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Solemate:Smart Assistive Shoes For Visually Impaired people

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ABSTRACT

This paper aims to address the development of a device that shall help and serve as an effective solution for visually impaired. Blind people face constraints in independent mobility and navigation. Daily activities are hampered by their inability to conceive to their surroundings. The developed model aims to guide the blind person and prevent them from unwanted collisions with the obstacles through pre-recorded voice commands hence providing an active feedback. The model consists of two modules- cane and shoe unit. Both are integrated together, working as a single unit facilitated by "Bluetooth" connectivity and offers solution for orientation through digital compass. The Best Known Solution Was To Use A White Cane When They Walk. But Sometimes A White Cane Cannot Sense Big Objects. Wont It Be Brilliant If They Had A Better Help To Walk With, Than A White Cane For Themselves?These Shoes Would Be A New Interface To Help With Environmental Awareness For Those Who Cannot See.It Can Help The Visually Impaired To Walk And Spot Small Objects, Without The Use Of Any Stick And Even Alerts Them Of Any Obstacles In The Way.Our Approach Is Divided Into Three Main Parts.

The First Part Is The Obstacle Detector That Uses An Infrared Transducer To De- tect Objects In Front Of A User.

For The Second Part, Which Is The Main Control Unit With Embedded Soft- ware Design, A Microcontroller Is Used To Calculate Obstacle Distance, Control Buzzer, And Check Battery Status.

The Last Part Is The Device Implementation That Presents The Communication With The Hearing Aids Or The Mobile App.

Keywords: **Bluetooth, Cane module, Digital compass, IR ranging sensor, PIC microcontroller, Shoe module, Voice chip.**

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I. INTRODUCTION

A considerable amount of research effort has been channeled towards the identification and utilization of information of human actions. This project is mainly developed for visually impaired people. There are about 22% of visually impaired people in the world population. Blind people are not able to walk like normal people. Because of being visually impaired, they face problems like accidents, mishaps, falling off, not being able to walk in unknown areas etc. Modern technologies can be implemented to create something that will make sure that these people can find it easy to walk just like normal people.

Solemate is one of those technologies which can help visually impaired people. Technology has tremendously helped lives of people all around the world. Technology aids to help Visually Impaired people are yet to mature. Blind Stick is still the only technology aid available and known for majority of Visually Impaired. Considering the recent advancements in Smart Phone Technology, few challenges faced by Visually Impaired can be addressed.Solemate is a Smart Assisting shoe that will help the visually impaired to walk where he/She wants. Various types of sensors, actuators, microprocessors are used to detect the obstacles, depth or height of the obstacles etc. Using Solemate may provide an Optimistic approach for the visually Impaired people. Voice commands, Buzzer sounds can be used to alert the visually impaired to avoid the obstacle.

II. LITERATURE SURVAY

A. Paper I

The cane has an ergonomic design and an embedded electronic system. The electronic system uses haptic sensing to detect obstacles above the waistline. When an obstacle is detected, the cane vibrates or makes a sound. The device was designed to detect physical barriers above the waistline based on echo detection and to give tactile feedback in the form of vibration (or sound) inside the cane to warn about potential collisions. The haptic sensor and controller are embedded in the cane. Battery life was ten hours. The delay time was obtained when the echo signal arrived, and the distance to the obstacle was computed. Finally, the haptic feedback, which relies on the measured distance, was triggered.

B. Paper II

White cane can only be used to detect obstacles up to knee-level within a range of only 2-3 feet. Cane mounted knee-above obstacle detection and warning system using ultrasound beam to enhance the horizontal and vertical detection range. A detachable unit comprising of an ultrasonic ranger, vibrator and a microcontroller was developed which can detect obstacles above knee level. Distance information is conveyed to the user though a vibrator. Vibration frequency increases as the obstacle comes closer. Enables the person to effectively scan the area in front and detect obstacles on the ground such as uneven surfaces, holes, steps, walls etc. The user keeps the cane at a convenient inclination. As a result the ultrasonic detection cone is directed upwards and allows detection of kneeabove obstacles. Device consists of an 8051 microcontroller SRF04 ultrasonic ranger, and a vibrator. Runs on a standard Li-ion rechargeable battery. For charging the user connects an AC or USB adapter fully charged battery lasts about 10 hours of constant usage before recharging.

