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(54) Title: HAND WEARABLE HAPTIC FEEDBACK BASED NAVIGATION DEVICE

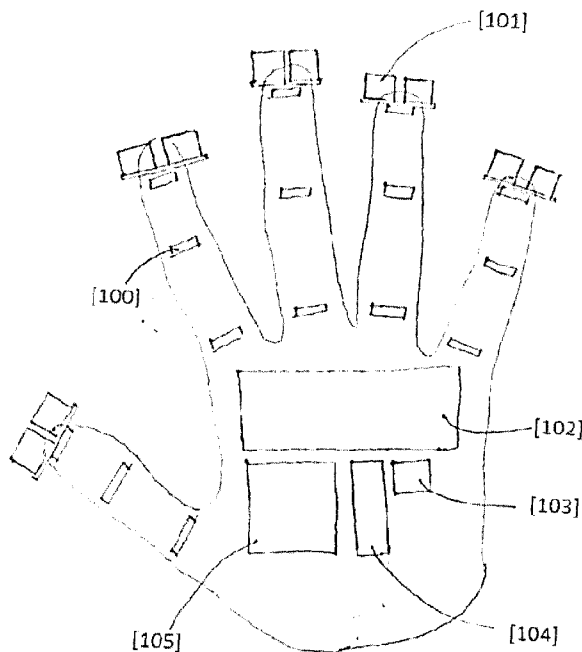


Fig 2

(57) Abstract: The present invention is a hand wearable haptic feedback based navigation device for distance sensing which has the flexibility of attachment and detachment of the navigation sensors (101) and has the flexibility of sensing the distance of the obstacle in multiple directions covering maximum 180 degrees in the direction of pointing of the hand. The device measures the distance of obstacle using sensors (101) at the tip of a finger. The measurement is broken down into categories on the basis of distance. This category is eventually informed to the user via haptic feedback actuators (100) strategically located on the specific finger. The feedback is taken to three dimensions by mapping the hand's spacial orientations using Inertial measurement units (2).

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- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
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HAND WEARABLE HAPTIC FEEDBACK BASED NAVIGATION DEVICE

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FIELD OF INVENTION

The present invention relates to the field of guiding and navigation systems and devices. More specifically, it relates to a hand wearable haptic feedback based navigation device. The device can be used to assist blind people while walking, to access the obstacles and their distances. It can also be used by soldiers to access their enemy in dark night. It can, in fact, be used for applications where a normal vision with eyes is not possible.

15

BACKGROUND OF THE INVENTION

ABOUT NAVIGATION SYSTEMS AND DEVICES: A navigation system is a system that aids in navigation. Navigation systems may be entirely on board a vehicle or vessel, or they may be located elsewhere and communicate via radio or other signals with a vehicle or vessel, or they may use a combination of these methods.

20 Navigation systems may be capable of:

- Containing maps which may be displayed in human readable format via text or in a graphical format.
- determining a vehicle or vessel's location via sensors, maps, or information from external sources
- 25 • providing suggested directions to a human in charge of a vehicle or vessel via text or speech
- providing directions directly to an autonomous vehicle such as a robotic probe or guided missile
- providing information on nearby vehicles or vessels, or other hazards or obstacles
- 30 • providing information on traffic conditions and suggesting alternative directions

Types of navigation systems

- **Automotive navigation system**
- **Marine navigation system**
- 5 • **Global Positioning System**, a group of satellites and computers that can provide information on any person, vessel, or vehicle's location via a GPS receiver
- **GPS navigation device**, a device that can receive GPS signals for the purpose of determining the device's location and possibly to suggest or give directions
- **Surgical navigation system**, a system which determines the position of surgical
10 instruments in relation to patient images such as CT or MRI scans.
- **Inertial guidance system**, a system which continuously determines the position, orientation, and velocity (direction and speed of movement) of a moving object without the need for external reference
- **Robotic mapping**, the methods and equipment by which an autonomous robot is be
15 able to construct (or use) a map or floor plan and to localize itself within it
- **Web navigation**
- **XNAV for Deep Space**

ABOUT HAPTIC TECHNOLOGY:

- 20 **Haptic technology** is a tactile feedback technology which takes advantage of the sense of touch by applying forces, vibrations, or motions to the user. This mechanical stimulation can be used to assist in the creation of virtual objects in a computer simulation, to control such virtual objects, and to enhance the remote control of machines and devices (telerobotics).

25 **Applications of Haptic technology**

- **Tactile electronic displays**

A tactile electronic display is a kind of display device that presents information in tactile form. The two most popular kinds of tactile electronic displays are various refreshable braille displays and the Optacon.

