Title: TACTILE DEVICE, NAVIGATION DEVICE AND SYSTEM COMPRISING SUCH A TACTILE DEVICE AND NAVIGATION DEVICE

Abstract: The invention relates to a tactile device comprising a plurality of actuators (32) for producing navigation instructions. The tactile device is formed by an article of clothing wearable by a user. The tactile device is formed in such a way that, when being worn by a user, the plurality of actuators (32) are positioned in a substantially closed path, surrounding part of a body of the user.
Tactile device, navigation device and system comprising such a tactile device and navigation device

TECHNICAL FIELD

The present invention relates to a tactile device comprising a plurality of actuators for producing navigation instructions. Also, the present invention relates to a navigation device, a vehicle comprising such a navigation device, and a system comprising such a tactile device and navigation device. The invention further relates to a method for providing tactile navigation instructions, a computer program and a data carrier.

STATE OF THE ART

Prior art navigation devices based on GPS (Global Positioning System) are well known and are widely employed as in-car navigation systems. Such a GPS based navigation device relates to a computing device which in a functional connection to an external (or internal) GPS receiver is capable of determining its global position. Moreover, the computing device is capable of determining a route between start and destination addresses, which can be input by a user of the computing device. Typically, the computing device is enabled by software for computing a “best” or “optimum” route between the start and destination address locations from a map database. A “best” or “optimum” route is determined on the basis of predetermined criteria and need not necessarily be the fastest or shortest route.

The navigation device may typically be mounted on the dashboard of a vehicle, but may also be formed as part of an on-board computer of the vehicle or car radio. The navigation device may also be (part of) a hand-held system, such as a PDA.

By using positional information derived from the GPS receiver, the computing device can determine at regular intervals its position and can display the current position of the vehicle to the user. The navigation device may also comprise memory devices for storing map data and a display for displaying a selected portion of the map data.

Also, it can provide instructions how to navigate the determined route by appropriate navigation directions/instructions displayed on the display and/or generated as audible signals from a speaker (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 upon the applicable junctions/turnings etc. in the map itself.

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.

It is also known to enable a user to choose the kind of route calculation algorithm deployed by the navigation device, selecting for example from a ‘Normal’ mode and a ‘Fast’ mode (which calculates the route in the shortest time, but does not explore as many alternative routes as the Normal mode).

It is also known to allow a route to be calculated with user defined criteria; for example, the user may prefer a scenic route to be calculated by the device. The device software would then calculate various routes and weigh more favourably those that include along their route the highest number of points of interest (known as POIs) tagged as being for example of scenic beauty.

The navigation instructions may be displayed on the display and/or generated as audible signals from the speaker. In some circumstances, a user may have difficulties seeing and/or hearing such navigation instructions.

According to a known alternative, the navigation instructions may be communicated to the user using a tactile device, generating vibrations that may be detected by a user. However, such known tactile devices are not easily compatible with existing navigation devices, and the tactile navigation instructions are not so easy to understand by a user.

Therefore it is an object of the present invention to provide an improved way of presenting tactile navigation instructions to a user.

SHORT DESCRIPTION

According to an embodiment, there is provided a tactile device comprising a plurality of actuators for producing navigation instructions, characterized in that the tactile device is formed by an article of clothing wearable by a user, the tactile device being formed in such a way that, when being worn by a user, the plurality of actuators are positioned in a substantially closed path, surrounding part of a body of the user.
This provides a tactile device that is arranged to provide intuitive navigation instructions that are readily understood by a user and are easy to remember.

According to an embodiment, the tactile device further comprises a processing device arranged to receive input from a navigation device and transmit control signals to the actuators. Such a tactile device can easily be used in combination with a navigation device, for instance an in-car navigation device, or a handheld navigation device.

According to an embodiment, the input from the navigation device comprises a sequence of identification codes identifying navigation instructions. This is an easy way of providing information from the navigation device to the tactile device.

According to an embodiment, the processing device is arranged to translate the received input from the navigation device into control signals for the actuators, wherein the translation comprises applying at least one selection rule, for selecting which part of the input from the navigation device is translated into control signals for the actuators.

The selection rules make it possible to translate the input from the navigation device into tactile instructions, that are suitable for use in a tactile device.

According to a selection rule, all identification codes following a predetermined identification code are discarded, including the predetermined identification code.

According to a selection rule, whenever a combination of two predetermined identification codes are present, one of the two identification codes is discarded. For instance, when ‘now turn right at the round-about’, may be translated into “now turn right”, as the tactile instruction for a round-about may take too much time to be given in combination with a ‘now’ instruction.

According to a selection rule, predetermined identification codes are discarded.

This may be advantageously, as some tactile instructions may be superfluous or may be too difficult for a user to understand via tactile instructions.

According to an aspect, there is provided a navigation device, comprising an input-output device, the navigation device being arranged to output a sequence of identification codes identifying navigation instructions.

According to an aspect, there is provided a vehicle, comprising a navigation device according to the above.

According to an aspect, there is provided a system, comprising a tactile device according to the above and a navigation device according to the above.
According to an aspect, there is provided a method for providing tactile navigation instructions, the method comprising:

- receiving input from a navigation device,
- translating the input from the navigation device in control signals for controlling actuators,
- outputting the controlling signals to the actuators.

This method may be used by a device, to make it compatible with a navigation device that may not specially be adapted to provide tactile instructions.

According to an aspect, there is provided a computer program, when loaded on a computer arrangement, arranged to perform the method described above.

According to an aspect, there is provided a data carrier, comprising a computer program according to the above.

