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Research paper

An Assistive Bag for Blind and Deaf

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Abstract

People with disabilities who use visual aids like hearing aid, blind stick for obstacle detection while walking etc. are often discriminated in the society as they are handicapped. The main focus of this paper is to create an assistive device for the visually impaired as well as the deaf to make them socially acceptable without showing their disability to the society by using visible aid. It is incorporated with features like GPS location update, GSM-based messaging system to notify relatives of the location of the user in case of emergency situations and voice recognition based home automation. It uses ultrasonic sensors to detect obstacles and vibration motors to notify the user about the obstacle thus eliminating the use of external device for communication.

Keywords— *visually impaired, deaf, ultrasonic sensors, vibrating motors, GPS, GSM, voice recognition based home automation.*

1. Introduction

Navigation for visually impaired and deaf people is a big problem. "India currently has around 12 million blind people against 39 million globally" which makes India home to one-third of the world's blind [1]. Over 21 million people in India are suffering from one or the other kind of disability out of which the people with vision disability accounts to 48.5% and having hearing disability accounts to 5.8% according to 2001 census data. In the past decades, many devices have been made for the blind to assist them which are available in various forms like portable, wireless, wearable etc. Features like RFID, GPS technology are the most recent technologies that are used these days. But the problem with RFID technology for navigation is that it can be used only for a defined known area which requires complex setup. Also, internet connection is required at all times for GPS technology when used for navigation purpose. With the development of modern technology many different types of navigational aids have been developed to assist the blind people commonly known as electronic travel aid [2]. People with impaired vision mostly use cane or guide dogs for navigation. Smart cane is one of the most common assisting tool for the visually impaired people [3]. The main advantage is low cost. But still these systems are of limited assistance which are not hands-free. Also, it can be used only for recognizing above the knee obstacles. [4] Other smart aids include "An Effective Fast Response Smart Stick for Blind People" [15], which is a stick incorporated with infrared sensor to detect the objects present around them. The major disadvantage of this proposed method is that it can operate only during day time. Another proposed aid is The NavBelt which is a navigational aid and consists of a portable computer, ultrasonic sensors and stereophonic headphones in which the computer applies navigation and obstacle avoidance technologies that was originally developed for mobile robots[4].

The "2D vibration array as an assistive device for visually impaired", proposed methodology deals with implementation of a wearable 2D vibration array (miniature vibrators) connected to a portable computer and two miniature cameras (attached to a pair of dark glasses), a microphone and an ear speaker. The cameras capture images from the surrounding environment and after appropriate processing 3D representations are created. These 3D space representations are projected on the 2D array attached to the person's chest vibrates in various levels corresponding to the distances of the surrounding obstacles [5]. According to the voice operated outdoor navigation system for visually impaired persons describes a Navigation system that makes use of GPS (the Global Positioning System), voice and ultrasonic sensor for obstacle detection. [14] which uses voice commands to guide the bind person through an unknown environment. This model cannot be used for people having hearing impairment and is possible only where internet connection is available at all times.

Hence the major objective of the proposed idea is to create a hands-free device incorporated with MaxSonar –ultrasonic obstacle detection sensors which detect the obstacles in front, top, bottom, pit holes and sideways thus providing maximum coverage area for the user. When obstacles are detected, the MaxSonar sensors located at shoulders and side of the smart bag generates analog /PWM signals which are received by microcontroller and are processed using algorithm to analyze the obstacle position and produce specific vibration patterns to the vibration motors placed on the back of the bag. The bag also includes a panic safety button which when pressed during emergency situations, sends the location of the user to his relative using GPS and GSM module. [13] By using this normal looking smart bag, the blind person can easily navigate his path with safety. With the smart features incorporated in this bag, it makes the person more self-reliant and independent. It will make their life simpler and they can live with confidence and dignity without showing their disability by using visible aids.