- 30 A **refreshable braille display** or **braille terminal** is an electro-mechanical device for displaying braille characters, usually by means of round-tipped pins raised through holes in a

flat surface. Blind computer users, who cannot use a normal computer monitor, use it to read text output. Speech synthesizers are also commonly used for the same task, and a blind user may switch between the two systems or use both at the same time depending on circumstances.

- 5 The **Optacon** (OPTical to TActile CONverter) is an electromechanical device that enables blind people to read printed material that has not been transcribed into Braille.

- **Tele operators and simulators**

- 10 Teleoperators are remote controlled robotic tools—when contact forces are reproduced to the operator, it is called *haptic teleoperation*. When such devices are simulated using a computer (as they are in operator training devices) it is useful to provide the force feedback that would be felt in actual operations. Since the objects being manipulated do not exist in a physical sense, the forces are generated using haptic (force generating) operator controls. Data representing touch sensations may be saved or played back using such haptic technologies.
- 15 Haptic simulators are used in medical simulators and flight simulators for pilot training.

There are many other applications of haptic feedback such as their use in video games, personal computers, mobile devices, medical field, robotics and art design.

(Ref: Wikipedia)

- 20 Many navigation systems and devices have been designed and developed based on haptic feedback . They suffer from the following limitations.

LIMITATIONS OF EXISTING NAVIGATION SYSTEMS AND DEVICES:

1. **High Cost-** The available navigation systems are very expensive.
- 25 2. **Less portability-** The available devices once fitted, are difficult to remove hence making them less portable
3. **Maintenance problems-** The existing devices being technically complex, are difficult and expensive to manufacture to provide them to grass root people. At the same time, these are difficult to repair on breakdown.

4. **Multi direction sensing not possible-** No existing device provides a multi-directional realistic and relative data covering an angle upto 180 degree using distance sensors.

5. **Lack of open source capability-** Since the circuitry and designing of existing devices is very complex, none of them provides the capability to customize the same as per the requirement of a specific individual .

INNOVATIVE SOLUTION PROPOSED BY INVENTOR:

The inventor has designed and developed a hand wearable haptic feedback based navigation device which overcomes the above limitations of existing devices.

The design and concept makes the device utter reliable, ergonomic, simple and reasonable. The device senses the 'distance' and 'direction' of the obstacles in 0-180 degree field of view and 4-6 directions in all. This information is communicated via Haptic feedback vibration motors on the surface of the hand and embedded in the glove.

PRIOR ART AND ITS DRAWBACKS:

Patent application No.	Difference with present invention
WO2013025823 A2	The device in the referred patent application is a wearable tactile stimulation device which includes a facial mask, an air-suit, a pair of gloves, integrated conduits and nozzles configured to deliver tactile stimulation to portions of users face, hands, and/or body. The tactile stimulation can be delivered via puffs of air transmitted through the conduits and nozzles. A controller can be configured to control tactile stimulation by controlling the generation and delivery of puffs of air. The puffs can be delivered individually, or in combination. In comparison, the present invention uses removable and detachable sensors along with arduino controller. The circuit and software are simple and realistic as compared to the above application.
EP 2629241 A1 and EP 2629242 A1	The device in the referred patent application is a wearable device including a camera, a processor and a control interface between the wearable device and a user of

	the wearable device. In comparison, the present invention uses removable and detachable sensors along with arduino controller . No camera is used as input device.
WO2007105937 A1	The invention in the referred patent application relates to a tactile device comprising a plurality of actuators 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 are positioned in a substantially closed path, surrounding part of a body of the user. In comparison, the present invention uses removable and detachable sensors along with arduino controller. The circuit and software are simple and realistic as compared to the above application.
CN 102614068 A	The invention in the referred patent application discloses an accompanying robot system for assisting a visually impaired person in walking. The accompanying robot system comprises a vibrational touch waistband arranged on the waist of the visually impaired person, and four tracked robots positioned on the front, back, left and right of the visually impaired person; the four tracked robots and the vibrational touch waistband form a wireless sensor network through an Ad Hoc Network; each tracked robot comprises a body and a control module; the control module comprises an ultrasonic distance measurement sensor, a laser distance measurement sensor, a motion control module, a wireless communication module, a central processing module and a power supply; the ultrasonic distance measurement sensor and the laser distance measurement sensor are arranged at the back and front ends of the body, and outputs of the ultrasonic distance measurement sensor and the laser distance measurement sensor are connected with the central processing module; the output of the central processing module is connected with the motion control module; the output of