C. Paper III

Shoes were used to guide the blind person, fitted with an array of ultrasonic sensors around the sole. The sensors are supported by the proprietary circuit located inside the shoe of the user. The concept used in this prototype is that the obstacles will be detected by these sensors and the information about it will be given to the user in real time as physical notice. For the physical feedback, the shoe has made use of some vibrating boxes that the user can put in his/her pockets. Arduino controller keeps polling the ultrasonic sensors and provides feedback via the boxes.This information is processed and fed to the user via one of his other working senses – here it has used the sense of touch. They've used the Arduino Mega 2560 for processing.

Advantage: keeps the user's hands free for doing other tasks.

D. Paper IV

The main features are that Blind Shoes are equipped with vibration sensors can indicate a number of obstacles.Sensors will vibrate when they encounter a number of obstacles, such as holes, vehicles, walls, and even be able to show the road markings. The sensor will vibrate when comrades blind encounter resistance at a distance of 80 cm to 1 meter and a height of 15 cm as well as on the hole or limiting the sidewalk. Blind Shoes are also equipped with a single chip microcomputer that acts as the brain that controls all of the features and data storage. Smart shoes can charge the battery automatically. Blind Shoes can charge the battery by itself through kinetic generator pinned under the soles of shoes. The battery will be charged automatically when the user step.

III.DESIGN OF SOLUTION

By making use of advancements in Smart technology, algorithms were presented to address solutions to problems described. Certain features of Smart Phone like Global Positioning System(GPS), Bluetooth, General packet radio service (GPRS), Multi Media Player are mandatory for the solution. Most Smart Phones are equipped with these features by default. Voice Input is a module that acts as interface for User (Visually Impaired) and Smart Phone. Vision Impaired to be trained by someone first time for interaction. Voice commands act as input. For flexibility of end-user, voice commands can be given at any speech rate.
The server module is responsible for (1) capturing location info of users from time to time and (2) Voice command usage by each user. Through Administration console, the Smart Phone ID - International Mobile Station Equipment Identity (IMEI) number along with user detail will be pre-registered in User Tracking database.

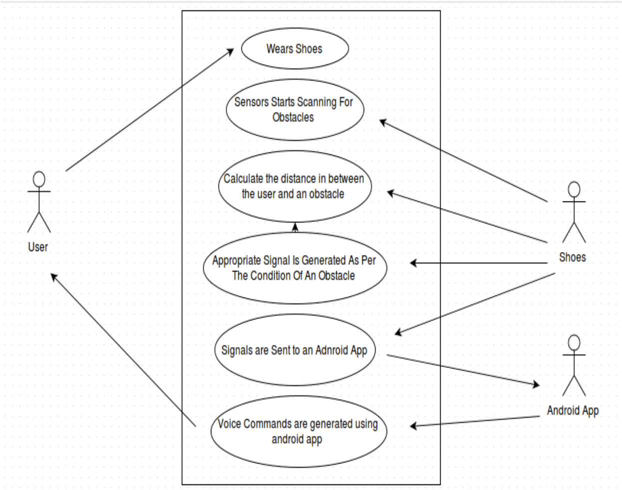


Fig : Use Case Diagram for SOLEMATE

Through http protocol, Smart Phone can interact with Google Maps. Application is designed to be common for any type of user and can be hosted on any platform or technology with support for database. Application stores location info (Longitude, Latitude) and Voice commands info sent for tracking purposes. In emergency situations for Vision Impaired, this info helps tremendously. Posting of info at designated interval to server can be pre-configured on Smart Phone,

