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(54) APPARATUSES AND SYSTEMS FOR AN ASSISTIVE CANE FOR THE VISUALLY IMPAIRED

(57) The invention provides an apparatus for a handle of a cane, preferably an assistive cane, the apparatus comprising: a housing defining an outer appearance of the apparatus; attachment means for attaching the housing to the handle of the cane; a first sensor located inside the housing configured to transmit a signal in a first direction, wherein the first direction is an upward direction when the apparatus is attached to the handle of the cane; and at least one first indication device located inside the housing and connected to the first sensor, wherein the first sensor is configured to identify obstacles located within the first direction and wherein the at least one first indication device is configured to indicate an obstacle upon identification by the first sensor.

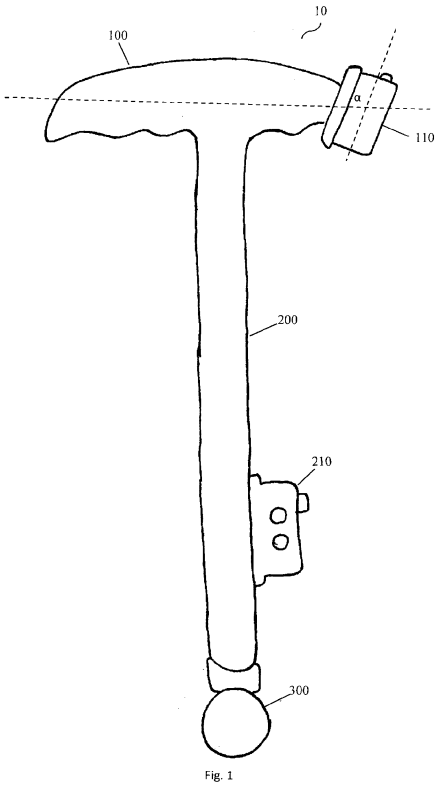

Fig. 1

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Description

[0001] The present disclosure relates to apparatuses and systems for a cane, in particular an assistive cane for the visually impaired.

[0002] Currently available electronic canes either provide an audible alert to the user for obstacles in the outdoor environment or the users are alerted by receiving haptic feedback for surrounding obstacles, without receiving further notice about the direction of the obstacle in space (right, left, straight compared to the direction of movement).

[0003] The aforementioned electronic canes may detect obstacles in the low and middle level (middle & low level), and the user receives either auditory or haptic feedback.

[0004] Currently, there is no assistive cane available that provides multiple and diverse safety functionalities for visually impaired people. That is, assistive canes lack the ability to provide automatic safety measures for various hazards for visually impaired people.

[0005] It is an object of the present invention to overcome the aforementioned deficiencies of the prior art and to provide apparatuses and devices for an assistive cane for the visually impaired that has increased functionalities. Further objects will be apparent from the following description.

[0006] The object(s) is/are achieved with the features of the independent claims. Dependent claims define preferred embodiments of the invention.

[0007] In particular, the present disclosure relates to an apparatus for a handle of a cane, preferably an assistive cane, the apparatus comprising: a housing defining an outer appearance of the apparatus; attachment means for attaching the housing to the handle of the cane; a first sensor located inside the housing configured to transmit a signal in a first direction, wherein the first direction is an upward direction when the apparatus is attached to the handle of the cane; and at least one first indication device located inside the housing and connected to the first sensor. The first sensor is configured to identify obstacles located within the first direction and wherein the at least one first indication device is configured to indicate an obstacle upon identification by the first sensor.

[0008] Various embodiments may preferably implement the following features.

[0009] Preferably, at least one first indication device comprises a vibration motor.

[0010] Preferably, the at least one first indication device comprises two first indication devices.

[0011] The first sensor is preferably configured to locate obstacles at a height of a user's head.

[0012] The attachment means are preferably configured to attach the housing under a predetermined angle with respect to the handle of the cane such that the first direction is tilted in a forward direction by the predetermined angle when the apparatus is attached to the handle of the cane.

[0013] The apparatus preferably further comprises a Bluetooth device located inside the housing and configured to connect to an external device.

[0014] The external device is preferably a mobile device and more preferably a mobile phone.

[0015] The apparatus preferably further comprises a signaling device, preferably a speaker, wherein the signaling device is configured to transmit a signal upon receiving a respective command via the Bluetooth device from the external device.

[0016] The Bluetooth device is preferably further configured to receive a signal from a traffic light, wherein the signal indicates the status of the traffic light and wherein the at least one first indication device is configured to indicate the status of the traffic light based on the received signal.

[0017] The first sensor is preferably configured to detect an increase or decrease in the distance to the obstacle and wherein the at least one first indication device is preferably configured to vary a predetermined parameter of the indication in accordance with the detected increase or decrease of distance to the obstacle.

[0018] The apparatus preferably further comprises a switch for switching the apparatus on and off.

[0019] The apparatus preferably further comprises a rechargeable battery for power supply.

[0020] The housing is preferably waterproof and/or shock-resistant.

[0021] The present disclosure also relates to an apparatus for a shaft of a cane, preferably an assistive cane, the apparatus comprising: a housing defining an outer appearance of the apparatus; attachment means for attaching the housing to the shaft of the cane; a second sensor located inside the housing configured to transmit a signal in a second direction, wherein the second direction is any direction other than an upward direction when the apparatus is attached to the shaft of the cane; and a second indication device located at a first position on a handle of the cane and connected to the second sensor. The second sensor is configured to identify obstacles located within the second direction and wherein the second indication device is configured to indicate an obstacle upon identification by the second sensor.

[0022] Various embodiments may preferably implement the following features.

[0023] The apparatus preferably further comprises: a third sensor located inside the housing configured to transmit a signal in a third direction, wherein the third direction is any direction other than an upward direction and the second direction when the apparatus is attached to the shaft of the cane; and a third indication device located at a second position on the handle of the cane and connected to the third sensor, wherein the third sensor is configured to identify obstacles located within the third direction and wherein the third indication device is configured to indicate an obstacle upon identification by the third sensor.

[0024] The apparatus preferably further comprises: a fourth sensor located inside the housing configured to transmit a signal in a fourth direction, wherein the fourth direction is any direction other than an upward direction and the second and third direction when the apparatus is attached to the shaft of the cane; and a fourth indication device located at a third position on the handle of the cane and connected to the fourth sensor, wherein the fourth sensor is configured to identify obstacles located within the fourth direction and wherein the fourth indication device is configured to indicate an obstacle upon identification by the fourth sensor.

[0025] The apparatus preferably further comprises: a fifth sensor located inside the housing configured to transmit a signal in a fifth direction, wherein the fifth direction is any direction other than an upward direction and the second, third and fourth direction when the apparatus is attached to the shaft of the cane; and a fifth indication device located at a fourth position on the handle of the cane and connected to the fifth sensor, wherein the fifth sensor is configured to identify obstacles located within the fifth direction and wherein the fifth indication device is configured to indicate an obstacle upon identification by the fifth sensor.

[0026] The second, third, fourth or fifth direction preferably corresponds to one of a left side, a right side, a front side or a bottom side direction when the apparatus is attached to the shaft of the cane.

[0027] The first position on the handle of the cane is preferably associated with the second direction and/or the second position on the handle of the cane is preferably associated with the third direction and/or the third position on the handle of the cane is preferably associated with the fourth direction and/or the fourth position on the handle of the cane is preferably associated with the fifth direction.

[0028] Preferably, any one of the second, third, fourth or fifth sensor is configured to detect an increase or decrease in the distance to the obstacle and wherein the respective second, third, fourth or fifth sensor is preferably configured to vary a predetermined parameter of the indication in accordance with the detected increase or decrease.

