is selected or input for example, a travel

route can be determined in a known manner utilizing a received GPS signal indicating a current location of the navigation device, stored map information, and the received travel destination as described above.

Thereafter, it can be determined in step S14, by processor 210 for example, whether or not the particular route of travel determined will include travel through a tunnel. Again, the tunnel may be something that is flagged in memory 230 and then detectable by the processor 210 for example, upon determining the route of travel. If the route of travel will not involve travel through a tunnel, then the travel route may be output and the instructions may be output in a normal manner in step S16, taking into consideration any other reasons to output or not output the instructions of course.

If the answer to step S14 is yes, then it can be determined in step S18 by the processor 210 for example, whether or not the navigation device 200 has entered the tunnel in a manner somewhat similar to that set forth in Figure 5A for example. Subsequent steps S20, S22, S23, S24, and S26 of Figure 5B can occur in a manner similar to that previously described with regard to respective steps S4, S6, S8, and S10 of Figure 5A. It should be noted that the order of steps S20, S22, S23 and S24 is not important, as the processor 210 can determine each of the various conditions in any order.

It should further be noted that the determining of entry of the navigation device 200 into the tunnel of Figures 5A and 5B can further include a step of the processor 210 determining a lack of receipt of a GPS signal, normally useable to indicate a current location of the navigation device 200, for a period of time exceeding the threshold. For example, the processor 210 can first determine that the GPS signal has not been received for a period of time, such as three seconds for example, and if so, the processor 210 can then determine whether or not the navigation device 200 has entered the tunnel in the manner previously described.

In such an instance, in step S7 of Figure 5A or step S23 of Figure 5B, it may be determined, by the processor 210 for example, whether or not a navigation instruction is due to be output within a threshold "z" distance of an estimated current position of the navigation device 200. Thus, if the processor 210 determine a lack of receipt of a GPS signal for a period of time exceeding the

threshold, for example three seconds, the processor 210 can then determine in step S7 of Figure 5A or step S23 of Figure 5B, whether or not a next instruction is due to be output within a threshold “z” distance of an estimated current position of the navigation device 200 (noting that the processor 200 can determine an estimated current position of the vehicle in which the navigation device is located based upon a last known GSP position signal received, a last known speed of the vehicle and time passed since a valid GPS signal was received). If the answer is yes, the processor 210 will instruct output of the instruction (likely within the tunnel for example) in step S10. Such a threshold “z” can be, for example, two miles, wherein an instruction is output upon the processor 210 determining an instruction is due to be output within two miles of a current position of the navigation device 200. It should be noted that such a step S7 or S23 is optional, when at least one of steps S4, S6 and S8 are utilized, and it should be noted that any of steps S4, S6, and S8 or steps S20, S22 and S24 are optional when respectively S7 or S23 are utilized in conjunction with the determination of the lack of a GPS signal for a threshold time period.

It should further be noted that the processor 210 determining of the lack of receipt of a GPS signal may include storing a time at which the navigation device 200 receives a GPS signal, and counting the time after a GPS signal is received, and comparing the count to the threshold to determine whether or not the threshold has been exceeded. Such steps can be included in either of the processes shown in Figures 5A and 5B for example.

Regarding the various distance thresholds described in steps S4 and S6, these thresholds may be the same or equal, or may further be different. For example, the distance threshold in steps S4 of Figure 5A and S20 of Figure 5B may be a relatively longer distance than the distance threshold set in steps S6 of Figure 5A and S24 of Figure 5B, as it may be desirable to output navigation instructions within a tunnel only if a tunnel is of a great distance or great length, wherein it may further be desirable to output navigation instructions within a tunnel if another or next instruction is due to be output to the user within only a short distance of the exit of the tunnel.

It should be noted that each of the aforementioned aspects of an embodiment of the present application have been described with regard to the method of the present application. However, at least one embodiment of the present application is directed to a navigation device 200, including a processor 210 to determine, during a route of travel of a navigation device 200, entry of the navigation device 200 into a tunnel; and an output device 241 to output a navigation instruction to a user of the navigation device 200 within the tunnel, for travel along the travel route, upon the processor 210 determining, subsequent to determining entry of the navigation device 200 into the tunnel, at least one of the tunnel being longer than a first threshold distance, a navigation instruction being due to be output within a second threshold distance of an exit of the tunnel and the navigation instruction being due to be output within the tunnel. Such a processor 210 may enable options and/or enable display of icons, upon receipt of an indication of selection of options. Thus, such a navigation device 200 may be used to perform the various aspects of the method described with regard to Figures 5A and 5B, as would be understood by one of ordinary skill in the art. Thus, further explanation is omitted for the sake of brevity.

In at least one embodiment of the present application, a method includes determining, during travel of a navigation device 200 along a travel route, when a GPS signal is received by a navigation device 200 and determining when a GPS signal is not received by the navigation device 200 for a period of time exceeding the threshold. The method further includes outputting a navigation instruction to a user of the navigation device 200, for travel along the route, upon determining that a GPS signal was not received by the navigation device 200 for a period of time exceeding the threshold.

In at least one embodiment of the present application, a navigation device 200 includes a processor 210 to determine, during travel of a navigation device 200 along a travel route, when a GPS signal is received by a navigation device 200 and to determine when a GPS signal was not received by the navigation device 200 for a period of time exceeding a threshold. An output device 241 is further included to output a navigation instruction to a user of the navigation device 200, for travel along the route, upon the processor 210 determining that a GPS

signal was not received by the navigation device 200 for a period of time exceeding the threshold.

Figure 6A illustrates an example embodiment of the present application. In this example embodiment, in step S30, it is initially determined, by the processor 210 for example, whether or not a GPS signal was received. If so, the system proceeds back to repeat step S30, assuming this determination occurs during travel of a navigation device 200 along a travel route.

If it is determined that a GPS signal was not received by the navigation device 200, the process moves to step S32 where it is determined, by the processor 210 for example, whether or not a threshold time was exceeded, namely, whether or not the GPS signal was not received by the navigation device 200 for a period of time exceeding a threshold.

If it is determined that a GPS signal was not received by the navigation device 200 for a period of time exceeding the threshold in step S32, then the processor 210 moves to step S34, wherein a navigation instruction is output by an output device 241 of the navigation device 200, to a user of the navigation device 200.

It should be understood that the steps S30 and S32 may be performed by a processor 210 of the navigation device 200 for example. Further, the output of the navigation instruction by an output device 241 may include at least one of a display of the navigation instruction, by an integrated input and display device 290 of the navigation device 200 for example, and/or an audible output of the navigation instruction, via a speaker or other audible output device of the navigation device 200 for example.

