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(54) PERSONAL GPS NAVIGATION DEVICE

(76) Inventor: **Pieter Geelen**, Hilversum (NL)

Correspondence Address:
Woodbridge & Associates, P.C.
P.O. Box 592
Princeton, NJ 08542-0592 (US)

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(52) **U.S. Cl.** **701/213**; 342/357.06; 701/200

(57) **ABSTRACT**

A personal GPS navigation device capable of simultaneously displaying a map, an indication of the current position of the device on the map and a GPS signal strength indicator. The device differs from the prior art in displaying a GPS signal strength indicator at the same time as the navigation map and hence does not require a user to leave the navigation mode to call up a separate GPS information screen in order to see the GPS signal strength. The GPS navigation device of this invention is further capable of displaying icons indication Points of Interest, whose display may be prioritised by type or by density of occurrence. The GPS of this invention is further able to calculate a speed of the device and use that speed to change the zoom of the map. The device is also able to change map zoom as the device approaches route situations requiring complex decisions.

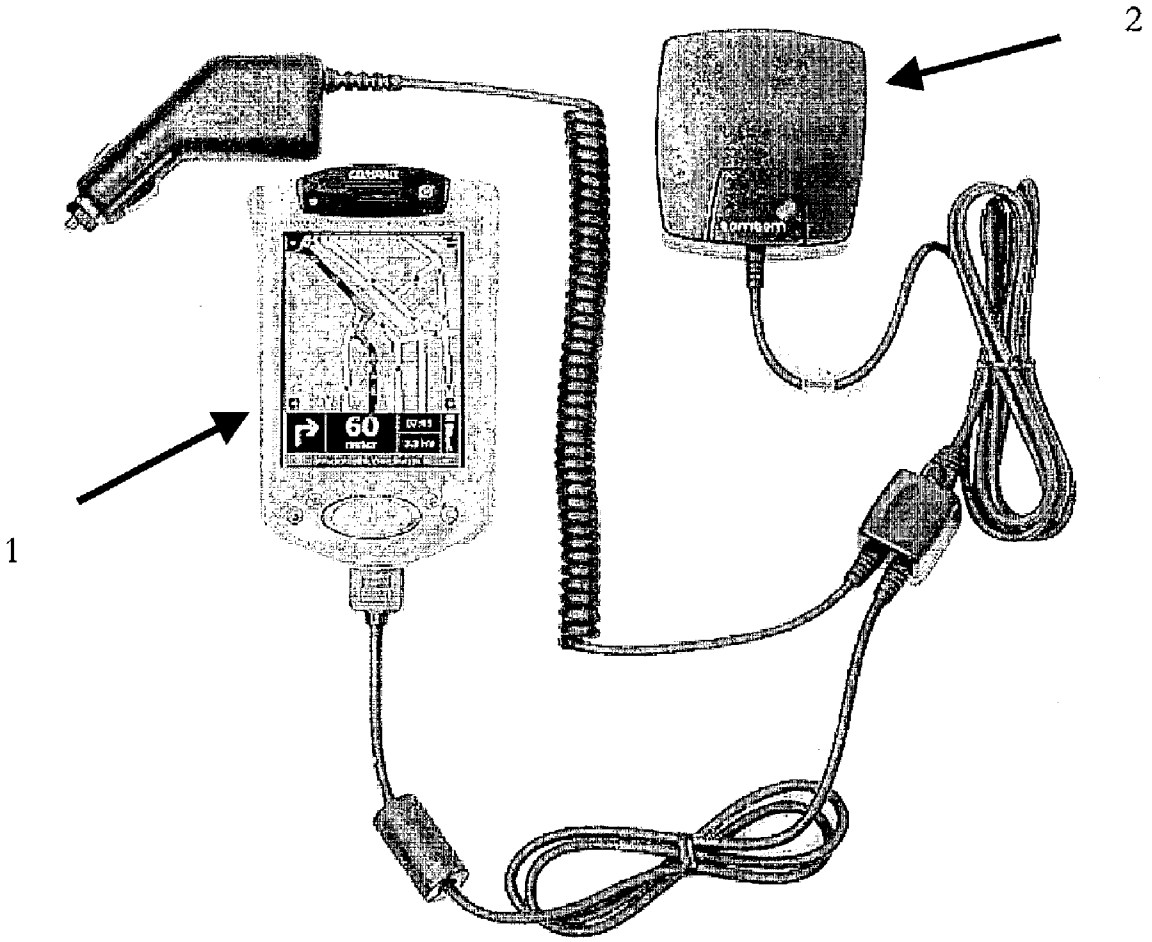


Figure 1A

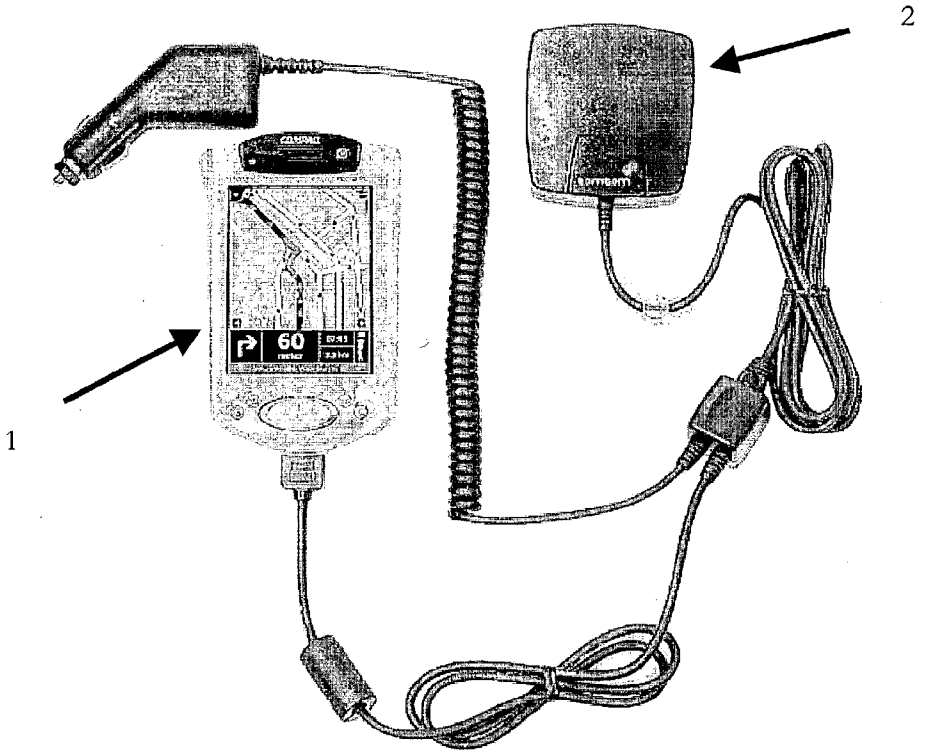


Figure 1B

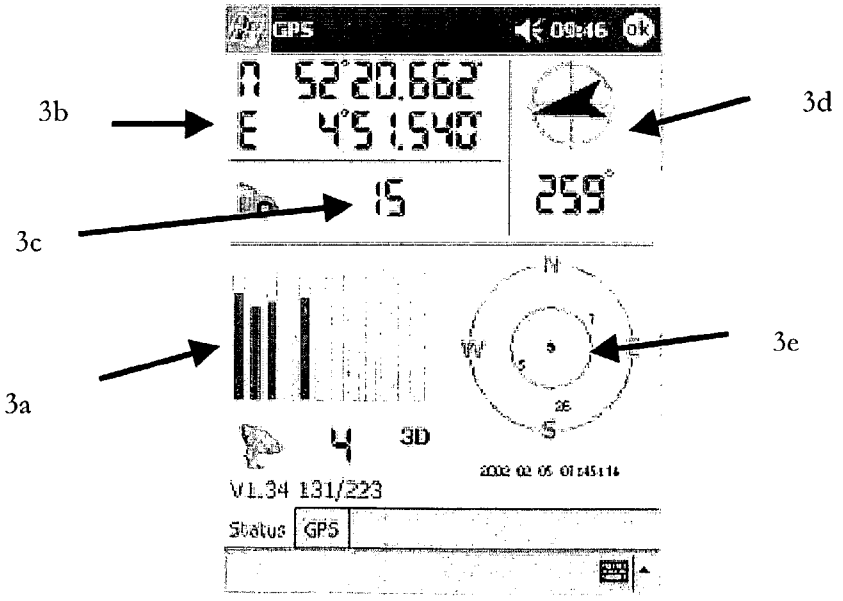


Figure 2A

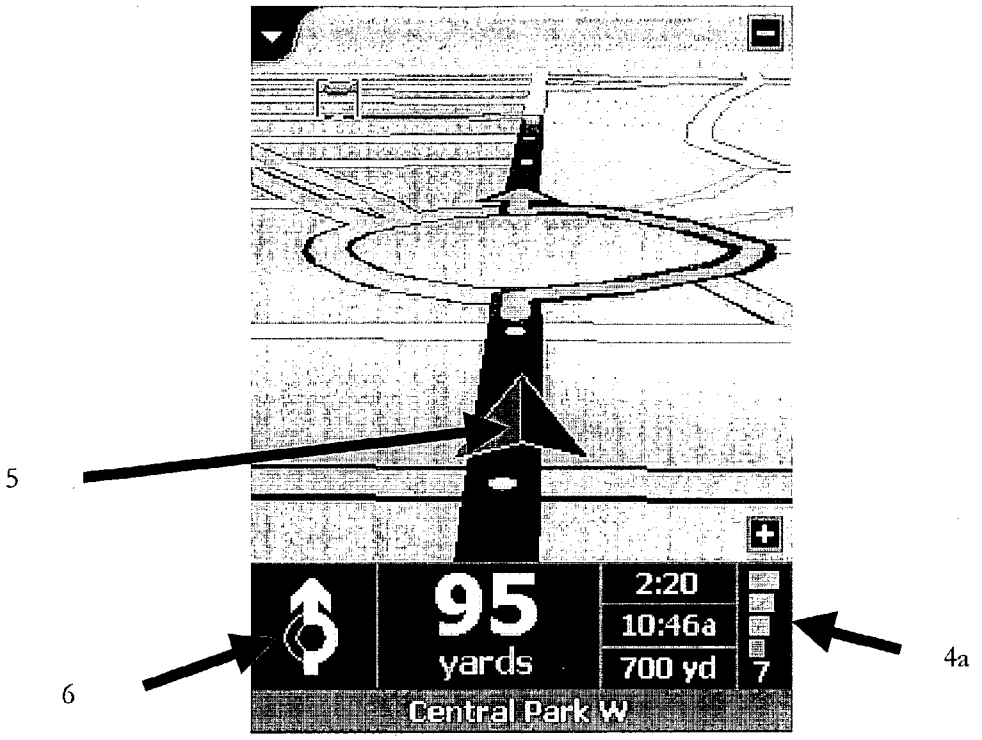


Figure 2B

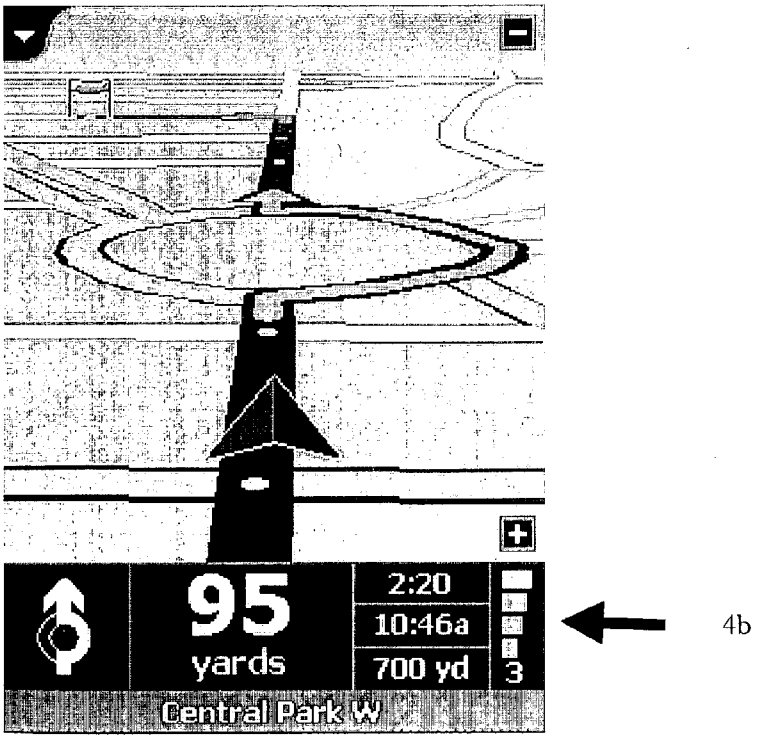
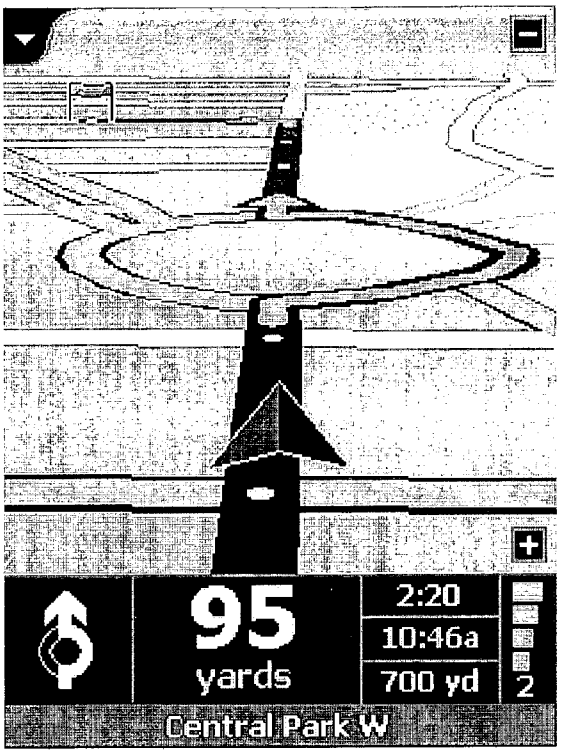
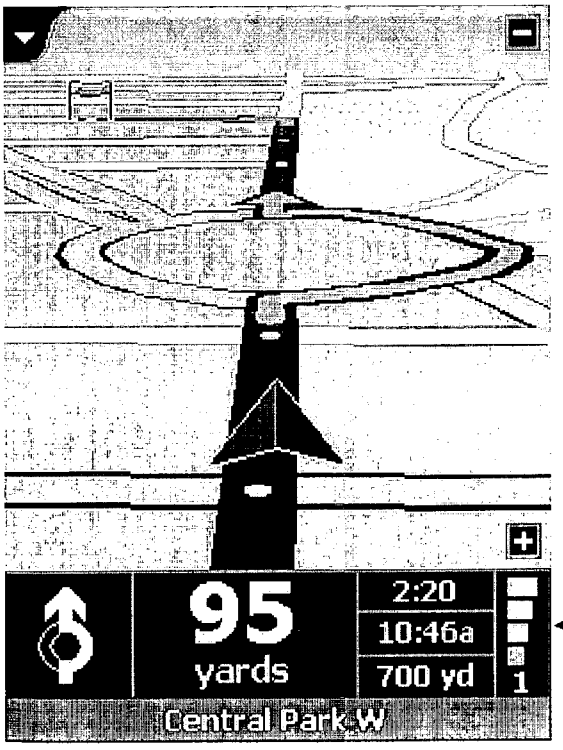


Figure 2C



4c

Figure 2D



4d

Figure 2E

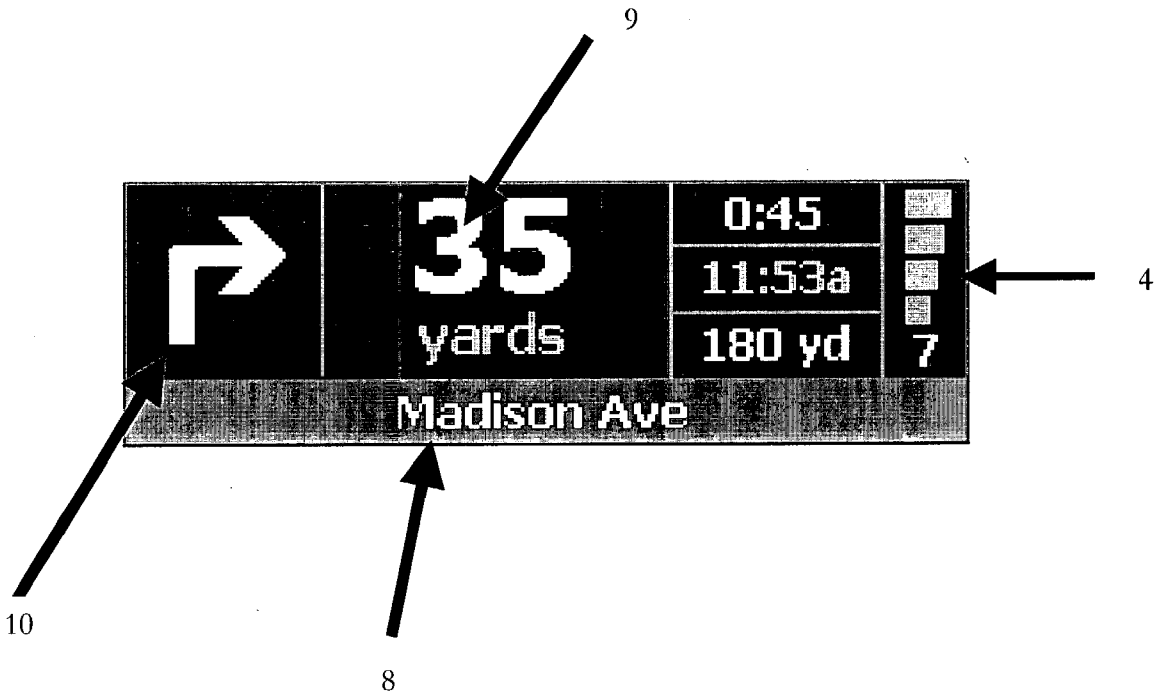
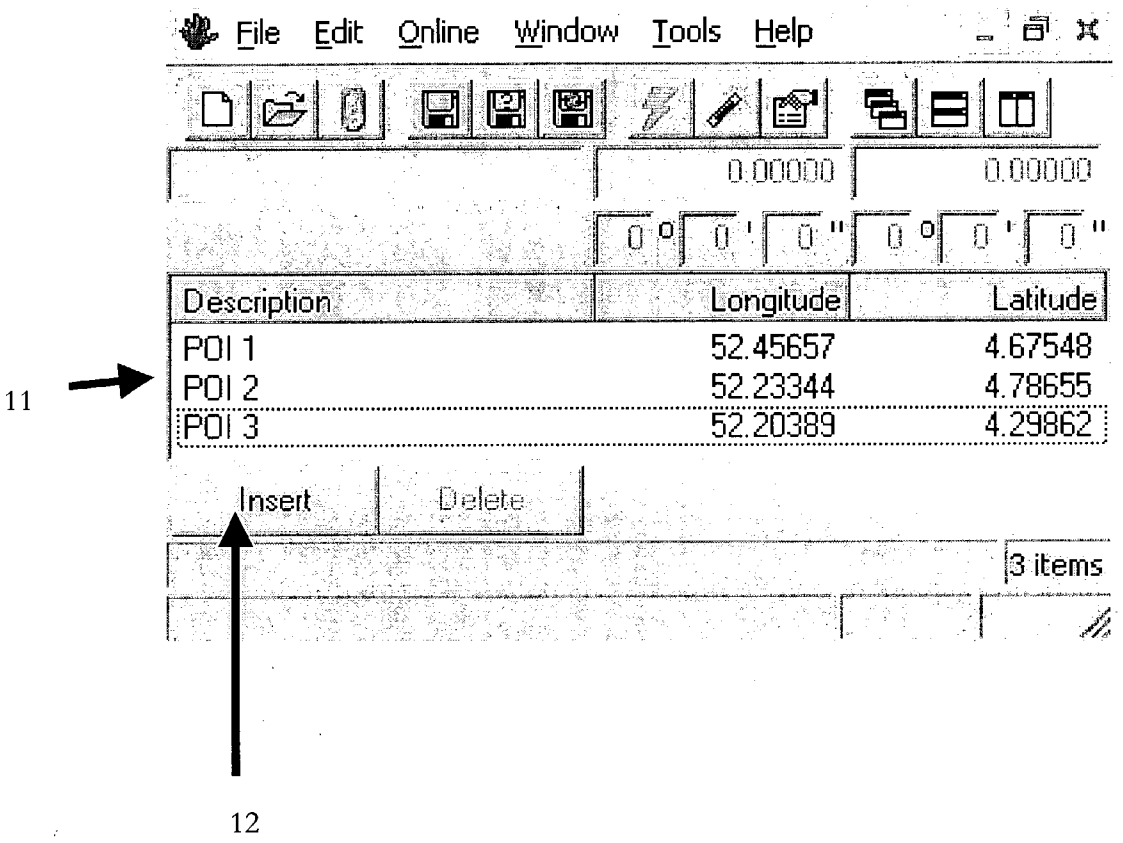


Figure 3


File
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Description
Longitude
Latitude
POI 1
52.45657
4.67548
POI 2
52.23344
4.78655
POI 3
52.20389
4.29862
Insert
Delete
3 items
11
12