[0029] The apparatus preferably further comprises a Bluetooth device located inside the housing and configured to connect to an external device.

[0030] The external device is preferably a mobile device and more preferably a mobile phone.

[0031] The apparatus preferably further comprises a signaling device, preferably a speaker, wherein the signaling device is configured to transmit a signal upon receiving a respective command via the Bluetooth device from the external device.

[0032] The Bluetooth device is preferably further configured to receive a signal from a traffic light, wherein the signal indicates the status of the traffic light, and wherein at least one of the second, third, fourth or fifth indication device is configured to indicate the status of the traffic light based on the received signal.

[0033] Preferably, at least one of the second, third, fourth or fifth sensor is configured to detect an increase or decrease in the distance to the obstacle, and wherein the respective second, third, fourth or fifth indication device is configured to vary a predetermined parameter of the indication in accordance with the detected increase or decrease of distance to the obstacle.

[0034] Preferably, any one of the first to fifth sensor is an ultrasonic sensor or an infrared sensor.

[0035] The apparatus preferably further comprises a switch for switching the apparatus on and off.

[0036] The present disclosure also relates to a system comprising: a cane, preferably an assistive cane, wherein the cane comprises a handle and a shaft connected to the handle; an apparatus for the handle of the cane as described above; and an apparatus for the shaft of the cane as described above. The handle is configured to receive the apparatus for the handle of the cane and the shaft is configured to receive the apparatus for the shaft of the cane.

[0037] The present disclosure thus offers on the one hand the detection of obstacles at the height of the head and therefore protects the user from dangerous obstacles, and on the other hand it provides a connection of sensors that enable the user to get a 3D understanding of his/her surroundings.

[0038] At the same time the user can use the robotic cane both as conventional and as a robotic one, depending on the space in which he/she is each time. In addition, through his/her smartphone he/she can communicate with the cane and the cane may produce sound so that the user can locate its position each time.

[0039] The exemplary embodiments disclosed herein are directed to providing features that will become readily apparent by reference to the following description when taken in conjunction with the accompanying drawings. In accordance with various embodiments, exemplary systems, methods, devices and computer program products are disclosed herein. It is understood, however, that these embodiments are presented by way of example and not limitation, and it will be apparent to those of ordinary skill in the art who read the present disclosure that various modifications to the disclosed embodiments can be made while remaining within the scope of the present disclosure.

[0040] Thus, the present disclosure is not limited to the exemplary embodiments and applications described and illustrated herein. Additionally, the specific order and/or hierarchy of steps in the methods disclosed herein are merely exemplary approaches. Based upon design preferences, the specific order or hierarchy of steps of the disclosed methods or processes can be rearranged while remaining within the scope of the present disclosure. Thus, those of ordinary skill in the art will understand that the methods and techniques disclosed herein present various steps or acts in a sample order, and the present disclosure is not limited to the specific order or hierarchy

presented unless expressly stated otherwise.

[0041] The above and other aspects and their implementations are described in greater detail in the drawings, the descriptions, and the claims.

Fig. 1 is a schematic illustration of a system according to an embodiment.

Fig. 2 is a schematic illustration of an apparatus for a handle of a cane according to an embodiment.

Fig. 3 is an schematic illustration of an apparatus for a shaft of a cane according to an embodiment.

Fig. 4 is a schematic illustration of the handle of the cane according to an embodiment.

[0042] Fig. 1 shows a system comprising a cane 10 according to an embodiment. The cane 10 comprises a handle 100, a shaft 200 and an optional wheel 300. The system further comprises a first apparatus 110 and a second apparatus 210.

[0043] As can be seen from Fig. 1, the first apparatus 110 is attached to the front side of the handle 100. The first apparatus 110 is attached to the handle 100 such that the top surface of the first apparatus 110 faces towards the walking direction of a user using the cane 10. In other words, the first apparatus 110 is attached to the handle 100 such that a longitudinal direction of the handle 100 and the front surface of the first apparatus 110 form an angle $\alpha > 90°$ so that the front surface of the first apparatus 110 faces (slightly) towards the ground and the top surface of the first apparatus 110 faces (slightly) towards in said walking direction.

[0044] The second apparatus 210 is attached to the shaft 200 of the cane 10 at a relatively low position along the shaft's length. Relatively low meaning in this case below half the length of the shaft 200 and preferably below two third of the length of the shaft 200.

[0045] The second apparatus 210 is positioned essentially in the same direction as the first apparatus 110. That is, the front side of the first and second apparatus 110, 210 face int the same direction, which is the walking direction for a user using the cane 10. The respective back sides of the first and second apparatus 110, 210 are attached to the handle 100 and the shaft 200, respectively.

[0046] The wheel 300 is attached at the bottom of the shaft 200 and allows the userto push the cane 10 on the ground.

[0047] The first and second apparatus 110, 210 are further described with reference to Figs. 2 and 3. Fig. 2 shows the first apparatus 110 attached to the handle 100. The first apparatus comprises an ultrasonic sensor 111. The ultrasonic sensor 111 transmits ultrasonic signals in a direction perpendicular to the top surface of the first apparatus 110. Therefore, the first ultrasonic sensor 111 transmits ultrasonic signals to detect obstacles in the walking direction of the user that are located at a height of the user's head.

[0048] In an embodiment, the above described tilting of the first apparatus 110 towards a walking direction of the user may not be implemented. Rather, the first ultrasonic sensor 111 may be configured to transmit the ultrasonic signals under said tilt towards the walking direction of the user. In an embodiment, both of the first apparatus 110 and the ultrasonic sensor 11 may have tilts as described before. In any case, it is preferred that the ultrasonic signal is transmitted such that detection of obstacles at a height of the user's head in the walking direction of a user.

[0049] The first apparatus 110 further comprises a buzzer 112 (e.g. a speaker), which is used as a signaling device 112 and a switch 113 to turn the first apparatus 110 on and off. Both of the buzzer 112 and the switch 113 are located at the bottom surface of the first apparatus 110.

[0050] The first apparatus 110 further comprises a Bluetooth device (not shown) located inside the first apparatus 110 and configured to connect to an external device, preferably a mobile device and more preferably a mobile phone.

[0051] The buzzer 112 is configured to transmit a signal upon receiving a respective command via the Bluetooth device from the external device. This way the user can locate the cane by inputting a respective command in the external device upon which a signal, such as a sound, is created by buzzer 112.

[0052] In addition, the first apparatus 110 further comprises at least one, preferably two, vibration motor(s) (not shown) located at the back surface of the first apparatus 110. The vibration motors will indicate an obstacle at the height of the user's head upon detection by the first ultrasonic sensor 111 by providing a noticeable vibration to the handle 100. The vibration motor(s) may be referred to as a first indication device 114.

[0053] Fig. 3 shows the second apparatus 210 with four additional ultrasonic sensors, i.e. a second ultrasonic sensor 211, a third ultrasonic sensor 212, a fourth ultrasonic sensor 213, a fifth ultrasonic sensor 214. The second ultrasonic sensor 211 is located on the right side of the second apparatus 210. The third ultrasonic sensor 212 is located on a front side of the second apparatus 210. The fourth ultrasonic sensor 213 is located on a left side of the second apparatus 210. The fifth ultrasonic sensor 214 is located on a bottom side of the second apparatus 210.

[0054] The second ultrasonic sensor 211 transmits an ultrasonic signal towards the right side of the second apparatus 210 with respect to a walking direction of a user of the cane. The third ultrasonic sensor 212 transmits an ultrasonic signal towards the front side of the second apparatus 210 with respect to a walking direction of a user of the cane, i.e. towards the walking direction of the user. The fourth ultrasonic sensor 213 transmits an ultrasonic signal towards the left side of the second apparatus 210

with respect to a walking direction of a user of the cane. The fifth ultrasonic sensor 214 transmits an ultrasonic signal towards the bottom side of the second apparatus 210 with respect to a walking direction of a user of the cane, i.e. towards the ground.