Figure 6B describes a further embodiment of the present application. In this embodiment, it is determined whether or not a GPS signal was received. If so, the process moves to step S42 wherein the GPS signal is stored in memory 230 for example, thereby storing a current location of the navigation device 200.

Once the GPS signal is received, a counter is reset in step S44 to begin counting. The process then cycles back to step S40.

If it is determined in step S40 that a GPS signal was not received, by the processor 210 of the navigation device 200 for example, a current count can be compared in step S46 by the processor 210 to a threshold (such as the threshold time of step S32 of Figure 6A for example). Thereafter, in step S48, it

can be determined by the processor 210 for example, whether or not the threshold is exceeded in step S48. If so, the navigation instruction may be output in step S52 in a manner somewhat similar to that previously described. If not, the count is updated in step S50 and it is again determined whether or not the GPS signal is received in step S40.

Alternatively, the processor 210 can check a difference in time between a current time and a time at which a last GPS signal was received. For example, a GPS module of the navigation device 200 may send out a position signal every second, and with that position it may send out a flag to determine whether it was valid or not. Thereafter the processor 210 can count the number of invalidity flagged GPS positions, instead of comparing a time between a current time and a time when a last valid GPS signal was received.

Figure 6C describes a further alternative embodiment of the present application. Initially, it is determined in step S60 whether or not a GPS signal was received. If it is determined that a GPS signal was received, then the system cycles back to step S60. However, if it is determined that a GPS signal was not received by the navigation device 200, it is determined in step S62, by the processor 210 for example, whether or not a threshold time was exceeded since a last receipt of a GPS signal. If not, the process cycles back to step S60. However, if it is determined, by the processor 210 of the navigation device 200 for example, that a GPS signal was not received by the navigation device 200 for a period of time exceeding a threshold, the process moves to step S64. In Step S64, it is determined whether or not the navigation device 200 is traveling along a portion of the travel route proximate to a known area of GPS signal loss.

Such an area may be a flagged area detectable by the processor 210 in a manner similarly described with regard to the tunnel in Figures 5A and 5B for example, wherein such a line of travel between two nodes on stored map information is "flagged" or otherwise marked, similar to the marking of a tunnel for example. Nodes are usually marked at junctions and therefore an entire stretch of map information between two junctions may be marked as a known area of GPS signal loss (although tunnels can occur between nodes, as well). Such an area may be at least one of a tunnel, a mountain, an underpass, a canyon, an urban canyon, etc. Again, the known area of GPS signal loss may

be flagged in a manner similar to that previously discussed with regard to the tunnel in Figures 5A and 5B of the present application for example.

The processor 210 may determine, in step S64, whether or not the known area of GPS signal loss is proximate to a current location of the navigation device 200 by the processor 210 determining whether or not a last known GPS location of the navigation device 200 is within a threshold distance of the known area of GPS signal loss. If the answer to step S64 is no, the method proceeds back to step S60. However, if the answer is yes, a next navigation instruction is output in step S66, namely upon the processor 210 determining that the navigation device 200 is traveling along a portion of the travel route proximate to a known area of GPS signal loss.

As nodes are usually marked at junctions and therefore an entire stretch of map information between two junctions may be marked as a known area of GPS signal loss. Such an area may be at least one of a tunnel, a mountain, an underpass, a canyon, an urban canyon, etc. Again, the known area of GPS signal loss may be flagged in a manner similar to that previously discussed with regard to the tunnel in Figures 5A and 5B of the present application for example, such that when the GPS signal is lost during such an area of travel, it will be presumed by the processor 210 that it was due to entrance to a tunnel, mountain, underpass, canyon, an urban canyon etc.

It should be noted that the output of the navigation instruction in step S66 normally occurs within the known area of GPS signal loss. However, this does not have to be the case. For example, an instruction may be output within a threshold time period after GPS signal loss, such as 3 seconds after the entering the known area of GPS signal loss for example. However, this could be tied to other parameters, for example, such as if a next instruction is due to be output within a threshold distance of an exit of the known area of GPS signal loss or within a threshold distance of an estimated current position of the navigation device 200 (noting that the processor 200 can determine an estimated current position of the vehicle in which the navigation device is located based upon a last known GPS position signal received, a last known speed of the vehicle and time passed since a valid GPS signal was received).

Further, in at least one other embodiment of the present application, the output in step S66 can be conditioned, by the processor 210 determining, for example, that a navigation instruction is due to be output within a threshold “z” distance of an estimated current position of the navigation device 200. Thus, if the processor 210 determines a lack of receipt of a GPS signal for a period of time exceeding the threshold in step S62, for example three seconds, the processor 210 can then determine whether or not a next instruction is due to be output within a threshold “z” distance of an estimated current position of the navigation device 200 (noting that the processor 200 can determine an estimated current position of the vehicle in which the navigation device is located based upon a last known GPS position signal received, a last known speed of the vehicle and time passed since a valid GPS signal was received). If the answer is yes, the processor 210 will instruct output of the instruction (likely within the tunnel for example) in step S66. Such a threshold “z” can be, for example, two miles, wherein an instruction is output upon the processor 210 determining an instruction is due to be output within two miles of a current position of the navigation device 200.

In any of the aforementioned embodiments of the present application, a navigation instruction may be adjusted prior to output, to compensate for a period of time when the GPS signal was determined not to be received. For example, if an instruction was due to be output upon exiting of a tunnel for example, and it is known that the instruction was to be output within a certain distance of an exit, a highway entrance, any other particular turn, etc., the next instruction may be output within the tunnel early in step S10 of Figure 5A for example, after being adjusted by increasing a distance parameter for example. For example, instead of stating that “after 100 meters turn right,” the navigation instruction may be adjusted, prior to output to compensate for the period of time when the GPS signal was determined not to be received. For example, instruction may be output as “after 500 meters turn right.” The navigation device 200 keeps updating position based upon the last known GPS position and the last known instruction. Thus, the adjustment of the navigation instruction may be done by the processor 210, for example, based upon a last known GPS location, a location at which an instruction was

supposed to be output, and a distance traveled (based upon a speed of travel and a time passing between when the last GPS signal was received). For example, if the vehicle in which the navigation device 200 is located is traveling at 20 meters/second, GPS signal loss occurs 1000 meters before a next turn is due, for example, instead of outputting an instruction saying "turn right in 1000 meters", if the instruction is given 5 seconds after losing the GPS signal, it will be adjusted to "turn right in 900 meters" as it assumes that the vehicle traveled another 100 meters in those 5 seconds.