Figure 4A

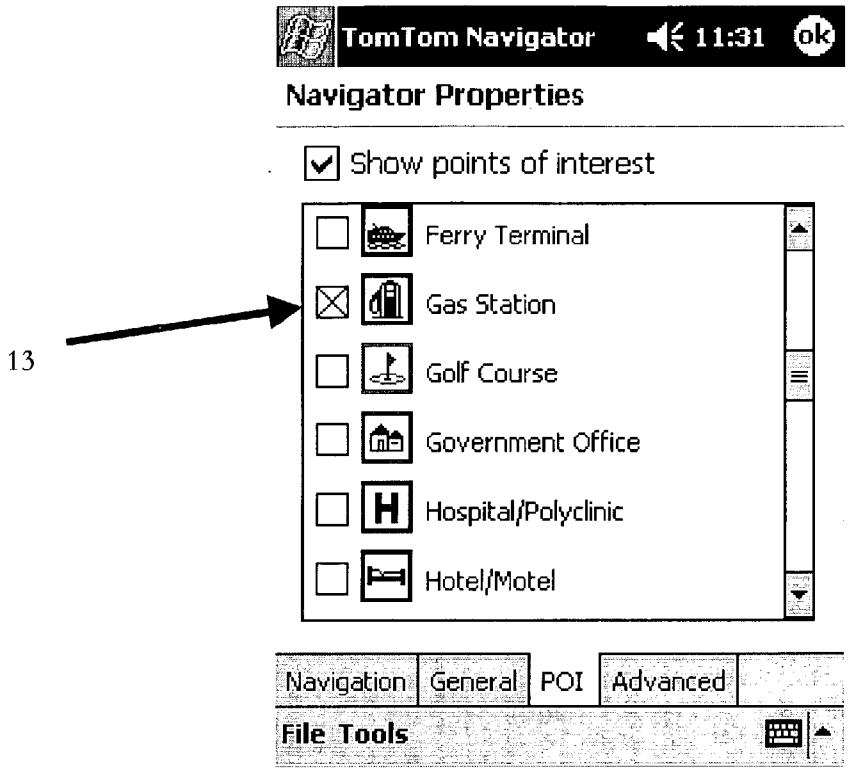


Figure 4B

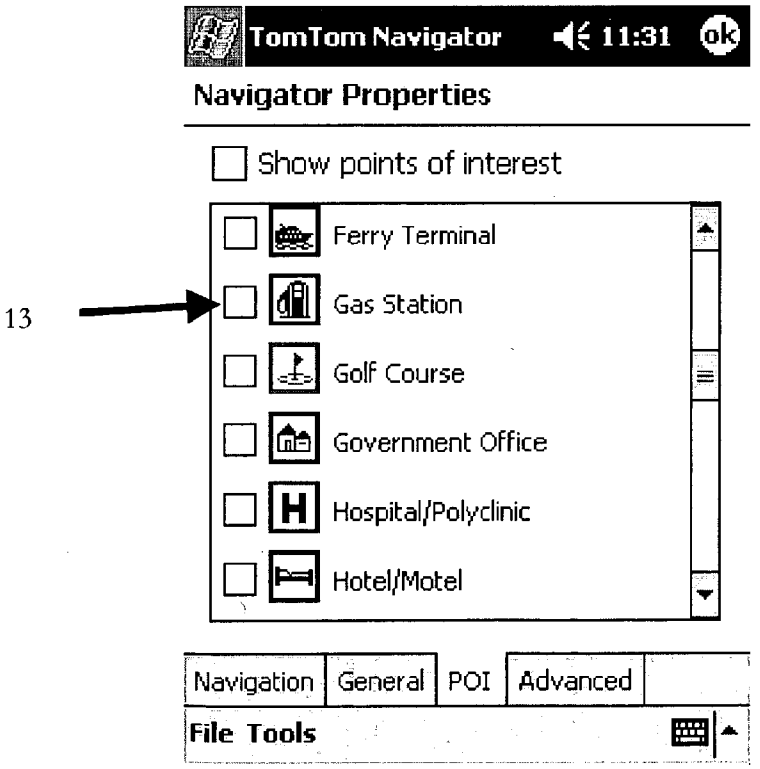


Figure 5A

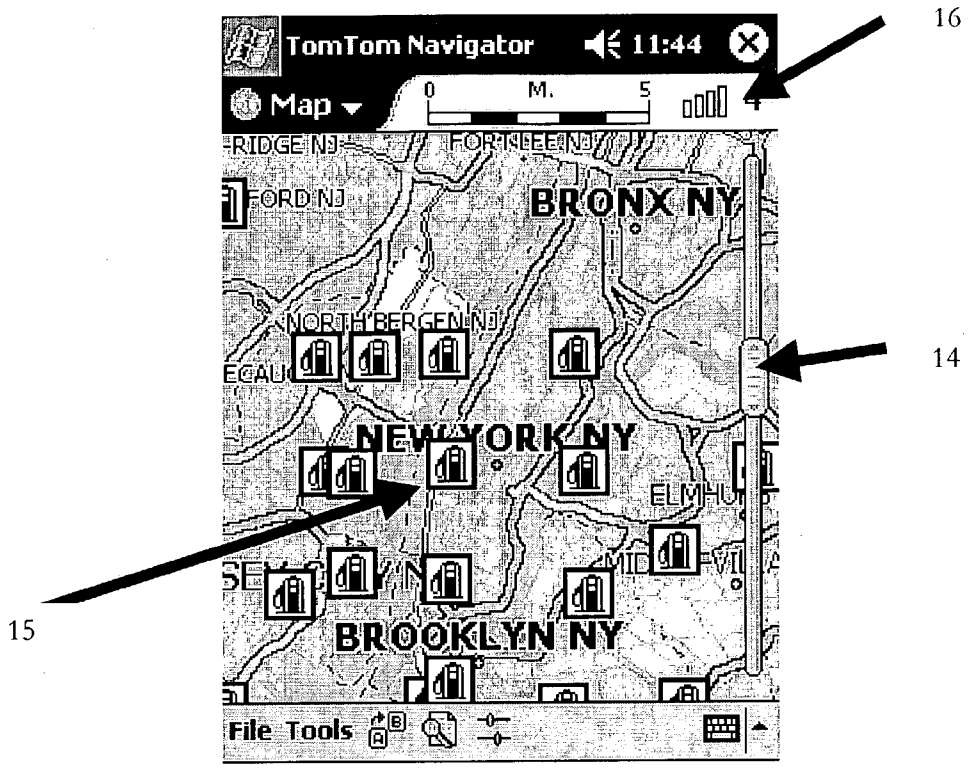


Figure 5B

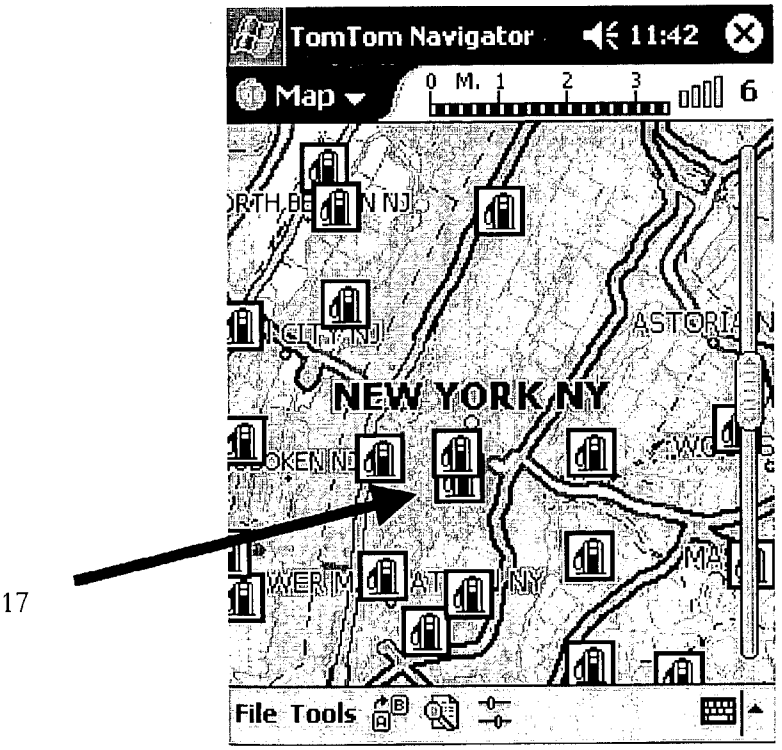
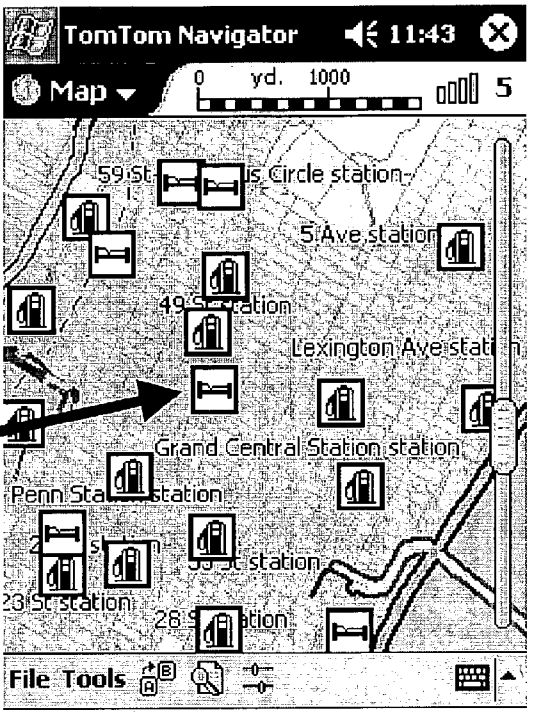


Figure 5C



18

Figure 5D

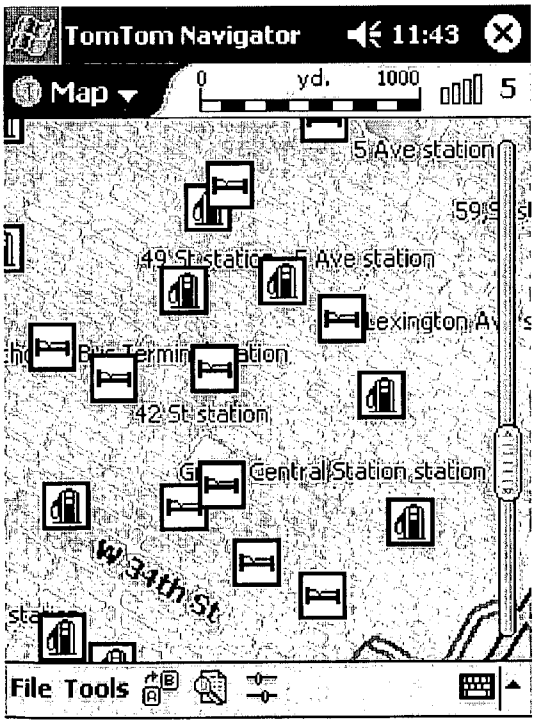
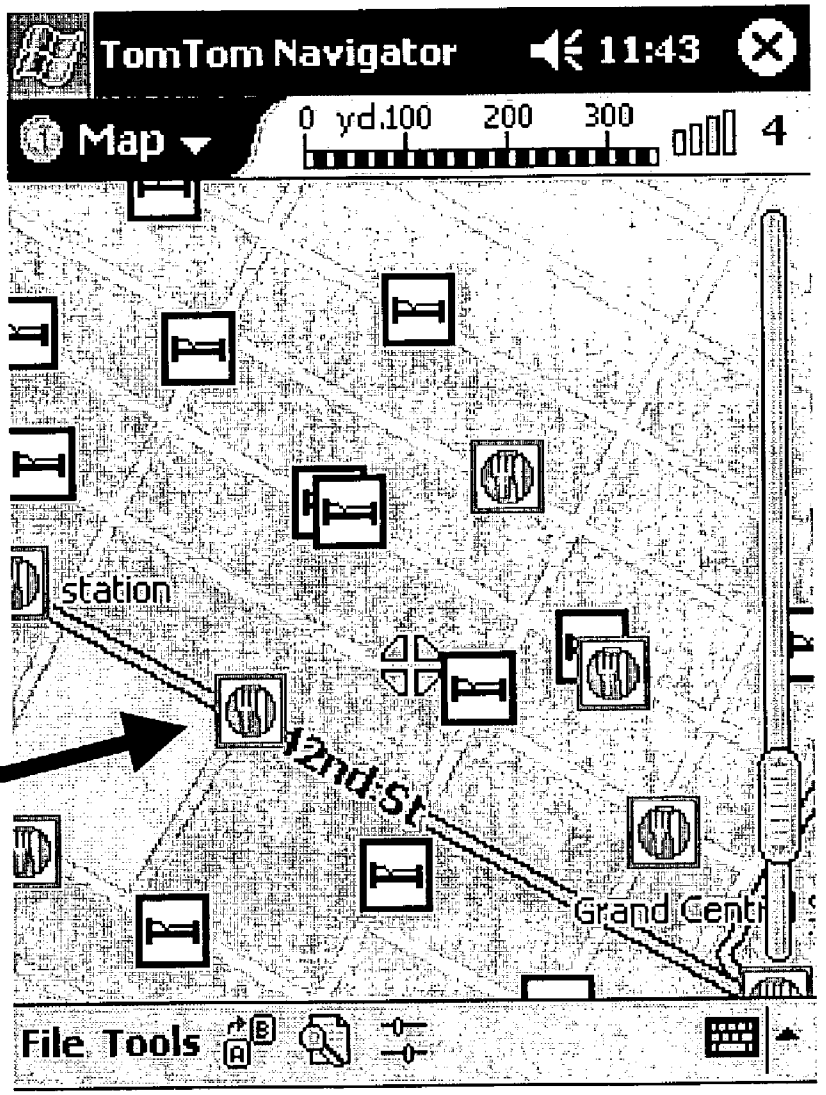


Figure 5E


TomTom Navigator
11:43
Map
0 yd.100 200 300
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station
12nd St
Grand Centi
File Tools
19

