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Enhanced App Based Navigation System for Visually Impaired

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ABSTRACT

This paper gives the idea of a smart electronic aid for visually challenged people. This system offers obstacle detection, SOS, location tracking. The system consists of ATmega328P, three ultrasonic sensors, Bluetooth module, buzzer and a smart phone. Our project directs to the development of an Electronic Travelling Aid (ETAs) device which will help the blind to find path free of obstacles. This kit is fixed to the waist belt. The detection of objects is in three directions: overhead, infront and below knees. Audio alerts of the objects detected will be given to the blind person based on different conditions mentioned. The App replaces the need for additional hardware by making use of in built in sensor like GPS and functionality like TTS. Also emergency calling through app is included which will be helpful for the person in difficult situations.

Keywords— Visually impaired, Ultrasonic sensor, Bluetooth, Android App, GPS, Emergency call.

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I. INTRODUCTION

As per the research, the estimate number of people visually impaired in the world is 285 million, of whom 39 million are blind and 246 million having low vision. India has 15 million of visually impaired people. Fortunately, Blindness in India has dropped by 47% from 12 million in 2006-07 to 4.8 million in 2019.

Blindness restricts a person's ability to do daily chores and earn wages for their survival. For navigation these people depend on conventional methods such as guide dogs, white cane and rough mental mapping which is highly unreliable. To enhance the mobility Electronics Travelling Aid (ETA) devices act as promising aid to support and encourage the blind as they struggle for an independent life. This aid to move as confidently as sighted people. The ETA should promise the person 1) safety, comfort, validity.2) It should be low cost effective and ergonomic.

According to Telecom Regulatory Authority of India (TRAI) the number of smart phone subscribers is growing exponentially in India. This includes both sighted and sight deficit users. In urban areas visually impaired smart phone users rely on accessibility features. For example Apple introduced Voice-Over feature to overcome smart phone accessibility barrier for low vision users. Similarly Android provides Talk Back feature to read options on screen. Other accessibility features includes on screen magnifier, large text option, high contrast viewing mode.

From past two decades, many travelling aids have showcased in form of various designs such as cane, shoes, waist belt, gloves etc. The most prominent element used is ultrasonic sensor for object detection. Some of existing systems are as follows- the work presented by object detection and issue vibro-tactile and voice feedback, emergency calling, provide location and time information to user. It includes Mobile App, Arduino pro mini and Bluetooth module [1]. A walking cane which works in fixed and hurdle detection mode. It detects solid and liquid obstacles and give voice feedback. It guides user from source to destination using GPS (Global Positioning System) [2]. System that helps in hassle free navigation by determining objects ahead and direction towards destination using Google API. Assistance is given through Voice feedback through TTS (Text-to-

Speech) [3]. To navigate in known environment campus navigation system was introduced. It uses an Android application for finding the users position and generates audio feedback. It also has cloud based geo-spatial data store for unique important location information. A sonic sensor attached to system helps user to avoid obstacles during outdoor navigation through audio and haptic alerts [4]. Recent computing techniques are making way for more accurate and real time assistance [5].

II. PROPOSED SYSTEM

In our project the components used are ATmega328PU microcontroller, three ultrasonic sensors HC-SR04, Bluetooth module HC-05 and a buzzer. This system aims to develop an ETA which is fixed to the waist belt. The three ultrasonic sensors are placed one below the other in vertical sequence. The transmitter of ultrasonic sensor sends signal at 180 degree in 0.034m/s and when this signal touches any obstacle, it reflects back and this reflected signal is received by the receiver of ultrasonic sensor (US). The time of transmission and receiving of signals are noted and total distance is divided by 2.

A. Block Diagram

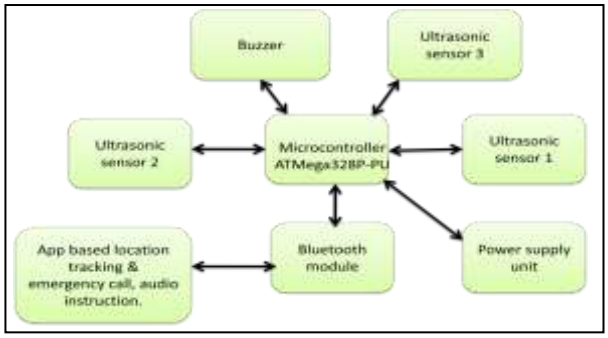
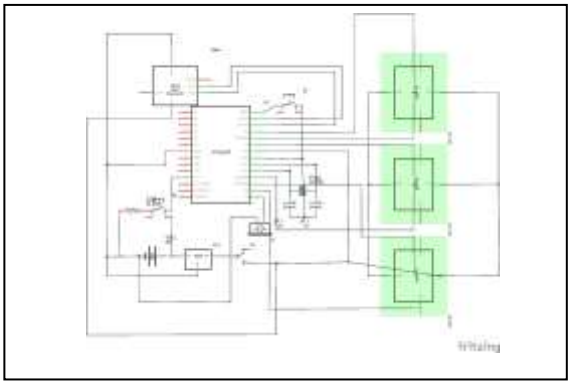