It should be noted that each of the aforementioned aspects of an embodiment of the present application have been described with regard to the method of the present application. However, at least one embodiment of the present application is directed to a navigation device 200, including a processor 210 to determine, during travel of a navigation device 200 along a travel route, when a GPS signal is received by a navigation device 200 and to determine when a GPS signal was not received by the navigation device 200 for a period of time exceeding a threshold. An output device 241 is further included to output a navigation instruction to a user of the navigation device 200, for travel along the route, upon the processor 210 determining that a GPS signal was not received by the navigation device 200 for a period of time exceeding the threshold. Such a processor 210 may enable options and/or enable display of icons, upon receipt of an indication of selection of options. Thus, such a navigation device 200 may be used to perform the various aspects of the method described with regard to Figures 6A-C, as would be understood by one of ordinary skill in the art. Thus, further explanation is omitted for the sake of brevity.

The methods of at least one embodiment expressed above may be implemented as a computer data signal embodied in the carrier wave or propagated signal that represents a sequence of instructions which, when executed by a processor (such as processor 304 of server 302, and/or processor 210 of navigation device 200 for example) causes the processor to perform a respective method. In at least one other embodiment, at least one method provided above may be implemented above as a set of instructions contained on a computer readable or computer accessible medium, such as one of the memory devices previously

described, for example, to perform the respective method when executed by a processor or other computer device. In varying embodiments, the medium may be a magnetic medium, electronic medium, optical medium, etc.

Even further, any of the aforementioned methods may be embodied in the form of a program. The program may be stored on a computer readable media and is adapted to perform any one of the aforementioned methods when run on a computer device (a device including a processor). Thus, the storage medium or computer readable medium, is adapted to store information and is adapted to interact with a data processing facility or computer device to perform the method of any of the above mentioned embodiments.

The storage medium may be a built-in medium installed inside a computer device main body or a removable medium arranged so that it can be separated from the computer device main body. Examples of the built-in medium include, but are not limited to, rewriteable non-volatile memories, such as ROMs and flash memories, and hard disks. Examples of the removable medium include, but are not limited to, optical storage media such as CD-ROMs and DVDs; magneto-optical storage media, such as MOs; magnetism storage media, including but not limited to floppy disks (trademark), cassette tapes, and removable hard disks; media with a built-in rewriteable non-volatile memory, including but not limited to memory cards; and media with a built-in ROM, including but not limited to ROM cassettes; etc. Furthermore, various information regarding stored images, for example, property information, may be stored in any other form, or it may be provided in other ways.

As one of ordinary skill in the art will understand upon reading the disclosure, the electronic components of the navigation device 200 and/or the components of the server 302 can be embodied as computer hardware circuitry or as a computer readable program, or as a combination of both.

The system and method of embodiments of the present application include software operative on the processor to perform at least one of the methods according to the teachings of the present application. One of ordinary skill in the art will understand, upon reading and comprehending this disclosure, the manner in which a software program can be launched from a computer readable medium in a computer based system to execute the functions found in

the software program. One of ordinary skill in the art will further understand the various programming languages which may be employed to create a software program designed to implement and perform at least one of the methods of the present application.

The programs can be structured in an object-orientation using an object-oriented language including but not limited to JAVA, Smalltalk, C++, etc., and the programs can be structured in a procedural-orientation using a procedural language including but not limited to COBAL, C, etc. The software components can communicate in any number of ways that are well known to those of ordinary skill in the art, including but not limited to by application of program interfaces (API), interprocess communication techniques, including but not limited to report procedure call (RPC), common object request broker architecture (CORBA), Component Object Model (COM), Distributed Component Object Model (DCOM), Distributed System Object Model (DSOM), and Remote Method Invocation (RMI). However, as will be appreciated by one of ordinary skill in the art upon reading the present application disclosure, the teachings of the present application are not limited to a particular programming language or environment.

The above systems, devices, and methods have been described by way of example and not by way of limitation with respect to improving accuracy, processor speed, and ease of user interaction, etc. with a navigation device 200. Further, elements and/or features of different example embodiments may be combined with each other and/or substituted for each other within the scope of this disclosure and appended claims.

Still further, any one of the above-described and other example features of the present invention may be embodied in the form of an apparatus, method, system, computer program and computer program product. For example, of the aforementioned methods may be embodied in the form of a system or device, including, but not limited to, any of the structure for performing the methodology illustrated in the drawings.

Example embodiments being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the present invention, and all such

modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

CLAIMS

1. A method, comprising the step of:
determining, during travel of a navigation device along a travel route determined thereby upon receipt of a travel destination, when a GPS signal is received by a navigation device and determining when a GPS signal was not received by the navigation device,
and characterized by the further steps of
outputting a navigation instruction to a user of the navigation device after making positive determination of at least one of the following primary conditions:
 - a GPS signal was not received by the navigation device for a period of time exceeding a threshold
 - the navigation device is traveling along a portion of the travel route proximate to a known area of GPS signal loss.
2. The method of claim 1 wherein the known area of GPS signal loss is flagged.
3. The method of claim 1 or 2, wherein the known area of GPS signal loss includes at least one of a tunnel, a mountain, an underpass, a canyon and an urban canyon.
4. The method of any preceding claim wherein the navigation instruction is output when a positive determination of one of the following additional conditions is met:
 - the portion of the forthcoming travel route within the known area of GPS signal loss is longer than a threshold distance,
 - the location at which a navigation instruction is due to be output is within the known area of GPS signal loss, and
 - the location at which a navigation instruction is due to be output is within a threshold distance of the location at which the forthcoming travel route emerges from the known area of GPS signal loss.

- the location at which a navigation instruction is due to be out is within a threshold distance of an estimated current position of the navigation device.

5. A method according to claim 4 wherein the output of the navigation instruction is delayed until the navigation device is present at the location at which the next navigation instruction is due to be output and when one or more of the conditions is met.

6. The method of any preceding claim, wherein the output includes at least one of display of the navigation instruction and an audible output of the navigation instruction.

7. The method of any preceding claim wherein the navigation instruction is adjusted, prior to output, to compensate for the period of time when the GPS signal was determined not to be received.

8. The method of any preceding claim wherein the navigation device stores a time at which the navigation device receives a GPS signal, and on determining that a GPS signal is not received, the method includes the further steps of counting a time after the last GPS signal received time, and comparing the count to the threshold to determine whether or not the threshold has been exceeded.

9. A computer program comprising computer program code means adapted to perform all the steps of any of claims 1-8 when run on a computer.

10. A computer program as claimed in claim 9 when embodied on or in a computer readable medium.

11. A navigation device in which the method of any of claims 1-8 is effected, comprising:

a processor, an output device, and memory, said processor determining whether the various conditions is met, and if so, subsequently causing output of the navigation instruction through said output device.

12. The navigation device of claim 11, wherein the output device includes at least one of a display to visually display the navigation instruction and an audible output device to audibly output the navigation instruction.

