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(54) **NAVIGATION DEVICE AND METHOD FOR DISPLAYING ALTERNATIVE ROUTES**

NAVIGATIONSEINRICHTUNG UND VERFAHREN ZUM ANZEIGEN ALTERNATIVER ROUTEN

DISPOSITIF DE NAVIGATION ET PROCEDE POUR L'AFFICHAGE DE DIFFERENTS ITINERAIRES POSSIBLES

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(73) Proprietor: **Tomtom International B.V.**
1017 CT Amsterdam (NL)

(72) Inventors:
- **PINKUS, Ayal**
  NL-1017 CT Amsterdam (NL)
- **NEEF, Edwin**
  NL-1017 CT Amsterdam (NL)
- **JURGENS, Sven-Erik**
  NL-1017 CT Amsterdam (NL)
- **GRETTON, Mark**
  London NW1 6DE (GB)

(74) Representative: **Langley, Peter James et al**
Origin Limited,
52 Muswell Hill Road
London N10 3JR (GB)

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Description

BACKGROUND OF THE INVENTION

1. Field of the invention

[0001] This invention relates to a navigation device that can display navigation data. The device find particular application as an in-car navigation system.

2. Description of the prior art

[0002] GPS based devices are well known and are widely employed as in-car navigation systems. Reference may be made to the Navigator series software from the present assignee, TomTom B.V. This is software that, when running on a PDA (such as a Compaq iPaq) connected to an external GPS receiver, enables a user to input to the PDA a start and destination address. The software then calculates the best route between the two end-points and displays instructions on how to navigate that route. By using the positional information derived from the GPS receiver, the software can determine at regular intervals the position of the PDA (typically mounted on the dashboard of a vehicle) and can display the current position of the vehicle on a map and display (and speak) appropriate navigation instructions (e.g. 'turn left in 100 m'). Graphics depicting the actions to be accomplished (e.g. a left arrow indicating a left turn ahead) can be displayed in a status bar and also be superimposed over the applicable junctions/turnings etc in the roads shown in the map itself. Reference may also be made to devices that integrate a GPS receiver into a computing device programmed with a map database and that can generate navigation instructions on a display. The term 'navigation device' refers to a device that enables a user to navigate to a pre-defined destination. The device may have an internal system for receiving location data, such as a GPS receiver, or may merely be connectable to a receiver that can receive location data.

[0003] It is known to enable in-car navigation systems to allow the driver, whilst driving in a car along a route calculated by the navigation system, to initiate a route re-calculation. This is useful where the vehicle is faced with construction work or heavy congestion.

[0004] Reference may be made to US 6118389 which discloses techniques for calculating a re-route. Initiating the re-route calculation requires activation of a specific detour switch, which may however be inconvenient to the user US 5928307 also describes a system with a dedicated 'avoid' key on, a keyboard.

[0005] Reference may also be made to US 5544060, which enables a device to preview the calculated route by displaying in successive screens each different road and turning that the vehicle has to take; the user however bas to manually sequence through each successive screen using a preview switch until he reaches die road that he wants to exclude from the route; he then selects a cancel switch; a new route is calculated which excludes the cancelled toad.

[0006] Finally, reference may also be made to US 5859628; although this docs not specifically describe any kind, of detour function for a navigation system, it does describe a touch screen based navigation device.

[0007] The present invention aims to improve on the user interaction aspects of initiating a route re-calculation.

SUMMARY OF THE INVENTION

[0008] In a first aspect, there is a navigation device programmed with a map database and software that enables a route to be planned to a destination, wherein the device is further programmed to be able to display a 2D or 3D road, navigation map on a touch screen display, the map showing the current position of the device on a planned route; characterised in that the user, can, by touching the screen, task away from the 2D or 3D navigation map to a menu screen which displays one or more options that, if selected through a further touch action, initiate a re-calculation of the route to find a detour away from the planned route.

[0009] This user interaction, approach is simpler, more flexible and more intuitive than prior art approaches that require the user to activate a specific, hardware-based detour switch. Further, since a route re-calculation only requires 2 quick touch actions to the screen, it can be safely completed by a driver even whilst driving.

[0010] The menu screen may display selectable options relating to one or more of the following functions:

(a) calculate alternative route;
(b) calculate alternative route without including a predefined extent of the road ahead;
(c) calculate alternative route without including a predefined road;
(d) revert to original route.

[0011] This approach gives the driver far greater flexibility in his route re-calculation options than was available with prior art, hard-wired detour switches.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The present invention will be described with reference to the accompanying drawings, in which **Figure 1** is a screen shot from a navigation device implementing the present invention; the screen shot shows a plan map view and a status bar running along the bottom of the display;
Figure 2 is a screen shot from the navigation device implementing a 3-D view;
Figure 3 is a screen shot from the navigation device showing various route planning functions that enable a user to require the device to plot a new route to the destination that (i) is an alternative route; (ii) avoids a road-

block immediately ahead; (iii) avoids predefined roads or (iv) is a reversion to the original route.

