Smart Cane

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***Abstract*- The primary objective of this paper is to permit blind persons to explore autonomously in the outside environment. Ordinary route navigational systems in the outdoor environment are expensive and its manufacturing is time consuming. Blind people are at extensive drawback as they regularly do not have the data which is required, while passing obstacles and dangers. They generally have little information about data such as landmarks, heading and self-velocity information that is crucial for them to explore through new environment. It is our conviction that advances in innovations could help and encourage these blind persons in their regular operations. This work goes for giving the route to blind persons, by designing a cost - effective and more flexible navigation system. Here we are developing a navigation system that makes use of sounds in order to provide navigation instruction to the user the conversion of speech into a text is done by a pocket sphinx and Google API, whereas the text to speech conversion is done by Espeak. Route navigation is taken care by a Raspberry pi. Ultrasonic sensor is being used for detecting obstacles and a water level sensor is used for detecting water. We can also get weather update by using this system. MEMS sensor is used to intimate the user's friend in case of emergency. The whole system is mounted to a pack that is fitted to an ordinary white cane. It is light and convenient and it doesn't obstruct any of the client's detects while it is being utilized.**

***Index terms*- GPS, MEMS sensor, Ultrasonic sensor, Water sensor**

I.INTRODUCTION

Vision is the most important part of human life as 83% of information human being gets from the environment is via sight. According to a survey, as of 2017 there were 253 million people live with vision impairment, 36 million are blind and 217 million have moderate to severe vision impairment. About 81% of people are blind or they have temperate or severe vision impairment in the age of 50 years and above. Globally, the main cause of vision loss is the chronic eye diseases. Uncorrected refractive errors and then un-operated cataract are the top two major causes for the vision impairment. Cataracts which are not diagnosed remain the leading cause of blindness in low and middle countries. The infectious eye diseases, such as trachoma and onchocerciasis, have been reduced considerably over the past 25 years. Over 80% of all vision impairment can be prevented or cured.

The traditional and oldest mobility aids for persons with visual impairment are the walking cane and guide dogs. The main drawbacks of these aids are essential skills and training phase, range of motion and very little information carried. In recent times there have been a lot of electronic devices aids to help the blind navigate independently and safely. One of the major factors in developing these technical aids is the compatibility with the user. He should not have trouble with a product and it should be easy to use. The notification system used should also be comfortable and reliable. Another major factor is the cost of such products. Since they are already paying for treatments, the price of the product should be in reasonable. Other feature of these products should be the durability. The users might not be able to charge the system. So, appropriate measure should be taken for it.

To identify the position and orientation and location of a blind person GPS technology is used. In comparison to other technologies many blind guidance systems use ultrasonic sensors because of its immunity to the environmental noise. Another reason of using ultrasonic sensor is that the technology is relatively inexpensive, and also ultrasound emitters and detectors are small enough to be carried without the need for complex circuitry. Water sensor is used for detecting water. MEMS sensor is used to intimate the user's friend in case of an emergency. In addition to it we get weather update. SMS alert can be sent in case of emergency. The user receives the alert in the audio format. This design is a cost effective one and it is compatible and durable.

Three categories of visual assistive technologies are vision enhancement, vision substitution, and vision replacement. The main focus in this section is the vision substitution category including its three Subcategories; Electronic Travel Aid (ETAs), Electronic Orientation Aid (EOAs), and Position Locator Devices (PLDs).

A. Electronic Travel Aids (ETAs)

To collect data about the nearby environment and it transfers the data to the user using sensor cameras, SONAR scanners the Electronic Travel Aids are used.

B. Electronic Orientation Aids (EOAs)

These devices provide pedestrians with directions in unfamiliar places.

C. Position Locator Devices (PLD)

These devices determine the precise position of its holder such as devices that use GPS technology.