13. The navigation device of either claim 11 or 12 further in which a time at which the navigation device receives a GPS signal is stored in said memory, said processor counting a time after a GPS signal is received and comparing the count to the threshold to determine whether or not the time threshold has been exceeded.

14. The navigation device of any of claims 11-13, wherein the processor causes output of the navigation instruction only when both primary conditions are met.

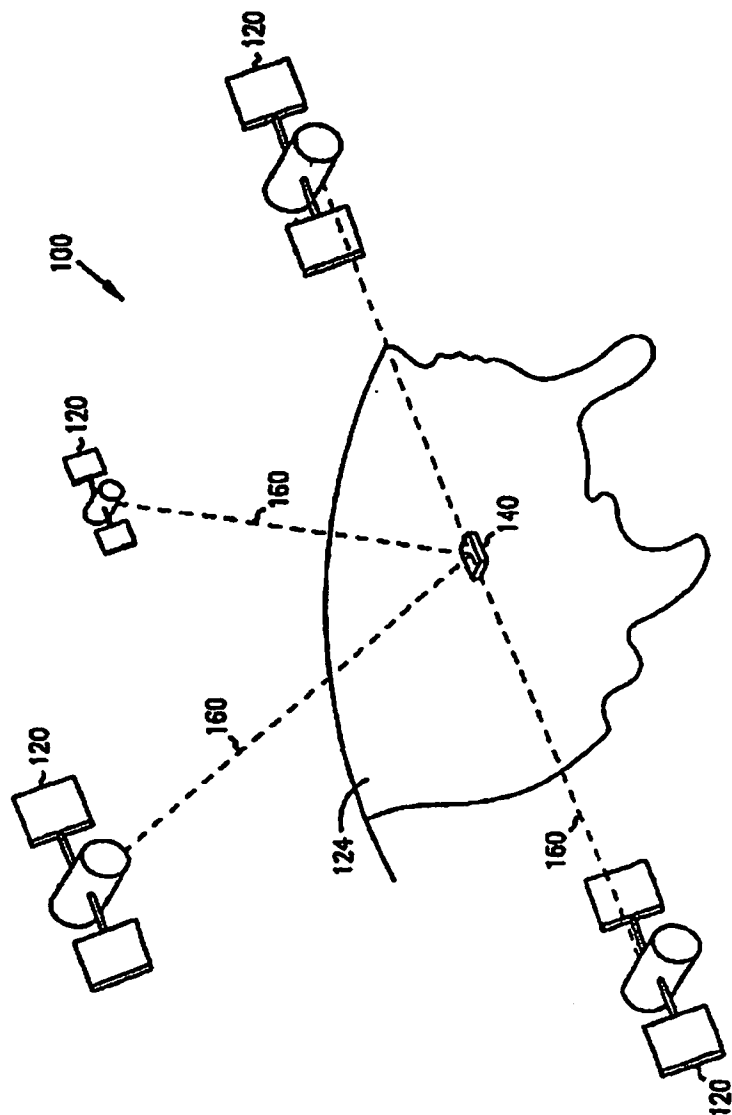
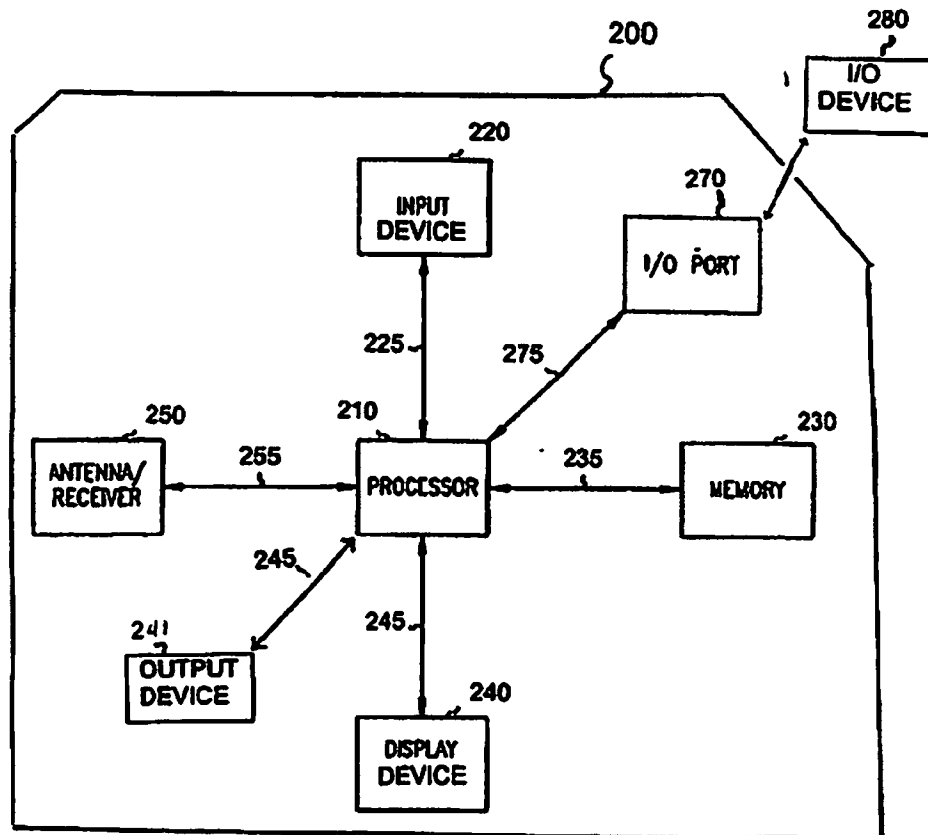