Fig. 1. Block diagram

B. Schematic Circuit Diagram

Circuit diagram was designed using fritzing version 0.9.3 software. Proposed design contains two buttons to reset and emergency calling respectively and a on/off switch.



C. Diagrammatic Representation

We have placed the top and the bottom sensors inclined at 45 degree and the middle sensor facing straight. The top sensor is used to detect overhead objects, the middle one detects the obstacles ahead and the bottom sensor helps to detect obstacles below knee or also to determine whether there are ascending and descending steps.

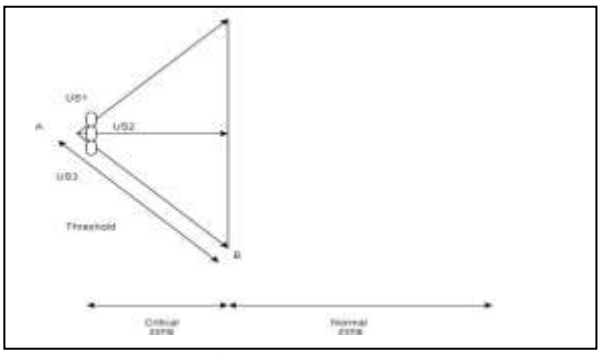


Fig. 3. Placement of ultrasonic sensors and their span

D. Obstacle Detection Algorithm & Flowchart

Algorithm for waist belt:

1. At the starts of the system wait for 3 seconds and set the threshold which will be the distance between the bottom sensor and ground.
2. If th is greater than top sensor distance then overhead object is detected and output is given as “Object overhead”.
3. If object detected by middle sensor is within 50cm, it is known as critical zone and the buzzer is allowed to beep.
4. If object detected by middle sensor is between 55cm and 180 cm then count of number of steps is given up to that object. If object detected by bottom sensor is between A and threshold (th), it is known that there are descending steps and output is given as “Climb down”. A is the distance between bottom sensor and threshold.
5. If object detected by bottom sensor is between B and threshold, it is known that there are ascending steps and output is given as “Climb up”. B is the distance between bottom sensor and threshold.
6. If middle sensor detects objects between 50cm and 70cm and at the same time if bottom sensor detects object between A and threshold, it is known that there is a hurdle and the buzzer is allowed to beep.
7. If threshold is less than top sensor distance and at the same time middle sensor detects object between 50cm and 70cm and also if the bottom sensor detects object is less than threshold , then it is known that there is wall ahead and output is given as “Turn around”.
8. If threshold is less than top sensor distance and at the same time middle sensor detects

object between 50cm and 70cm and also if the bottom sensor detects object is less than threshold , then it is known that there is wall ahead and output is given as “Turn around”.

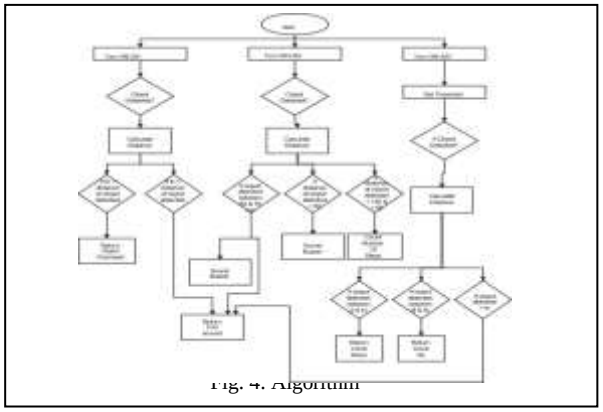


Fig. 4. Algorithm

TABLE I. CONDITIONS AND INSTUCTIONS ISSUED FOR OBSTACLE DETECTION

Sr .No	Sensor 1	Sensor 2	Sensor 3	course of action	Output
1.	if th >top sensor distance	-	-	Detect overhead object	Object overhead
2.	-	Middle sensor object<50	-	Detect object in critical zone	Buzzer sound
3.	-	Middle sensor object detect>55 and Middle sensor object detect<180	-	Count number of footsteps up to object	Number of steps
4.	-	-	if object detected between A and th"	Detects descending steps	Climb down
5.	-	-	if object detected between B and th"	Detects ascending steps	Climb up
6.	-	Object detected between 50 and 70	if object detected between A and th"	Hurdle detected	Buzzer beep
7.	If th< top sensor distance	Object detected between 50 and 70	If object detected < th"	Wall detected	Turn around