2. Proposed Methodology

The backpack is designed in such a way that the ultrasonic sensors detects the obstacles and the blind person is notified about the obstacle using vibrators which is in contact with the body of the person. The Ultra Sonic sensors-MB1010 and MB1000 used in detecting the objects are placed on the straps of the bag which detects the obstacles in the front, top level hanging objects, steps and also detects man holes on the ground [11]. Along with these it also detects obstacles approaching from left and right side of the person while crossing roads. After detecting these obstacles, it is conveyed to the user using vibration patterns.

These vibrating motors are placed on the back of the bag which vibrate and is sensed by the back of the person. These vibrators are located on different positions which conveys the direction of obstacles. All the sensors are placed at different angles to cover the maximum range around the blind person. This backpack is designed with a combination of GPS tracking device which sends location of the person via SMS using a GSM module and a voice recognition system for home automation making it secure and user friendly.[13]

Advantages

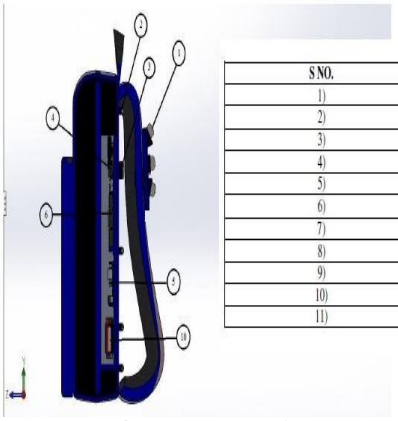
- As normal backpacks are used hence the possibility to show the disability of the person is eliminated.
- It is a hands-free device.
- Increased coverage area over existing models.
- It has smart features like voice recognition using home automation, location update text to relatives in panic situations.
- It has obstacle detection range of 5m.

3. System Design

The proposed model is shown in Fig.1 describes the alignment of seven proximity sensors on shoulder straps of the bag. The seven vibration motors are placed on the back of the bag which touches the user back which helps in feeling the vibration patterns produced by the vibration motors for different scenarios of obstacle detection. Fig.2. describes the position of the various components in the bag which includes-power supply, power distribution board, GPS module, GSM module and microcontroller in the circuit board case placed inside the bag. Fig.3. describes the Alignment of sensors with angles on the bag. The sensors are placed at various angles to cover maximum coverage area for increased safety for the user. The Fig.4. shows the alignment of the Vibration motors on the bag to notify the user of the different position of the obstacles. The vibration motors 6 and 7, according to the Fig.4 are placed on the adjusters which comes around the user's waist.

The MCU, GPS, GSM modules, power distribution board are placed inside the bag in a rectangular case holding all the hardware components including battery. A panic safety button is placed on one of the strap helps user to send location updates to his/her family member through SMS.

Fig. 1: 3D representation of smart bag using solid works



S NO.	COMPONENT NAME
1)	MAXSONAR SENSOR
2)	VIBRATING MOTOR
3)	PANIC SAFETY PUSH BUTTON
4)	GSM MODULE
5)	MICROCONTROLLER
6)	GPS MODULE
7)	ADJUSTABLE STRAP
8)	POWER DISTRIBUTION BOARD
9)	BLUETOOTH MODULE
10)	BATTERY
11)	REFLECTING RADIUM STRIP