FIG. 1

**Fig. 2**

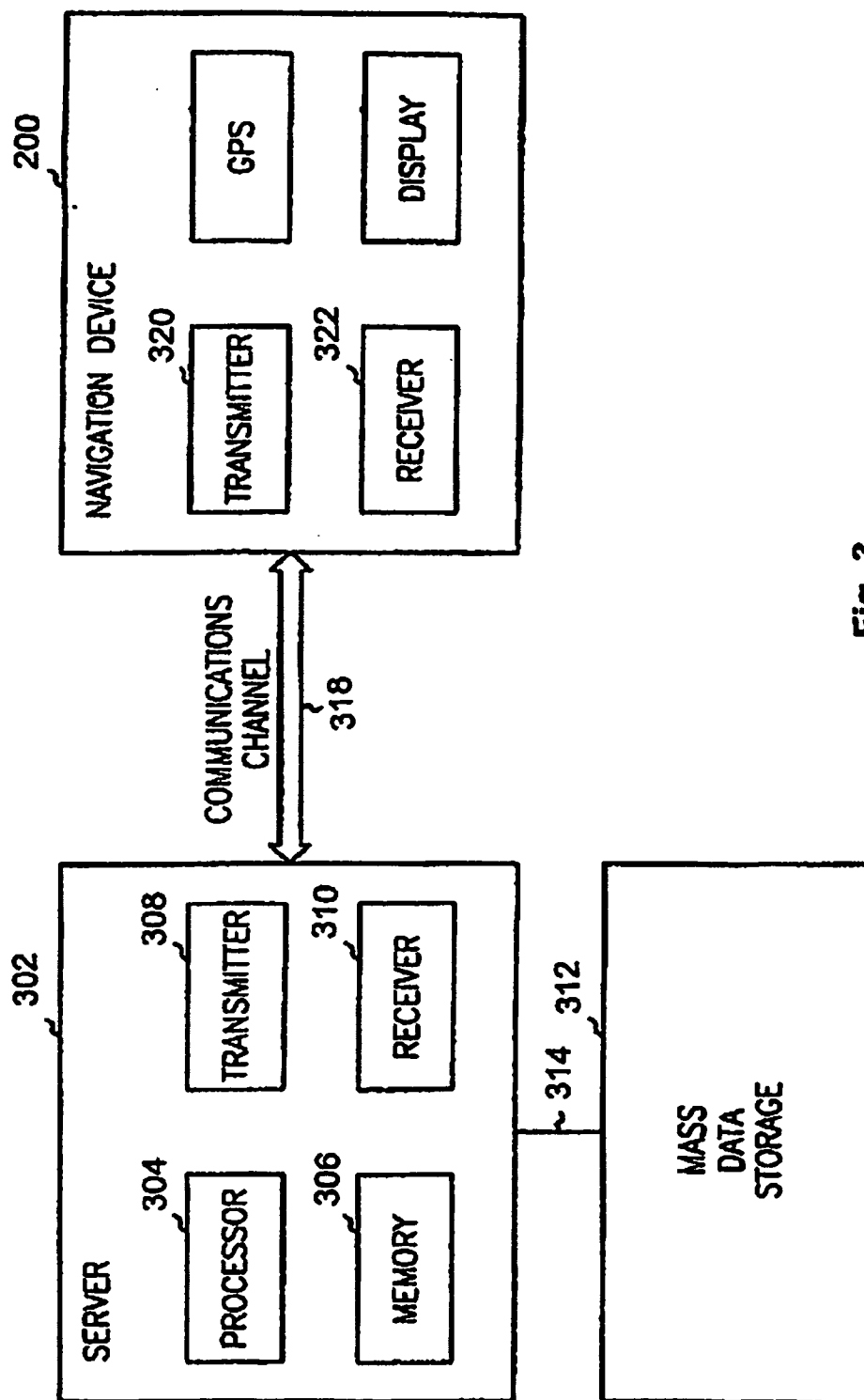


Fig. 3

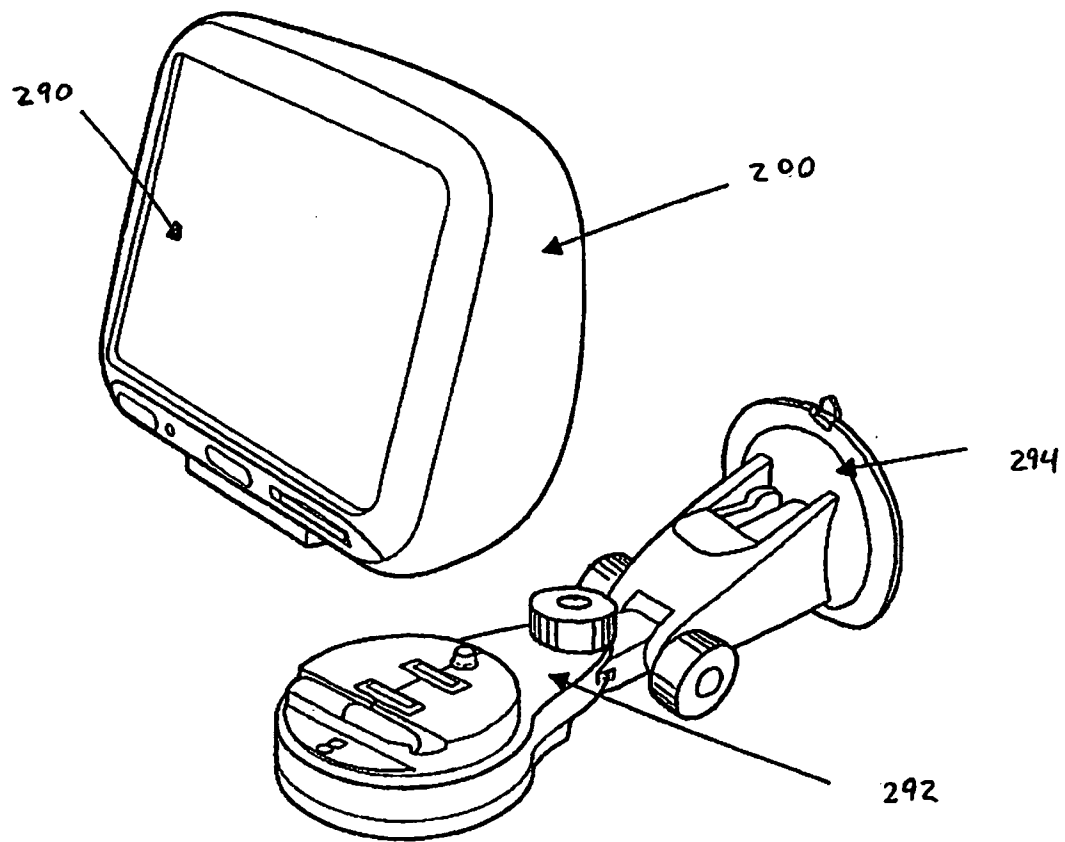


Figure 4A