[0055] The second to fifth ultrasonic sensors 211-214 are configured to indicate an obstacle in the respective direction of transmission of the ultrasonic signal. That is, the second ultrasonic sensor 211 is configured to locate an obstacle on the right side of the second apparatus 210 with respect to a walking direction of a user of the cane. The third ultrasonic sensor 212 is configured to locate an obstacle on the front side of the second apparatus 210 with respect to a walking direction of a user of the cane, i.e. in the walking direction of the user. The fourth ultrasonic sensor 213 is configured to locate an obstacle on the left side of the second apparatus 210 with respect to a walking direction of a user of the cane. The fifth ultrasonic sensor 214 is configured to locate an obstacle on the bottom side of the second apparatus 210 with respect to a walking direction of a user of the cane, i.e. on the ground.

[0056] The second apparatus 210 further comprises a switch 215 to turn the second apparatus 210 on and off. The switch 215 is located at the top surface of the second apparatus 210.

[0057] Fig. 4 shows the handle 100 with the first apparatus 110 attached thereto. In addition, Fig. 4 shows vibrations 101, 102, 103 and 104.

[0058] The first vibration 101 is located at the right side of the handle 100 and configured to indicate an obstacle to the right side of the user's walking direction upon detection by the second ultrasonic sensor 211. The second vibration 102 is located at the top side of the handle 100 and configured to indicate an obstacle in front of the user's walking direction upon detection by the third ultrasonic sensor 212. The third vibration 103 is located at the left side of the handle 100 and configured to indicate an obstacle to the left side of the user's walking direction upon detection by the fourth ultrasonic sensor 213. The fourth vibration 104 is located at the bottom side of the handle 100 and configured to indicate an obstacle at the ground within the user's walking direction upon detection by the fifth ultrasonic sensor 214.

[0059] The above arrangement of the vibrations 101-104 on the handle 100 is one way of achieving a 3D-navigation. However, the present disclosure is not limited to the embodiment of Fig. 4. In fact, it will be appreciated that the vibrations 101-104 may be located at different locations on the handle 100 for achieving a 3D-navigation. For example, the vibrations 101-104 may all be located on one side of the handle 100, while the location of each vibration may correspond to a different finger of the user's hand. In this way, each finger will be associated with a different direction (i.e. a different sensor 211-214). Other configurations are possible as long as it is clear to the user which vibration corresponds to which direction (sensor).

[0060] Further details and functionalities of various embodiments are further described in the following with reference to Figs. 1-4.

[0061] Embodiments provide a robotic cane 10 designed to assist visually impaired people in their transportations.

[0062] In an embodiment, the cane 10 comprises a cane frame, five ultrasonic sensors 111, 211, 212, 213, 214, six vibrations 114, 101, 102, 103, 104, namely two vibration motors 114 and four (simple) vibrations 101-104, two waterproof boxes 110, 210 that are also shock-resistant, two bluetooth systems and one speaker (buzzer 112) and two on-off switches 113, 215.

[0063] In an embodiment, a processor and a corresponding program (software) that is integrated in the system is provided in order to operate successfully.

[0064] In an embodiment, a system that is placed inside traffic lights and a corresponding system that is integrated in the first or second apparatus 110, 210 is provided, so that the user can be notified whether the traffic light is green to pass, or red to wait.

[0065] In an embodiment, a smart cane may be provided as such, but the two boxes 110, 210 with the sensors and vibrations can also be added to existing white canes.

[0066] In an embodiment, the robotic cane 10 is made of aluminum to ensure its resistance to vibrations and shocks. The color of the cane 10 may be white, so that it can be well understood that it is a white cane 10 for visually impaired people.

[0067] In an embodiment, the cane 10 has an additional wheel 300 on its bottom, e.g. with a diameter of 3 to 5 cm, preferably 4 cm (at its point of contact with the ground), to facilitate the user's movement.

[0068] In an embodiment, the wheel 300 rotates in two axes (around itself and in the direction of the user's movement).

[0069] In an embodiment, the cane 10 has reflective strips in, e.g., three points (low level, medium and high), so that it becomes visible during the evening and late-night hours.

[0070] The height for the cane 10 is not fixed and specifically it extends from 80 cm to 120 cm with increments of 4 cm (extension step). The cane 10 may weigh 600 g.

[0071] In an embodiment, the handle 100 is configured as a non-slip handle 100 with four prescribed partitions for each finger of the user. The size of each partition may be about 1 cm to ensure the correct use (grip) of the cane 10.

[0072] In an embodiment, the handle 100 of the cane 10 has a length of about 12-18 cm and preferably 15 cm, the four simple circular vibrations (vibrations 101, 102, 103, 104) have a diameter of about 1.0-1.8 cm and preferably 1.2 cm, wherein vibrations bigger than 1.0 cm may be easier to be recognized by the user and vibrations smaller than 1.8 cm may ensure that the vibrations from the sensors do not overlap (at least for the user's perception when vibration is caused). The vibrations are

placed as follows:

Vibration 102 is located at the top and middle of the handle 100 and its purpose is to alert the user for obstacles coming in his/her straight line (along the direction of movement). Vibration 101 is located on the right side of the handle and may specifically be located about seven cm away from the front of the handle 100, so that it is identical to the part of the handle 100 that comes in contact with the user's index finger. Vibration 103 is located on the left side of the handle 100 and at a distance of about ten cm from the front of the handle 100, so that it correlates with the part of the handle 100 that comes into contact with the user's ring finger . The front being defined as the part of the handle that has the first box 110 attached thereto, i.e. towards the moving direction of the user.

[0073] The two vibrations 101, 103 inform the user about obstacles that he/she will find on the right or on the left side along the direction of his/her movement, respectively. Finally, vibration 104 is placed at the bottom of the handle and opposite (anti diametrical) to vibration 102.

[0074] In an embodiment, the first one of the white waterproof boxes 110, which contains sensor 111 is placed in the front of the handle 100 of the cane 10.

[0075] In an embodiment, the box 110 is screwed to the handle 100 using a metal side support angle of about three cm and has two screws that connect one part of the corner with the handle 100 and two screws that connect the box 110 to the other side of the angle. In the same way this box 110 can be attached to the handle 100 of any other cane 10.

[0076] In an embodiment, the box 110 is relatively small (e.g. 7 length * 7 width * 5 height cm) and consists of sensors and cables inside, so that the whole electronic system is protected from weather and / or damage.

[0077] In an embodiment, an ultrasonic sensor 111 is placed at the top of the box 110, which emits ultrasonic waves checking for obstacles at the height of the user's head (for example branches, low balconies, open windows, etc.).

[0078] In an embodiment, the distance at which the sensor 111 is detecting obstacles is determined each time by the height of the user and is less than or equal to the distance of the handle 100 of the cane 10 from the end of the user's head.

[0079] In an embodiment, two vibration motors 114 are placed on the side of the box 110 that is screwed to the metal corner of the handle 100. At this point it should be emphasized that vibration motors provide more intense vibration than (simple) vibrations, as head protection is a matter of great importance for visually impaired people.

[0080] That is, in the present disclosure vibration motors distinguish from vibrations by their strength of vibration that is created by it.

[0081] As mentioned above with reference to the vibrations 101-104, the distinction between the sensor 111 and the other sensors 101-104 may be made differently than to employ vibration motors for sensor 111 and vibrations 101-104 for sensors 211-214. For example, in an embodiment, there may be no vibrations motor, but a fifth vibration associated with the sensor 111 located at a distinct position on the handle 100, such that the user can differentiate between the different vibrations provided on the handle 100.