`**Fig. 2:** Position of the components in the bag

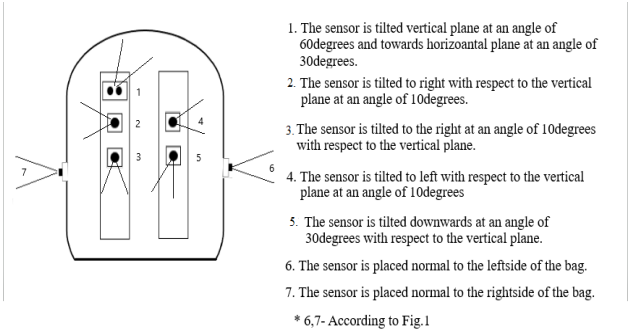


Fig. 3: Alignment of sensors on the bag

Fig. 4: Alignment Vibration motors on the bag

4. Block Diagram

The block diagram of proposed methodology is shown in Fig.5 which describes the power distribution from the supply to MCU, input signals from ultra-sonic sensors, and output signals from the MCU to vibration motors. The Panic safety button which when pressed powers ON GSM and GPS module and sends location of the user to the prefixed number via SMS. The microphone receives commands from user which is decoded by MCU and sends the command to home automation setup via SMS. This SMS is read by home automation circuit and activate relays to switch ON/OFF of the devices.

The home automation circuit includes a GSM SIM 900A module connected to a MCU and relay switches to control the devices remotely using voice command by the user.

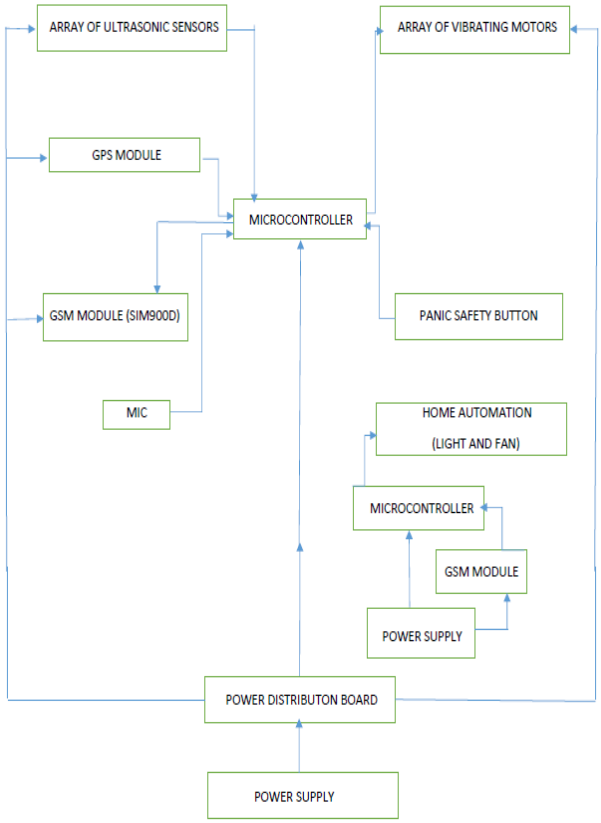


Fig. 5: Block diagram of proposed system

5. System Operation

When the system is turned ON, the ultrasonic sensors MB1010 and MB1000 send ultrasonic waves and find the obstacles-situated at the top, front, down, left and right sides of the user [11]. When the obstacle is detected, the vibration motors generate specific pattern to notify the user. In case of emergency situations, provision for panic safety button is there which when pressed sends the GPS location via SMS to the relatives by using GSM technology. For indoor purpose, voice recognition system is incorporated in the bag for home automation for the ease of the user. The working flow of system is described in Fig.6.

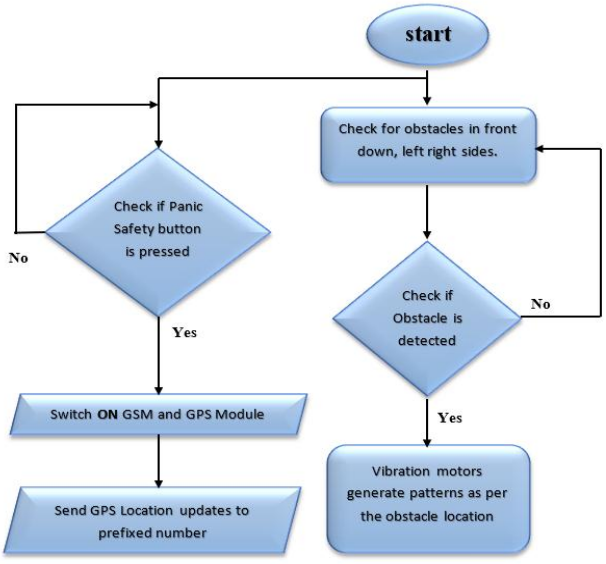


Fig. 6: Working flow of system

6. Obstacle Detection

Fig.7 Describes the direction of ultrasonic waves while detecting people in front direction when ultrasonic sensors are placed in the straps of the bag.