II. HARDWARE COMPONENTS

A. RASPBERRY PI

The Raspberry Pi is a low-cost credit-card sized single-board. There are a few different versions of the Raspberry Pi, each made for different uses. All of the current versions use a microSD card for the operating system and file storage. They are driven by a micro-USB port one audio/video jack socket, having one HDMI port, and a 40-pin GPIO connector. These are the list of the current versions of the Raspberry Pi and their features.

Model A+: The Model A+ is the inexpensive, lesser and it has only fewer connectors than the other versions of the Raspberry Pi. It is also used in small, low-power projects. It has the features of a single-core 700 MHz ARM processor, 256MBs of RAM and one USB port.

Model B+: The Model B+ is more costly than the Model A+ and it has more connectors and RAM. And the features of the Model B+ are single-core 700 MHz ARM processor, four USB ports, 512MBs of RAM, and one Ethernet port.

Model B: Model B in Raspberry Pi 2 is more costly than the other versions of the Raspberry Pi and has additional RAM and a faster processor. The features of the Model B are quad-core 900MHz ARM processor, 1GB of RAM, four USB ports and one Ethernet port.

B. ULTRASONIC SENSOR

Ultrasonic transducers are divided three broad categories Transmitters, Receivers and Transceivers. Conversion of electrical signal into ultrasonic signal is done by the Transmitter, receiver convert ultrasonic signal into electrical signals, and transceivers can both convey and accept ultrasound. Ultrasonic transducers are used to convert the AC into the ultrasound, as well as they can be used in reverse. Ultrasonic sensor usually refers to piezoelectric transducers or capacitive transducers. Piezoelectric crystals are used to change the size and shape when a necessary voltage is applied; AC voltage makes them fluctuate at the same frequency and produce ultrasonic sound. Capacitive transducers use electrostatic fields between a conductive diaphragm and a backing plate. In the same way ultrasonic transducers are used in the radar and sonar systems which estimate targets by interpreting the reflected signals. For example, by measuring the time between sending a signal and receiving an echo the distance of an object can be calculated. Ultrasonic noises that are present under the certain conditions are detected by the Passive ultrasonic sensors which are basically microphones.

It releases a 40 kHz ultrasound which can be travels through the air and if there is any object or problem on its path it will bounce back to the module. Considering the travel time and the speed of the sound the distance can be calculated. The accurateness of Ultrasonic sensor can be affected by the temperature and humidity. It is important to understand that some objects cannot be detected by ultrasonic sensors. This is because of objects which are shaped or positioned in such a way the sound wave bounces off the object, but they are rebounded away from the Ultrasonic sensor. It is also probable that the object is too small enough to reflect the sound back to the sensor to be detected. Other objects can absorb the sound wave all together (cloth, carpeting, etc), which means that there is no way for the sensor to detect them accurately.

The formula has used to find the distance between the obstacle and the person, by using the Distance Formula: Distance = speed * time; OD = {[Speed of Sound * Time Taken] / 2} Where, OD: Distance between an obstacle and the person in meters. Speed of Sound: We take speed of sound as 343meter/sec. Time Taken: Time interval between the pulse

radiated and the pulse received. The HC-SR04 Ultrasonic Module has 4 pins. Ground, VCC, Trigger, Echo. The Ground and the VCC pins of the module needs to be connected to the Ground and the 5 volts pins on the Raspberry pi respectively and the trig and echo pins to any GPIO pin on the Raspberry pi. In order to generate the ultrasound you need to set the Trig on a High State for 10 μs. That will send out an 8 cycle sonic burst which will travel at the speed sound and it will be received in the Echo pin. The sound wave traveled can be measured in time in milliseconds will be shown in the Echo pin.

C. MEMS

Micro-Electro-Mechanical Systems, or MEMS, is a technology that in its most general form can be defined as miniaturized mechanical and electromechanical elements that are made using the techniques of micro fabrication. The efficient elements of Micro-Electro-Mechanical Systems are actuators sensors, and microelectronics, the most important elements is the micro sensors and micro actuators. The basic principle of operation behind the MEMS sensor is the movement of a small proof mass etched into the silicon surface of the integrated circuit and suspended by small beams. Consistent with Newton's second law of motion (F = ma), as an acceleration is applied to the device, a force develops which displaces the mass. The supportive beams turns into a spring, and the fluid trapped inside the IC acts as a damper, resultant in a second order lumped physical system. This is the source of the limited operational bandwidth and non-uniform frequency response of sensor.