	the central processing module is bi directionally connected with the wireless communication module. Although the system disclosed above uses sensors but the overall system is very complex and hence expensive which makes it unsuitable for grass root user. In contrast, the present device is low cost, fulfills the objective of being affordable and industrially applicable.
CN201076033 Y ES2367059 (A1)	The devices of the patent applications as referred are only capable of telling 'distance' from only 'one' direction due to presence of only 'one' ultrasonic sensor. In comparison, in the present invention, sensors are detachable and attachable with the help of spring fit arrangement or the like, thus can be mounted at the fingertips, thumb or at any area in the hand, thereby making the device capable of covering any angle.
US20130039152	The device of the patent application has a fixed and defined plane for mounting two sensors. In comparison, in the present invention, sensors are detachable and attachable with the help of spring fit arrangement or the like, thus can be mounted at the fingertips, thumb or at any area in the hand, thereby making the device capable of covering any angle.
CN 202844047 U	The devices of the patent application is based on multiple sensors connected with the blind walking aid especially a hat which has embedded circuit device comprising of a base plate power supply module, an ultrasonic module main control module , voice outputting module to transmit voice information to the user. In comparison, in the present invention, sensors are detachable and attachable with the help of spring fit arrangement or the like, thus can be mounted at the fingertips, thumb or at any area in the hand, thereby making the device capable of covering any angle. The device uses haptic feedback system and no voice outputting module is

	required.
US5047994 (A)	The patent application referred here is a supersonic bone conduction hearing aid that receives conventional audiometric frequencies and converts them to supersonic frequencies for connection to the human sensory system by vibration bone conduction. In contrast, the device of the present application uses haptic feedback system and no voice outputting module is required. It uses sensors and no audio frequencies are received or transmitted.
US2010278012 (A1) and US4761770 (A)	Both the referred patent uses audio frequency range as receiver or transmitter. In contrast, the device of the present application uses haptic feedback system and no voice outputting module is required. It uses sensors and no audio frequencies are received or transmitted.
CN201591719 (U) WO2006074993 (A2) US6671226 (B1) US6198395 (B1) WO9740403 (A1) WO9600401 (A1) US4712003 (A) US4280204 (A) EP0008455 (B1)	The utility models referred here provide intelligent blind aid system and an intelligent blind aid either in the form of cane or goggles or waist bands. Most of these provide intelligent blind aid cane; a first ultrasonic range acquisition module is arranged at the middle of the cane; the ultrasonic transmitting head of the first ultrasonic range acquisition module faces to the front for detecting obstacles ahead; a second ultrasonic range acquisition module is arranged at the upper part of the cane; the ultrasonic transmitting head of the second ultrasonic range acquisition module faces upwards to the front for detecting obstacles in a front upper place; an infrared range acquisition module is arranged at the lower part of the cane at the vertical distance of 2-30 cm to the ground; and the infrared transmitting head faces to the front for detecting low obstacles on the ground. In contrast, the device of the present application uses haptic feedback system. It neither is a cane nor uses infrared frequencies.
WO9740403 (A1)	The device of the patent application is a personal object detector

	using continuous transmission frequency modulation and an audio output device. In contrast, the device of the present application uses haptic feedback system.
MX2009001705 (A) and GB2448166 (A)	The devices of the patent applications have fixed and defined plane for mounting two sensors. In comparison, in the present invention, sensors are detachable and attachable with the help of spring fit, clip fit arrangement or the like, thus can be mounted at the fingertips, thumb or at any area in the hand, thereby making the device capable of covering any angle.
WO2007084122 (A3) and US2006098533 (A1)	The devices of the patent applications are used for determining the direction of an acoustic highlight, comprising receiving backscattered, analog, ultrasonic sound-pressure pulses at the microphones of said acoustic vector probe; converting said backscattered analog ultrasonic sound-pressure pulses simultaneously into digital form and inputting these signals into said digital signal processor; lowering the frequency of said backscattered ultrasonic sound-pressure pulses to the audible range by heterodyning thereby highlighting the source of backscattered ultrasonic pulses. In contrast, the device of the present application uses haptic feedback system rather than audio output.
US2009122648 (A1), WO2008086178 (A1) and US6469956 (B1)	The referred patent applications use wide-band sonar system as a mobility aid by the visually impaired. The system includes an acoustic source and a pair of miniature microphone arrays with frequency-dependent beam patterns designed to mimic the properties of the human ear. Each microphone is preferably mounted near a respective ear of the user. The acoustic source and microphone arrays are mounted on the user's head so that the system will always be aligned therewith-as an example, they may be mounted near the user's ears on conventional eyeglass frames or a similar mounting device. Then each ear of the human receives measurement

	information. In contrast, the device of the present application uses haptic feedback system rather than audio output.
CN201076033 (Y)	The utility model relates to a glove which uses ultrasound to achieve obstacle prompt for blind, the structure comprises a first isolation sheet metal , an ultrasound emission probe , an ultrasound receiving transducer and a vibration motor , wherein the first isolation sheet metal is sleeved on a fourth and a fifth finger portions of the glove , the ultrasound emission probe, the ultrasound receiving transducer and the vibration motor are arranged on the first isolation sheet metal, one end of a connecting line is connected with the ultrasound emission probe, the ultrasound receiving transducer and the vibration motor, and the other end is connected with a circuit board which is equipped with a power interface. The device is capable of probing the distance of an obstacle on a road and transforms the distance messages of the obstacle into vibration to prompt the blind. He is capable of judging the distance of the obstacle in accordance with change in strength of the probe. Although the system disclosed above uses ultrasonic sensors as well as haptic feedback but the present device has sensors that are detachable and attachable with the help of spring fit arrangement or the like, thus can be mounted at the fingertips, thumb or at any area in the hand, thereby making the device capable of covering any angle and any direction.