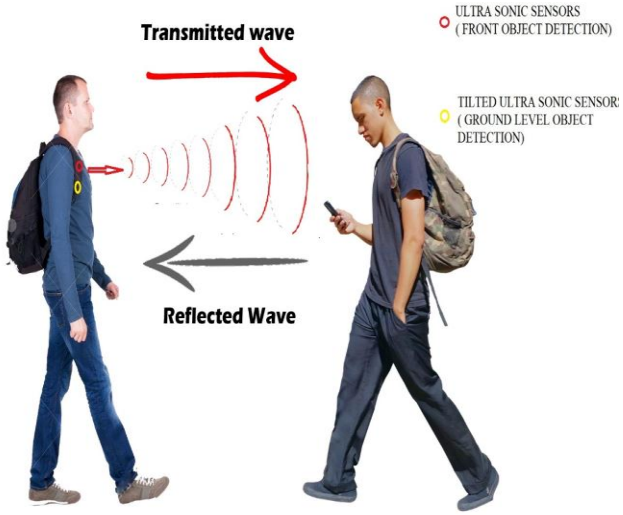


Fig. 7: Front detection of obstacles

Fig.8 Describes the direction of ultrasonic waves while detecting manhole in front direction when ultrasonic sensors are tilted with and angle 30 degree and placed on the straps of the bag.

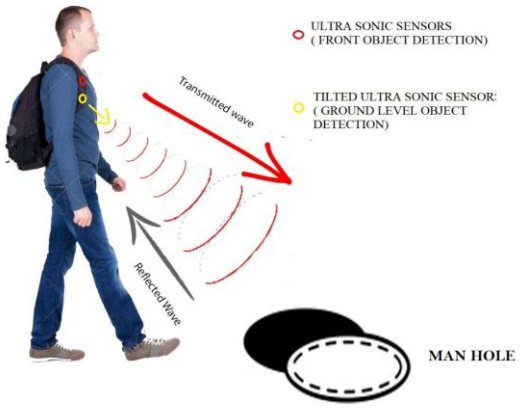


Fig. 8: Front man hole detection

For manhole detection, when the sensor 5 ranges above the threshold distance value, the vibration motor 5 vibrates to notify the user about the man hole or trench in front of the user.
Table 1 - describes the various vibration patterns generated by MCU for different obstacle position.

Table 1: Mapping of sensors to Vibration motors

Sensor	Obstacle location	Corresponding vibrating motor
Sensor 1	For front hanging objects	Vibration motor 1
Sensor 2	Front Right	Vibration motor 2
Sensor 3	Front	Vibration motor 3
Sensor 4	Front left	Vibration motor 4
Sensor 5	Front manhole	Vibration motor 5
Sensor 6	Left Side (Side detection)	Vibration motor 6
Sensor 7	Right Side (Side detection)	Vibration motor 7

Table 2 - describes the various vibration patterns generated by MCU for different obstacle position.

Table 2: Vibration pattern

Cases	Response of the vibrating motor
Obstacle is static or in motion and user is in motion and both are moving towards each other.	Vibration pattern is as follows: - 3seconds ON 1 second OFF.
Obstacle and user both are static	Idle mode condition: manual control is used to switch of the system to reduce power consumption.
Obstacle is static and is present at one or both sides of the user who is in motion(example- wall on the side of the user) .	If obstacle is present at the same distance for more than 30 seconds vibration pattern is as follows: - 2seconds ON 2 seconds OFF
Obstacle and user both are in motion (example-when moving in crowded area)	Threshold value decreases to 30cm for all sensors by the remote control.