SHORT DESCRIPTION OF THE DRAWINGS

Embodiments of the invention will now be described, by way of example only, with reference to the accompanying schematic drawings in which corresponding reference symbols indicate corresponding parts, and in which:

- Figure 1 schematically depicts a schematic block diagram of a navigation device,
- Figure 2 schematically depicts a schematic view of a navigation device,
- Figures 3a and 3b schematically depict a tactile device according to an embodiment,
- Figure 4a and 4b schematically depict a tactile device according to an embodiment,
- Figure 5 schematically depicts a tactile device according to an embodiment,
- Figure 6 schematically depicts a flow diagram according to an embodiment of the invention,
- Figure 7 schematically depicts a tactile device according to an embodiment,
- Figure 8a, 8b, 8c schematically depicts different articles of clothing according to different embodiments.

DETAILED DESCRIPTION
Figure 1 shows a schematic block diagram of an embodiment of a navigation device 10, comprising a processor unit 11 for performing arithmetical operations. The processor unit 11 is arranged to communicate with memory units that store instructions and data, such as a hard disk 12, a Read Only Memory (ROM) 13, Electrically Erasable Programmable Read Only Memory (EEPROM) 14 and a Random Access Memory (RAM) 15. The memory units may comprise map data 22. This map data may be two dimensional map data (latitude and longitude), but may also comprise a third dimension (height). The map data may further comprise additional information such as information about petrol/gas stations, points of interest. The map data may also comprise information about the shape of buildings and objects along the road.

The processor unit 11 may also be arranged to communicate with one or more input devices, such as a keyboard 16 and a mouse 17. The keyboard 16 may for instance be a virtual keyboard, provided on a display 18, being a touch screen. The processor unit 11 may further be arranged to communicate with one or more output devices, such as a display 18, a speaker 29 and one or more reading units 19 to read for instance floppy disks 20 or CD ROM's 21. The display 18 could be a conventional computer display (e.g. LCD) or could be a projection type display, such as the head up type display used to project instrumentation data onto a car windscreen or windshield. The display 18 may also be a display arranged to function as a touch screen, which allows the user to input instructions and/or information by touching the display 18 with his finger.

The speaker 29 may be formed as part of the navigation device 10. In case the navigation device 10 is used as an in-car navigation device, the navigation device 10 may use speakers of the car radio, the board computer and the like.

The processor unit 11 may further be arranged to communicate with a positioning device 23, such as a GPS receiver, that provides information about the position of the navigation device 10. According to this embodiment, the positioning device 23 is a GPS based positioning device 23. However, it will be understood that the navigation device 10 may implement any kind of positioning 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 geographical location.

However, it should be understood that there may be provided more and/or other memory units, input devices and read devices known to persons skilled in the art.

Moreover, one or more of them may be physically located remote from the processor unit 11, if required. The processor unit 11 is shown as one box, however, it may comprise several processing units functioning in parallel or controlled by one main processor that may be located remote from one another, as is known to persons skilled in the art.

The navigation device 10 is shown as a computer system, but can be any signal processing system with analog and/or digital and/or software technology arranged to perform the functions discussed here. It will be understood that although the navigation device 10 is shown in Fig. 1 as a plurality of components, the navigation device 10 may be formed as a single device.

The navigation device 10 may use navigation software, such as navigation software from TomTom B.V. called Navigator. Navigator software may run on a touch screen (i.e. stylus controlled) Pocket PC powered PDA device, such as the Compaq iPaq, as well as devices that have an integral GPS receiver 23. The combined PDA and GPS receiver system is designed to be used as an in-vehicle navigation system. The embodiments may also be implemented in any other arrangement of navigation device 10, 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).

Figure 2 depicts a navigation device 10 as described above.

Navigator software, when running on the navigation device 10, causes a navigation device 10 to display a normal navigation mode screen at the display 18, as shown in Fig. 2. This view may provide driving instructions using a combination of text, symbols, voice guidance and a moving map. Key user interface elements are the following: a 3-D map occupies most of the screen. It is noted that the map may also be shown as a 2-D map.

The map shows the position of the navigation device 10 and its immediate surroundings, rotated in such a way that the direction in which the navigation device 10 is moving is always "up". Running across the bottom quarter of the screen may be a status bar 2. The current location of the navigation device 10 (as the navigation device
10 itself determines using conventional GPS location finding) and its orientation (as inferred from its direction of travel) is depicted by a position arrow 3. A route 4 calculated by the device (using route calculation algorithms stored in memory devices 11, 12, 13, 14, 15 as applied to map data stored in a map database in memory devices 11, 12, 13, 14, 15) is shown as darkened path. On the route 4, all major actions (e.g. turning corners, crossroads, roundabouts etc.) are schematically depicted by arrows 5 overlaying the route 4. The status bar 2 also includes at its left hand side a schematic icon depicting the next action 6 (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 190 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 35 minutes), the actual estimated arrival time 29 (4.50 am) and the distance to the destination 26 (31.6Km). The status bar 2 may further show additional information, such as GPS signal strength in a mobile-phone style signal strength indicator.

As already mentioned above, the navigation device may comprise input devices, such as a touch screen, that allows the users to call up a navigation menu (not shown). From this menu, other navigation functions can be initiated or controlled. Allowing 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. The navigation menu includes the option for the user to input a destination.

The actual physical structure of the navigation device 10 itself may be fundamentally no different from any conventional handheld computer, other than the integral GPS receiver 23 or a GPS data feed from an external GPS receiver. Hence, memory devices 12, 13, 14, 15 store the route calculation algorithms, map database and user interface software; a processor unit 12 interprets and processes user input (e.g. using a 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.