Figure 6A

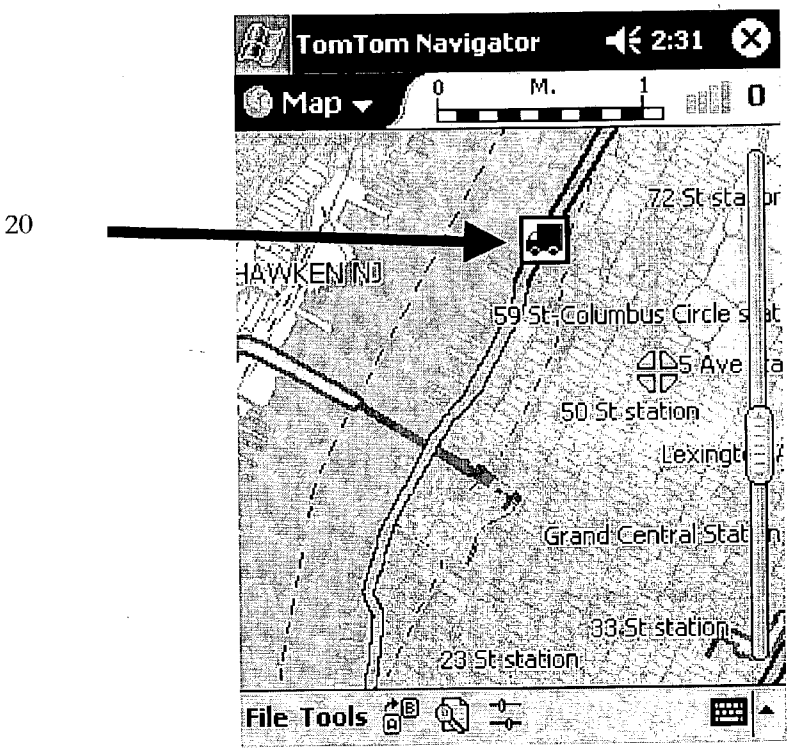


Figure 6B

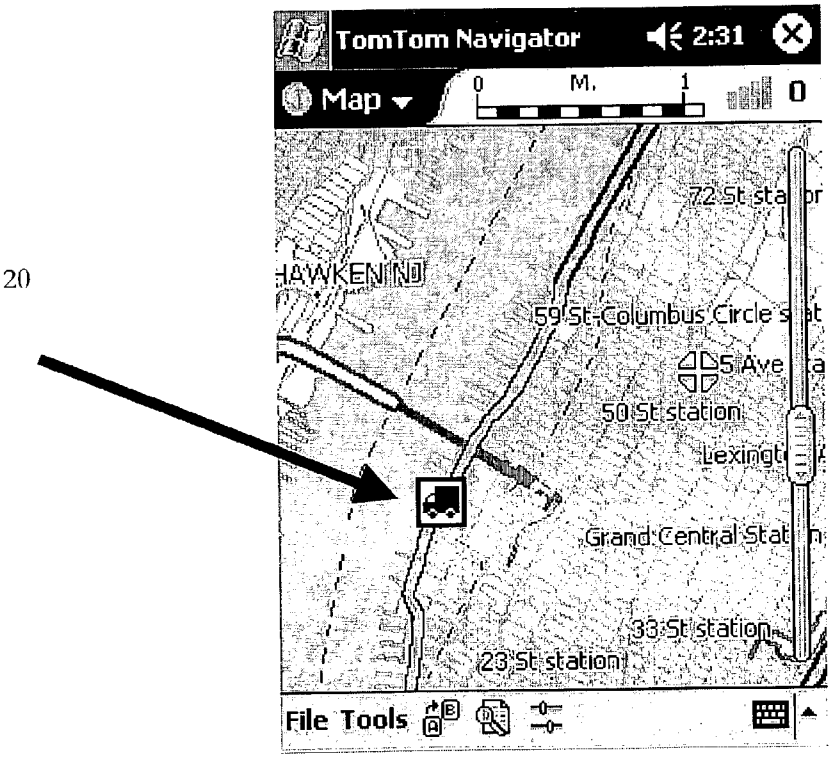


Figure 7A

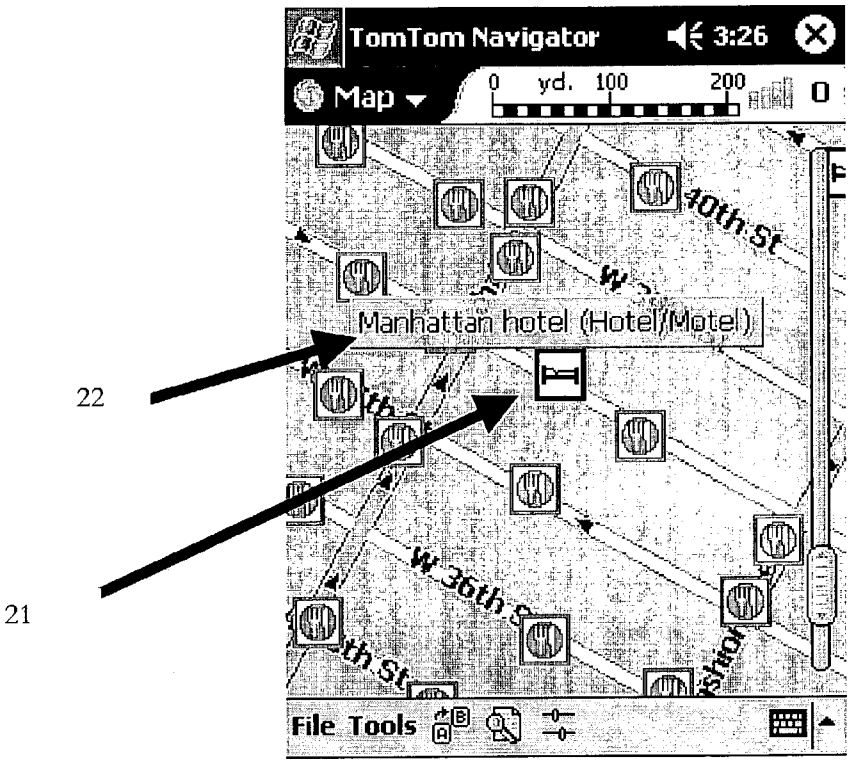
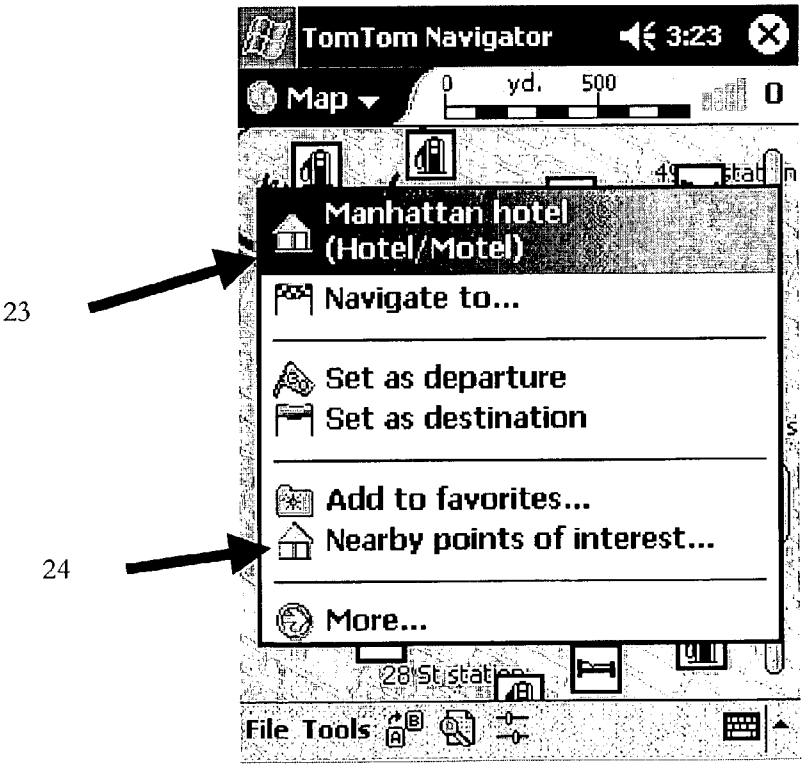


Figure 7B



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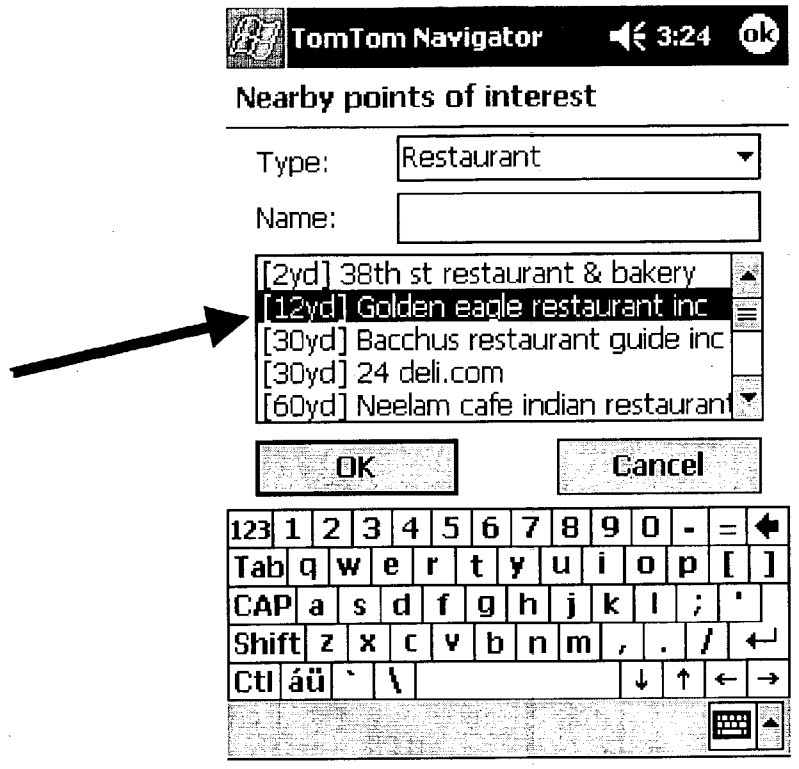


Figure 7D

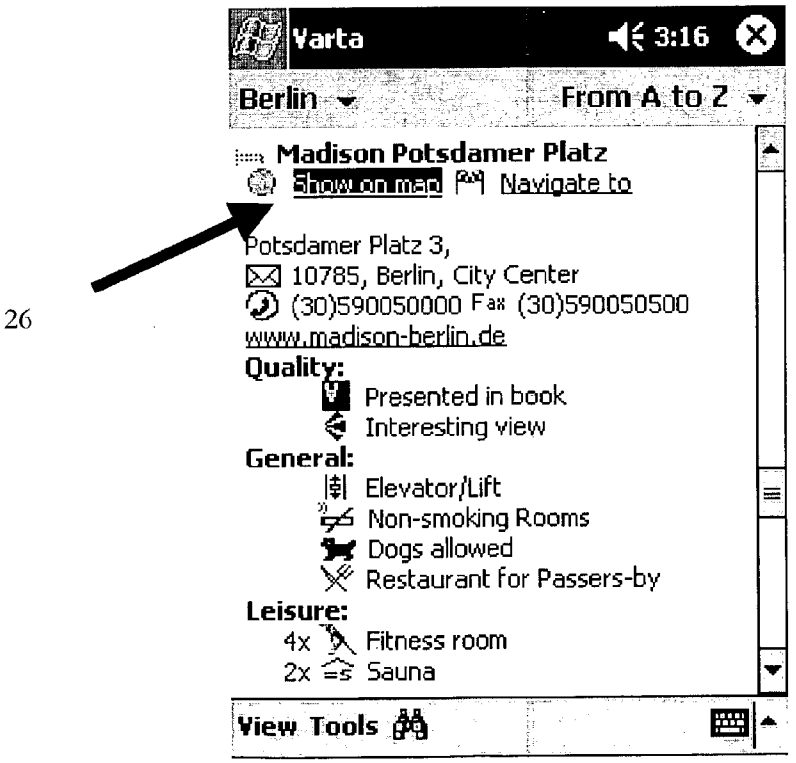
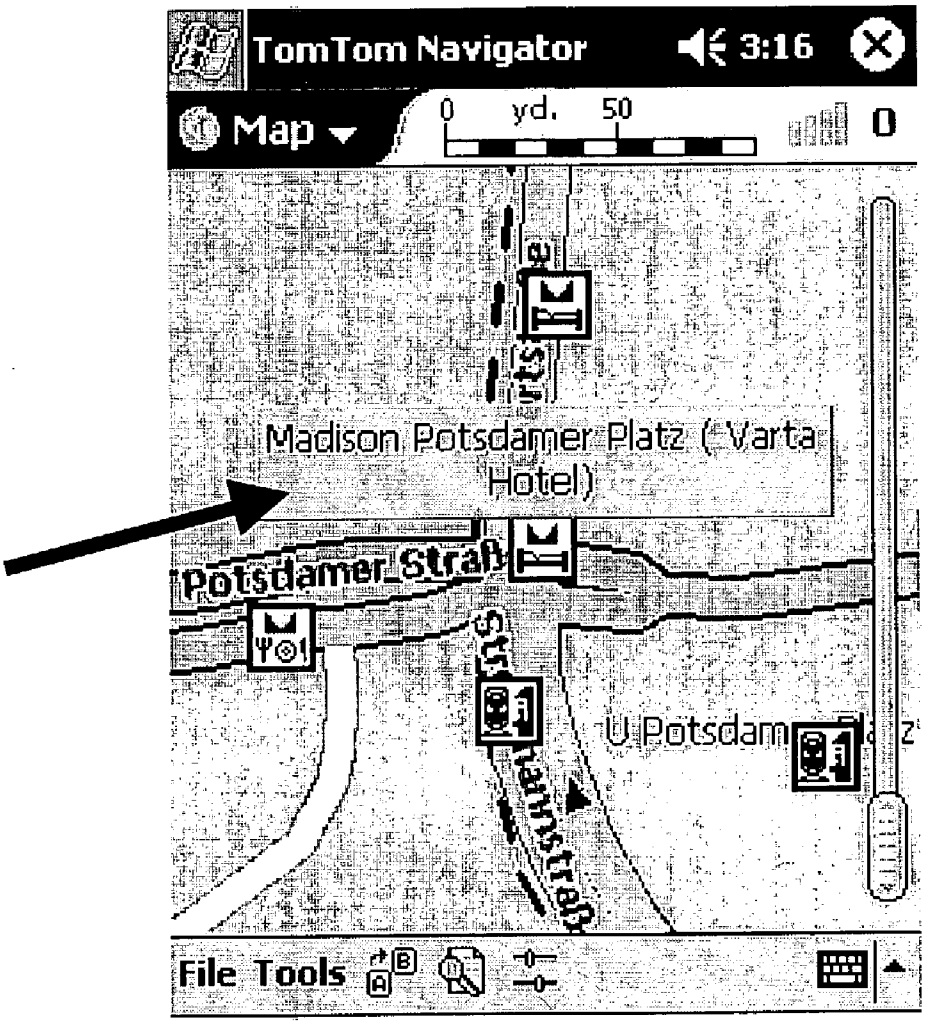