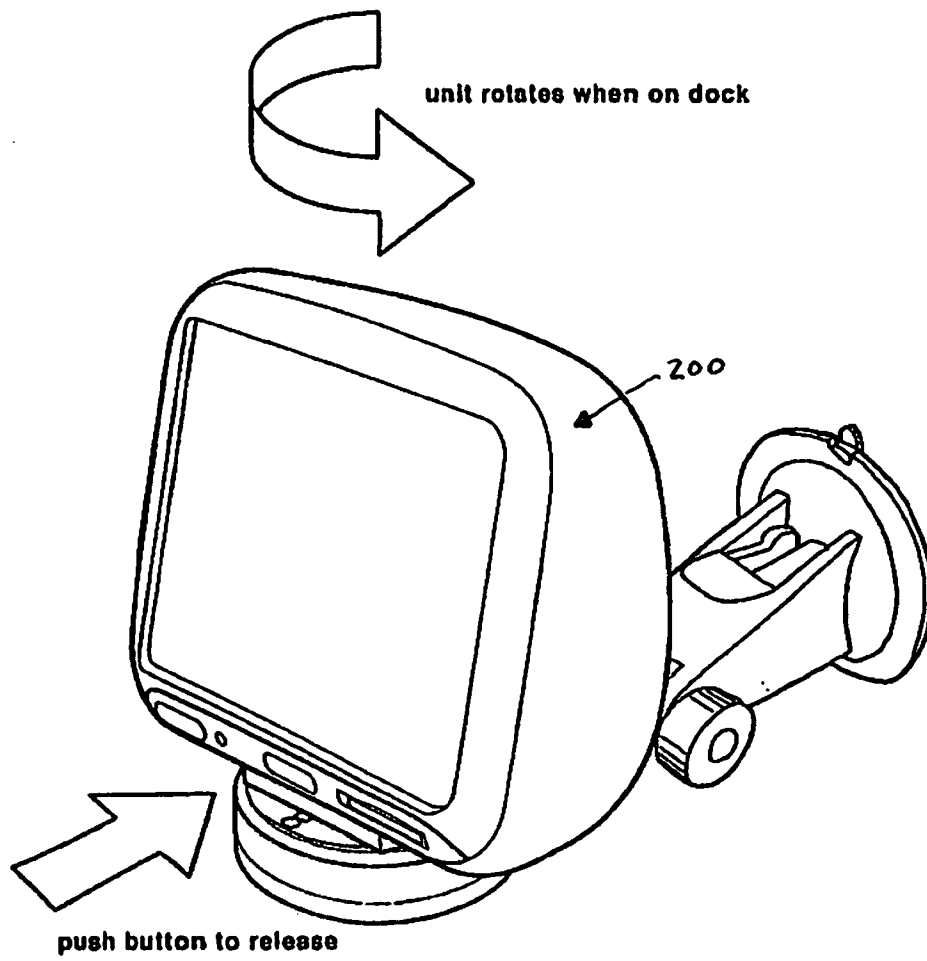


Figure 4b

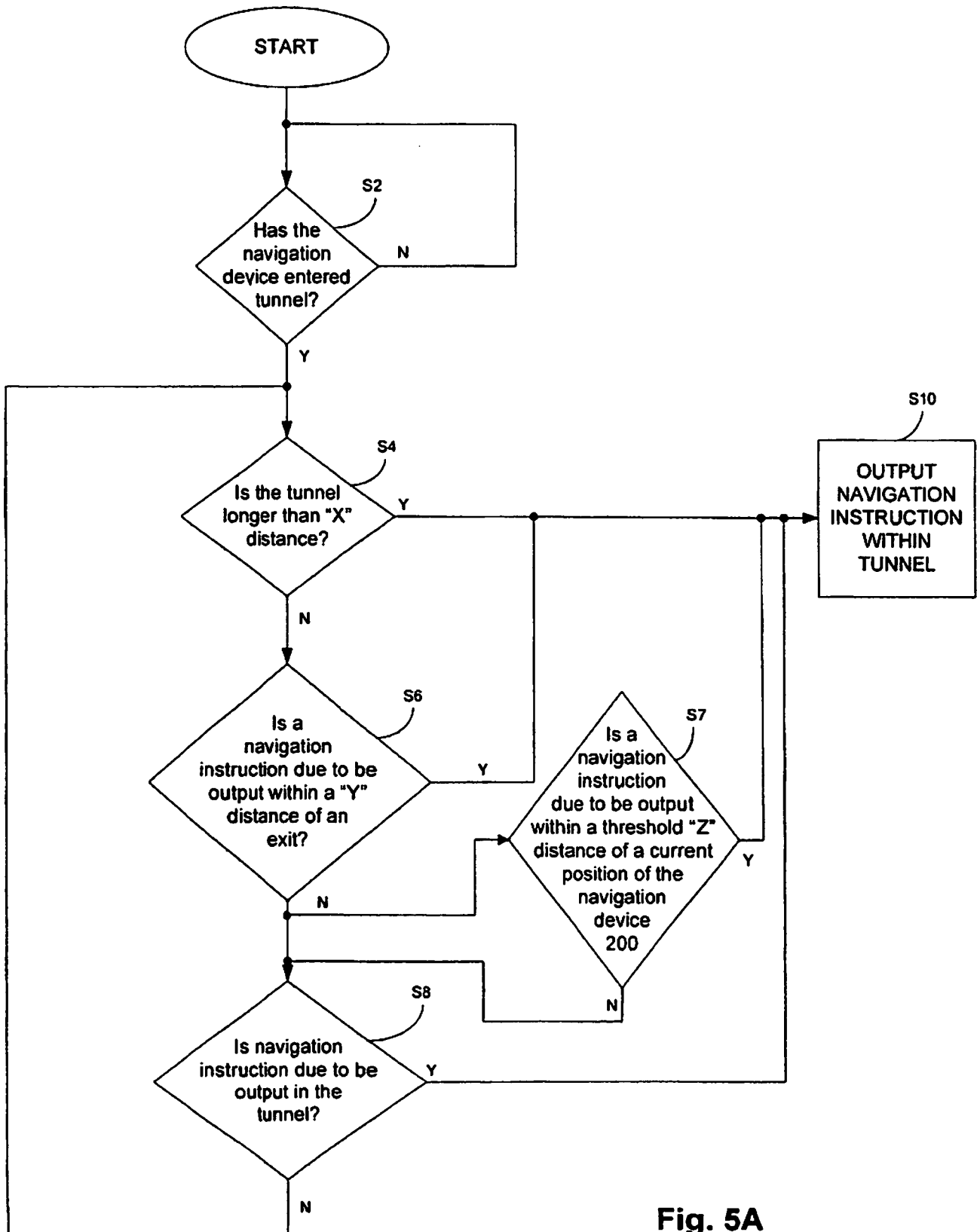


Fig. 5A

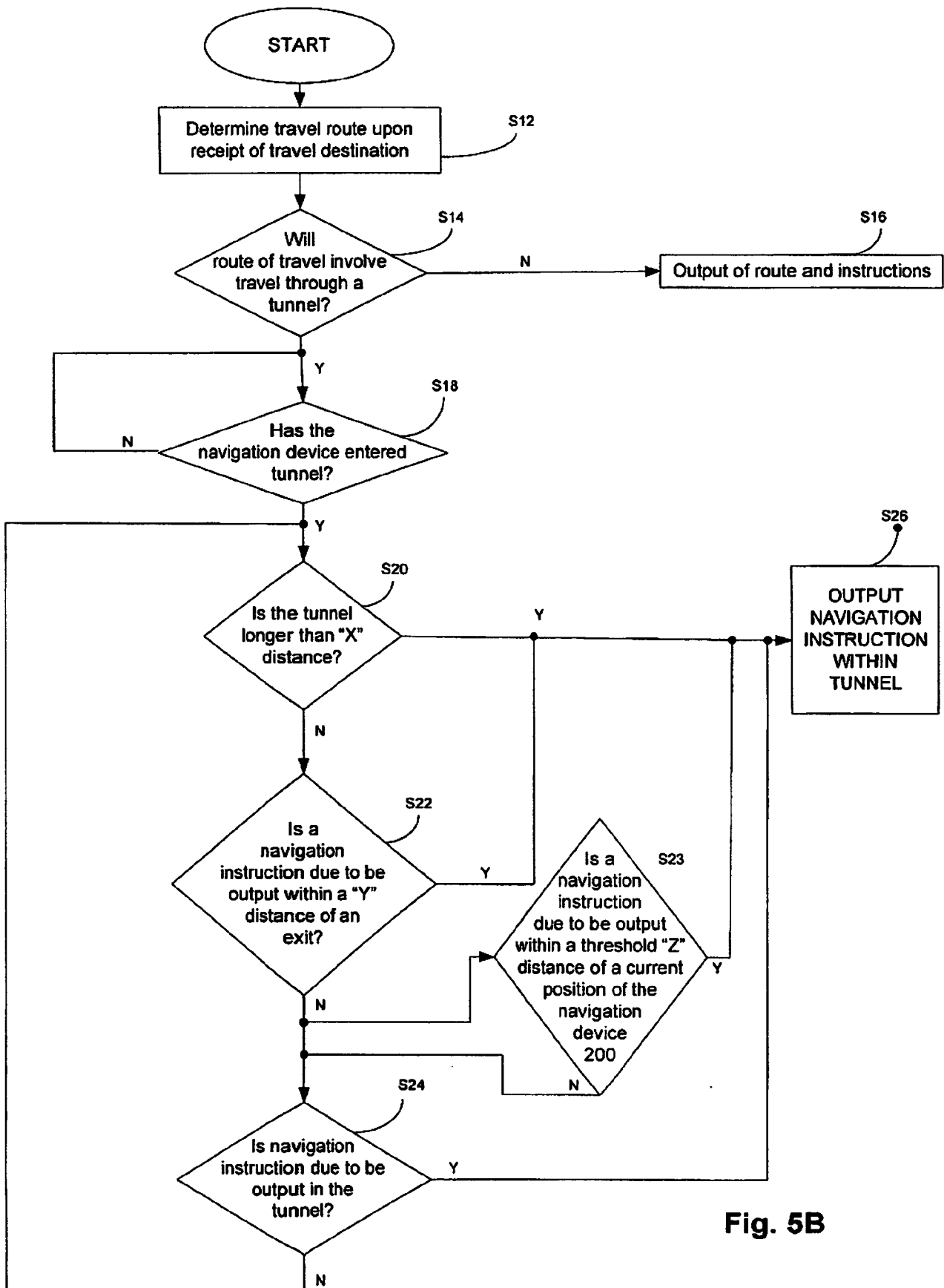