The navigation device 10 may further comprise an input-output device 25 that allows the navigation device to communicate with remote systems, such as other
navigation devices 10, personal computers, servers etc., via network 27. The network
27 may be any type of network 27, such as a LAN, WAN, Bluetooth, Internet, intranet
and the like. The communication may be wired or wireless. A wireless communication
link may for instance use RF-signals (radio frequency) and a RF-network.

More specifically, the user inputs his start position and required destination into
the navigation software running on the navigation device 10, using the input devices
provided, such as a touch screen 18, keyboard 16 etc.. 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.

Roads themselves are described in the map database that is part of navigation
software (or is otherwise accessed by it) running on the navigation device 10 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.

Route calculation uses complex algorithms that are part of the navigation
software. The algorithms are applied to score large numbers of potential different
routes. The navigation 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 the
processor unit 11 and then stored in a database in the memory devices 12, 13, 14, 15 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).
As already mentioned above, the navigation instructions generated by the navigation device 10 may be displayed on the display 18 and/or generated as audible signals from the speaker 29. According to an embodiment, the navigation instructions may also be communicated to the user via a tactile device. The tactile device may be used to generate tactile signals that may be noticed by a user. The tactile signals may for instance be vibrations generated by vibrators.

However, since the level of detail of the information that may be provided using tactile signals is limited according to prior art systems, effort has been put into developing a tactile device that enables provision of many different tactile signals that are rather self-explaining and/or easy to remember by a user.

**Embodiment 1**

According to an embodiment, the tactile device may be formed by a belt 30, as schematically shown in Fig. 3a.

The belt 30 may comprise a plurality of actuators 32. The actuators 32 may be placed anywhere along the belt 30, for instance equidistant with respect to each other.

The actuators 32 may be arranged to generate tactile signals, such as a vibrations, that may be sensed by a user, wearing the belt 30. Different types of actuators 32 may be used for generating tactile signals, each with its particular specifications and its own way of feeling.

According to a variant, vibro-tactile actuators may be used, generating vibro-tactile signals. Vibro-tactile signals are generated by giving a user signals by having something vibrate on the skin of the user (possibly via some layers of clothing).

Different types of vibro-tactile actuators are known. According to a variant, mechanical vibrations are used, where the vibrations are created by tactors (i.e. vibrating motors). Such tactors are easy to control and may easily be implemented. Also, such tactors consume little energy, are safe, lightweight and cost-efficient.

Furthermore, tactors may be used to generate a number of tactile signals, by varying a number of parameters. For instance, the following parameters may be controlled are frequency of the vibrations, amplitude of the vibration, location of the vibration and timing.

For instance, the location of the vibration may be controlled by choosing the location of the tactors with respect to the body of the user. However, the location of the
vibration may further be controlled by controlling the location where a vibration is actually felt by a user, which may be different from the location of the tactor itself. For instance, when the tactors are turned on in a sequence with a certain overlay (i.e. switching off a first tactor some time after a second tactor have been switched on), the overlay may be felt by a user as if the position of the vibration is moving. Also, when two neighbouring tactors are turned on it feels as if the location of the vibration is in-between the two tactors.

The control of the tactors allow for easy and accurate timing. Tactors may easily and directly be turned on and switched off, without significant time delay. By timing is meant the way that the tactor turns on and off. i.e. the time that a vibration signal lasts and the time in-between two vibration signals when a certain signal is given.

Also, tactile signals generated by tactors are easily felt by a user. Another way to create vibro-tactile signals may be to use pneumatic actuators, vibrating motors and electro-tactile actuators to create tactile signals in the form of vibrations.

According to a further variant, tactile signals may be generated using muscle like technologies like EAP (electronically actuated polymers) or SMA (smart memory alloy), as are known to a skilled person. These technologies offer the possibility to generate tactile signals, that might feel a bit like someone squeezing, e.g. your arm. These techniques provide tactile signals that may easily be sensed by a user.

According to a further variant, tactile signals may be generated using smart fluids. In normal circumstances, such fluids are in a liquid phase, but when an electric field is applied, these fluids are in a solid state. They are especially useful when trying to create tactile pressure.

The frequency of the (vibration) signals of the actuators 32 may be varied. The frequency may be within a range of 100 – 500 Hz, as these are proven to be easily detectable by a user. However, any other suitable frequency may be used.

The belt 30 may further comprise at least one fastening element 31.1, 31.2, to fasten the belt 30 around the body of a user. A first fastening element 31.1 may be positioned at one end of the belt 30, a second fastening element 31.2 may be positioned at the other end of the belt 30. The first and second fastening elements 31.1, 31.2 may be arranged to cooperate.

The fastening elements 31.1, 31.2 may for instance be formed by two pieces of
Velero. However, the fastening elements 31.1, 31.2 may also be formed by any other elements to fasten a belt, such as for instance a buckle, arranged to buckle the belt 30.

Fig. 3b shows a perspective view of a closed belt, the fastening elements 31.1, 31.2 cooperating.

The belt 30 may be formed to be worn by a user. Therefore, the belt 30 may have an adjustable size, so to fit different users having different body sizes. This may be achieved by providing flexible fastening elements 31, such as relatively large pieces of Velcro.

Also, the belt 30 may be adjustable in order to provide the user with the possibility to adjust the pressure of the belt and the actuators 32 on the body. Actuators 32 may rest lightly on the skin, allowing the user to feel the vibration against the skin, and to so isolate the location of the vibration with ease. Too much pressure might cause the vibrations to be felt in the bone structure, making them less isolated due to skeletal conduction.

Also, tightening the belt 30 too much may impede blood circulation.