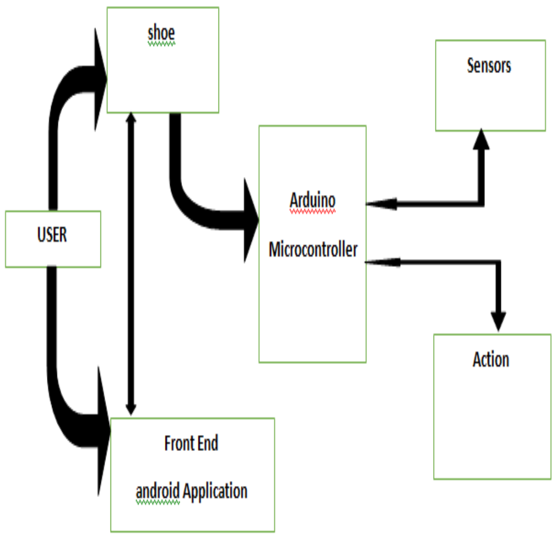
Algorithm 1. Where am I? Algorithm to help Vision Impaired locate where he/she is and how far is the person from home and what is the nearby known place (Cue Point) recorded earlier.

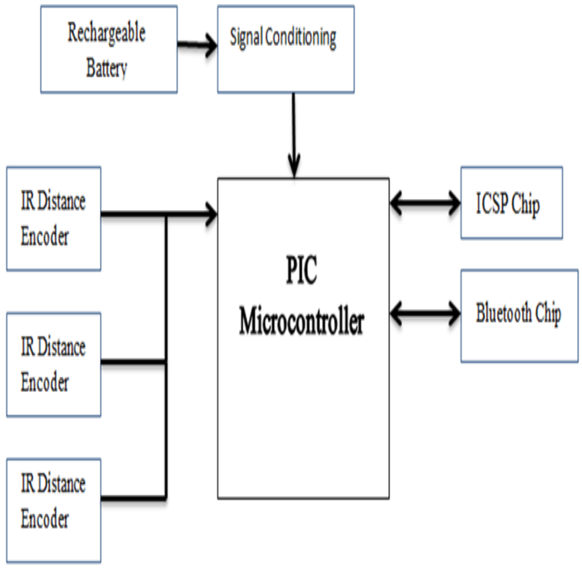
1. Using GPS, capture Longitude (Current Long), Latitude(Current Latt) of current Location
2. Calculate distance to Home(CuePointHome) from Current Location
3. For each Cue Point pre-stored,
a. Calculate Distance Difference from Current Location to Cue Point
b. Identify nearby Cue Point that Vision Impaired can recognize
4. Say distance to Home
5. Say nearby Cue Point in meters

Algorithm 2. Who is around me? Objective of this algorithm is to identify any known places like restaurants, parks, café around for Vision Impaired. This algorithm makes use of GPS device.
1. Scan Devices around with GPS
2. Display all the places

Algorithm 3. Emergency notification to Home Emergency situations arise more often for Vision Impaired when they are outside as they cannot make out where they are. When in Emergency, this algorithm notifies people back home with a message that provides GPS location of Vision Impaired with Google Map URL. With Google Maps URL people back home can spot the location and help Vision Impaired.
1. Using GPS, capture Longitude, Latitude of current Location
2. For each Emergency Contact Pre-Stored Generate Google Maps URL with captured Longitude and Latitude

IV. ARCHITECTURE DESIGN





block diagram of shoe module

V. HARDWARE REQUIREMENT

The major components used in both the modules are:
1. PIC Microcontroller- PIC18F45K22
2. 3-terminal positive voltage regulator- LM78M05CDT
3. Voice Chip Playback/ Recorder- ISD1700 Multi-Message Single Chip Voice Record & Playback Devices
4. Rechargeable Battery- FG20121
5. Standard Bluetooth chip
6. Digital Compass Multi Sensor Board- GY-80 3 Axis Gyro - 3Axis Accelerometer

SALIENT FEATURES OF THE COMPONENTS

• *PIC Microcontroller-*
1. High performance RISC CPU,
2. C Compiler Optimized Architecture,
3. Up to 1024 Bytes Data EEPROM storage,
4. 40 pin, low power, high performance,
5. 2.3V to 5.5V supply voltage,
6. 35 I/O pins, plus 1 Input-Only Pin,
7. Analog-to-Digital Converter (ADC) module, 10-bit resolution, up to 30 external channels,
8. In-Circuit Serial Programming (ICSP) requiring single supply 3V
9. In-Circuit Debug (ICD),
10. High-Current Sink/Source 25 mA/25 mA,
11. Two Master Synchronous Serial Port (MSSP) Modules,
12. Two Enhanced Universal Synchronous Asynchronous Receiver Transmitter (EUSART) modules.