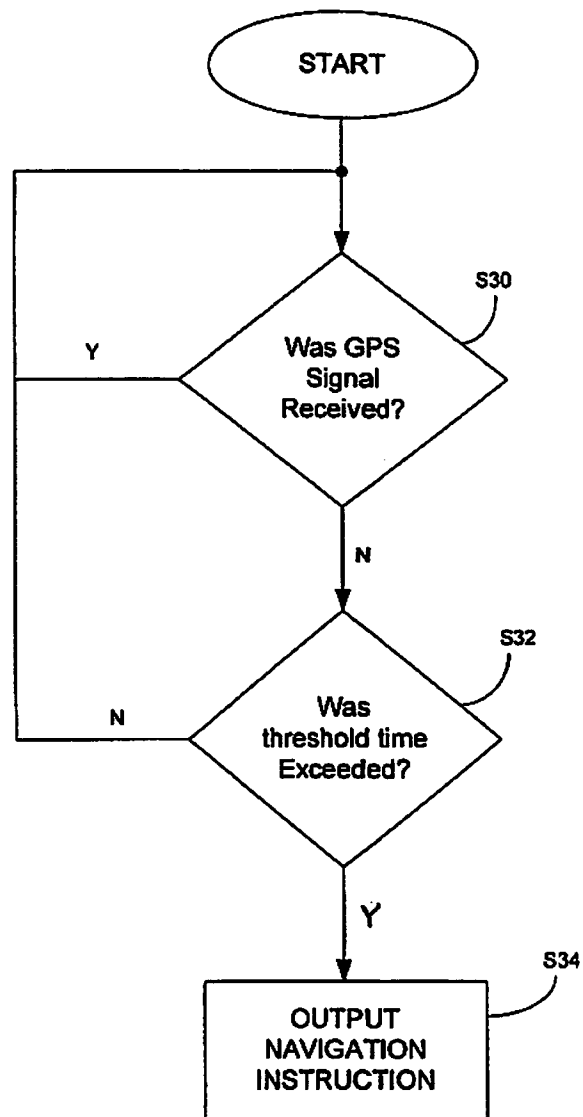
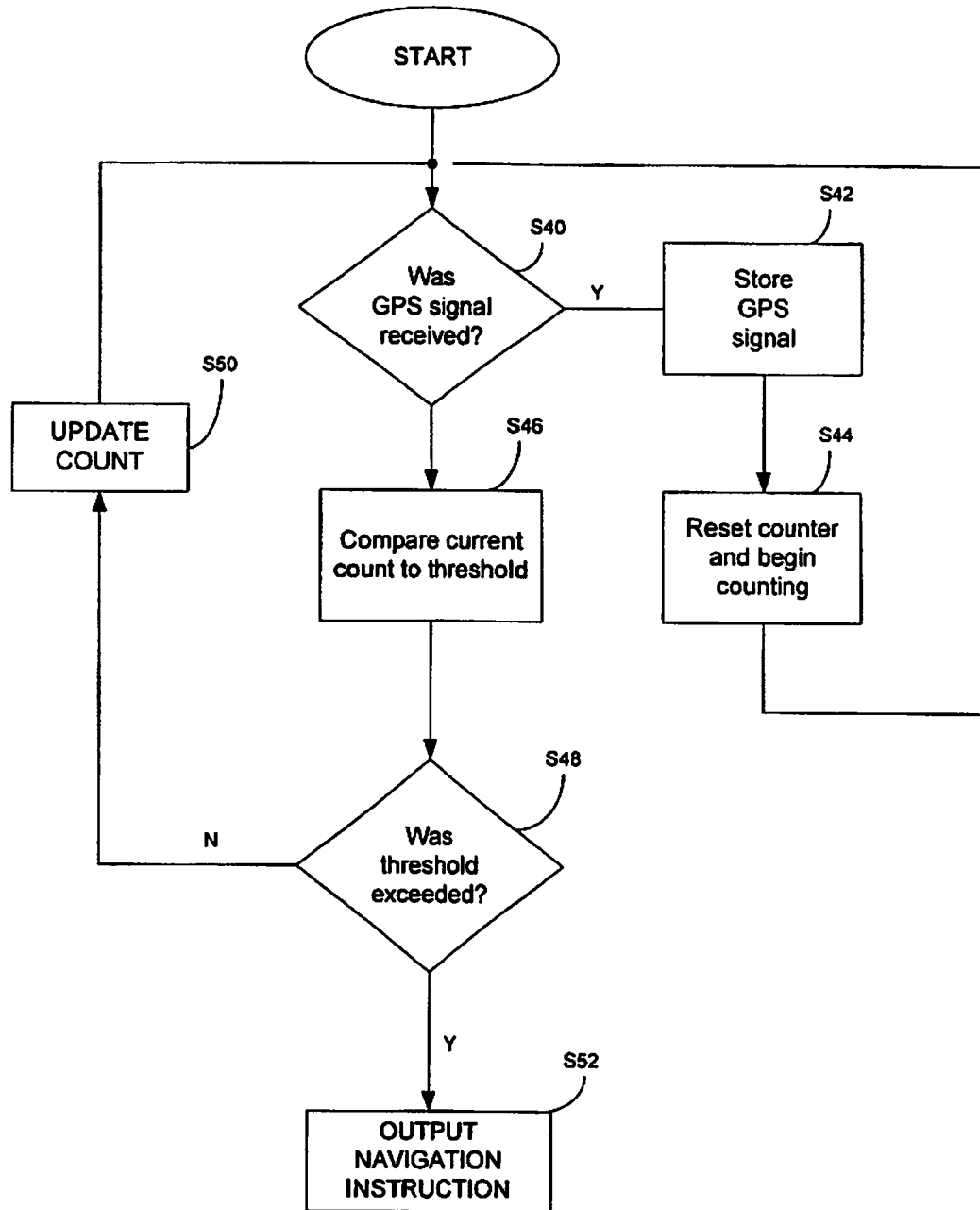
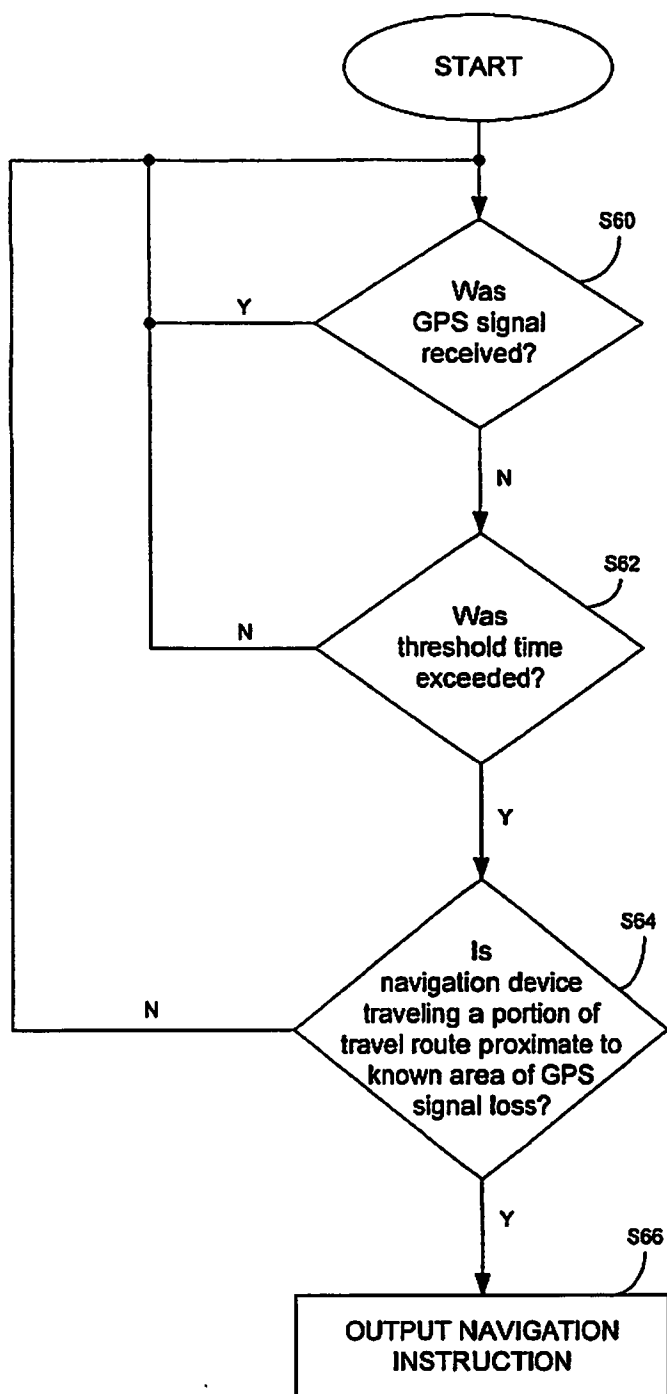