Hence it is clear that none of the available patents are able to achieve the desired results of the present invention.

OBJECT OF THE PRESENT INVENTION:

1. The main object of the present invention is to disclose a hand wearable haptic feedback based navigation device which has the flexibility of attachment and detachment of the navigation sensors.
2. Another object of the invention is to disclose a hand wearable haptic feedback based navigation device which has the flexibility of sensing the distance of the obstacle in multiple directions covering a maximum of 180 degree field of view in the direction in which the hand is pointing.
3. Yet another object of the present invention is to disclose a hand wearable haptic feedback based navigation device which constantly transmits the distance of an obstacle to an external high performance device via wired or wireless communication after combining it with a 10 degrees of freedom Inertial measurement sensor that senses the special orientation of the hand with respect to the distance measured. Hence producing a 3D image of the objects/area in front in the form of a 3D graph.

SUMMARY OF THE INVENTION:

20

In the present exemplary embodiment, the present invention consists of distance sensors mounted on the gloves at the position of the finger tips. These sensors sense the distance of any hindrance, obstacles etc. from the finger's tip and transmit them to the microcontroller which is embedded in the glove itself. The microcontroller accordingly drives the vibration motors embedded in the glove. Since there are 5 fingers; all in different direction which when opened in full stretch make an angle of roughly 180 degrees, every finger tells the distance of obstacle in its direction.

30

BRIEF DESCRIPTION OF DRAWINGS:**FIGURE 1:** Block diagram of present invention**Numbering :**

1. Distance sensor unit, it may be ultrasonic based, infrared based, laser based or any distance sensing device. For 5 fingers there are five such sensors.

2. 10 degrees of freedom Inertial measurement sensor
3. Arduino or any low power based microcontroller unit
4. Wireless or wired transmission device
5. High performance device (IOS, android based mobile platforms, computers, laptops or any other high performance device).
6. 3D output device
7. A wireless signal transmitter
8. Arduino or any other MCU
9. Distance calibrator
10. Logic circuit for Distance = 0-33% of the maximum distance or any set category.
11. First Vibrator
12. Logic circuit for Distance = 33-66 of the maximum distance or any set category.
13. Vibrator 2 powered ON on that particular finger.
14. Logic circuit for Distance 66-99% of the maximum distance or any set category.
15. Vibrator 3 powered ON on that particular finger.

20 **FIGURE 2:** Present embodiment as a glove

Numbering :

100. Vibrators or any other haptic feedback generating device.
101. Distance sensors
102. Battery pack, may or may not be disposed on hand though
103. Bug and error detection unit
104. Arduino or any other capable microcontroller unit or even a circuit
105. 10 degrees of freedom Inertial measurement sensor along with wireless or wired transmission unit.

30 **FIGURE 3:** Hand pointing in two axis at a time

FIGURE 4: Hand pointing in three axis at a time

FIGURE 5: Hand pointing in one axis 180 degrees

35 **FIGURE 6:** Hand pointing in downward direction

DETAILED DESCRIPTION OF THE INVENTION:

When a person is not using his eyes for sensing distance, there are two practical alternate means to achieve distance sensing i.e. hearing or touch. Auditory (hearing) system, generally being able to process only one sound at a time makes it difficult for the user to understand any auditory signal that informs the presence of more than one obstacle and it's direction at the very same time.

Also if the person is using a pair of headphones as a part of the obstacle detection device, he might not be able to hear the horn of an approaching car or a whistle of a police man etc. at the same point of time resulting in accidents or injuries. Hence we may conclude that headphones set a barter agreement somewhere between sight and hearing as the user is neither able to hear clearly not able to see (if he is blind).

Speaker based audio feedback is evidently not practical in already noisy places and may prove to be disturbing in places where silence needs to be maintained.

The present invention uses the other alternative of using touch sense to detect distance.

Referring fig 2, in the present exemplary embodiment, the inventor has designed and developed special pair of gloves which is provided with attachable and detachable distance sensors (101) along with a microcontroller (104) embedded in the glove itself. The present invention is powered by a battery pack (102) which may or may not be disposed on hand though, a bug and error detection unit (103) for detecting any electronic, mechanical or software malfunction. Also provided is a 10 degrees of freedom Inertial measurement sensor unit (105) along with wireless or wired transmission unit.