• *Voltage Regulator-*
1. Employs built-in current limiting,
2. Thermal shutdown, and safe-operating area protection,
3. Adequate heat sinking,
4. Eliminates the noise,
5. Output voltages of 5V, 12V, and 15V possible
6. Line Regulation 7.2V <= VIN <= 25V

• *Voice Chip Playback/ Recorder-*

1. Message duration is user selectable in ranges from 26 seconds to 120 seconds,
2. Operating voltage spans a range from 2.4 V to 5.5V,
3. Designed for operation in either standalone or microcontroller (SPI) mode,
4. Chip self-manages the address locations for multiple messages.
5. Multi-Level Storage (MLS) array,
6. Simple push-button interface, includes five pushbuttons 'PLAY', 'REVERSE', 'FORWARD', 'ERASE', 'VOICE', 'GLOBAL ERASE',
7. Zero power message storage.

• *Digital Compass Multi Sensor Board-*
1. Board combines sensors into a single tiny package used together as an inertial management unit,
2. consists of 3 Axis Gyro, 3 Axis Accelerometer,
3. only needs 4 wires to get started
4. GND- GROUND
5. Supply voltage-GY80 is 5v and 3.3v compatible
6. SCL - I2C Clock
7. SDA - I2C Data
8. 3 Axis Accelerometer - Measures acceleration. Can be used to sense linear motion, vibration, and infer orientation and force.
9. 3 Axis Gyroscope - Measures angular rotation which can be used to infer orientation.

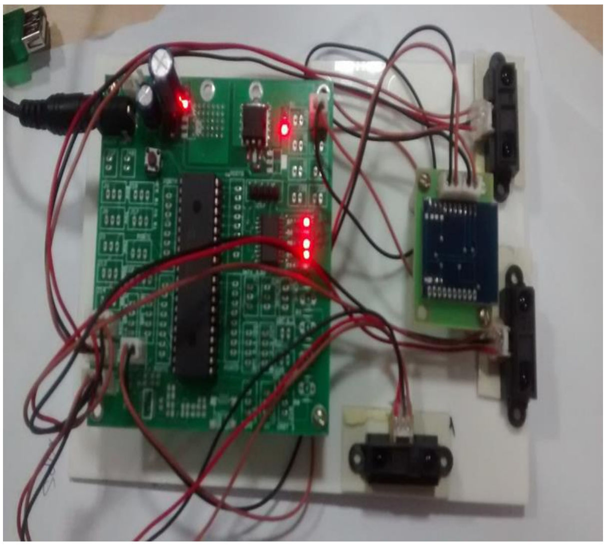
• *Rechargeable Battery-*
1. Nominal Voltage 12 Volt
2. Nominal Capacity 1.2 Ah, 20 hours rate
3. Maximum charging current 0.3 A,
4. Weight 0.60 kg,
5. Operative temperature range -20 °C to 50 °C

SOFTWARE USED

1. EAGLE software for PCB designing
2. MPLAB for PIC Controller programming.
3. Arduino for sensor testing

VI. HARDWARE IMPLEMENTATION

We have tried our level best to make the system look as compact as possible. On the shoe, the shoe unit is mounted on the exposed surface of feet, while the sensors are fabricated into the shoe as required. While for the cane unit, we have tried to fit the entire circuitry into a compact box and minimum exposed wiring so that it doesn't hamper with the user's movement. The sensor has been fitted at an optimum position on the cane so as to detect the obstacle before it touches the stick, keeping in mind that typically blind people hold the cane at an inclination of about 55 to 60 degrees.



VII. CONCLUSION

It has been observed that developed support system- is accurate in detecting the obstacle and alerting the visually impaired person find their way bypassing every obstacle that comes on their way to the destination.

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