[0082] If the ultrasonic sensor 111 detects an obstacle at a height up to the user's head, the vibration motors 114 are activated and the user receives a signal to protect himself/herself.

[0083] In an embodiment, this box 110 also includes a speaker (buzzer112) and a bluetooth device (for example HC-05, HC-06 etc.). Bluetooth may be connected to the user's mobile phone (paired devices) and the user can type in his/her smartphone, e.g. either the letter "o" (open) or "c" (close).

[0084] The first command ("o") may activate the buzzer 112 and the user can locate his/her robotic cane 10 by the sound produced. With the second command("c") the user may turn off the buzzer 112.

[0085] In an embodiment, the box 110 also includes an on-off switch 113, e.g. a button, and a power battery. The battery may be rechargeable (6 or 9 V in total) and at the bottom of the box 110 a plug receiver may be provided, that connects the battery to its charger. This receiver may be provided on the bottom of the box 110 and it may be covered by a plastic cover.

[0086] Finally, in an embodiment, a microprocessor (e.g. arduino, photon, etc.) is provided inside the box 110, which provides an output voltage greater than or equal to 3.3 V to operate the ultrasonic sensors 111.

[0087] Hence, the first white box 110 is used for protection (from the obstacles in head & high level) and for localization of the cane 10. Once again, this box 110 can be used independently and be applied in any cane 10.

[0088] At the bottom of the cane 10 and at a distance of about 10-12 cm, preferably 10 cm, from the point where the wheel 300 is placed, the second waterproof white box 210 is attached. In particular, the box 210 is placed above the wheel 300 so that the wheel 300 can freely move in both axes. Moreover, as the cane 10 may also be used as a simple cane 10 (without wheel 300), users can use the bottom part of the cane 10 to identify stairs. Therefore, it is preferable that the box 210 is placed at a distance of about 10-12 cm from the point where the wheel 300 is placed, as the average stair step (rise) is about 15 cm.

[0089] In an embodiment, the box 210 is screwed directly onto the cane 10 with two sheet screws, one at the top of the box 210 and one at the bottom.

[0090] In an embodiment, this box 210 is larger than the other box 110 as it includes more sensors 211-214 (the size of the box 210 may be approximately 10 length * 10 width * 5 height cm). In an embodiment, in the middle of the direct contact of the cane 10 (more particular the shaft 200 of the cane 10) with the box 210 and specifically inside the box 210, a hole with a diameter of at least 0.4

cm is drilled in order to pass five copper cables covered with PVC.

[0091] The cables may be about 110 cm long, so that there is enough length (cable) available in each opening of the folding cane (from 80 to 120 cm). The cables are starting from the inside of box 110 at the bottom of the cane 10 and end in the handle 100 of the cane 10.

[0092] The cables extend inside the aluminum cane 10, which is hollow up to the handle 100 of the shaft 200 where they are connected to the four vibrations 101-104 that have been placed in the handle 100 as mentioned above.

[0093] The four of these cables are placed in digital ports of the microprocessor that will be placed in the box 210, in order to be properly activated. This microprocessor should also give an output voltage greater than or equal to 3.3 V to operate the sensors 211-214 that will be placed in the box 210. The last cable is placed in the ground provided by the microprocessor.

[0094] Additionally, the cables are connected to the vibrations 101-104 on the handle 100 of the cane 10 as follows: one cable is connected to each vibration 101-104 in the positive current input and the last cable that communicates with the ground of the microprocessor is connected to the free pin of each vibration 101-104.

[0095] In an embodiment, the four ultrasonic sensors 211-214 are placed in the lower white box 210 as follows: the sensor 211 to the right of the box 210, as it sends ultrasonic waves to detect obstacles on the user's right. This sensor 211 activates the vibration 101 of the handle 100 on the right side. The ultrasonic sensor 213 is placed on the left side of the box 210 and is connected to the left vibration 103 of the handle 100. The purpose is to detect obstacles to the left of the user. The ultrasonic sensor 212 is placed in the front side of the box 210, in the direction of movement, and it is connected with the vibration 102 placed at the top of the handle 100, to detect obstacles in the user's direction of movement. Finally, another sensor 214 is placed at the bottom of the white box 210 sending signals to the ground. This sensor 214 is connected to the vibration 104 at the bottom of the handle 100. The vibration 104 is activated when the sensor 214 detects a large increase in the distance between the ground and the cane 10, which means either that a sidewalk is ending or that there is a pothole in front of the user. Either way, the user is notified by the vibration 104 on the bottom of the handle 100. Both cases require special attention and hence, the user is notified.

[0096] So every time an obstacle is detected by the sensors 211-214 of the robotic cane 10, the user is informed by vibration on the handle 100 he/she holds about the direction of the obstacle. So the robotic cane 10 provides a 3D navigation system. Each ultrasonic sensor 101-104 is placed in the middle of the corresponding side of the handle 100 (at 5 cm).

[0097] In an embodiment, the intensity of the vibrations 101-104 can increase as the user gets closer to the obstacle and becomes intense and uninterrupted when the user's distance from an obstacle is less than, e.g., 50 cm.

[0098] In an embodiment, the user can select mode A (to be notified for obstacles that are closer than or equal to 1 m away) or mode B (to be notified for obstacles that are closer than or equal to 2 m away). In both cases the intensity of vibration will increase as the user moves closer to the obstacle.

[0099] Therefore, the user knows how close or far from him/her the obstacle is in addition to the direction of the obstacle. This distance can be modified if the user wishes to do so.

[0100] In an embodiment, inside this box 210, an on-off switch 215 is placed as well as a rechargeable battery (total voltage 6-9 V) in addition to the ultrasonic sensors 211-214 and the microprocessor. At the bottom of the box 210 there is a protected plastic cover for the charging spot of this box 210.

[0101] In an embodiment, the box 210 may also comprise a bluetooth receiver, that is activated only when the ultrasound sensor 214 placed on the bottom of the box 210 detects an increment in the distance between the cane 10 and the ground. At this point the bluetooth (HC-05, HC-06) receiver is activated and starts searching for close bluetooth devices (the same type HC-05, HC-06) that act as transmitters. These transmitters can either be a smart traffic light (using bluetooth) that already exist, or a bluetooth functionality that can be placed in existing traffic lights as follows: A light sensor identifies whether the green light is on or off. Then, in case of detecting an on green traffic light, a signal is transmitted through the bluetooth system to each cane 10 that searches to receive signals. If green light is off, no transmission of signal is implemented.

[0102] Hence if the bluetooth system inside the box 210 receives a signal, all the vibrations 101-104 on the handle 100 of the cane 10 may start pulsating so that the user realizes that he/she can pass the street. Alternatively, an additional vibration (not shown) may be provided for the indication of the status of the traffic light or a different scheme may be implemented using the existing vibrations 101-104 to indicate the status of the traffic light.

[0103] In an embodiment, both boxes 110, 210 may be sealed to maintain their waterproof property and to be resistant to damages and shocks, since they include all the electrical parts of the robotic cane 10.

[0104] In an embodiment, the boxes 110, 210 include different switches as the user can choose whether he/she wants to use the robotic advantages of the cane 10 or use it as a simple white cane 10. In addition, he/she may be in a very crowded enclosed space (for example a bus) and may want to use only the head protection and not the 3D navigation system. So he/she can always use only the functions of the cane 10 he/she wants.

[0105] The ultrasonic sensors are one possible embodiment. Infrared (IR) sensors may also be used. That is at least one, or all, of the aforementioned sensors may alternatively be implemented as IR sensors in embodiments of the disclosure. However, the use of ultrasonic

sensors may be preferable as they can detect obstacles in a greater distance than an IR sensors.

