Smart Voice Navigation System and Advanced Cane for Visually Impaired Person

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Abstract- **Independence is the building methodology in achieving dreams, goals and objectives in life. Visually impaired persons find themselves challenging to go out independently. This project hypothesizes a smart cane that alerts visually impaired people over obstacles that could help them in walking with less accident and its objective is to address the development work of a cane that could communicate with the person through voice alert and vibration. Recently, there are many Electronic Travel Aids (ETAs) devices with advanced technology and computer vision system are introduced to assist the visually impaired for safe and independent walking. To overcome the limitations, a portable smart cane is designed and developed to detect the obstacles in the path of visually impaired person. This project is designed with ultrasonic sensor to detect the obstacles and alert the blind person. Additionally heart beat sensor is provided to monitor the heart pulse of the person and whenever there is any abnormality; location of user can be tracked and sent as message to the relatives using android application. Here guidance is provided as a voice playback to the user, using android application. Thus the user can independently navigate just using the voice commands provided by the device. An wireless module setup is provided in the places used by the person in order to indicate the person is reached the specified place. Computer simulation is done to essence the performance of the system using proteus software. In case, the stick is lost it can be found using the cane detection device.**

Index Terms- **Electronic Travel Aids, ultrasonic sensor, voice playback, android application.**

I. INTRODUCTION

Human way of travelling consists of two specific components: sensing of the environment for obstructions to travel (e.g., obstacles and hazards) and navigating to outlying destinations beyond the detectable environment. Methods of updating position and orientation can be classified on the basis of kinematic order. Position-based navigation is computed using external signals which indicate the traveller's position and orientation (often in association with an external or internal map). Velocity-based navigation relies on external signals indicating the traveller's velocity; displacement and direction change from the origin of travel are computed by integrating the velocity vector. Acceleration- based navigation is computed by the double integration of the traveller's linear and gyratory accelerations to obtain displacement and direction change from the origin of travel, but with no external signals required[1]. With 7.8 million blind people in India, the country has 20 per cent of the 39 million blind populations across the world. Currently most blind people rely on people, pets and canes to find their way in buildings and other places alike [2]. This can be a hassle for both the visually impaired person as well as others. Conventional navigational systems in the indoor environment are expensive and its manufacturing is time consuming. This work aims at designing a cost-effective and more flexible navigation system for the visually impaired. One of the earlier approaches has been to install location identifiers throughout the environments travelled by blind persons to assist the travel by tracking the blind person. Instead, developers have designed identifiers that can be remotely sensed by the blind traveller using appropriate equipment. One such system being deployed in demonstration projects is 'Talking Signs' (Crandall, Gerry, and Alden, 1993; Loughborough, 1979). In this system, infrared transmitters are installed throughout the travel surroundings (e.g., railway station or airport). These highly direction-sensitive transmitters continuously transmit digital speech signals to the blind person indicating what obstacle is at the location of the transmitter (e.g., pillar); within a range of 15 m or 40 m (depending upon battery size), a blind traveller with an infrared receiver can receive the signal from the transmitter and hear the audio utterance; directional localization of the transmitter is possible by aligning the hand-held receiver to obtain maximum signal strength from the transmitter.

Sunita Ram et Al. [3] designed the “People sensor,” which uses pyroelectric and ultrasonic sensors to find and discern between human and non-human obstructions in the detection path. The system also measures the distance between the user and obstacles. Another work by John Zelek [4] is on an innovative technology, “the logical extension of the walking cane,” which allows visually handicapped individuals to use tactile feedback in their perceivable environment. There are many ways to determine the location and orientation of the user and provide routes. ‘Metranaut’ [5], developed by Asim Smailagic and Richard Martin, is a new wearable computer system that uses a bar code reader for input information and position from a series of bar code labels placed at strategically important places to guide visitors of CMU’s campus. A. R. Golding and N. Lesh [6] detect the user’s positional information by using inexpensive, wearable sensors that include a fluorescent light detector, a temperature sensor, 3D accelerometer and a 3D magnetometer, , that do not require modifications in the environment at all. Loomis was one of the first people to propose the idea using DGPS with an FM correction data receiver for the stable determination of the location of the traveler [7]. A similar work is done by Hideo Makino[8] et al. Other works that use GPS to find the user’s location are MoBic [9] and a work by Bruce Thomas, etc. [10]. BrailleNote GPS is another commercially available blind navigation tool. It allows the user to know nearby location names and the distance to destination along the travel. The location of the user is ascertained by computer vision techniques. From the registered images, based on straight-line features, the landmark lines are transferred onto an unregistered image by image-to-image matching to get accurate position for real world images taken by the camera later [11,12]. This approach is thought to be applicable to landscape environments.