The mechanism used for attachment and detachment can be any mechanism like stretchable wire loop fitted with sensor and made of elastic or any other suitable material or clip fit mechanism or any other mechanism that can let the distance sensing unit to be fixed on the finger and may or may also allow the user to rotate them about the fixed point. In the present embodiment, the inventor has shown already stretched and fitted sensors (101) at the position of the finger tips. These sensors sense the distance of any hindrance, obstacles etc. from the fingers tip and signals the microcontroller (104). Since there are 5 fingers all in different direction which when opened in full stretch, cover an angle of approximately 180 degrees, every finger is capable of sensing the distance of obstacle in its direction thereby covering multiple directions. Since the direction of the sensors can be fully controlled by the

user by pointing his finger to any direction, there is no limitation of sensing any particular direction.

WORKING OF THE DEVICE WITH REFERENCE TO FIG 1 AND 2:

5

1. Every finger is equipped with distance sensors (101) and three vibrators (100 of fig 2 or 11, 13, 15 of fig 1) for providing haptic feedback to the user; the user may use more or less vibrators on the finger depending on his sensing capability. To improve the reliability and ruggedness, every finger has a dedicated on board microcontroller (104) so that in case of failure of one, the rest can work.

2. The vibrators (100 of fig 2 or 11, 13, 15 of fig 1) are calibrated with respect to the distance of an obstacle from the user with the help of logic circuits (10, 12, 14 of Fig 1) in the MCU (104). Thus the following logic works:

15 a) When the obstacle is 0-50 cm (or any distance category assigned by the user), is close and is about to hit the user, logic circuit (10) gives output which powers up first vibrator (11 of Fig 1) and it starts vibrating.

b) When the obstacle is 50-200 cm (or any distance category assigned by the user) , is close to the user, logic circuit (12) gives output which powers up first vibrator (13 of Fig 1) and it starts vibrating.

20 c) When the obstacle is 200-400 cm (or any distance category assigned by the user), far away from the user, logic circuit (14) gives output which powers up first vibrator (15 of Fig 1) and it starts vibrating.

25 3. In a preferred embodiment, input from 10 degrees of freedom Inertial measurement sensor unit (105 of Fig 2 or 2 of fig 1) is also fed to the onboard microcontroller (104 of Fig 2). This performs the usual task with the vibrators but along with it also sends the data of distance sensed by all the distance sensors and the direction and position of the hand sensed via 10 degrees of freedom Inertial measurement sensor (105 of Fig 2 or 2 of fig 1) to a wireless or wired signal transmitter (4 of fig 1) working as a high performance device. This device may be a mobile, laptop or any other high performance portable or non-portable.

30

4. The high performance device (4 of fig 1) receives the 'direction and spacial orientation of hand' and the distance of the obstacle from the distance sensors and plots that in the form of

a graph on 3D output device (**6 of fig 1**) . The hand now works like a bionic scanner. As the user moves the hand in random directions the graph gets plotted. Every direction has a coordinate on the 10 degrees of freedom Inertial measurement sensor therefore speed, randomness etc. does not affect the graph.

5

5. This graph can be saved or plotted on a high performance machine by sending the data through wireless signal transmitter (**7 of fig 1**) to an external display, projector etc.

10 The above description makes this device applicable to be used by soldiers or police also who have to work in dark at times to fight the enemy. Since the valuable data including direction, distance, shape, size etc in the form of 2D or 3D graph , can be transmitted to distant location also using wireless transmission unit (**7 of fig 1**), it may be received at a distant location using a receiver.

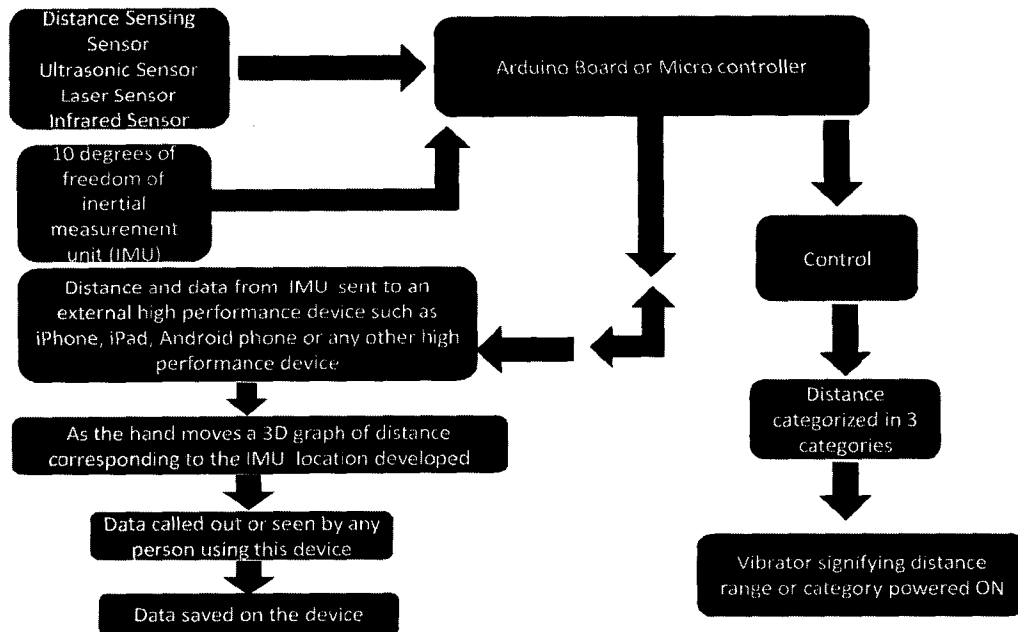
15 More detailed view can be achieved by combining sensors such as infrared sensors, PIR sensors and night vision. The distance may be also be mapped via high performance laser sensors and the user may be able to map an entire locality from a suitable height with greatest accuracy.