[0106] In summary, embodiments of the present disclosure provide a robotic cane for the visually impaired. The disclosure relates to the construction of a robotic cane, which is used by visually impaired people. This cane may be waterproof and shockproof. It provides a unique protection to the user against obstacles at the height & head level, by detecting obstacles through an ultrasonic sensor and activating vibration motors to notify the user. The robotic cane offers a three-dimensional navigation system with ultrasonic sensors that detect obstacles in each direction along the user's movement (front, right, left). The user is notified for these obstacles by a vibration system on the handle of the cane. He/She is informed both about the direction of these obstacles as well as their distance in relation to the user's position. The user is also informed about potholes in the direction of his movement or about the end of a sidewalk through an ultrasonic sensor. For this purpose, the cane may have a total of five ultrasonic sensors and six vibrations (vibration motors and simple vibrations). Also, the cane may have a sound localization system. This allows the user via his/her mobile phone to activate a buzzer located on the cane in order to find it in any place. The cane may also act as a signal receiver from smart traffic lights and notify the user whether there is a green light to pass or a red light to wait. The 3D navigation system and the protection system boxes, can also be applied to every cane and not only to the described one.

[0107] As mentioned above, in order to implement the various functionalities a processor may be employed. The processor may control the various components described above, such as the ultrasonic sensors, the vibration motors, the vibrations, the buzzer and the switches. The processor may also implement the respective determination algorithms to detect an obstacle based on the transmitted ultrasonic signals. The respective determination algorithms based on ultrasonic signals are well known to the skilled person and can be implemented in various ways without departing from the scope of the disclosure.

[0108] While various embodiments of the present disclosure have been described above, it should be understood that they have been presented by way of example only, and not by way of limitation. Likewise, the various diagrams may depict an example of architecture or configuration, which are provided to enable persons of ordinary skill in the art to understand exemplary features and functions of the present disclosure. Such persons would understand, however, that the present disclosure is not restricted to the illustrated example architectures or configurations, but can be implemented using a variety of alternative architectures and configurations. Additionally, as would be understood by persons of ordinary skill in the art, one or more features of one embodiment can be combined with one or more features of another embodiment described herein. Thus, the breadth and scope of the present disclosure should not be limited by any of the above-described exemplary embodiments.

[0109] It is also understood that any reference to an element herein using a designation such as "first," "second," and so forth does not generally limit the quantity or order of those elements. Rather, these designations can be used herein as a convenient means of distinguishing between two or more elements or instances of an element. Thus, a reference to first and second elements does not mean that only two elements can be employed, or that the first element must precede the second element in some manner.

[0110] Additionally, a person having ordinary skill in the art would understand that information and signals can be represented using any of a variety of different technologies and techniques. For example, data, instructions, commands, information, signals, bits and symbols, for example, which may be referenced in the above description can be represented by voltages, currents, electromagnetic waves, magnetic fields or particles, optical fields or particles, or any combination thereof.

[0111] A skilled person would further appreciate that any of the various illustrative logical blocks, units, processors, means, circuits, methods and functions described in connection with the aspects disclosed herein can be implemented by electronic hardware (e.g., a digital implementation, an analog implementation, or a combination of the two), firmware, various forms of program or design code incorporating instructions (which can be referred to herein, for convenience, as "software" or a "software unit"), or any combination of these techniques.

[0112] To clearly illustrate this interchangeability of hardware, firmware and software, various illustrative components, blocks, units, circuits, and steps have been described above generally in terms of their functionality. Whether such functionality is implemented as hardware, firmware or software, or a combination of these techniques, depends upon the particular application and design constraints imposed on the overall system. Skilled artisans can implement the described functionality in various ways for each particular application, but such implementation decisions do not cause a departure from the scope of the present disclosure.

[0113] In accordance with various embodiments, a processor, device, component, circuit, structure, machine, unit, etc. can be configured to perform one or more of the functions described herein. The term "configured to" or "configured for" as used herein with respect to a specified operation or function refers to a processor, device, component, circuit, structure, machine, unit, etc. that is physically constructed, programmed and/or arranged to perform the specified operation or function.

[0114] Furthermore, a skilled person would understand that various illustrative logical blocks, units, devices, components and circuits described herein can be implemented within or performed by an integrated circuit (IC) that can include a general purpose processor, a digital signal processor (DSP), an application specific inte-

grated circuit (ASIC), a field programmable gate array (FPGA) or other programmable logic device, or any combination thereof. The logical blocks, units, and circuits can further include antennas and/or transceivers to communicate with various components within the network or within the device. A general purpose processor can be a microprocessor, but in the alternative, the processor can be any conventional processor, controller, or state machine. A processor can also be implemented as a combination of computing devices, e.g., a combination of a DSP and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a DSP core, or any other suitable configuration to perform the functions described herein. If implemented in software, the functions can be stored as one or more instructions or code on a computer-readable medium. Thus, the steps of a method or algorithm disclosed herein can be implemented as software stored on a computer-readable medium.

[0115] Computer-readable media includes both computer storage media and communication media including any medium that can be enabled to transfer a computer program or code from one place to another. A storage media can be any available media that can be accessed by a computer. By way of example, and not limitation, such computer-readable media can include RAM, ROM, EEPROM, CD-ROM or other optical disk storage, magnetic disk storage or other magnetic storage devices, or any other medium that can be used to store desired program code in the form of instructions or data structures and that can be accessed by a computer.

[0116] In this document, the term "unit" as used herein, refers to software, firmware, hardware, and any combination of these elements for performing the associated functions described herein. Additionally, for the purpose of discussion, the various units are described as discrete units; however, as would be apparent to one of ordinary skill in the art, two or more units may be combined to form a single unit that performs the associated functions according embodiments of the present disclosure.

[0117] Additionally, memory or other storage, as well as communication components, may be employed in embodiments of the present disclosure. It will be appreciated that, for clarity purposes, the above description has described embodiments of the present disclosure with reference to different functional units and processors. However, it will be apparent that any suitable distribution of functionality between different functional units, processing logic elements or domains may be used without detracting from the present disclosure. For example, functionality illustrated to be performed by separate processing logic elements, or controllers, may be performed by the same processing logic element, or controller. Hence, references to specific functional units are only references to a suitable means for providing the described functionality, rather than indicative of a strict logical or physical structure or organization.

[0118] Various modifications to the implementations described in this disclosure will be readily apparent to those skilled in the art, and the general principles defined herein can be applied to other implementations without departing from the scope of this disclosure. Thus, the disclosure is not intended to be limited to the implementations shown herein, but is to be accorded the widest scope consistent with the novel features and principles disclosed herein, as recited in the claims below.

Claims

1. Apparatus (110) for a handle (100) of a cane (10), preferably an assistive cane, the apparatus (110) comprising:

   a housing defining an outer appearance of the apparatus (110);
   attachment means for attaching the housing to the handle (100) of the cane (10);
   a first sensor (111) located inside the housing configured to transmit a signal in a first direction, wherein the first direction is an upward direction when the apparatus (110) is attached to the handle (100) of the cane (10); and
   at least one first indication device (114) located inside the housing and connected to the first sensor (111),
   wherein the first sensor (111) is configured to identify obstacles located within the first direction and wherein the at least one first indication device (114) is configured to indicate an obstacle upon identification by the first sensor (111).

2. The apparatus (110) of claim 1, wherein the at least one first indication device (114) comprises a vibration motor, and preferably the at least one first indication device (114) comprises two first indication devices.

3. The apparatus (110) of any one of claims 1 to 2, wherein the attachment means are configured to attach the housing under a predetermined angle with respect to the handle (100) of the cane (10) such that the first direction is tilted in a forward direction by the predetermined angle when the apparatus (110) is attached to the handle (100) of the cane (10) and/or
   the apparatus further comprises a Bluetooth device located inside the housing and configured to connect to an external device, preferably a mobile device and more preferably a mobile phone.