The Drishti system provides its users the layout of the indoor facility, and gives him/her an extensive picture of what the environment is like. As the user walks around, the system ensures travel safety by employing timely obstacle prompting. Another feature of this system is that it can also communicate with the user and answer varied contextual awareness questions on demand. Because GPS is not available indoors, and because the requirements of measurement error change, the Drishti system switches to a different location tracking technology: ultrasonic positioning service, which provides a high precision measurement scale, for indoor use and prompts the user with the indoor room layout [13]

system model

In this project we are going to use two ultrasonic sensors to detect obstacles and staircase. The ultrasonic sensor will emits signal generated from the microcontroller. These signal after coming in contact with the obstacle, the signal will be received back. This echo signal is collected by the sensor receiver and based on computing signal it alerts the person in advance about the obstacle. Based upon the difference in distance, obstacle and staircase will be differentiated.

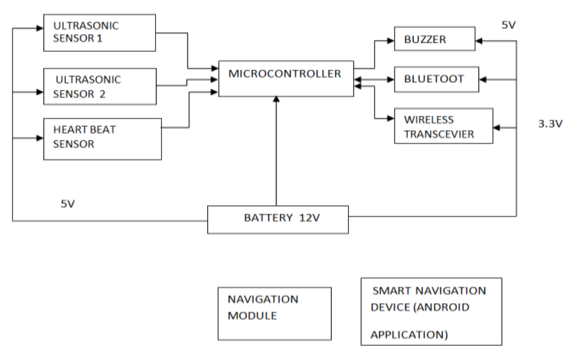

Figure 1: Block diagram of the smart cane

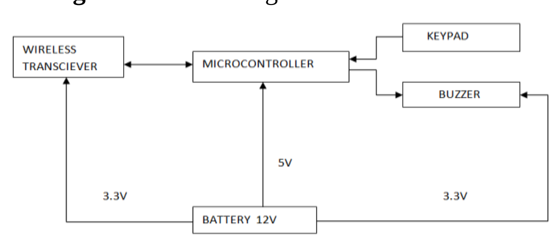

Figure 2: Block diagram of cane detection device

Ultrasonic sensor:

The advantages of ultrasonic sensing is its outstanding capability to probe inside objects non-destructively because ultrasound can propagate through any kind of media including solids, liquids and gases except vacuum. In typical ultrasonic sensing the ultrasonic waves travel in a medium and are often focused on detecting objects so that useful reflection based on the interaction of ultrasonic energy with the objects are acquired as ultrasonic signals that are in form of waves.

Ultrasound waves are generated by piezoelectric crystals. Piezoelectric means "pressure electric" effect. When an electric current is applied to a quartz crystal, its shape changes with polarity. Ultrasonic ranging and detecting devices use high-frequency sound waves to detect the presence of an object and its range. The systems either measure the echo reflection of the sound from objects or detect the interruption of the sound beam as the objects pass between the transmitter and receiver.

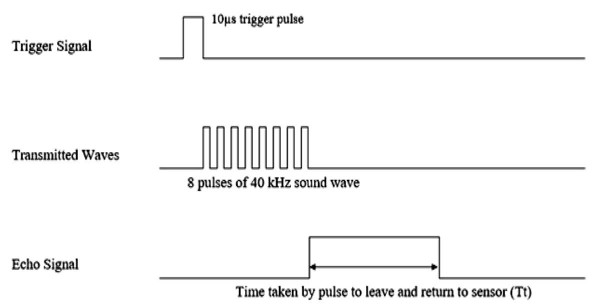

Figure 3: Timing Diagram of Ultrasonic Sensor

Heartbeat sensor:

Infrared waves are not visible to the human eye. In the electromagnetic spectrum, infrared radiation can be found between the visible and microwave regions. The infrared waves typically have wavelengths between 0.75 and 1000µS. Infrared (IR) communication is a very common wireless communication technology. IR communication is an easy to use and inexpensive wireless communication. IR Communication generally comprises of IR Transmitter and Receiver.

The sensor emits IR light and gives a signal when it detects the reflected light. The emitter is simply an IR LED (Light Emitting Diode) and the detector is simply an IR photodiode which is sensitive to IR light of the same wavelength as that emitted by the IR LED.