According to the variants shown in Fig.’s 3a and 3b, the belt 30 comprises eight actuators 32. However, it will be understood that a suitable number of actuators 32 may be used, such as for instance four, five, six or more actuators 32. By using a belt 30, that in use surrounds the complete body of a user, any suitable number of actuators 32 may be used. The actuators 32 may be positioned along the belt 30 at any desired position, such that in use, the actuators 32 are sufficiently far removed from each other, to make the tactile signals generated by different actuators 32 easily be distinguishable from each other. Also, the actuators 32 may be positioned along the belt in such a way that in use each actuator 32 abuts against, or is close to a certain part of the body of the user.

According to an embodiment, a tactile device is provided, comprising a plurality of actuators 32 for producing navigation instructions, characterized in that the tactile device is formed by an article of clothing wearable by a user, the tactile device being formed in such a way that, when being worn by a user, the plurality of actuators 32 are positioned in a substantially closed path, surrounding part of a body of the user. This provides a tactile device that may produce a variety of tactile instructions that may easily and intuitively be understood by a user, and may be remembered easily. Because the actuators 32 form a substantially closed path, in use, surrounding part of a body of
the user, such as the waist of a body, the device may provide tactile instructions to
different parts of the body intuitively corresponding to different navigational
instructions, such as straight on, left, sharp right, go backwards etc.

The fact that the actuators 32 surround part of the body has the advantage that it
is possible to give the user an egocentric 360° ‘view’. The location of the vibration may
easily be understood by the user, i.e. when the user has to go completely around a
roundabout and has to go back in the direction where he/she came from, then this may
be presented with a ‘roundabout’ signal (actuating all actuators 32 sequentially)
followed by vibrations on the back. This is more easily understood as a pattern of some
kind that may be generated with for example three tactors located on the front of the
body. Using a tactile device with actuators on one side of the body only, indicating to
go in a direction that is currently behind you, is not easy and not self-explaining. It
would require special knowledge by a user to understand a certain tactile instruction.

Another advantage of having the tactors surrounding part of the body is that this
allows to provide the user with signals that also convey what type of turn is coming up.
The user may easily distinguish the following types: sharp left, regular left or keep to
the left. This is done by actuating the actuator 32 to give a vibration in a certain
location that directly correlates to the type of corner coming up.

Also, the fact that the actuators 32 surround part of the body, makes it possible
to provide the user with signals that are easy to understand and would be complex and
difficult to interpret if there are only actuators located on one side of the body, for
instance the front of the body. An example would be the signal that moves 360° around
the body of the user and is easily recognized as being a roundabout.

The advantage of having actuators 32 all around the body is that it provides the
possibility to give the user easily understandable cues rather then signals that have to be
translated or interpreted by the user. (i.e. for the user it is more difficult to recognize a
certain pattern that would mean sharp left then a vibration that is given on the back left
of the body.)

Based on the above, the belt 30 allows generating a relatively high number of
different tactile signals. From this relatively high number of tactile signals, a set of
tactile instructions may be chosen that are intuitively understood by a user and/or may
easily be remembered.
The actuators 32 of belt 30 are controlled to provide tactile signals according to control signals. The control signals may be generated by a cooperating navigation device 10, as described above. Therefore, each actuator 32 may be arranged to communicate with navigation device 10 directly, for instance using a wired communication link or a wireless communication link.

According to a variant, the actuators 32 do not directly receive control signals from the navigation device 10. According to such a variant, as shown in Fig. 4a, the belt 30 further comprises a processing device 33 that is arranged to communicate with the navigation device 10. The processing device 33 may comprise memory devices 34, a processor unit 35, and an input-output device 36. The processor unit 35 may be arranged to communicate with the memory device 34 and input-output device 36. The input-output device 36 may be arranged to receive input from the navigation device 10 and transmit control signals to the actuators 32.

The communication link between the belt 30 and the navigation device 10 may be any type of communication link, such as a wired communication link, or a wireless communication link. The communication link may use any type of network 27, such as a LAN, WAN, Bluetooth and the like. A wireless communication link may for instance use RF-signals (radio frequency) and a RF-network.

Although not shown in the Figures, the belt 30 may further comprise power storage devices, such as (storage) batteries or the like, and/or power generating devices, such as solar cells. The (storage) batteries may be AA batteries, or batteries known from cell-phones. The belt 30 may further comprise a connection for charging the (storage) batteries.

Although not shown in the Figures, the belt 30 may further comprise (soft) buttons, woven into the fabric of the belt 30, or placed on top of it. The buttons may for instance be used to control the intensity of the actuators 32 (i.e. controlling the frequency and/or the amplitude). The buttons may be connected to the processing device 33.

It will be understood that parameters of the actuators 32 (frequency, amplitude, timing) may be controlled via buttons on the belt 30 or via input devices on the navigation device 10, such as keyboard 16, mouse 17, display 18, being a touch screen.

The parameters of the actuators 32 may be adjusted by a user depending on the circumstances. For instance, a user driving an Italian V-twin motor cycle may
experience other or more vibrations than a user driving a Japanese four cylinder. Therefore, a user on a Japanese four cylinder might want to have a more intense vibration from the actuators 32 (higher frequency, higher amplitude).

The buttons on the belt 30 may be used by a user to adjust the intensity (frequency/amplitude) of the vibrations of the actuators 32 to his/her preference. The buttons on the belt 30 may therefore adjust the intensity of all actuators 32 at the same time, or may adjust the intensity of individual actuators 32, for instance in case the user feels a certain actuator 32 vibrate more or less intense than the others, for instance as a result of the bone structure, body shape and body fat of that person.

The belt 30 may be made of any suitable material. The material may be chosen to have certain characteristics that make it more suitable. The material of the belt 30 may be stretchable. The reason that the material may be stretchable is that such a material would provide a tight (but not too tight) fit for different users, having different body sizes. This ensures that the actuators 32 are pressed against the body of the user, so that the tactile signals will easily be sensed by the user.