4. The apparatus of claim 3, further comprising a signaling device (112), preferably a speaker, wherein the signaling device (112) is configured to transmit a signal upon receiving a respective command via the Bluetooth device from the external device.

5. The apparatus of any one of claims 1 to 4, wherein the first sensor (111) is configured to detect an increase or decrease in the distance to the obstacle and wherein the at least one first indication device (114) is configured to vary a predetermined parameter of the indication in accordance with the detected increase or decrease of distance to the obstacle.

6. The apparatus of any one of claims 1 to 5, wherein the first sensor (111) is an ultrasonic sensor or an infrared sensor.

7. Apparatus (210) for a shaft (200) of a cane (10), preferably an assistive cane, the apparatus (210) comprising:

a housing defining an outer appearance of the apparatus (210);
attachment means for attaching the housing to the shaft (200) of the cane (10);
a second sensor (211) located inside the housing configured to transmit a signal in a second direction, wherein the second direction is any direction other than an upward direction when the apparatus (210) is attached to the shaft (200) of the cane (10); and
a second indication device (101) located at a first position on a handle (100) of the cane (10) and connected to the second sensor (211),
wherein the second sensor (211) is configured to identify obstacles located within the second direction and wherein the second indication device (101) is configured to indicate an obstacle upon identification by the second sensor (211).

8. The apparatus (210) of claim 7, further comprising:

a third sensor (212) located inside the housing configured to transmit a signal in a third direction, wherein the third direction is any direction other than an upward direction and the second direction when the apparatus (210) is attached to the shaft (200) of the cane (10); and
a third indication device (102) located at a second position on the handle (100) of the cane (10) and connected to the third sensor (212),
wherein the third sensor (212) is configured to identify obstacles located within the third direction and wherein the third indication device (102) is configured to indicate an obstacle upon identification by the third sensor (212).

9. The apparatus (210) of claim 7 or 8, further comprising:

a fourth sensor (213) located inside the housing configured to transmit a signal in a fourth direction, wherein the fourth direction is any direction other than an upward direction and the second and third direction when the apparatus (210) is attached to the shaft (200) of the cane (10); and
a fourth indication device (103) located at a third position on the handle (100) of the cane (10) and connected to the fourth sensor (213),
wherein the fourth sensor (213) is configured to identify obstacles located within the fourth direction and wherein the fourth indication device (103) is configured to indicate an obstacle upon identification by the fourth sensor (213).

10. The apparatus (210) of any one of claims 7 to 9, further comprising:

a fifth sensor (214) located inside the housing configured to transmit a signal in a fifth direction, wherein the fifth direction is any direction otherthan an upward direction and the second, third and fourth direction when the apparatus (210) is attached to the shaft (200) of the cane (10); and
a fifth indication device (104) located at a fourth position on the handle (100) of the cane (10) and connected to the fifth sensor (214),
wherein the fifth sensor (214) is configured to identify obstacles located within the fifth direction and wherein the fifth indication device (104) is configured to indicate an obstacle upon identification by the fifth sensor (214).

11. The apparatus (210) of any one of claims 7 to 10, wherein the second, third, fourth or fifth direction corresponds to one of a left side, a right side, a front side or a bottom side direction when the apparatus (210) is attached to the shaft (200) of the cane (10) and/or the apparatus further comprises a Bluetooth device located inside the housing and configured to connect to an external device, preferably a mobile device and more preferably a mobile phone.

12. The apparatus (210) of claim 11, further comprising a signaling device, preferably a speaker, wherein the signaling device is configured to transmit a signal upon receiving a respective command via the Bluetooth device from the external device.

13. The apparatus (210) of any one of claims 7 to 12, wherein at least one of the second, third, fourth or fifth sensor (211, 212, 213, 214) is configured to detect an increase or decrease in the distance to the obstacle, and wherein the respective second, third, fourth or fifth indication device (101, 102, 103, 104) is configured to vary a predetermined parameter of the indication in accordance with the detected increase or decrease of distance to the obstacle.

14. The apparatus (210) of any one of claims 7 to 13,

wherein any one of the second to fifth sensor (211, 212, 213, 214) is an ultrasonic sensor or an infrared sensor.

15. A system comprising:

a cane (10), preferably an assistive cane, wherein the cane (10) comprises a handle (100) and a shaft (200) connected to the handle (100);
an apparatus (110) for the handle (100) of the cane (10) of any one of claims 1 to 6; and
an apparatus (210) for the shaft (200) of the cane (10) of any one of claims 7 to 14,
wherein the handle (100) is configured to receive the apparatus (110) for the handle (100) of the cane (10) and the shaft (200) is configured to receive the apparatus (210) for the shaft (200) of the cane (10).

Amended claims in accordance with Rule 137(2) EPC.

1. Apparatus (110) for a handle (100) of a cane (10), preferably an assistive cane, the apparatus (110) comprising:

a housing defining an outer appearance of the apparatus (110);
attachment means for attaching the housing to the handle (100) of the cane (10);
a first sensor (111) located inside the housing configured to transmit a signal in a first direction, wherein the first direction is an upward direction when the apparatus (110) is attached to the handle (100) of the cane (10) and the cane (10) is in use; and
at least one first indication device (114) located inside the housing and connected to the first sensor (111),
wherein the first sensor (111) is configured to identify obstacles located within the first direction and wherein the at least one first indication device (114) is configured to indicate an obstacle upon identification by the first sensor (111), and
wherein the first sensor (111) is configured to detect an increase or decrease in the distance to the obstacle and wherein the at least one first indication device (114) is configured to vary a predetermined parameter of the indication in accordance with the detected increase or decrease of distance to the obstacle.

2. The apparatus (110) of claim 1, wherein the at least one first indication device (114) comprises a vibration motor, and preferably the at least one first indication device (114) comprises two first indication devices.

3. The apparatus (110) of any one of claims 1 to 2, wherein the attachment means are configured to attach the housing under a predetermined angle with respect to the handle (100) of the cane (10) such that the first direction is tilted in a forward direction by the predetermined angle when the apparatus (110) is attached to the handle (100) of the cane (10) and/or
the apparatus further comprises a Bluetooth device located inside the housing and configured to connect to an external device, preferably a mobile device and more preferably a mobile phone.

4. The apparatus of claim 3, further comprising a signaling device (112), preferably a speaker, wherein the signaling device (112) is configured to transmit a signal upon receiving a respective command via the Bluetooth device from the external device.

5. The apparatus of any one of claims 1 to 4, wherein the first sensor (111) is an ultrasonic sensor or an infrared sensor.

6. Apparatus (210) for a shaft (200) of a cane (10), preferably an assistive cane, the apparatus (210) comprising:

a housing defining an outer appearance of the apparatus (210);
attachment means for attaching the housing to the shaft (200) of the cane (10);
a second sensor (211) located inside the housing configured to transmit a signal in a second direction, wherein the second direction is any direction other than an upward direction when the apparatus (210) is attached to the shaft (200) of the cane (10) and the cane (10) is in use; and
a second indication device (101) located at a first position on a handle (100) of the cane (10) and connected to the second sensor (211),
wherein the second sensor (211) is configured to identify obstacles located within the second direction and wherein the second indication device (101) is configured to indicate an obstacle upon identification by the second sensor (211), and
wherein the second sensor (211) is configured to detect an increase or decrease in the distance to the obstacle, and wherein the respective second indication device (101) is configured to vary a predetermined parameter of the indication in accordance with the detected increase or decrease of distance to the obstacle.