Bluetooth:

Bluetooth is a wireless technology standard for exchanging data over short distances. Bluetooth uses a radio technology called frequency hopping spread spectrum, which chops up the data being sent and transmits chunks of it on up to 79 bands in the range 2400 -2483.5 MHz. This range is in the globally unlicensed Industrial, Scientific and Medical (ISM) 2.4 GHz short range radio frequency band.

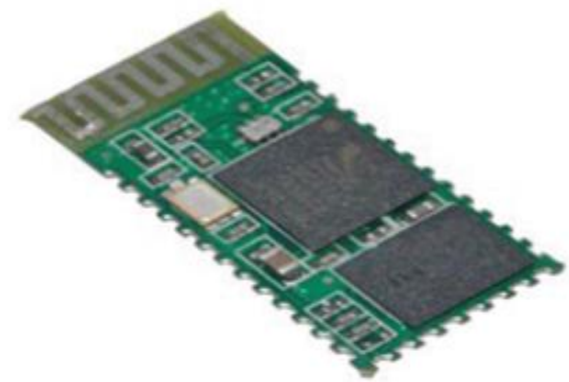

Figure 4: Bluetooth

Bluetooth is a packet based protocol with a master-slave structure. One master may communicate with up to7 slaves in a piconet; all devices share the master's clock. Packet exchange is based on the basic clock, defined by the master which ticks at 312.5µs intervals. Two slots make up a slot pair of 1250 µs. In the simple case of single-slot packets the master transmits in even slots and receives in odd slots; the slave, conversely, receives in even slots and transmits in odd slots. Bluetooth provides a secure way to connect and exchange information between devices. It was principally designed as a low-bandwidth technology.

Wirless Transceiver:

A transceiver is a device comprising both a transmitter and a receiver that are combined and share common circuitry or a single housing. When no circuitry is common between transmit and receive functions, the device is a transmitter-receiver. RFM75 is a GFSK transceiver operating in the world wide ISM frequency band at 2400- 2483.5 MHz

Burst mode transmissions and up to 2Mbps air data rate make them suitable for applications requiring ultra low power consumption. The embedded packet processing engines enable their full operation with a very simple MCU as a radio system. Auto re-transmission and auto acknowledge give reliable link without any MCU interference.

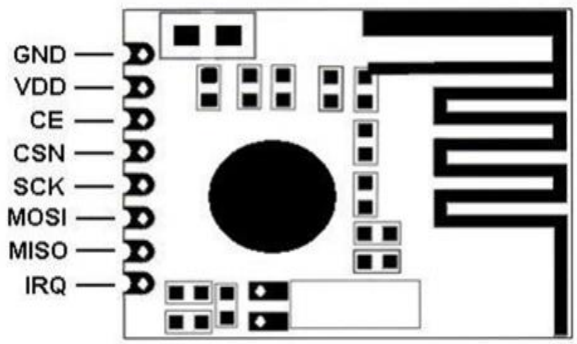

Figure 5: Wireless transceiver

In general, the designer of wireless systems has two overriding limitations: it must work over a convinced distance and transfer a convinced amount of information within a data rate. The size of the RF modules is very small and have an extensive range of a operating voltage that is 3V to 12V. Basically, these modules are 433 MHz RF TX and RX modules. The transmitter (TX) draws no power when transferring logic zero while fully destroying the carrier frequency, thus consume considerable low power in battery operation. When logic1 is sent carrier is fully on to about 4.5mA with a 3V power supply. The information is sent serially from the transmitter (TX) which is received by the receiver. Transmitter (TX) and the receiver (RX) are duly interfaced to two Microcontrollers for transferring the data.

PIC16F877 Microcontroller:

The PIC-16F887 is one of the largest product from microchip.It features all the components which the modern microcomputer have.This powerful yet easy-to-program (only 35 single word instructions) CMOS FLASH-based 8-or 44-pin package. The PIC16F887 features 256 bytes of EEPROM data memory, self programming, an ICD, 2 Comparators, 14 channels of 10-bit Analog-to-Digital (A/D) converter, 1 capture/compare/PWM and 1 Enhanced capture/compare/PWM functions, a synchronous serial port that can be configured as either 3-wire Serial Peripheral Interface (SPI™) or the 2-wire Inter-Integrated Circuit (I²C™) bus and an Enhanced Universal Asynchronous Receiver Transmitter (EUSART). All of these features make it ideal for more advanced level A/D applications in automotive, industrial, appliances or consumer applications.