Figure 7E


TomTom Navigator
3:16
Map
0 yd. 50
0
Madison Potsdamer Platz (Varta Hotel)
Potsdamer Straß
U Potsdam
File Tools

27

Figure 8A

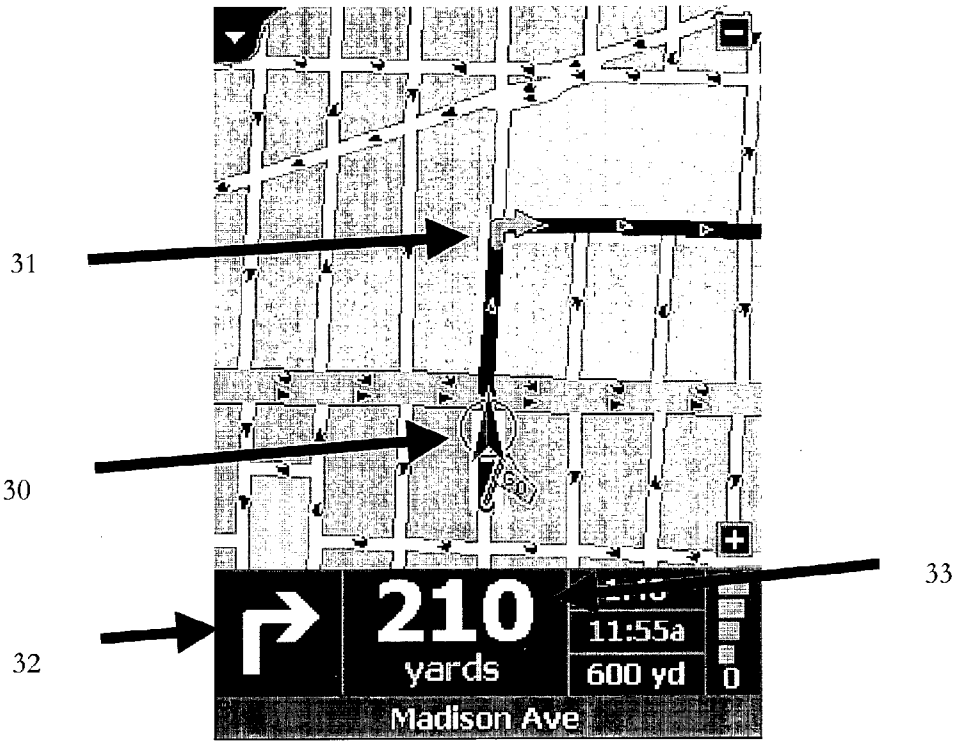


Figure 8B

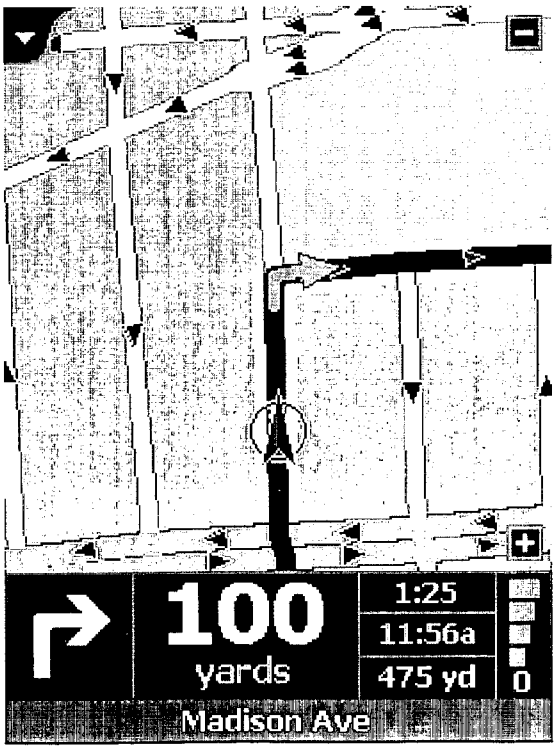


Figure 8C

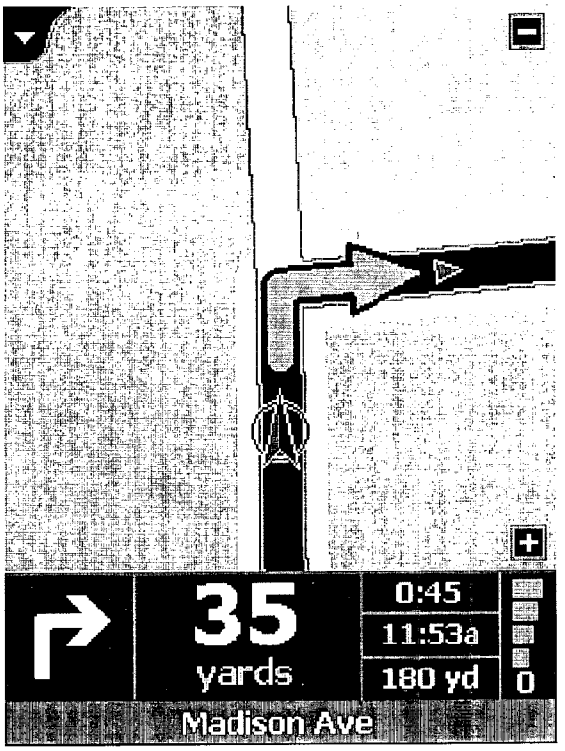


Figure 8D

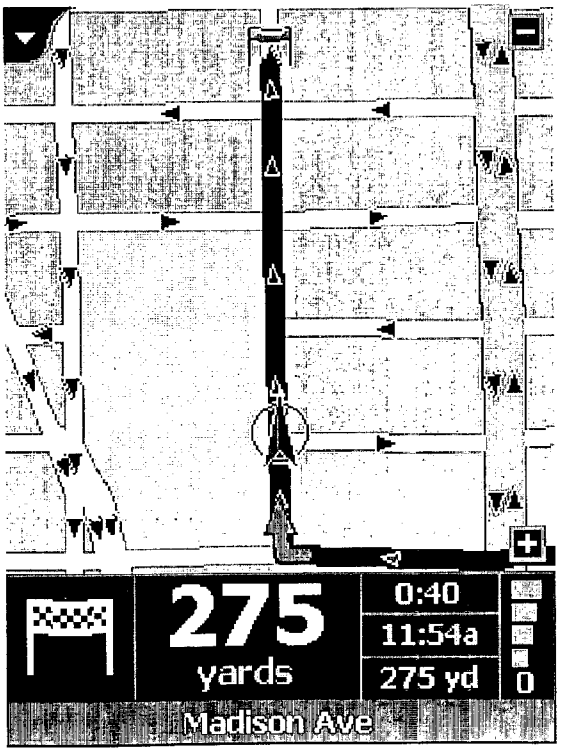


Figure 9A

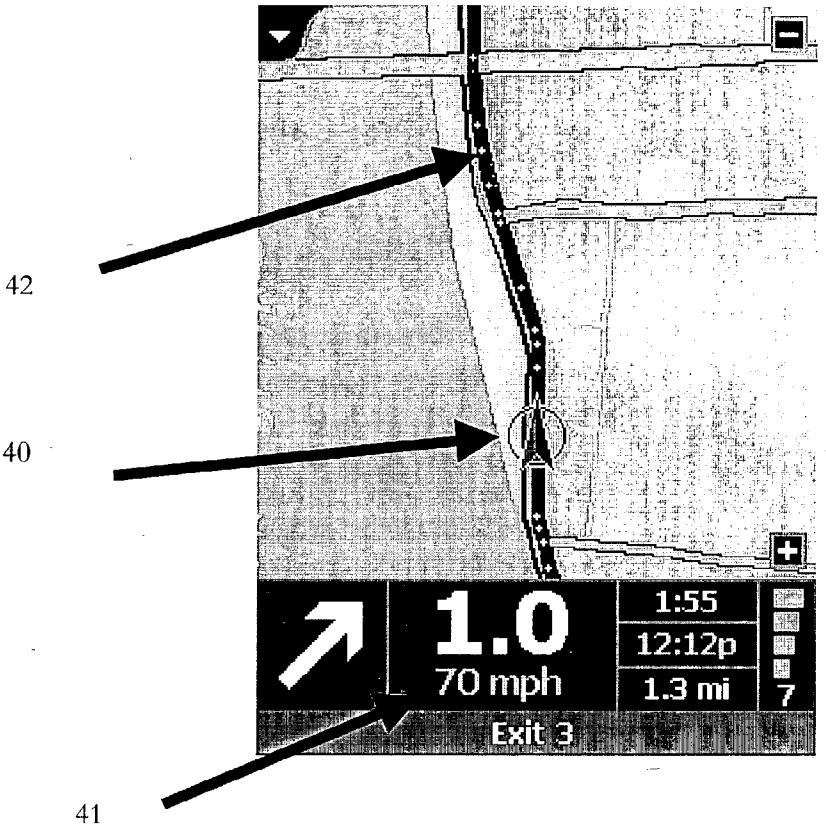


Figure 9B

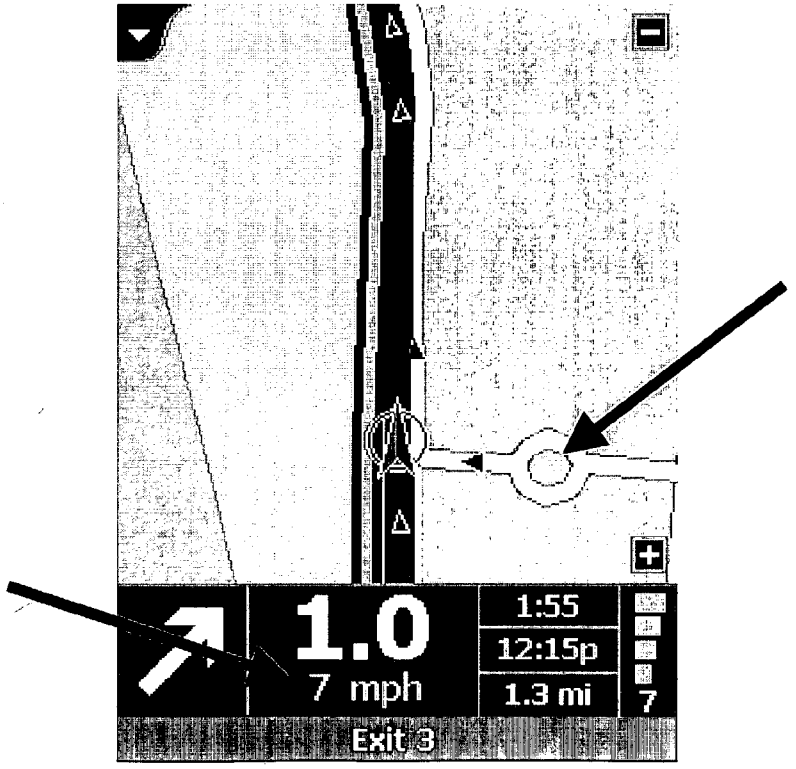
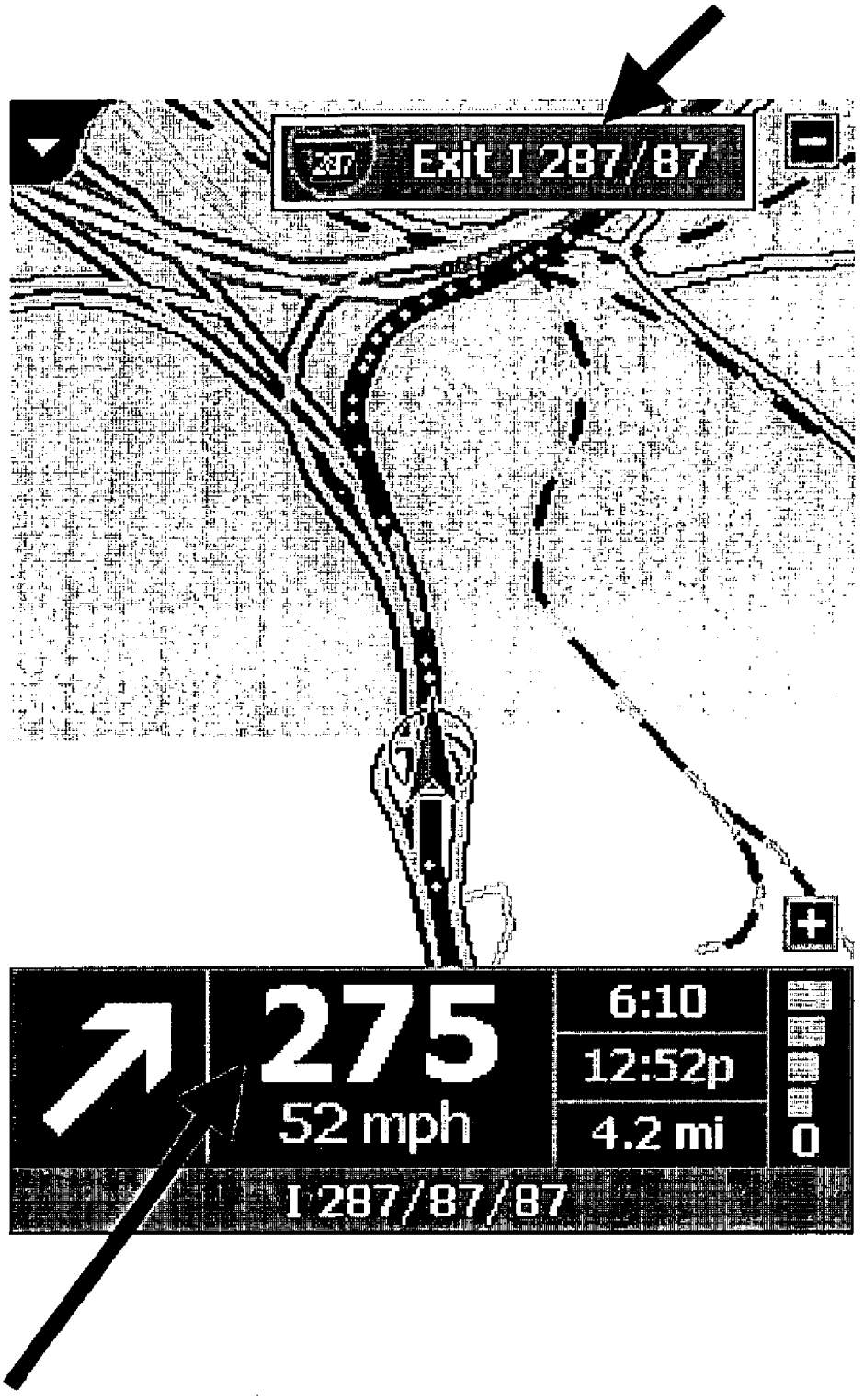


Figure 10A

50

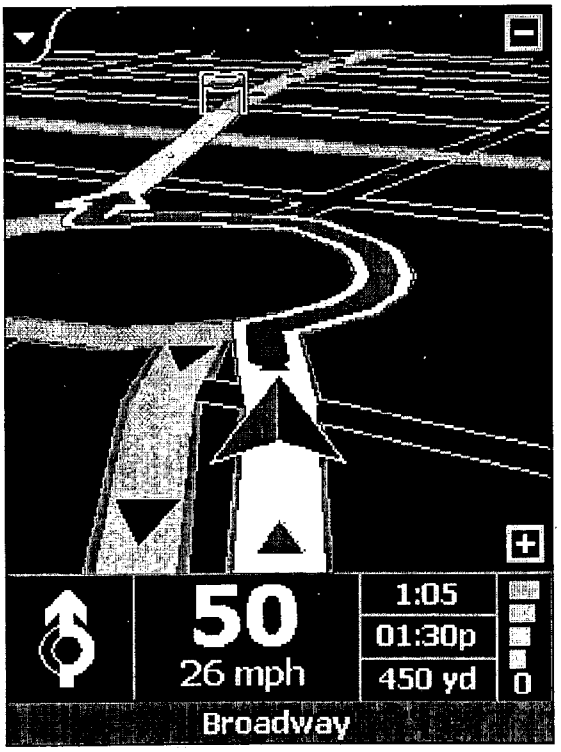


51

Figure 11A



Figure 11B



PERSONAL GPS NAVIGATION DEVICE

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] This invention relates to a personal GPS navigation device. A personal GPS navigation device is any electronic device that can process GPS location data and display the location of the device on a map. The device may be a dedicated navigation device, or a general purpose electronic device, such as a personal digital assistant, smart phone, mobile telephone, laptop or palmtop computer. The device may be portable or fixed in a vehicle.

[0003] 2. Description of the Prior Art

[0004] Personal navigation devices are becoming increasingly common. A particularly successful approach is to connect a PocketPC™ powered PDA (personal digital assistant) to a GPS receiver: the PDA, when running navigation software, becomes a GPS based personal navigation device. Another successful format is the dedicated GPS device, used by hikers, sailors etc. In some countries, mobile telephones will have to be equipped with a GPS receiver in order to be able to send the location of that telephone in the event of an emergency, greatly increasing the adopting of GPS technology as a mass-market technology. Portable GPS receiver devices have also been used in personal safety devices as described in, for instance, U.S. Pat. No. 6,480,557 to Rog, et al. entitled "Portable GPS-receiver for a personal safety system", the contents of which are hereby incorporated by reference.

[0005] GPS device have also been incorporated into road vehicles and integrated into road map data bases to provide navigation and vehicle tracking systems as described in, for instance, U.S. Pat. No. 4,837,700 to Ando, et al. entitled "Method and apparatus for processing data in a GPS receiving device in a road vehicle" and U.S. Pat. No. 5,225,842 to Brown, et al. entitled "Vehicle tracking system employing global positioning system (GPS) satellites", the contents of both of which patents are hereby incorporated by reference.

[0006] One common feature of current personal GPS navigation devices is that they can display a GPS information screen, such as the screen shown in **FIG. 1B**. The GPS information screen shows: how many GPS satellite signals are being received and their individual strength at **3***a;* the location co-ordinates of the device at **3***b;* the speed of the device at **3***c;* the direction of movement of the device at **3***d;* the relative orientation of GPS satellites that a signal is being picked up from at **3***e*. The GPS information screen is useful when getting a first GPS fix. Once a fix has been established, most users then switch to the map mode, which causes a map to be displayed on the screen of the personal navigation device, indicating the location of the device with an arrow.

SUMMARY OF THE PRESENT INVENTION

[0007] In a first aspect, a personal GPS navigation device is programmed to display, at the same time, each of the following:

[0008] (a) a map;

[0009] (b) an indication of the current position of the device on the map; and

[0010] (c) a GPS signal strength indicator.

[0011] Hence, the device differs from the prior art in displaying a GPS signal strength indicator at the same time as the navigation map (e.g. when the device is in navigation mode) and hence does not require a user to leave the navigation mode to call up a separate GPS information screen in order to see the GPS signal strength. This is very useful, particularly for ordinary consumers, who can see at a glance if the reason that location tracking has been lost is because the received GPS signals are inadequate. (The approach is similar to how network coverage is shown on both the idle screen of a cellular mobile telephone and when a voice call is being made: it is very useful to have the strength of the network coverage graphically represented on the screen that is seen when actually about to make/receive or actually making a voice call.)