DETAILED DESCRIPTION

System Overview

[0013] The present invention is implemented in software from TomTom B.V. called Navigator. Navigator software runs on a touch screen (i.e. stylus controlled) Pocket PC powered PDA device, such as the Compaq iPaq. It provides a GPS based navigation system when the PDA is coupled with a GPS receiver. The combined PDA and GPS receiver system is designed to be used as an in-vehicle navigation system. The invention may also be implemented in any other arrangement of navigation device, such as one with an integral GPS receiver/computer/display, or a device designed for non-vehicle use (e.g. for walkers) or vehicles other than cars (e.g. aircraft). The navigation device may implement any kind of position sensing technology and is not limited to GPS; it can hence be implemented using other kinds of GNSS (global navigation satellite system) such as the European Galileo system. Equally, it is not limited to satellite based location/velocity systems but can equally be deployed using ground-based beacons or any other kind of system that enables the device to determine its geographic location.

[0014] Navigator software, when running on a PDA, results in a navigation device that causes the normal navigation mode screen shown in **Figure 1** to be displayed. This view provides driving instructions using a combination of text, symbols, voice guidance and a moving map. Key user interface elements are the following: a 2-D map **1** occupies most of the screen. The map shows the user's car and its immediate surroundings, rotated in such a way that the direction in which the car is moving is always "up". Running across the bottom quarter of the screen is the status bar **2.** The current location of the device, as the device itself determines using conventional GPS location finding and its orientation (as inferred from its direction of travel) is depicted by an arrow **3.** The route calculated by the device (using route calculation algorithms stored in device memory as applied to map data stored in a map database in device memory) is shown as darkened path **4** superimposed with arrows giving the travel direction. On the darkened path **4,** all major actions (e.g. turning corners, crossroads, roundabouts etc.) are schematically depicted by arrows **5** overlaying the path **4.** The status bar **2** also includes at its left hand side a schematic **6** depicting the next action (here, a right turn). The status bar **2** also shows the distance to the next action (i.e. the right turn - here the distance is 220 meters) as extracted from a database of the entire route calculated by the device (i.e. a list of all roads and related actions defining the route to be taken). Status bar **2** also shows the name of the current road **8,** the estimated time before arrival **9** (here 2 minutes and 40 seconds), the actual estimated arrival time **10** (11.36am) and the distance to the destination **11** (1.4Km). The GPS signal strength is shown in a mobile-phone style signal strength indicator **12.**

[0015] If the user touches the centre of the screen **13,** then a navigation screen menu is displayed; from this menu, other core navigation functions within the Navigator application can be initiated or controlled. Allowing core navigation functions to be selected from a menu screen that is itself very readily called up (e.g. one step away from the map display to the menu screen) greatly simplifies the user interaction and makes it faster and easier.

[0016] The area of the touch zone which needs to be touched by a user is far larger than in most stylus based touch screen systems. It is designed to be large enough to be reliably selected by a single finger without special accuracy; i.e. to mimic the real-life conditions for a driver when controlling a vehicle; he or she will have little time to look at a highly detailed screen with small control icons, and still less time to accurately press one of those small control icons. Hence, using a very large touch screen area associated with a given soft key (or hidden soft key, as in the centre of the screen **13)** is a deliberate design feature of this implementation. Unlike other stylus based applications, this design feature is consistently deployed throughout Navigator to select core functions that are likely to be needed by a driver whilst actually driving. Hence, whenever the user is given the choice of selecting on-screen icons (e.g. control icons, or keys of a virtual keyboard to enter a destination address, for example), then the design of those icons/keys is kept simple and the associated touch screen zones is expanded to such a size that each icon/key can unambiguously be finger selected. In practice, the associated touch screen zone will be of the order of at least 0.7 cm^2 and will typically be a square zone. In normal navigation mode, the device displays a map. Touching the map (i.e. the touch sensitive display) once (or twice in a different implementation) near to the screen centre (or any part of the screen in another implementation) will then call up a navigation menu (see **Figure 3)** with large icons corresponding to various navigation functions, such as the option to calculate an alternative route, and re-calculate the route so as to avoid the next section of road (useful when faced with an obstruction or heavy congestion); or recalculate the route so as to avoid specific, listed roads.