Also, the material of the belt 30 may be such that it is pervious to moisture/water. This is especially important in the summer time when users tend to perspire. A material that is pervious to water not only increase comfort, but also makes the belt 30 more durable. Sweat contains salt, which, if not transported through the belt 30, could stay on the inside of the belt, causing oxidation on connectors or circuitry of the belt 30, causing them to fail.

Figure 4b schematically depicts a motorcyclist riding a motorcycle. The motorcyclist is wearing a belt 30. The motorcycle further comprises a navigation device 10. Interaction between the belt 30 and the navigation device 10 is schematically shown by the arrow.

Embodyment 2

According to a further embodiment, the belt 30 may be formed as a kidney-belt, for providing support of a user and providing protection of a user against impact, for instance in case of an accident. Such kidney-belts are for instance used by people riding a motor cycle and are known to a skilled person.
The belt 30 may comprise a support portion 37, schematically depicted in Fig. 5. Such as support portion 37 may be formed in such a way that it provides optimum support and protection.

The material of the belt 30, at least of the support portion 37 may be chosen to provide support and protection.

**Embodyment 3**

According to a further embodiment, the belt 30 comprises a processing device 33 as described above and shown in Fig. 4, arranged to receive input from the navigation device 10 and transmit control signals to the actuators 32. The processing device 33 may be arranged to communicate with the actuators 32 via a wired communication link, or may be arranged to communicate with the actuators 32 via a wireless communication link. The communication link between the processing device 33 and the actuators is indicated by the dotted line in Fig. 4. The processing device 33 may further be arranged to translate the input received from the navigation device 10 into control signals for the actuators 32.

By providing the processing device 33 with the functionality of translating the input received from the navigation device 10, the belt 30 may be used in combination with any navigation device 10 that is arranged to provide output comprising navigation instructions in any form.

The navigation device 10 may be arranged to provide output to the input-output device 36 of the processing device 33 on the belt 30 using input-output device 25 of the navigation device 10. The communication between the input-output device 25 of the navigation device and the input-output device of the processing device 33 on the belt 33 may be wired or wireless. The communication link may use any type of network 27.

The output of the navigation device 10 may simply be an indication of the navigation instructions that are displayed by the navigation device 10 using display 18 or are played by the navigation device 10 using speaker 29. The navigation device 10 may comprise a set of navigation instructions, each having a unique identification code.

Table 1 schematically depicts such a set of navigation instructions as may be stored in the memory device 12, 13, 14, 15 of the navigation device 10.
<table>
<thead>
<tr>
<th>Identification code</th>
<th>Navigation instruction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>after 50 metres</td>
</tr>
<tr>
<td>2</td>
<td>after 100 metres</td>
</tr>
<tr>
<td>3</td>
<td>after 500 metres</td>
</tr>
<tr>
<td>4</td>
<td>after 800 metres</td>
</tr>
<tr>
<td>5</td>
<td>ahead</td>
</tr>
<tr>
<td>6</td>
<td>now</td>
</tr>
<tr>
<td>7</td>
<td>turn left</td>
</tr>
<tr>
<td>8</td>
<td>turn right</td>
</tr>
<tr>
<td>9</td>
<td>then</td>
</tr>
<tr>
<td>10</td>
<td>at the round-about</td>
</tr>
<tr>
<td>11</td>
<td>at the first exit</td>
</tr>
<tr>
<td>12</td>
<td>at the second exit</td>
</tr>
<tr>
<td>13</td>
<td>at the third exit</td>
</tr>
<tr>
<td>14</td>
<td>at the end of the street</td>
</tr>
<tr>
<td>20</td>
<td>....</td>
</tr>
<tr>
<td>50</td>
<td>destination reached</td>
</tr>
</tbody>
</table>

Table 1

The navigation device 10 is arranged to generate all kinds of navigation instructions, such as: after 100 metres, turn left at the round-about (nr. 2-7-10), or after 50 metres, turn right then turn left at the round-about (nr.1-8-9-7-10).

Also stored in the navigation device 10 are icons and sound samples associated with the respective identification codes. The navigation device 10 is arranged to display the associated icons via display 18 and play the associated sound samples using speaker 29. According to this embodiment, the navigation device 10 is further arranged to output the sequence of navigational instructions that are to be communicated to the user via input-output 25 of the navigation device 10.
According to this embodiment, the processing device 33 is arranged to receive the sequence of instructions (such as nr.1-8-9-7-10) and translate these into appropriate control signals for controlling the actuators 32.

Embodiment 4

According to a further embodiment, the processing device 33 may be arranged to process the input received from a navigation device 10 to translate the received input in appropriate control signals.

Fig. 6 schematically depicts a flow diagram of the actions as may be performed by the processing device 33 of the belt 30. In order to execute the flow diagram the memory device 34 may comprise program instructions readable and executable by the processor unit 35. The memory device 33 may further comprise a look-up table as will be explained in more detail below.

In a first action 40, the processing device starts execution of the flow diagram. This may be triggered by a user by pressing a button to switch the processing device 33 on.

In a next action 41, the processing device 33 receives input, e.g. from navigation device 10, using input-output device 36 of the processing device 33. The input may for instance comprise a sequence of identification codes identifying navigation instructions, for instance nr.1-8-9-7-10. The input may further comprise data that is not relevant for the navigation instructions, such as header information, that is filtered out in a first selection. The information that is filtered away is debug information.

In a next action 42, the processing device 33 may apply the first selection, selecting the data that relate to navigation instructions. Thus, all data, except the identification codes identifying navigation instructions are discarded. This may for instance result in a series of integers.