[0012] In one implementation, the GPS signal strength indicator comprises several bars, with all bars being visible if the strength of the received GPS signal exceeds a predefined requirement and none visible if the GPS signal strength is below a second predefined requirement. The term 'bar' should be expansively construed to cover any region, icon, graphic of any shape that can visually represent a signal strength level. The GPS signal strength indicator can be part of the main display used to display the map or can be discrete, separate hardware entirely, such as LED indicators on the housing of the device. A bar is 'visible' if it is readily visually differentiated from other bars; these other bars may still be visually apparent, but in a less prominent manner than a 'visible' bar.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The present invention will be described with reference to the accompanying drawings, in which

[0014] **FIG. 1A** is a photograph of a personal GPS navigation device according to the present invention;

[0015] **FIG. 1B** is a prior art GPS information screen;

[0016] **FIGS. 2A-2D** are screen shots from an implementation showing a GPS signal strength indicator at varying levels;

[0017] **FIG. 2E** is an expanded view of the navigation bar from an implementation, showing the GPS signal strength indicator in more detail;

[0018] **FIG. 3** is a screen shot from an implementation showing how Point of Interest data can be inserted into a database running on the device;

[0019] **FIGS. 4A-4B** are screen shots from an implementation showing how different kinds of Point of Interest icons can be selectively enabled/disabled for display;

[0020] **FIGS. 5A-5E** are screen shots from an implementation showing how Point of Interest icons can be prioritised to reduce screen clutter;

[0021] **FIGS. 6A-6B** are screen shots from an implementation showing how moving Point of Interest icons can be displayed;

[0022] **FIGS. 7A-7E** are screen shots from an implementation showing how actions can be associated with a Point of Interest icons;

[0023] **FIGS. 8A-8D** are screen shots from an implementation showing how map auto-zooming occurs when approaching a decision point;

[0024] **FIGS. 9A-9B** are screen shots from an implementation showing how the map simplifies at higher speeds;

[0025] FIGS. **10**A-C are screen shots from an implementation showing how the next major route change is displayed.

DETAILED DESCRIPTION

[0026] The present invention will be described with reference to an implementation from Palmtop Software BV of Amsterdam, Netherlands called TomTom Navigator™. Referring to **FIG. 1**, the TomTom Navigator GPS system runs on a PocketPC powered DPA, such as the Compaq ipaq **1** and comprises a GPS receiver **2** and navigation software running on the Compaq ipaq **1**.

[0027] In the TomTom Navigator GPS system, routes/roads are described in a database running on the personal GPS navigation device as lines—i.e. vectors (i.e. 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 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.

[0028] Route calculation uses complex algorithms applied to score large numbers of potential different routes. Once a route is calculated by the PDA, the PDA in effect has stored in a database a sequence of road names and actions to be done at predetermined distances along each road of the route (e.g. after 100 meters, turn left into street x).

[0029] 1. GPS Signal Strength Indicator

[0030] FIGS. **2**A-D show a typical navigation screen (aerial view) created by the TomTom Navigator GPS system for a vehicle driving down Central Park West in New York, N.Y., USA. The position of the vehicle is given by the arrow **5**. A navigator bar, indicated generally at **6**, includes essential navigation information. It also includes a GPS signal strength indicator **4**. The GPS signal strength indicator **4** is visible in normal navigation mode and hence there is no need to task away to a separate GPS information screen to see this information; minimising the need to task away from the main navigation mode screen (showing the map and current vehicle location) is very useful as the device is meant to be used as an in-vehicle navigation system and driver distractions need to be at a minimum. Further, its apparent similarity to the familiar network coverage indicator in a mobile telephone screen makes it an easily understood user interface element.