[0017] The actual physical structure of the device itself may be fundamentally no different from any conventional handheld computer, other than the integral GPS receiver or a GPS data feed from an external GPS receiver. Hence, memory stores the route calculation algorithms, map database and user interface software; a microprocessor interprets and processes user input (e.g. using a device touch screen to input the start and destination addresses and all other control inputs) and deploys the route calculation algorithms to calculate the optimal route. 'Optimal' may refer to criteria such as shortest time or shortest distance, or some other user-related factors.

[0018] More specifically, the user inputs his start posi-

tion and required destination in the normal manner into the Navigator software running on the PDA using a virtual keyboard. The user then selects the manner in which a travel route is calculated: various modes are offered, such as a 'fast' mode that calculates the route very rapidly, but the route might not be the shortest; a 'full' mode that looks at all possible routes and locates the shortest, but takes longer to calculate etc. Other options are possible, with a user defining a route that is scenic - e.g. passes the most POI (points of interest) marked as views of outstanding beauty, or passes the most POIs of possible interest to children or uses the fewest junctions etc.

[0019] Roads themselves are described in the map database that is part of Navigator (or is otherwise accessed by it) running on the PDA as lines - i.e. vectors (e.g. start point, end point, direction for a road, with an entire road being made up of many hundreds of such sections, each uniquely defined by start point/end point direction parameters). A map is then a set of such road vectors, plus points of interest (POIs), plus road names, plus other geographic features like park boundaries, river boundaries etc, all of which are defined in terms of vectors. All map features (e.g. road vectors, POIs etc.) are defined in a co-ordinate system that corresponds or relates to the GPS co-ordinate system, enabling a device's position as determined through a GPS system to be located onto the relevant road shown in a map.

[0020] Route calculation uses complex algorithms that are part of the Navigator software. The algorithms are applied to score large numbers of potential different routes. The Navigator software then evaluates them against the user defined criteria (or device defaults), such as a full mode scan, with scenic route, past museums, and no speed camera. The route which best meets the defined criteria is then calculated by a processor in the PDA and then stored in a database in RAM as a sequence of vectors, road names and actions to be done at vector end-points (e.g. corresponding to pre-determined distances along each road of the route, such as after 100 meters, turn left into street x).

Route re-calculation

[0021] An implementation of the present invention facilitates access to functions that enable alternative routes to be calculated by placing a menu of graphical icons (or any other kind of way or option to allow selection of the functions, such as lists, check boxes etc.) on a menu screen that is easily accessed from the main navigation screen- i.e. the screen that is displayed during actual or simulated/preview navigation. As noted above, in normal navigation mode (and also the 'demonstrate route' mode for simulated/preview navigation - see later), the device displays an animated map that shows the location of the navigation device as the journey progresses. Touching the map (i.e. the touch sensitive display) once (or twice in a different implementation) near to the screen centre (or any part of the screen in another implementation) will then call up a 'Recalculate' menu screen (see **Figure 3)** with large icons corresponding to various navigation functions, such as the option to calculate an alternative route **3C ;** re-calculate the route so as to avoid the next section of road **3A** (useful when faced with a roadblock); and recalculate the route so as to avoid specific, listed roads **3B.** The following sections describe these and other alternative route functions in more detail. Some of these functions may be initiated directly from the Recalculate menu screen; others may be at a deeper level in the menu structure. However, all can be initiated by selecting options such as graphical icons, lists, check boxes which are unambiguously associated with touch screen areas that are large enough to allow the user to select them with a fingertip whilst safely driving, typically at least 0.7cm^2 in area.

Alternative route function: 'avoid roadblock'

[0022] With this function, a user could select an 'avoid roadblock' function 3A that causes the system to recalculate a route on the basis that the road immediately ahead (or some user defined or system default distance ahead, e.g. 100 metres) is blocked.

[0023] As noted earlier, a route planning algorithm in Navigator will work out an optimal route (optimal may refer to criteria such as shortest time or shortest distance, or some other factors) by exploring different routes and scoring them against the required criteria. In this way, one route which best meets the defied criteria is generated. If whilst actually driving along a route, an unexpected event occurs that requires the user to detour away from the pre-calculated route, such as a roadblock, the user can inform the Navigator software that his immediate road ahead is blocked and require the software to recalculate a new route, taking his current position as a new starting position, but taking the first turning possible away from the old calculated route. This first turning might be ahead or behind the current car position. The system, in constructing the new route, explores a large number of possible routes to the destination from the current position, but excludes the road immediately ahead.

[0024] Selecting the 'avoid roadblock' function **3A** has to be fast and involve the absolute minimum number of screen interactions to minimise driver distraction. This can be achieved by the user being able to switch from normal navigation mode (in which the current position of the car is shown on a map, as shown in **Figures 1** or **2)** to a Recalculate menu mode, as shown in **Figure 3,** by pressing a key or selecting any point on the screen or selecting a given region of the screen. Where a given region has to be selected. (e.g. the approximate centre of the map), then the touch activation zone is sufficiently large that it can readily and reliably be selected by a user with his fingertip without needing to look carefully at the screen for more than a moment. A touch zone of 0.7cm^2, centred on the map, has been found to be sufficient.