Each sensor is mapped with a vibrating motor according to the Table.1. Thus, when the obstacle is detected by a specific sensor, the vibration motor mapped to that sensor will vibrate according to this table as per the different scenarios specified in Table.2. The microcontroller is coded based on the various scenarios for the ease of the user.

7. System Hardware Description

The following hardware components are used in the proposed system design.

A. Proximity Sensors

The proposed model uses proximity sensors like MB1000 which has wide beam, works at 20Hz reading rate operating at 2.5-5.5V with low 20mA average current requirement which is great for people detection applications and MB1010 for long and narrow range obstacle detection [6] whereas the other proximity sensor MB1010 has narrow long beam works at 20Hz reading rate operating at 2.5-5.5V with low 20mA average current requirement which is great for long obstacle detection application with a maximum range of 254 inches [7].

B. Micro Control Unit

The proposed model uses MSP432P401R MCU which is a low power, high performance microcontroller which includes a 48MHz ARM Cortex-M4F, 80uA/MHz active power and 660nA RTC operation with 16-bit performance and AES256 accelerator [8]. This microcontroller has a memory of 256KB flash and 64KB RAM with 4x16-bit and 2x32-bit timers.

C. GSM Modem Sim900

GSM modem is a device which is used for the communication of the user with the display board. It has slots for holding SIM card and RS-232 port for connection with computer and other devices. It works with frequencies 850/ 900/ 1800/ 1900 MHz the baud rate can be from 9600-115200. With the AT command, it is suitable for SMS transfer, Voice as well as DATA transfer application in M2M interface. The sending of SMS and receiving the SMS can by controlled by the AT commands from the microcontroller [9].
The Modem Specifications are:
• Quad-Band GSM/GPRS 850/ 900/ 1800/ 1900 MHz
• RS232 interface for direct communication
• Configurable baud rate
• SIM Card holder.
• Built in Network Status LED
• Input Voltage: 5V-12V DC
• SMS:
1. Point to point MO and MT
2. SMS cell broadcast
3. Text and PDU mode

D. GPS Module

The proposed system uses NEO-6 module series is a family of stand-alone GPS receivers which has high performance u-blox 6 positioning engine. They are flexible and cost-effective receivers which offers numerous connectivity in a miniature 16x12. 2x4 mm package. The compact architecture has power and memory options which make NEO-6 modules ideal for battery operated mobile devices at cheap cost. The 50-channel u-blox 6 positioning engine boasts a Time-To-First-Fix (TTFF) of under 1 second [10]. This innovative design and technology suppresses jamming sources as-well-as mitigates multipath effects, giving NEO-6 GPS receivers excellent navigation performance even in the most challenging environments.

E. Vibration Motor

Flat 1027 mobile vibration motors are used to generate vibrations which is used to notify the user about the obstacle present. This vibration motor has a voltage range of DC 2.5-4 V with motor diameter of 10 mm and minimum rated rotating speed of 9000rpm, which is placed at the backside of the bag at different locations according to Fig.4 are in contact with the user. [12]

8. Future Scope

This navigation aid can be improvised to 360^0 obstacles detection surrounding the user. Implementing Image scanning technology an object can be scanned analyzed and also distance of the user from that obstacles can be detected using high end processors. This navigation aid further can be improvised to give step by step directions updates using google maps for user if he wants to walk to a destination from a source location.

9. Conclusion

Targeting 12 million blind people in India and 39 Million blind people across the globe [1] and applicable for all genders and age groups (7years above) this novel navigation system is designed and implemented with smart features for the blind user to live a life with security and independency. A MSP432P401R microcontroller was used to develop the smart obstacle detection system and notify the user through vibrating patterns in different scenarios. The primary objective of this proposed system was to create a hands-free device with features like emergency location updates to relatives and voice recognition based home automation.

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