Fig. 5B

**Fig. 6A**

**Fig. 6B**

**Fig. 6C**

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2007/008746

A. CLASSIFICATION OF SUBJECT MATTER

INV. G01C21/20 G01C21/26 G01C21/28 G01S5/14

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)

G01S

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 189 029 A (SANYO ELECTRIC CO [JP]; TOKYO SANYO ELECTRIC CO [JP]) 20 March 2002 (2002-03-20) column 1, line 36, paragraph 5 - column 9, line 35, paragraph 72; figures 1-5	1-14
X	US 2003/179133 A1 (PEPIN GILLES [CA] ET AL) 25 September 2003 (2003-09-25) page 1, paragraph 9 - page 5, paragraph 93; figures 1,4	1-14
P, X	JP 2007 003287 A (NISSAN MOTOR) 11 January 2007 (2007-01-11) abstract	1,6,9, 11,12
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☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search

15 January 2008

Date of mailing of the international search report

24/01/2008

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2007/008746

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DU ET AL: "Increasing the accuracy of trip rate information from passive multi-day GPS travel datasets: Automatic trip end identification issues" TRANSPORTATION RESEARCH PART A: POLICY AND PRACTICE, PERGAMON, vol. 41, no. 3, 1 December 2006 (2006-12-01), pages 220-232, XP005788658 ISSN: 0965-8564 the whole document -----	1-14

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2007/008746

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