[0025] The **Figure 3** menu mode displays a small

number of large icons, one of which is the 'avoid roadblock' **3A** option. This can be selected with one touch; when this occurs, the software re-calculates the route and gives instructions in the normal manner (voice; and/or on screen navigation prompts) to allow the user to proceed to his destination but avoid the road immediately ahead.

Alternative route function: 'avoid specific road'

[0026] This function allows a user to easily and rapidly select a specific, named road **3B** to mark as blocked so that he can use information from real time traffic information broadcasts on the radio.

[0027] When listening to the radio, a user may hear that a specific road or perhaps part of a motorway between defined junctions is blocked or heavily congested. If that road is on the user's calculated route, even though it might be many kilometres away, then he will want to have the software recalculate a new route as soon as possible. The system does this by calculating a route to the final destination using the current position as a start position and exploring different routes to the destination, but excluding the road indicated as to be avoided. The new route will then be calculated using normal route planning algorithms and the user diverted onto the new route.

[0028] Selecting the 'avoid specific road' function **3B** has also to be fast and involve the absolute minimum number of screen interactions to minimise driver distraction. This can be achieved by the user being able to switch from normal navigation mode **(Figures 1** or **2**, in which the current position of the car is shown on a map) to a Recalculate menu mode as described earlier (e.g. selecting a given region on the screen); the Recalculate menu displays a small number of large icons, several of which are named roads **3B** on the route which, if selected, can be selected with one touch; when this occurs, the software re-calculates the route and gives instructions in the normal manner (voice; and/or on screen navigation prompts) to allow the user to proceed to his destination but avoid the road immediately ahead. The device may have limited screen space to display many roads for exclusion; the Figure 3 implementation lists three. These three are selected using various weighting parameters (e.g. a prior history of the user wishing to avoid them; the next three major roads) or from dynamic, updated travel information received by the device from a traffic information data source, indicating that these are the next three roads on the route that are affected by traffic disturbance of some kind.

[0029] A final 'original' option **3D** allows the user to clear all earlier re-calculation inputs and re-calculate the original route.

[0030] A number of other navigation functions can be initiated from deeper in the menu hierarchy than the **Figure 3** menu. These are described below.

Alternative route function: 'penalties'

[0031] With this function, the system can also enable a user to mark certain points/regions as blocked or slow or to give penalties (or their inverse, awards) to a point/region to weight routing away from (or to) that point/region and have the system auto calculate an alternative route (or indeed the original route).

[0032] Route planning algorithms operate by assigning scores to different possible routes in relation to different criteria (e.g. scores for the time of journey, scores for the length of journey etc) and then determining which route has the best overall score. Normally, the user cannot interact directly with how the algorithm treats roads, junctions and other route features. But in Navigator it is possible: the user can directly alter the way the route planning algorithm evaluates or scores a route by awarding penalties/awards to any items, e.g. points/regions, that affect the route planning scoring. The route planning algorithm stores a list of all roads/junctions in vector form associated with each calculated route from start to destination; each item (e.g. road section, turning etc.) will typically have several parameters associated with it that are used in the scoring process to evaluate a best route. Hence, it is straightforward to alter the route scoring based on giving different weightings to different kinds of items. For example, one user might dislike junctions; in which case, the route scoring could count junction numbers in alternate routes and then weight more favourably routes with fewer junctions. Similarly, roads within certain user defined regions could have some of their scoring parameters altered to change the likelihood of a route being selected using them (either to increase or decrease the likelihood of selection). To enable the user to alter the weightings given to different items, the device could display a list of those items adjacent to check boxes (e.g. 'Like' and 'Don't Like'). Each user could then set up a personal profile that defined his or her personal preferences (e.g. one person might always prefer the scenic and historic; another straightforward driving with minimal junctions; yet another, always the shortest possible distance, irrespective of complexity).

[0033] Also, a user could penalise specific complex junctions on a simulated route (see 'Demonstrate route' function below) if they disliked them, or else could indicate that he wanted fewer turnings and the device would then count the number of turnings in alternative routes and give preference to the routes with fewer turnings.

Alternative route function: auto generate

[0034] A user can also simply select 'alternative route' **3C** if he wants to see another possible route: the system then recalculates a route, not using at least 80% of the roads from the prior route. If that route is still unsuitable, the user can obtain another alternative route again by selecting again 'alternative route' **3C**.

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