In a next action 43, the processing device 33 may apply a second selection, selecting part of the data that are to be translated into control signals, for controlling the actuators 32. This second selection may be using a number of selection rules.

A first selection rule may be to discard identification code 9 (then), and all identification codes following identification code 9. So, in case the processing device 33 received the following identification codes: nr.1-8-9-7-10 (after 50 metres, turn right then turn left at the round-about), according to the first selection code, only 1-8
will be translated into tactile instructions (after 50 metres, turn right). This may be
done because tactile instructions including a then-instruction may be too difficult for a
user to understand.

According to a further selection rule, information identifying which exit to take
on a round-about is discarded. So, for instance when the following sequence of
identification codes is received: 2-8-10-11 (After 100 metres, turn right at the round-
about at the first exit), the identification code 11 is discarded.

According to an embodiment, the identification codes outputted by the
navigation device 10 is chosen such that the direction (i.e. left, right, straight etc.)
matches the exit (first, second, third, …) that is to be taken. This ensures that
information referring to the exit to be taken can be discarded. When translating into
tactile signals, only direction is translated, since specifying the exit is only extra
information that would result in confusing tactile instructions.

A further selection rule may be to translate the distance to a next action into
specific tactile signals. Three types of distance information may be known:
- after x metres
- ahead,
- now.

According to such a further selection rule, all identification codes relating to
navigation instructions that are of the form: “after X metres”, are translated in a control
signal identifying that the intensity of the tactile instructions is for instance 70% of a
maximum intensity (for instance a frequency of 70% of a maximum intensity and an
amplitude of 70% of a maximum amplitude). The control signal may further identify
that the tactile instruction is to be given twice. So, in case the following instructions is
to be translated into a tactile signal: ‘after 100 metre turn right’, the actuator on the
right hand side of the user is actuated twice at 70% of the maximum intensity.

According to a further selection rule, the identification code that relates to
‘ahead’, may be translated in a control signal identifying that the intensity of the tactile
instructions is for instance 70% of a maximum intensity. The control signal may further
identify that the tactile instruction is to be given once.

Of course, many variations are conceivable, such as increasing the intensity with
decreasing distance to the next action.
According to a further selection rule, the identification code that relates to ‘now, may be translated in a control signal identifying that the intensity of the tactile instructions is at maximum intensity. The control signal may further identify that the tactile instruction is to be given three times.

According to a further selection rule, the identification code indicating the navigation instruction ‘at the end of the street’ may be discarded. So a navigation instruction ‘after 100 meters at the end of the road turn left’ (nr. 2-14-7) is translated in ‘after 100 meters turn left’ (nr. 2-7).

According to a further selection rule the navigation instruction: ‘now, turn right at the round-about’ (nr. 6-8-10) may be translated into ‘now, turn right’ (nr. 6-8). This may be done, since the information that the next turn is to be carried out at a round-about is most likely already given to the user a number of times before, for instance in combination with “after 100 metres …”, so there is no need to repeat the information about the round-about. Also, it may take too long to give a round-about instruction in case the turn is to be taken now. Therefore, according to a further selection rule, when a combination of identification codes 6 and 10 are present, the identification code 10 is discarded.

So, generally speaking, according to a selection rule, whenever a combination of two predetermined identification codes are present, one of the two identification codes may be discarded.

According to a further selection rule intensity may be dependent on the velocity of the user. The intensity may be increased with increasing velocity. The velocity may be determined by the navigation device 10 or by any other means, such as a built in velocity meter of the vehicle. The processing device 33 may be arranged to receive velocity information. Also, the vehicle or the navigation device 10 may be arranged to emit velocity information.

According to a further selection rule, certain navigation instructions may be discarded. For instance, the instruction “try to turn”, usually given when a user has taken a wrong turn, may be discarded. This may be advantageous in cases where a user prefers to have the freedom to take a new route, without being bothered by the “try to turn” instruction. According to a further selection rule, certain navigation instructions may be given only once. For instance, the “try to turn” instruction may be given only once.
The selection rules may be fixed and pre-stored in the navigation device 10, but may also be adjustable by a user, so he/she may adjust the selection rules to his/her preferences.

As a result, the processing device 33 is arranged to generate tactile signals that may easily and intuitively be understood by a user.

After the first and/or second selection the processing device 33 continues with a further action 44, which is to look up the control signals instructions associated with the selected identification codes. The control signals may be stored in a look-up table stored in memory device 34. Table 2 schematically depicts such a look-up table. The control signals may simply be numbers associated with the different actuators. The control signals given in table 2 correspond with the reference numbers depicted in Fig. 7. According to Fig. 7,