[0031] The GPS signal strength indicator **4** consists of 4 bars with the following functional meanings:

[0032] 4 bars **4***a* visible: Received GPS signal is strong enough to give 3D fix at high level of accuracy **(FIG. 2A)**

[0033] 3 bars **4***b* visible: Received GPS signal is strong enough to give a 3D fix; **(FIG. 2B)**

[0034] 2 bars **4***c* visible: Received GPS signal is strong enough to give a 2D fix **(FIG. 2C)**

[0035] 1 bar **4***d* visible: Received GPS Signal is present, but not strong enough to obtain a position fix **(FIG. 2D)**

[0036] 0 bars visible: No signal detected.

[0037] **FIG. 2E** shows the navigation bar **6** in more detail. It includes the following:

[0038] GPS signal strength indicator **4**. An indication of the number of satellites from which GPS signals are being received is also give—in this case **7**.

[0039] Name **8** of the current road or route being travelled along (Madison Aveneue in this case)

[0040] Distance to next turning to be taken **9** (35 yards in this case)

[0041] Nature of next turning to be taken **10** Cm this case, a right turn).

[0042] Further UI Features

[0043] The following features are also present in the TomTom Navigator GPS system. Each may be used independently of any other feature (and independently of displaying the GPS signal strength indicator with the map in navigation mode).

[0044] 2. Ability to Download POI

[0045] POIs are points of interest, such as museums, restaurants, petrol stations etc. The TomTom Navigator GPS system comes pre-loaded with several thousand POIs, which can automatically appear on a displayed map. POIs exist as a POI type and a longitude and latitude position in the TomTom Navigator GPS system database resident on the device.

[0046] An enhancement to the conventional use of POIs is to enable them to be downloaded to the device (e.g. over the internet or a wireless connection (using SMS or WAP etc) and inserted into the database. **FIG. 3** shows the menu screen listing three new POIs **11**, with location data; the user can choose to insert these into his database by selecting the 'insert' button **12**.

[0047] This approach enables third parties to supply POIs from a remote database over a WAN, with possibilities for promoting different POIs. For example, a national chain of gas stations could allow users to download to their personal GPS navigation devices the location of all of its gas stations, which could then be displayed with the correct logo at the correct map locations. The logos could also animate to draw attention to themselves. Location based advertising is also possible (for example, a department store with a sale on could allow POIs of its stores with a special 'Sale' logo to be downloaded). User can also create their own new categories of POIs and exchange them with others: hence, POIs for special interest categories can evolve, driven by the needs of users. An example might be that photographers could generate POIs for locations with outstanding views and store these POIs on not only their own personal GPS navigation devices, but also exchange them with other photographers. Motorists could identify particularly enjoyable roads with a new POI type and exchange these with others. Virtually any kind of location information can be

categorised with a POI and hence captured in the TomTom Navigator GPS system database resident on the device for display on a map and also exchange with other users.

[0048] 3. POI Selection

[0049] Proliferating the nature of possible POI stored could lead to considerable screen clutter, with much irrelevant information. Printed maps, for example, frequently include too much POI data, making it difficult to find a specific kind of POI of interest. The TomTom Navigator GPS system addresses this by listing all POI types and allowing the user to select which particular types are to be displayed: **FIGS. 4A and 4B** show a typical selection of POI types; only the checked item(s) will be displayed on a map: in this case, only gas stations, as shown in **FIG. 4A** since only the gas station POI check box **13** is selected. **FIG. 4B** shows that check box de-selected: no gas stations will now be displayed on the map in navigation mode.

[0050] 4. POI Prioritization

[0051] The TomTom Navigator maps are divided into grid cells (Navigator 1.0, for instance, uses a 4×5 grid). Within each cell, only a single POI is displayed on a map at a time. This reduces screen clutter. FIGS. **5**A-E show a map of New York at progressively greater enlargement; enlargement is increased by the user moving the zoom control **14** down. Hence, in **FIG. 5A**, there is a single gas station indicated as being present in the central Manhattan area **15**. (As an aside, it should be noted that GPS signal strength indicator is still apparent at **16**). Zoomed in, as shown in **FIG. 5B**, there are three gas stations **16** in central Manhattan. Zoomed in still further, as shown in **FIG. 5C**, there are many more now shown, plus POIs of other types, such as hotels (the bed icons, **18**). Zooming in further still, **FIG. 5D**, shows even more POIs. Further still, **FIG. 5E**, shows restaurants (icon **19**), as well as all hotels.

[0052] This logical introduction of different POI types, dependent on the zoom level is based on certain POIs (low-density POIs, like gas stations and amusement parks) being displayed in priority over others (high density POIs like restaurants). Further, certain high-density POIs are not displayed at all any more if you zoom out beyond a certain threshold (e.g. no restaurant POIs if map shows more than a certain number of square miles).

[0053] 5. Moving POIs

[0054] Another useful feature of the TomTom Navigator GPS system is that POIs do not need to have a fixed location in the database: their location in the database can be regularly, continuously or occasionally updated to show a new location; when this happens, the associated POI icon's position on the map will automatically move to the newly defined location. This feature is useful for tracking assets (e.g. vehicles; people too) and utilises the feature note earlier of sharing POI data: a vehicle could send regular SMS messages with its current location (using its own GPS system) to a mobile telephone equipped personal GPS navigation system, which could then use the location co-ordinates in the SMS message to update a POI uniquely associated with that vehicle. As the vehicle location alters, its position will change on the map, as shown in **FIGS. 6A and 6B**, where truck **20** can be seen moving down the route. Hence, a very low cost, yet sophisticated, asset tracking system can be deployed using this approach.

[0055] 6. Associating an Action with a POI

[0056] Selecting a POI can trigger a related action, such as opening a window with information about or functions relating to the POI, or a communication application that enables the user to call/text etc. that POI, or a browser window that opens a web page relating to that POI. Triggering may be direct or indirect (i.e. there are intervening steps).

[0057] **FIGS. 7A and 7B** illustrate opening a window with functions relating to the POI—in **FIG. 7A**, the user has selected the icon for Manhattan Hotel **21**: when he does this, the name of the hotel **22** is displayed above the hotel POI icon. When the user selects the name **22**, pop up menu list (**23** in **FIG. 7B** appears). Window **23** lists various functions relating to the Manhattan Hotel, such as navigating to it (i.e. making it the destination for a route calculation algorithm; the TomTom Navigator software then calculates a route from the current location to the Manhattan Hotel). Another option is "Nearby points of interest'**24**; if selected, a list of nearby POIs is shown, **FIG. 7C**, in ascending order of distance from the hotel. The user can see that 12 yards from the Manhattan Hotel is the Golden Eagle restaurant **25**. If the user selects this entry **25**, then more information on it is shown, including various contact numbers. **FIG. 7D** shows the information for a different hotel, this time in Berlin; if the user selects the web URL, then the device opens a browser window and opens the requested web page. If the user touches the telephone number, it is automatically called (assuming the device has phone capabilities). If the user selects the 'Show on map' item **26**, the hotel **27** is shown again on the map, a seen in **FIG. 7E**.

[0058] 7. Auto-Zooming of Map as Car Nears a Decision-Point

[0059] Another feature is that the map will automatically zoom-in when approaching a decision point, such as s turning, roundabout, intersection, merge etc. This ensures that the user can see detail when he needs it, without giving too much detail when it is not needed.

[0060] FIGS. **8**A-D show the user **30** turning right. In **FIG. 8A**, the user **30** can see that there is a right turn ahead from the map at **31** and from the right turn arrow **32** on the navigation bar. The navigation bar shows that the turning is 210 yards ahead **33**.

[0061] As the user approaches the turn, the map progressively and automatically zooms in so that, at 100 yards from the turning, **FIG. 8B**, the scale is considerably greater. 35 yards from the turning, **FIG. 8C**, and the scale has increased even more. After the turn has been completed, the zoom returns to its default zoom level, **FIG. 8D**.

[0062] 8. Auto-Zooming Depending on the Speed of the Car

[0063] **FIG. 9A** shows the vehicle **40** travelling at 70 mph (see navigation bar at **41**) along route **42**. If the user were instead traveling at 7 mph, as shown in **FIG. 9B**, then the map would be automatically zoomed in to show more detail. This ensures that the user can see the map extending far enough ahead to allow timely decisions to be made. In effect, the user sees a certain number of seconds ahead rather than a certain distance.

[0064] 9. Screen Simplifies Above User Defined Speed

[0065] A related feature is that the screen simplifies above speed (which may be user defined): this reduces unnecessary screen clutter and fast moving but irrelevant detail. Hence, in **FIG. 9B**, roundabout **44** is shown as the user is travelling slowly at 7 mph; but in **FIG. 9A**, the roundabout detail is not shown at al as the vehicle is travelling at 70 mph.

[0066] 10. Show Next Major Route Change

[0067] FIGS. **10**A-C shows how the TomTom Navigator system can display the next major route change. In **FIG. 10A**, it is exiting interstate highway 287/87: window **50** summarises **30** this. This shows a user departing from familiar territory (e.g. home) that the main purpose of many coming instructions is to take him to a certain highway exit. Allows driver to relax on long motorway journey since he can see at a glance that his exit is still 275 miles **51** away.

[0068] This feature can also show a user that the main purpose of many coming instructions is to take him to a certain highway—which allows him to follow the road signs rather than the instructions.

[0069] 11. Nightview

[0070] The conventional navigation mode view, **FIG. 11A**, can be replaced with a night view mode, **FIG. 11B**, which uses a light road against darker surroundings, plus lower brightness and very muted colors. The glare of the normal (daylight) colours, and the total amount of light coming from the whole PDA screen, can be bothersome and maybe even dangerous when the user drives at night).

[0071] Appendix 1

[0072] Navigator 2.0 Features

[0073] The following new features are present in the Navigator 2.0 software; this software runs on a Pocket PC powered PDA, such as the Compaq ipaq and provides a GPS based navigation system when the PDA is coupled with a GPS receiver. The combined PDA and GPS system is designed to be used as an in-car navigation system.

FEATURE	COMMENT
Demonstrate route function	Allows user to see the entire proposed route in animated fashion as if he is driving it. A fun feature, but also very useful for point-of-sale purposes to catch the eye of potential purchasers of the Navigator software and GPS system. The user inputs his start position and required destination in the normal manner into the Navigator software running on the PDA. The user then selects the manner in which a travel route is calculated: various modes could be 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 marked as views of outstanding beauty, or passes the most POIs of possible interest to children or uses the fewest junctions etc. Roads themselves are described in the database as lines - i.e. vectors (i.e. 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 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. Route calculation uses complex algorithms applied to score large numbers of potential different routes. Once a route is calculated by the PDA, the PDA in effect has stored in a database a sequence of road names and actions to be done at pre-determined distances along each road of the route (e.g. after 100 meters, turn left into street x). The user can ask for the entire journey along the route to be simulated on a map displayed on the PDA: in the conventional manner, the position of the car on the displayed map is marked with an arrow; as the journey simulation progresses, the streets move past the car arrow, which is optimally fixed approximately 1/3rd up from the bottom of the map, and centered. This requires the database sequence of road names and actions that define the route to be able to be sequentially selected (say simulating progress at a rate that allows the entire journey to be completed in 15 seconds) and for the map to display simulated progress of the car along the vectors which define the roads of the calculated route. The car is hence shown actually navigating along the route calculated by the Navigator software. In this way, a user can check that the route looks acceptable; the user may for example, prefer a route that avoids a certain region and he may want to confirm that the route suggested by the program does bypass it. Or the user may simply

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FEATURE	COMMENT
	feel more comfortable driving a route that he has had fully described and shown to him by the software before hand. In a point of sale system, the simulation can continuously repeat.
Alternative route function: 'avoid roadblock'	A user could select an 'avoid roadblock' function that causes the system to recalculate a route on the basis that the road immediately ahead is blocked. A route planning algorithm 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 software that his immediate road ahead is blocked and require the software to re-calculate 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 hence, 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. Selecting the 'avoid roadblock' function 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) to a menu mode by pressing a key or selecting any point on the screen; the menu mode displays a small number of large icons, one of which is the 'avoid roadblock' 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; 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'	Allows a user to easily and rapidly select a road to mark as blocked so that he can input information from real time traffic information broadcast on the radio. 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 kilometers 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. Selecting the 'avoid specific road' function 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 (in which the current position of the car is shown on a map) to a menu mode by pressing a key or selecting any point on the screen; the menu mode displays a small number of large icons, several of which are named roads 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; on screen navigation prompts) to allow the user to proceed to his destination but avoid the road immediately ahead. Typically, one touch on the screen is needed to open a window showing a list of future main roads (three currently are shown in Navigator 2.0); one further touch to select a listed icon as blocked. The system then recalculates an alternative route.
Alternative route function: 'penalties'	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. Also, a user could penalise specific complex junctions on a simulated route (see above) 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. 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