20 6. In yet another embodiment, two sensors can be mounted , one each at the top and bottom of the hand to sense stairs (ascending/descending), pits and sudden irregularities in the path. These sensors mounted on the top and bottom work in a similar manner and share a single MCU. There are two vibrators (**100**), one for the upper part of the hand and the other for lower part of the hand respectively. The vibrators (**100**) on the lower hand are calibrated in such a way so as to indicate an ascending stair, descending stair, sudden pit or a sudden
25 elevation. Similarly, the upper vibrators are calibrated in such a way so as to indicate a thin obstacle or a major big obstacle at the head level.

7. In one more embodiment, the sensors may have on board micro controller and may be integrally strapped on two or more individual fingers.

30

The present invention can be best understood with the help of following flow chart.



NOVELTY:

As is clear from the above discussion that none of the prior art patents have overcome the drawbacks of being non portable, workable only in closed system environment, direction sensing possibility of either one or two axis and high complexity and high cost of the device. The inventor came out with a novel solution to these problems by designing and developing a hand wearable haptic feedback based navigation device for distance sensing which has the flexibility of attachment and detachment of the navigation sensors and has the flexibility of sensing the distance of the obstacle in multiple directions covering a span of 0-180 degrees in the direction in which the hand is pointed.

The microcontroller used is Arduino which is an open source chip thereby making the device workable in any generic mode and customizable according to the user's demand. The device of present invention is less complex, easy to manufacture, is low cost and is user friendly.

Also, the unique concept of using a 10 degrees of freedom Inertial measurement sensor in combination with sensors and vibrators, converting the data received into graphs and maps, providing capability of transmitting the data to a remote location, makes it a versatile device for navigation .

None of the available prior art patents have provided solution of this kind, thus the invention is novel in itself.

INVENTIVE STEP:

The first inventive step lies in haptic feedback which is not specific to the hand but to every finger. This renders obstacles 5 directions to be sensed at a time. The second inventive step is to incorporate a 10 degrees of freedom Inertial measurement sensor to sense the spacial orientation of the hand. This eventually makes it possible to 3D map the view in front just by random hand movements. The third inventive step involves making the sensors detachable. This ensures that while the user needs lower accuracies in distance measurement he can free up fingers for normal use.

10

The final inventive step is the design. Firstly all the components are SMD and no moving parts are there such as servos etc. This manifests a robust design. Secondly the whole setup is wearable so the person need not carry it. Thirdly there is no tasking on the locomotive and auditory dexterity of the user as there is no audio feedback involved.

15

INDUSTRIAL APPLICATION:

The distance sensing device can be used successfully by blind as an aid while walking on road or on staircase. The same device can also be used by the soldiers in dark war field. They can simply wear this device and feel the vibration or view a 3D or 2D graph of what is in front.

Another application is in the field of animal study where the researchers have to watch the movement of animals in a jungle during night.

Therefore, the present invention finds application in any field where distance sensing is required without use of normal eye sight. The device is low cost and can be manufactured at an industrial scale with great ease.

Hence the industrial applicability of the present invention is quite obvious.

In the preceding detailed description, the invention is described with reference to exemplary drawings thereof. Various modifications and changes may be made thereto without departing from the broader spirit and scope of the invention as set forth in the description. The specification and drawings are accordingly, to be regarded in an illustrative rather than a restrictive sense. Thus without analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge, readily adapt it for various

applications without omitting features that from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention.