E. Bluetooth App Model

Smart phones have supremacy and potential. It comes with vast variety of APIs making it available for versatile applications. Android studio software is used for app development. Bluetooth module is interfaced with microcontroller. The scanned device is automatically connected to the android phone as MAC address of HC-05 is defined in App. All the data sent through the Bluetooth to the android application. The App converts the Text-To-Speech. Bluetooth API and TTS engine is used for this purpose

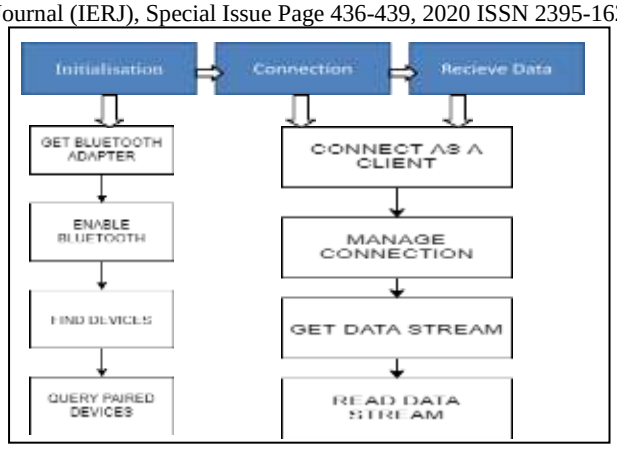


Fig. 5. Bluetooth App model

F. Emergency Calling and Location Tracking Concept

For emergency calling TelephonyManager API is implemented. Location API is included to Android devices from start. They contain provider objects, managers, addresses, geo coders etc. Location Manager is special object in location API which holds location providers, location details, minimum time span to check location etc. Location Listener provides updates for any change in location.SMS Manager is used to send messages to caretaker of visually challenged person. Real time Location tracking is also achieved by using Firebase [6].

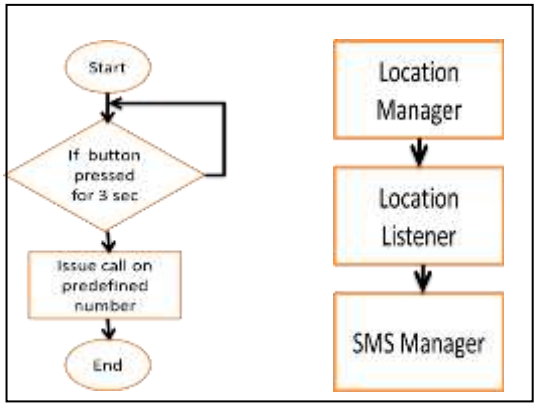


Fig. 6. Emergency calling flowchart and location tracking concept

III. RESULTS AND DISCUSSION

A. Hardware Implementation

Fig. 7. Waist belt based ETA

B. Software Implementation

- When the system first starts it calculates threshold and gives voice alert to move on. On detection of any obstacle voice assistance is provided.
- Bluetooth Connect: Turns ON Bluetooth and states if Bluetooth is connected successfully.

  Disconnect: Unpairs HC 05 from mobile.

  Clear: Clears output data stream received from Bluetooth.
- The system has a switch when pressed for 3 seconds call is issued to predefined number.
- The User Interface (UI) of the App is designed as per convenience of user. Bright and large components, High contrast.
- Inbuilt Talk back feature and magnifying gesture is used to navigate through smart phone.
- Our proposed system is designed for indoor as well as enclosed outdoor places such as garden, campus, hospitals etc.

Fig. 8. Snapshot showing data stream received through Bluetooth as voice output.

IV. CONCLUSION AND FUTURE WORK

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The main objective of this paper was to provide a uninterrupted path for smooth mobility. This is achieved through various conditions listed. We aimed for sturdy algorithm for object detection. In shelf product point of view this is low cost, compact and compatible with higher end computing field. Robust aid can be achieved using waterproof ultrasonic sensors. Real time object detection of both static and dynamic objects can be done by recent smart computing such as Artificial Intelligence and Machine Learning. To improve accuracy camera module can be mounted. Object Characteristics can be also conveyed through these. This also can include face recognition of familiar person. The designed App serves purpose of conveying location and emergency calling. In future, the App can be extended to contain functionalities such as speech- to-text (STT), navigating from one location to another by specifying source and destination address.

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