actuator 32.1 is associated with a first direction, i.e. straight ahead,
actuator 32.2 is associated with the direction approximately 45° to the right with respect to the first direction,
actuator 32.3 is associated with the direction approximately 90° to the right with respect to the first direction,
actuator 32.4 is associated with the direction approximately 135° to the right with respect to the first direction,
actuator 32.5 is associated with the direction approximately 180° to the right/left with respect to the first direction,
actuator 32.6 is associated with the direction approximately 135° to the left with respect to the first direction,
actuator 32.7 is associated with the direction approximately 90° to the left with respect to the first direction, and
actuator 32.8 is associated with the direction approximately 45° to the left with respect to the first direction.
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<th>Identification code</th>
<th>Control signals</th>
<th>Navigation instruction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2 subsequent vibrations, intensity: 70%</td>
<td>after 50 metres</td>
</tr>
<tr>
<td>2</td>
<td>2 subsequent vibrations, intensity: 70%</td>
<td>after 100 metres</td>
</tr>
<tr>
<td>3</td>
<td>2 subsequent vibrations, intensity: 70%</td>
<td>after 500 metres</td>
</tr>
<tr>
<td>4</td>
<td>2 subsequent vibrations, intensity: 70%</td>
<td>after 800 metres</td>
</tr>
<tr>
<td>5</td>
<td>1 vibration, intensity: 70%</td>
<td>ahead</td>
</tr>
<tr>
<td>6</td>
<td>3 vibrations, intensity 100%</td>
<td>now</td>
</tr>
<tr>
<td>7</td>
<td>32.7</td>
<td>turn left</td>
</tr>
<tr>
<td>8</td>
<td>32.3</td>
<td>turn right</td>
</tr>
<tr>
<td>9</td>
<td>-</td>
<td>then</td>
</tr>
<tr>
<td>10</td>
<td>Subsequently: 32.1/2/3/4/5/6/7/8</td>
<td>at the round-about</td>
</tr>
<tr>
<td>11</td>
<td>-</td>
<td>at the first exit</td>
</tr>
<tr>
<td>12</td>
<td>-</td>
<td>at the second exit</td>
</tr>
<tr>
<td>13</td>
<td>-</td>
<td>at the third exit</td>
</tr>
<tr>
<td>14</td>
<td>-</td>
<td>at the end of the street</td>
</tr>
<tr>
<td>....</td>
<td>....</td>
<td>....</td>
</tr>
<tr>
<td>14</td>
<td>Simultaneously: 32.1-2-3-4-5-6-7-8</td>
<td>destination reached</td>
</tr>
</tbody>
</table>

Table 2

It will be understood that in fact, table 2 may link the identification codes to a script or program instructions, holding information about which actuator(s) 32 is/are to
be turned on and information about the intensity (frequency, intensity) and timing etc. The timing information may for instance indicate whether or not a number of actuators 32 need to be actuated at the same time or successively. When the script or program instructions are executed by the processing device 33, the actuators 32 will produce the specific tactile signal.

Finally, in an action 45, the navigation device 10 may output the looked-up control signals to the appropriate actuators 32.

Further remarks

It will be understood that although the embodiments described above all refer to a belt, the actuators 32 may be provided in any other suitable way. For instance, the actuators 32 may be provided in a jacket, pair of trousers, t-shirt or any other article of clothing, as schematically depicted in Fig.’s 8a, 8b and 8c.

According to a further embodiment, the processing device 33 may be positioned remote from the actuators 32, and may for instance be incorporated in the navigation device 10. In fact, the functionality of the processing device 33 as described above, may be carried out by the processing unit 11 of the navigation device 10. In such a case the navigation device 10 may be arranged to output control signals via input-output device 25 to the actuators 32.

According to a further embodiment, the tactile device, such as the belt 30 and the navigation device 10 may be formed as a single system.

It will be understood the embodiments described above may be useful for all kinds of user groups.

It may for instance be a useful tool for deaf-people so they may use a navigation device 10 without having to look at the display 18 all the time.

Also, the embodiments described above may be useful in situations in which audible instructions are difficult to hear for instance for a user group that works in environments with a relatively high level of noise.

The embodiments may also be useful for chauffeurs and taxi drivers who don’t want to bother their customers with the sound of a navigation device. The embodiments may also be used in a car, in case people prefer a silent environment, or may want to
listen to music without being disturbed, or may want to have a conversation without being disturbed.

Also, the embodiments may be useful for users that don’t want or are not able to watch a display, such as bicyclists and walkers. The embodiments described above allow them to have a navigation device 10 in a pocket or bag, and be fully guided by tactile instructions.

According to a further embodiment, the tactile device, such as belt 30, may comprise a positioning device, such as a GPS receiver. The positioning device may provide information about the current location of the tactile device. The positioning device may be arranged to communicate with processor unit 35 of processing device 33. In such a case, the tactile device may be used in combination with a smart phone, PDA etc. that doesn’t comprise a positioning device. Such an embodiment makes the tactile device even more suitable for bicyclists, horseback riders, walkers etc.

The tactile device may be made water resistant, to make it useable in wet conditions, making the tactile device suitable for outdoor activities, such as biking in the rain.

According to an embodiment, a tactile device is provided, comprising a plurality of actuators 32 for producing navigation instructions, wherein the tactile device further comprises a processing device 33 arranged to receive input from a navigation device 10 and transmit control signals to the actuators 32.

Such a tactile device may be an article of clothing as described above, but may also be a tactile device formed by other means. It may for instance be formed by actuators being positioned in the handle-bars of a motorcycle, or the steering wheel of a car. The actuators may also be positioned in a seat of a motorcycle or vehicle. The tactile device may also be formed by a combination of the above described examples. For instance, tactile device may have actuators in the steering wheel, as well as in the seat or in an article of clothing.

According to such an embodiment, the processing device 33 comprises memory devices 34, a processor unit 35, and an input-output device 36, the processor unit 35 being arranged to communicate with the memory device 34 and input-output device 36, the input-output device 36 being arranged to receive the input from the navigation device 10 and transmit the control signals to the actuators 32.
According to such an embodiment, the input from the navigation device 10 comprises a sequence of identification codes identifying navigation instructions.

According to such an embodiment, the processing device 33 is arranged to translate the received input from the navigation device 10 into control signals for the actuators, wherein the translation comprises applying at least one selection rule, for selecting which part of the input from the navigation device 10 is translated into control signals for the actuators 32.