I claim:

1. A hand wearable haptic feedback based navigation device comprising:
 - 5 - distance sensing unit (1) mounted at the finger tip of each finger;
 - Arduino microcontroller (3), one for each finger, embedded in the device itself;
 - haptic feedback generating device (100) , one for each finger to produce haptic output in the finger of the user;
 - a 10 degrees of freedom Inertial measurement sensor (IMU) (2);
 - 10 - wireless or wired signal transmitter(4);
 - a battery pack (102);
 - a bug and error detection unit (103)
- wherein the same is capable of :
 - 15 - multi directional distance sensing covering maximum of 180 degrees;
 - sensing different distance ranges;
 - providing wireless or wired signals to remote locations.
2. A hand wearable haptic feedback based navigation device as claimed in claim 1 wherein multi directional distance sensing covering 180 degrees is achieved by using an attachment and detachment system with each sensor.
3. A hand wearable haptic feedback based navigation device as claimed in claim 1 wherein
 - 25 different distance ranges are achieved by calibrating each distance sensing unit (1) at a different distance sensing range.
4. A hand wearable haptic feedback based navigation device as claimed in claim 1 wherein wireless or wired signals to remote locations is achieved using wireless or wired signal
 - 30 transmitter (4) along with a 10 degrees of freedom Inertial measurement sensor (IMU) (2).
5. An attachment and detachment system as claimed in claim 2 wherein the same can be in the form of stretchable wire loop fitted with each distance sensing unit (1) or a clip fit mechanism or any other workable mechanism to attach and detach the distance sensing unit
 - 35 (1) to the part of hand.

6. An attachment and detachment system as claimed in claim 2 wherein this system can be made of elastic or any other material suitable for such functioning.
- 5 7. A hand wearable haptic feedback based navigation device as claimed in claim 1 wherein the distance sensing unit (1) comprises ultrasonic, infrared , PIR , night vision or laser sensors in stand alone or in any combination.
- 10 8. A hand wearable haptic feedback based navigation device as claimed in claim 1 wherein additional sensors and vibrators can also be mounted one each at the top and bottom of the hand respectively to sense stairs (ascending/descending), pits and sudden irregularities in the path.
- 15 9. A hand wearable haptic feedback based navigation device as claimed in claim 1 wherein the haptic feedback generating device (100) can be a vibrator or any other device capable of producing haptic feedback.
- 20 10. A hand wearable haptic feedback based navigation device and attachment and detachment system as claimed in claims 1-9 wherein the sensors may have on board micro controller and may be integrally strapped on two or more individual fingers.

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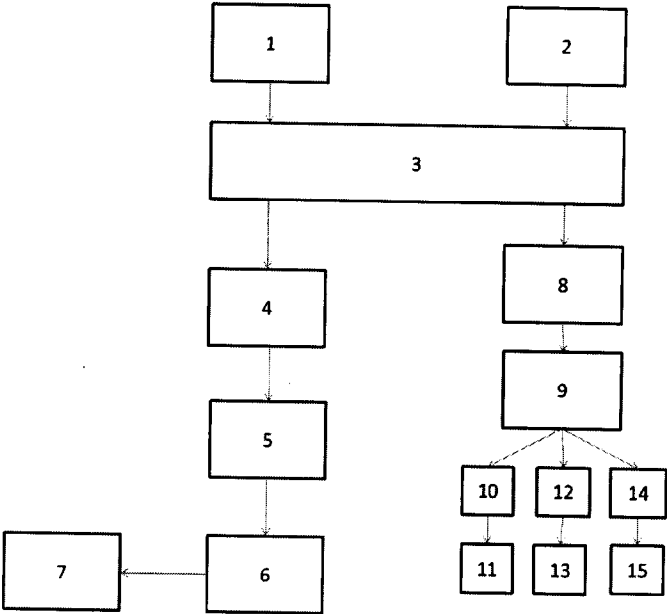