7. The apparatus (210) of claim 6, further comprising:

a third sensor (212) located inside the housing configured to transmit a signal in a third direction, wherein the third direction is any direction other than an upward direction and the second direction when the apparatus (210) is attached to the shaft (200) of the cane (10); and
a third indication device (102) located at a second position on the handle (100) of the cane (10) and connected to the third sensor (212),
wherein the third sensor (212) is configured to identify obstacles located within the third direction and wherein the third indication device (102) is configured to indicate an obstacle upon identification by the third sensor (212).

8. The apparatus (210) of claim 6 or 7, further comprising:

a fourth sensor (213) located inside the housing configured to transmit a signal in a fourth direction, wherein the fourth direction is any direction other than an upward direction and the second and third direction when the apparatus (210) is attached to the shaft (200) of the cane (10); and
a fourth indication device (103) located at a third position on the handle (100) of the cane (10) and connected to the fourth sensor (213),
wherein the fourth sensor (213) is configured to identify obstacles located within the fourth direction and wherein the fourth indication device (103) is configured to indicate an obstacle upon identification by the fourth sensor (213).

9. The apparatus (210) of any one of claims 6 to 8, further comprising:

a fifth sensor (214) located inside the housing configured to transmit a signal in a fifth direction, wherein the fifth direction is any direction other than an upward direction and the second, third and fourth direction when the apparatus (210) is attached to the shaft (200) of the cane (10); and
a fifth indication device (104) located at a fourth position on the handle (100) of the cane (10) and connected to the fifth sensor (214),
wherein the fifth sensor (214) is configured to identify obstacles located within the fifth direction and wherein the fifth indication device (104) is configured to indicate an obstacle upon identification by the fifth sensor (214).

10. The apparatus (210) of any one of claims 6 to 9, wherein the second, third, fourth or fifth direction corresponds to one of a left side, a right side, a front side or a bottom side direction when the apparatus (210) is attached to the shaft (200) of the cane (10) and the cane (10) is in use and/or

the apparatus further comprises a Bluetooth device located inside the housing and configured to connect to an external device, preferably a mobile device and more preferably a mobile phone.

11. The apparatus (210) of claim 10, further comprising a signaling device, preferably a speaker, wherein the signaling device is configured to transmit a signal upon receiving a respective command via the Bluetooth device from the external device.

12. The apparatus (210) of any one of claims 6 to 11, wherein at least one of the third, fourth or fifth sensor (211, 212, 213, 214) is configured to detect an increase or decrease in the distance to the obstacle, and wherein the respective third, fourth or fifth indication device (101, 102, 103, 104) is configured to vary a predetermined parameter of the indication in accordance with the detected increase or decrease of distance to the obstacle.

13. The apparatus (210) of any one of claims 6 to 12, wherein any one of the second to fifth sensor (211, 212, 213, 214) is an ultrasonic sensor or an infrared sensor.

14. A system comprising:

a cane (10), preferably an assistive cane, wherein the cane (10) comprises a handle (100) and a shaft (200) connected to the handle (100);
an apparatus (110) for the handle (100) of the cane (10) of any one of claims 1 to 5; and
an apparatus (210) for the shaft (200) of the cane (10) of any one of claims 6 to 13,
wherein the handle (100) is configured to receive the apparatus (110) for the handle (100) of the cane (10) and the shaft (200) is configured to receive the apparatus (210) for the shaft (200) of the cane (10).