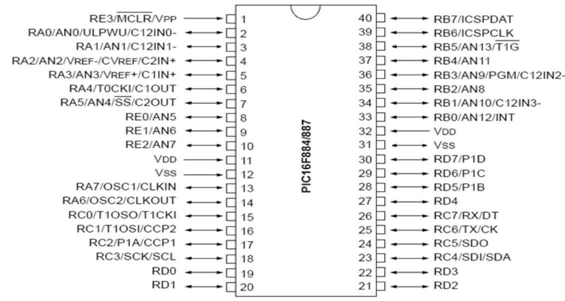

Figure 6: Pin diagram of PIC

Buzzer:

A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric. Typical uses of buzzers and beepers include alarm devices, timers, and confirmation of user input such as a mouse click or keystroke. A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric. Typical uses of buzzers and beepers include alarm devices, timers and confirmation of user input such as a mouse click or keystroke. Buzzer is an integrated structure of electronic transducers, DC power supply, widely used in computers, printers, copiers, alarms, electronic toys.

METHOD OF IMPLEMENTATION

In this project we are going to use two ultrasonic sensors to detect obstacles and staircase. The ultrasonic sensor will emits signal generated from the microcontroller. These signal after coming in contact with the obstacle, the signal will be received back. This echo signal is collected by the sensor receiver and based on computing signal it alerts the person in advance about the obstacle. Based upon the difference in distance, obstacle and staircase will be differentiated. We are going to interface the ultrasonic sensors and buzzer with the microcontroller and the complete module will be attached with the blind person’s stick. So whenever the blind person detects any obstacle up to a distance of 4 meters automatically the buzzer and voice alert will indicate about it to the blind person. Additionally, heart beat sensor is attached with it. The proposed architecture consists of an android application, cane detection device and wireless module. The android application is used to give voice alert, vibration and whenever there is any abnormalities in the heart pulse, the current location of user will be tracked and sent as message to the trusted contacts. User will also have the cane detection device to find the Smart Cane in case if it is lost. There are two wireless transceivers. One will be in the cane and other will be in this device. If cane is lost user will receive voice alert from the android application as 'your cane is missed' and buzzer sound from the cane. If the user goes near the cane by hearing the buzzer sound, the wireless transceiver in both the cane detection device and cane will get connected. If they get connected, there will be a voice alert from the android application like 'your cane is here'. Separate wireless module has been placed in specific places which get paired when the person with cane is nearby the place and the voice alert is generated about the name of the place.