Fig 1

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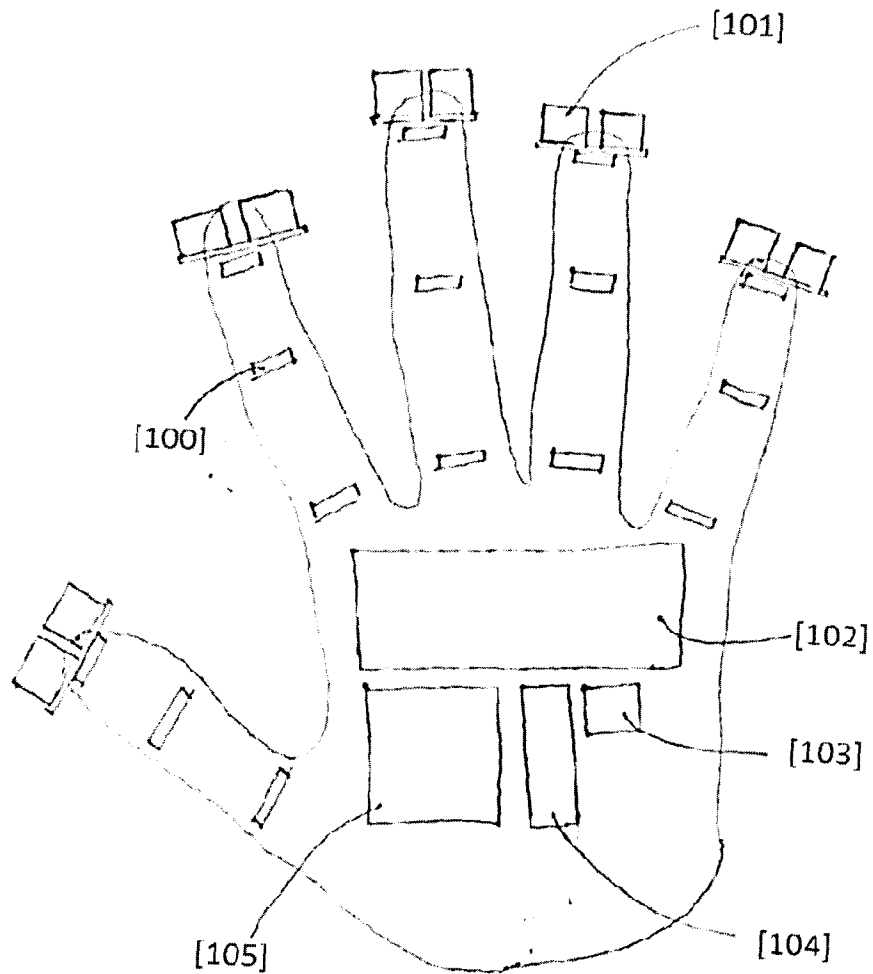


Fig 2



Fig 3

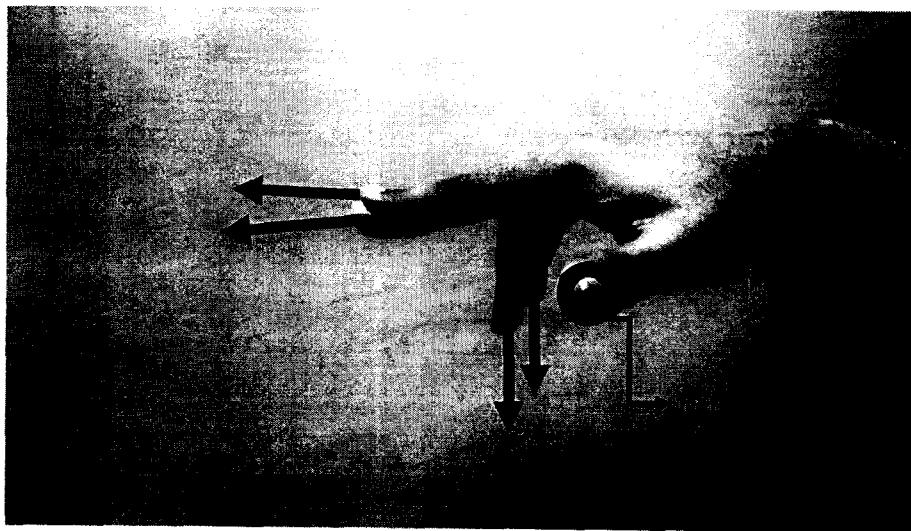


Fig 4

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Fig 5



Fig 6

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INTERNATIONAL SEARCH REPORT

International application No

PCT/IN2014/000742

A. CLASSIFICATION OF SUBJECT MATTER

INV. G01C21/36 G06F3/01 A61H3/06
ADD.

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 A61H G06F

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 practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2008/112519 A1 (UNIV PITTSBURGH [US]) 18 September 2008 (2008-09-18) abstract figures 1-5 paragraphs [0001] - [0002], [0007], [0017], [0020], [0025], [0028] - [0037], [0039], [0040], [0042] claims 1-20	1-10
X	US 6 115 482 A (SEARS JAMES T [US] ET AL) 5 September 2000 (2000-09-05) abstract figures 5a-5d, 6 column 1, lines 23-29 column 14, lines 56-59 column 24, line 52 - column 25, line 36 column 25, line 51 - column 26, line 6 claims 2-7, 25-27 ----- -/-	1-10



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

13 May 2015

Date of mailing of the international search report

22/05/2015

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INTERNATIONAL SEARCH REPORT

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2002/012014 A1 (MOHRI KOH [JP]) 31 January 2002 (2002-01-31) abstract figures 1-12 paragraphs [0029], [0031] - [0042] claims 1-4 -----	1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IN2014/000742

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2008112519 A1	18-09-2008	US 2008226134 A1 WO 2008112519 A1	18-09-2008 18-09-2008
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US 2002012014 A1	31-01-2002	NONE	