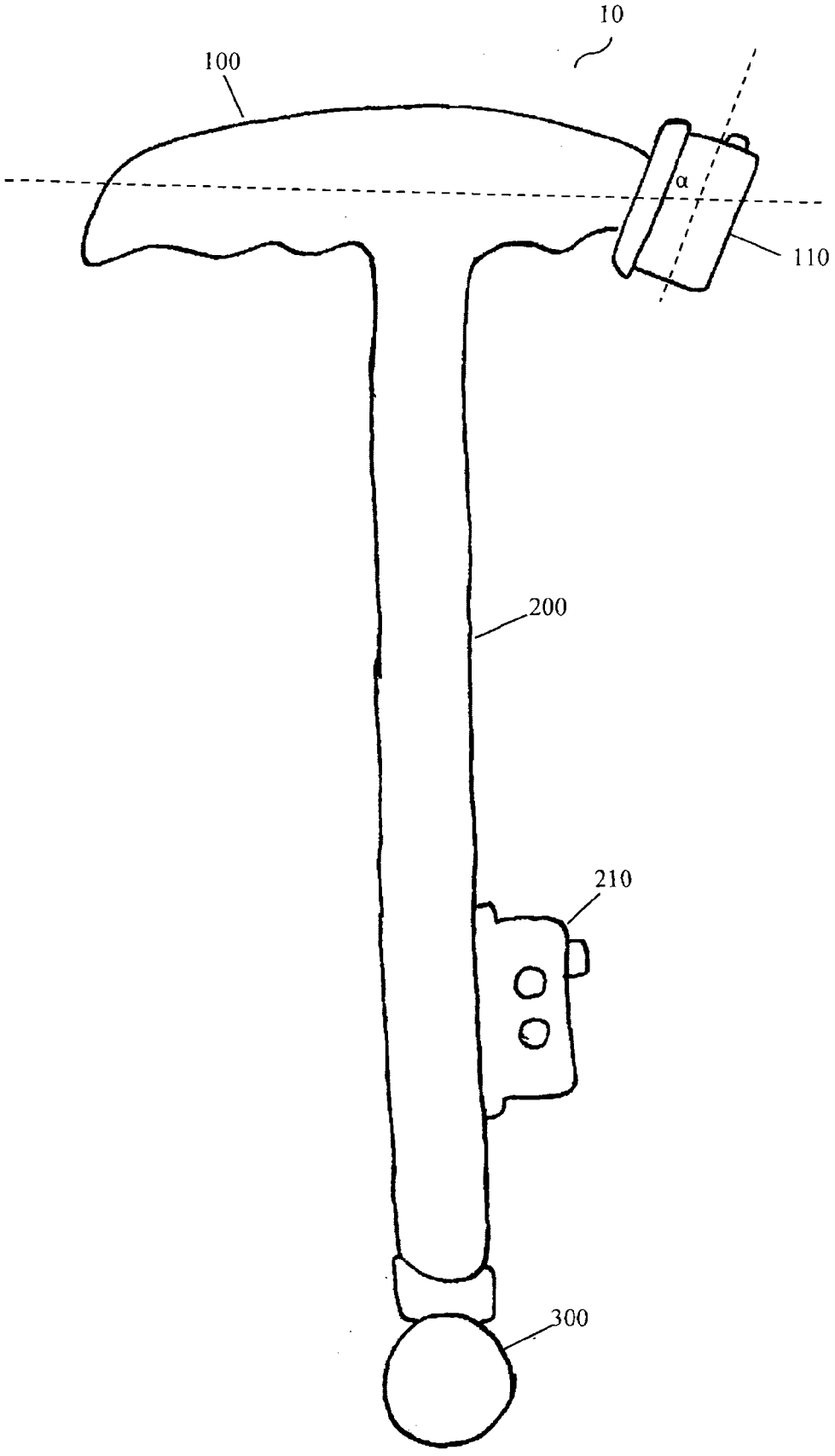

Fig. 1

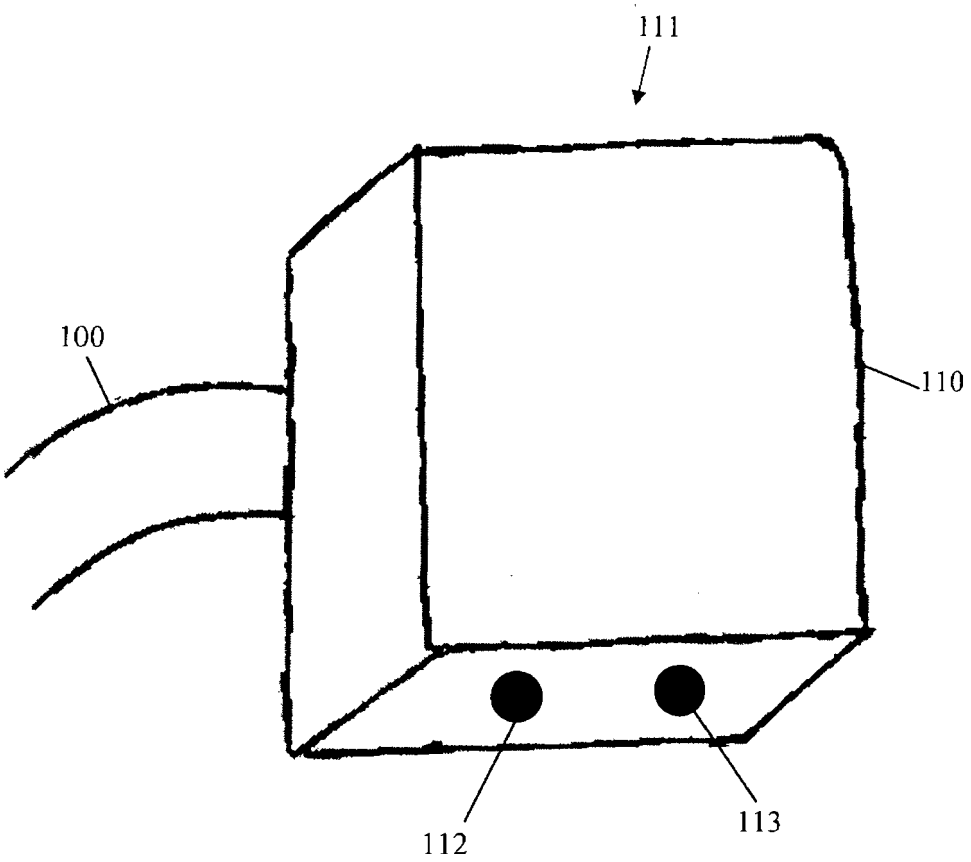

Fig. 2

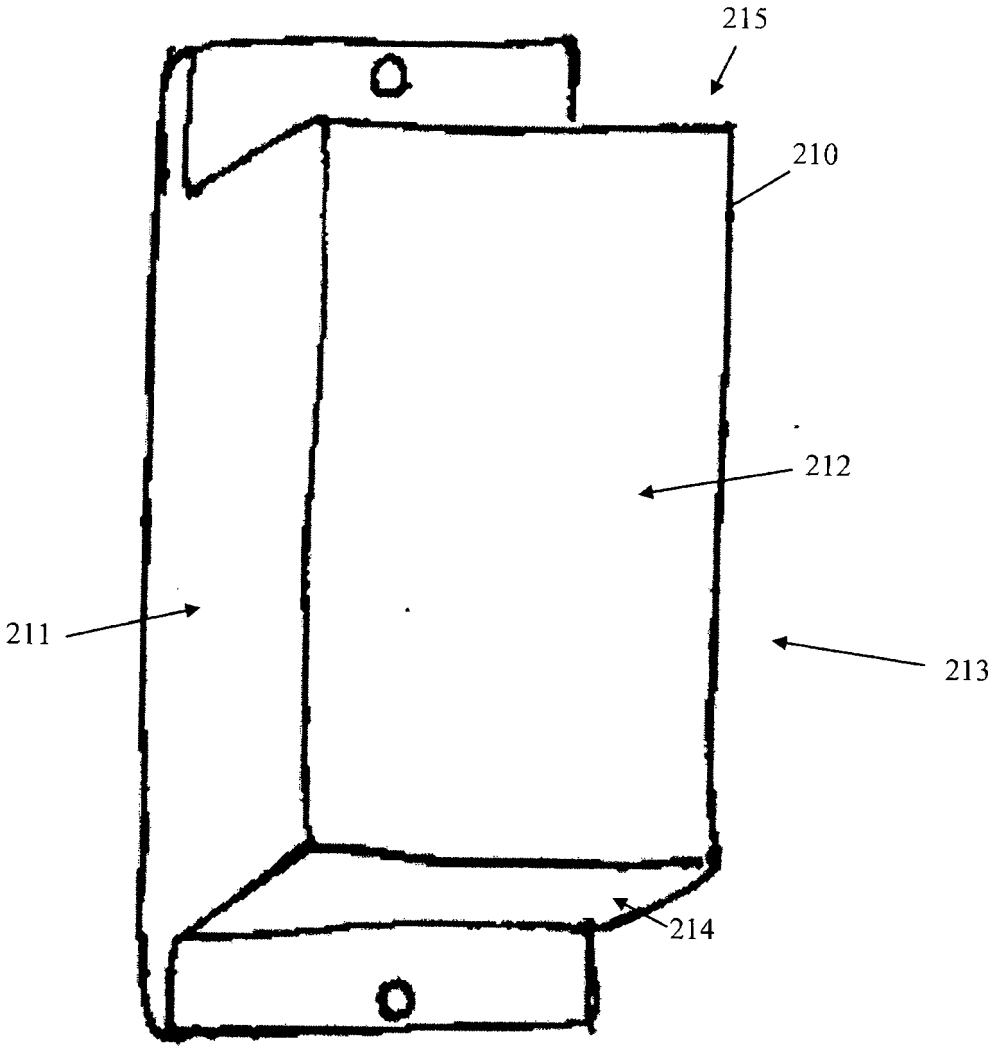

Fig. 3

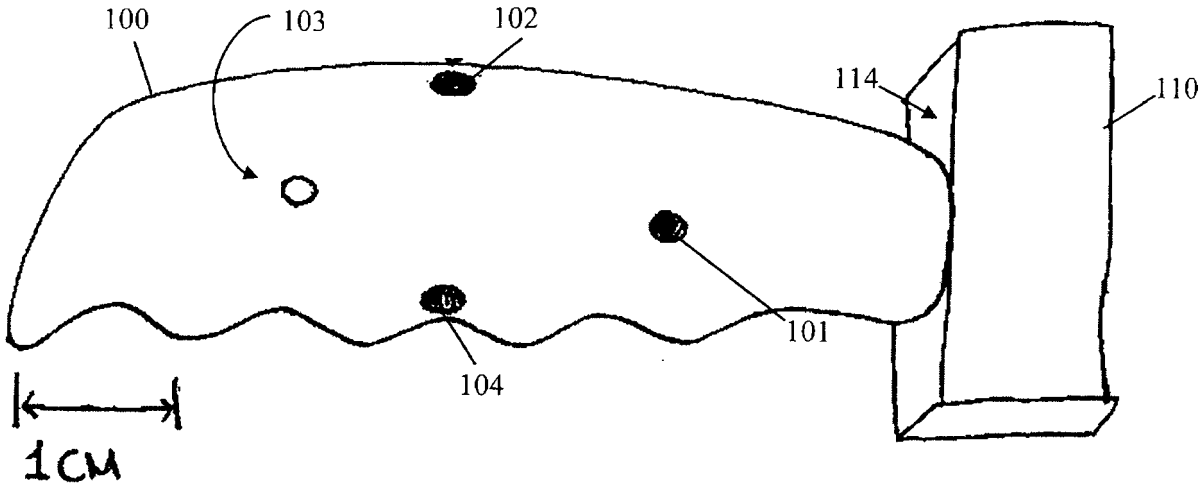

Fig. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 21 38 6028

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	26 October 2021	Teissier, Sara

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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