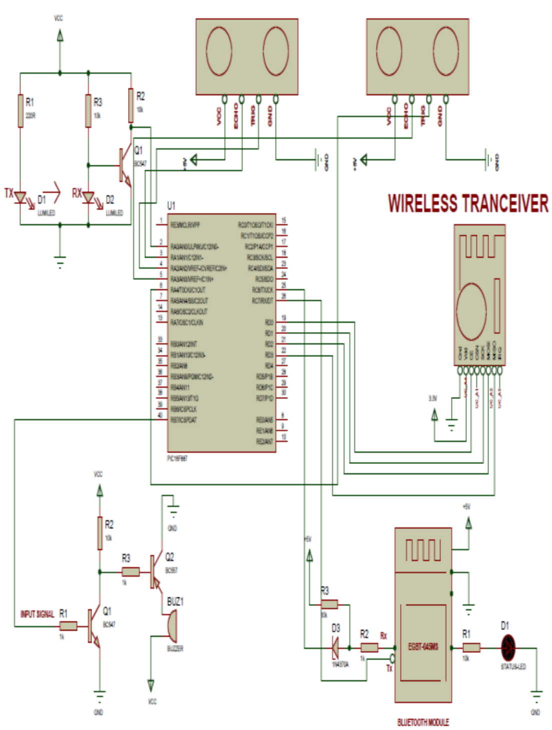

Figure 7a: Circuit diagram of transmitter section

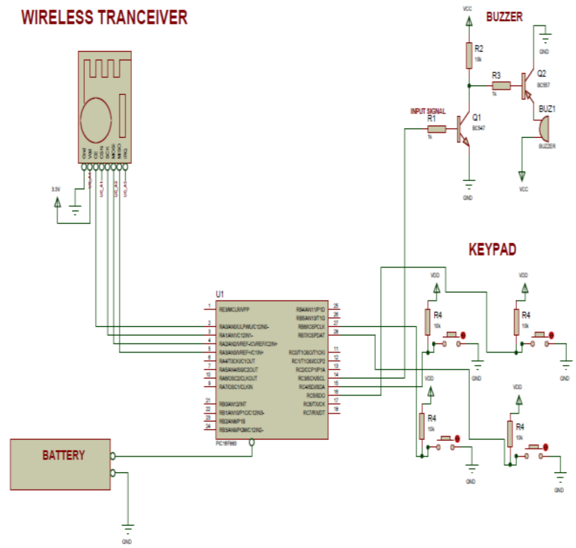

Figure 7b: Circuit diagram of receiver section

results

The shown figure 8 is the hardware design of the smart cane. Two ultrasonic sensors are placed in the bottom of the cane in order to indicate the presence of obstacle and steps. The heart beat sensor is placed on the handle of the cane to monitor the heart pulse. The Bluetooth module is placed in the cane to get paired with the android application.

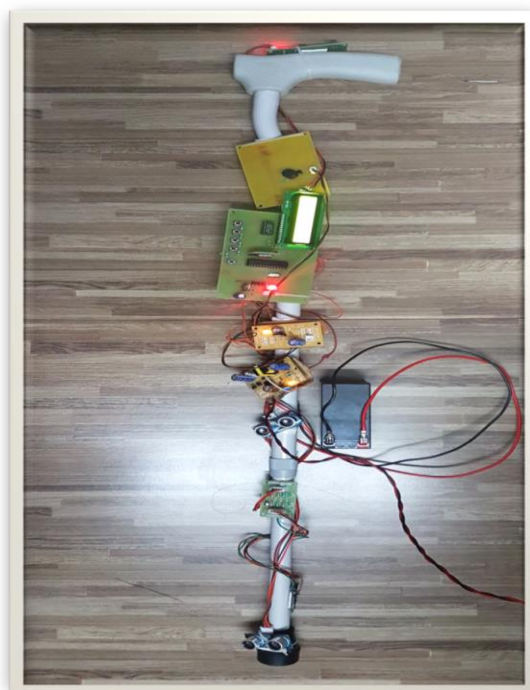

Figure 8 Hardware Setup Of Cane

A.Hardware Output:

Voice Command:

1.A voice alert will be generated from the android application as follows

2.If obstacle is detected then the command will be , 'turn left'.In case of steps being detected the command will be, 'steps be careful'.

3.when the person reaches the specific place where the wireless transceiver module is kept, the place's name is indicated through voice command from the android application.

4.In the absence of obstacle and steps the command will be , 'walk straight'.

Figure 9: SMS setup

The figure 5.4 is SMS which will be send to the trusted contact of the person about his current location in case of emergency like heart pulse abnormalities which is being monitored with heart beat sensor.

As ultrasonic sensors work on principle of echo, studying of its reflection on different obstacle is very important. Earlier majority of visually impaired people prefer to not use electronic aids, and use only canes or guide dogs. The underlying reasons for this include the relatively high costs and relatively poor levels of user satisfaction associated with existing electronic systems. So we tried to develop a low cost and user friendly system for blind people with greatest possible accuracy

CONCLUSION AND FUTURE SCOPE

Thus a smart cane is designed in such a way that it helps the blind person to walk confidently and prevents the difficulties faced by them. We have designed a low cost smart cane with the basic detection of obstacles and staircase and voice alerting system which helps in navigation. An android app is developed for voice based announcements which gives commands to the person about the direction to which he should move to reach his destination. And we have also designed the cane in such a way that it sends message to the trusted contacts about the current location of the person in case of emergency by monitoring the heart pulse with heart beat sensor using the android app. And a wireless module setup is implemented in the places used by the person in order to indicate the person has reached the specified places.The hardware complexity has been minimized as it aids in ease of interfacing the hardware components to the controller and also the programming is on high level programming language which reduces software complexity. With improved hardware to the proposed system the overall system performance has been improved

Future extension of the project:

- Image processing technology can be used in the need of finding the type of obstacle.
- The position of the ultrasonic sensors can be changed or rotated if it is placed in a movable casing.
- Extra sensors can be used in the need of detecting head above obstacles.
- Android app can be extended like giving directions to walk inside the places like college,malls,devotional places in accordance to the person need as a custom design using the data's of latitude and longitude of the location .

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