While specific embodiments of the invention have been described above, it will be appreciated that the invention may be practiced otherwise than as described. For example, the invention may take the form of a computer program containing one or more sequences of machine-readable instructions describing a method as disclosed above, or a data storage medium (e.g. semiconductor memory, magnetic or optical disk) having such a computer program stored therein. It will be understood by a skilled person that all software components may also be formed as hardware components.

The descriptions above are intended to be illustrative, not limiting. Thus, it will be apparent to one skilled in the art that modifications may be made to the invention as described without departing from the scope of the claims set out below.
CLAIMS

1. Tactile device comprising a plurality of actuators (32) for producing navigation instructions, characterized in that the tactile device is formed by an article of clothing wearable by a user, the tactile device being formed in such a way that, when being worn by a user, the plurality of actuators (32) are positioned in a substantially closed path, surrounding part of a body of the user.

2. Tactile device according to claim 1, wherein the tactile device comprises at least four actuators (32), for instance eight actuators (32).

3. Tactile device according to any one of the claims 1 – 2, wherein the article of clothing is one of a t-shirt, jacket, pair of trousers.

4. Tactile device according to any one of the claims 1 - 2, wherein the article of clothing is a belt (30).

5. Tactile device according to claim 4, wherein the belt (30) is a kidney-belt for supporting and protecting the user, the belt (30) comprising a support portion (37).

6. Tactile device according to any one of the preceding claims, wherein the actuators (32) comprise one of vibro-tactile actuators, vibrating motor, pneumatic actuators, electro-tactile actuators, electronically actuated polymers, smart memory alloy, smart fluids.

7. Tactile device according to any one of the preceding claims, wherein the actuators are arranged to generate vibrations within a frequency range of 100 – 500 Hz.

8. Tactile device according to any of the preceding claims, wherein the tactile device further comprises a processing device (33) arranged to receive input from a navigation device (10) and transmit control signals to the actuators (32).
9. Tactile device according to claim 8, wherein the processing device (33) comprises memory devices (34), a processor unit (35), and an input-output device (36), the processor unit (35) being arranged to communicate with the memory device (34) and input-output device (36), the input-output device (36) being arranged to receive the input from the navigation device (10) and transmit the control signals to the actuators (32).

10. Tactile device according to any one of the claims 8 - 9, wherein the input from the navigation device (10) comprises a sequence of identification codes identifying navigation instructions.

11. Tactile device according to any one of the claims 8 – 10, wherein the processing device (33) is arranged to translate the received input from the navigation device (10) into control signals for the actuators, wherein the translation comprises applying at least one selection rule, for selecting which part of the input from the navigation device (10) is translated into control signals for the actuators (32).

12. Tactile device according to claim 11, wherein according to a selection rule all identification codes following a predetermined identification code are discarded, including the predetermined identification code.

13. Tactile device according to any one of the claims 11 – 12, wherein according to a selection rule, whenever a combination of two predetermined identification codes are present, one of the two identification codes is discarded.

14. Tactile device according to any one of the claims 11 – 13, wherein the tactile device is arranged to receive velocity information, and according to a selection rule, the intensity of the navigation instructions may dependent on the velocity information.

15. Tactile device according to any one of the claims 11 – 14, wherein according to a selection rule, predetermined identification codes are discarded.
16. Navigation device, comprising an input-output device (25), the navigation device (10) being arranged to output a sequence of identification codes identifying navigation instructions.

17. Vehicle, comprising a navigation device (10) according to any one of the preceding claims.

18. System, comprising a tactile device according to claim 1 and a navigation device (10) according to claim 16.

19. Method for providing tactile navigation instructions, the method comprising:
   - receiving input from a navigation device (10),
   - translating the input from the navigation device (10) in control signals for controlling actuators (32),
   - outputting the controlling signals to the actuators.

20. Method according to claim 19, wherein the translation comprises at least one selection rule.

21. Method according to claim 20, wherein the input received from the navigation device (10) comprises identification codes, and according to a selection rule all identification codes following a predetermined identification code are discarded, including the predetermined identification code.

22. Method according to any one of the claims 20 – 21, wherein according to a selection rule, whenever a combination of two predetermined identification codes are present, one of the two identification codes is discarded.

23. Method according to any one of the claims 20 – 23, wherein according to a selection rule, the intensity of the navigation instructions may dependent on velocity information.
24. Method according to any one of the claims 20 – 23, wherein according to a selection rule, predetermined identification codes are discarded.

25. Computer program, when loaded on a computer arrangement, arranged to perform the method of claim 17.

26. Data carrier, comprising a computer program according to claim 25.
Fig 6

Start

Receive input

1st selection

2nd selection

Look up tactile instructions

output: control signals
### A. CLASSIFICATION OF SUBJECT MATTER

INV. G01C21/36  G01C21/20

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)

G01C

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, INSPEC

### C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<td>DATABASE INSPEC [Online] THE INSTITUTION OF ELECTRICAL ENGINEERS, STEVENAGE, GB; 2004, TSUKADA K ET AL: &quot;ActiveBelt: belt-type wearable tactile display for directional navigation&quot; XP002405314 Database accession no. 8262080 abstract</td>
<td>1,2,4-6, 8-11,16, 18-20, 25,26</td>
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* Special categories of cited documents:

- **A** document defining the general state of the art which is not considered to be of particular relevance
- **E** earlier document but published on or after the international filing date
- **L* document which may throw doubts on priority claims or which is cited to establish the publication date of another citation or other special reason (as specified)
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**I** later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

**X** document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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**S** document member of the same patent family

Further documents are listed in the continuation of Box C. See patent family annex.

- Date of the actual completion of the international search:
  23 November 2006

- Date of mailing of the international search report:
  19/12/2006

Name and mailing address of the ISA:
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2299 HV Rijswijk
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Authorized officer:
Hunt, Joke

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