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FEATURE	COMMENT
	user cannot interact directly with how the algorithm treats roads, junctions and other route features. But in Navigator 2 it is possible: the user can directly alter the way the route planning algorithm scores a route by awarding penalties/awards to 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).
Alternative route function: auto generate	A user can also simply select 'alternative route' if he simply wants to see another possible route: the system then recalculates a route, not using at least 80% of the roads from the prior route.
Alternative route planning: selecting calculation modes	A user can select 'normal', 'strict' and 'fast' planning modes: each results in different route planning algorithms being used that calculate the route either normally, or strictly (which may take many minutes as a great many permutations are explored) or quickly, (which may take a few seconds only as many simplifying assumptions are made about the optimal route).
Large soft keyboard	The device can display a large keyboard, far larger than conventional screen based keyboards on PDAs. This allows a user to input text more easily - and without taking the device out of the cradle or off the dashboard - and even using his finger rather than the stylus. The optimal dimensions on a iPaq are: QWERTY/AZERTY keyboard images: Horizontal spacing: 25 pixels center to center (button to button) Vertical spacing: 32 pixels center to center (button to button) ABC keyboard image: Horizontal spacing: 40 pixels center to center Vertical spacing: 32 pixels center to center NOTE: Numeric keyboard image is mixed (has both small and big keys) NOTE: Some keys might be 1 pixel smaller in width than other keys (aesthetics) therefore the center to center might be different from key to key. The individual key size in pixels is (width, height): 36 × 28 (ABC keyboard image) 21 × 28 (QWERTY/ASERTY keyboard image) 46 × 28 (arrow keys on QWERTY/AZERTY keyboard images) 70 × 28 (space/back keys on QWERTY/AZERTY keyboard images) NOTE: Some keys might be 1 pixel smaller in width than other keys (aesthetics) The total image sizes for different keyboards (width, height) are as follows: 240 × 155 (ABC keyboard image- as seen in Navigate to Address for example) 240 × 155 (QWERTY keyboard image - as seen in Navigate to Address for example) 240 × 155 (AZERTY keyboard image - as seen in Navigate to Address for example) 240 × 62 (2 line NUM/Arrowkeys image - as seen in Navigate to Address, 3rd page: "Enter house number or crossing") 240 × 31 (1 line Arrow key image - as seen in 'navigate to recent' for example) NOTE: This includes white-space edges in the range of 1 to 3 pixels. The above sizes enable a soft keyboard to be displayed that a user can readily operate with one finger when the device is mounted on a dashboard cradle with the car moving and without being significantly distracted from driving. Tolerances to the above sizes are approximately 25% (plus or minus).
Waypoints	If you pass a location of interest on your route (e.g. while driving), you can store your present location by a very simple action (e.g. a tap on the screen or by issuing a voice command). This stores a marker in a database of waypoints; in essence the co-ordinates of the location of interest. The waypoint can be marked on the map itself with a POI icon. Later, the user can retrieve and use it (or even

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FEATURE	COMMENT
	annotate and store it). For example, if marked as a POI on a map, the user could select the POI on the map, which would cause an annotation window to open, into which the user could input text (e.g. "great bookshop here").
House numbers	Each of the following features, on its own or in combination (Navigator 2.0 uses them in combination): (1) Show no house numbers on the screen except on request, when the user taps the screen. Then the relevant information pops up, and disappears again after a few seconds (2) Show the house number range for the piece of street between two corners that the user clicked on (3) show the street name and house number(s) for the exact spot the user clicked on (4) odd numbers are always shown in certain fixed colours (e.g. yellow-on-dark blue) and odd numbers are always shown in different fixed colours (e.g. white-on-black). If both even and odd numbers are shown (which is the usual case), odd numbers are always shown before even numbers.
Postal code input	User can input postal code of a city instead of typing in the actual city name, when defining a home or destination which will typically be far longer (and hence inconvenient with a small on-screen keyboard). Furthermore, this input variant is perfect for devices with numeric keyboards (e.g. mobile telephones) - since all countries except the United Kingdom use all-numeric postal codes that uniquely identify cities. This is useful when specifying a destination with a long name; it requires there to be database of city postal codes that can be matched against, ideally with the system guessing the entire postal code from the initial letters/numbers so that the user does not even have to enter the entire city code.
Geocoding	Adding WGC 84 (or other co-ord) system data automatically to an address in a contacts list by using the co-ord system knowledge of an integrated navigation program. The Navigator software is programmed with the WGC84 (or other co-ord system) co-ordinates of roads and house numbers along a road. Hence, when a user defines a start or destination address as part of the normal route planning process, the software determines the associated WGC84 co-ordinates; it can then also mark the start and destination positions on the map with appropriate icons. It can share this facility with a contacts application: a software component could take a contact address from the database used by the contact application and export it to the engine in the navigation software that converts addresses to WGC84 co-ordinates. This engine could then determine the WGC84 co-ordinates and then return that WGC84 data to a new field in the database used by the contacts application - the new field stores and makes available the WGC84 data within the contacts application or other applications.
Contacts integration	Auto-generating an option within the Contacts application to navigate to that contact within the navigation program and/or show the location of the contact on a mapping application.
Hot list of most important POIs	System offers a "navigate to nearby point of interest" option. This first provides a "hot list" of POI icons for the small set of "most often used" POI types. The list is initialized to generally useful POI types (for car drivers) like petrol station, restaurants, parking spots etc. Hence, a user can very readily ask the program to navigate him to the nearest petrol station etc. The system in effect recalculates a route with the closest relevant POI as the destination and the current location as the start. The user can manually adjust the types to suit his own needs. Furthermore, at least one of the icons will self-adjust to the most recently used type not already in the list.
POI along the route	Searching for POIs would normally be done by defining a point and searching outwards from that point to locate relevant POIs. Applying this approach to finding POIs along a route would be impossible on a PDA because you would in effect be replicating the search for all points along the route (potentially millions of separate searches for a long journey, which would be too great a load). We reverse this approach by taking each relevant POI and seeing if it is on a vectoir/line that that also defines part of the route - a simple and fast correlation process between POIs and route lines, that can rapidly be repeated for all POIs of relevance.

1. A personal GPS navigation device programmed to display, at the same time, each of the following:

(a) a map;

(b) an indication of the current position of the device on the map; and

(c) a GPS signal strength indicator.

2. The device of claim 1 in which the GPS signal strength indicator comprises several bars, with all bars being visible if a received GPS signal exceeds a predefined strength requirement and no bars are visible if the received GPS signal is below a second predefined strength requirement.

3. The device of claim 2 in which progressively more bars are visible as the received GPS signal increases beyond predefined strength requirements.

4. The device of claim 3 in which two bars are visible if the received GPS signal is strong enough for the device to obtain a 2D fix, but not a 3D fix.

5. The device of claim 4 in which three bars are visible if the received GPS signal is strong enough for the device to obtain the 3D fix.

6. The device of claim 1 in which the device is further programmed to display, at the same time as the map, a navigation bar comprising the GPS signal strength indicator and at least one element chosen from the group of elements consisting of a name of a route that the device is located on, a direction of travel required at a next junction, a speed of the device, a distance to a next junction to a new route and a distance to a destination.

7. The device of claim 1 which is capable of displaying on the map Point of Interest icons that have been downloaded to the device over a wide area network connection from a remote database.

8. The device of claim 1 which is able to selectively enable display of a category of Point of Interest icons.

9. The device of claim 1 in which the map is divided into grid cells of a predefined size and, within each such cell, the device enables only a single Point of Interest icon to be displayed.

10. The device of claim 9 in which a first category of Point of Interest icons having a first density of occurrence is given priority to appear over a second category of Point of Interest icons having s a second density of occurrence when the first density of occurrence is less than the second density of occurrence.

11. The device of claim 10 in which display of at least one category of Point of Interest icons is disabled when the map is zoomed out beyond a threshold.

12. The device of claim 1 in which moving Point of Interest icons can be displayed on the map.

13. The device of claim 1 able to associate an action with a Point of Interest icon displayed on the map.

14. The device of claim 13 in which the action is chosen from the group of actions consisting of opening a window with information about to the Point of Interest, opening a window with at least one function relating to the Point of Interest, opening a communications application that enables the device to communicate with the Point of Interest and opening a browser window that opens a web page relating to the Point of Interest.

15. The device of claim 1 able to automatically zoom into the map as the device approaches a decision point that may be complex to navigate, in order to reveal more detail to aid navigation.

16. The device of claim 1 able to calculate a speed of the device and to automatically zoom out as the speed of the device exceeds a predefined level.

17. The device of claim 1 able to calculate a speed of the device and in which detail shown in the map automatically decreases if the speed of the device exceeds a predefined level.

18. The device of claim 1 programmed to display a next major route change.

19. The device of claim 1 able to display the map in a mode suitable for viewing at night time, in which a route currently being travelled is shown in a brighter tone than a surrounding area.

20. Computer software for a portable computing device, the software enabling the device to display, at the same time, each of the following:

(a) a map;

(b) an indication of the current position of the device on the map; and

(c) a GPS signal strength indicator.

21. The software of claim 20 which enables the device to display the GPS signal strength indicator comprising several bars, with all bars being visible if a received GPS signal exceeds a predefined strength requirement and no bars are visible if the received GPS signal is below a second predefined strength requirement.

22. The software of claim 21 which enables progressively more bars to become visible as the received GPS signal increases beyond predefined strength requirements.

23. The software of claim 21 which enables a single bar to be visible if the received GPS signal exceeds the second predefined requirement, and the received GPS signal is not strong enough for the device to obtain a position fix.

24. The software of claim 23 which enables two bars to be visible if the received GPS signal is strong enough for the device to obtain a 2D fix, but not a 3D fix.

25. The software of claim 24 which enables three bars to be visible if the received GPS signal is strong enough for the device to obtain the 3D fix.

26. The software of claim 20 which enables the device to display, at the same time as the map, a navigation bar comprising the GPS signal strength indicator and an element chosen from the group of elements consisting of a name of a route that the device is located on, a direction of travel required at a next junction, a speed of the device, a distance to a next junction to a new route and a distance to a destination.

27. The software of claim 20 which enables the device to display on the map Point of Interest icons that have been downloaded to the device over a wide area network connection from a remote database.

28. The software of claim 20 which enables the device to allow the display of a category of Point of Interest icons to be selectively enabled.

29. The software of claim 20 which enables the map to be divided into grid cells of a predefined size and within each such cell, only a single Point of Interest icon is displayed.

30. The software of claim 29 which enables a first category of Point of Interest icons having a first density of

occurrence to be given priority to appear in a given cell over a second category of Point of Interest icons having s a second density of occurrence when the first density of occurrence is less than the second density of occurrence.

31. The software of claim 30 which enables display of at least one category of Point of Interest icons to disabled when the map is zoomed out beyond a threshold.

32. The software of claim 20 which enables moving Point of Interest icons to be displayed on the map.

33. The software of claim 20 which enables an action to be associated with a Point of Interest icon displayed on the map.

34. The software of claim 33 in which the action is chosen from the group of actions consisting of opening a window with information about the Point of Interest, opening a window with at least one function relating to the Point of Interest, opening a communications application that enables the device to communicate with the Point of Interest and opening a browser window that opens a web page relating to that Point of Interest.

35. The software of claim 20 which enables automatic zooming into the map as the device approaches a decision point that may be complex to navigate, in order to reveal more detail to aid navigation.

36. The software of claim 20 which enables calculation of a speed of the device and automatic zooming out of the map as the speed of the device exceeds a predefined level.

37. The software of claim 20 which enables calculation of a speed of the device and to automatically decrease the detail shown in the map if the speed of the device exceeds a predefined level.

38. The software of claim 20 which enables the device to display a next major route change.

39. The software of claim 20 which enables the device to display the map in a mode suitable for viewing at night time, in which a route currently being travelled is shown in a brighter tone than a surrounding area.

40. The device of claim 2 in which a single bar is visible if the received GPS signal exceeds the second predefined requirement, but the received GPS signal is not strong enough for the device to obtain a position fix.

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