D. WATER SENSOR

Water Level sensors are used to detect the level of water and other fluids and fluidized solids, including granular materials, and powders that present in the upper free surface. The level measurement can be either continuous or point values. The exact amount of substance in a certain place and the level in specified range can be measured by the Continuous level sensors.

E. GPS

Satellite navigation system which are used to gives the location and time information in all weather conditions by using the Global Positioning System it is found anywhere on or near the earth where there is an clear line of sight to four or extra GPS satellites. The system provides serious experiences to military, civil, and commercial users around the world. GPS is a system of 30 satellites revolving around the earth at an altitude of 20,000km. Each one transmits information about its position and the current time at regular intervals. These signals, travelling at the speed of light, are intercepted by your GPS receiver, which calculates how far away each satellite is based on how long it took for the message to arrive. The GPS (Global Positioning system) receiver continuously receives the latitude and longitude values for every position of the system and it is interfaced with the raspberry pi.

F. EARPHONE/SPEAKER

Earphone/Speaker is used for the purpose to make the visually impaired person to alert the obstacles which are nearby, and it also used to tell the direction and distance from the obstacle. It is better than the buzzer since, it provides more accurate results and is more perceptive, thereby, helping the person to react more easily.

G. SD CARD

The internal memory is of 8GB and it is of the flash card type. It is based on micro secure digital high capacity. Memory adapter is included.

H. POWER SUPPLY

This system requires a 5V power supply. We can use a battery, portable charger, micro USB or a rectifier as the input power source.

III. SOFTWARE

A. TEXT TO SPEECH

The function of a TTS system is to convert the given text into a spoken waveform. In order for us to give verbal instructions to the user, we need to convert our text instructions into audible speech. We decided to use E speak. The major benefit of using E speak is that it is open source and it allows you to output speech in many different languages. Therefore we sent a string of data to E speak with the instruction which we wanted to tell the user and this text to speech synthesizer converted the text into speech data, which was then played for the user. The

database has been created for different addresses which include bus stops, colleges, hospitals, etc. This conversion involves text processing and speech generation processes. This approach seeks to develop strategies for concatenating stored speech segments as a means of Synthesizing speech. Sub-word units, such as syllables or diaphones, in which articulation between adjacent phonemes are preserved, are considered as satisfactory units, under this approach to synthesizing speech, using the same tool the text to speech conversion was done into an Indian language (Hindi).

B. SPEECH TO TEXT

However, when we require specific information such as address, we must rely on a more versatile method for input. Speech to text allowed us to get input from the user simply by asking them to say the required piece of information into a microphone. Speech to text allows us to record the user's speech and convert it to text which can be used for the other parts of the system. We mainly used speech to text to get the user's desired destination address.

C. SPEECH RECOGNISION

We used the open source speech to text engine, pocket sphinx developed by Carnegie Melon University. We choose this particular open source engine because it allowed us to easily add new words to the dictionary of required words and also allowed us to train the engine to better recognize the speech of a particular user. To use pocket sphinx we needed to create input files for the engine .To "Teach" the engine a new word, we had to generate a phonetic dictionary containing the word and a language model containing the word as well. We also needed an acoustic model, but the one that came with pocket sphinx would be sufficient. The phonetic dictionary file is a simple mapping of the word to its corresponding phones. The phoneme for a word is just the distinct set of units of sound that describes that word and distinguishes it from other words.

D. GOOGLE VOICE RECOGNISION

Speech recognition can be accomplished by many ways on Raspberry Pi, the accurateness is very good, and it has a strong pronunciation; it starts recording and it saves the audio in a file format. The audio file is then sent to Google for conversion and text will be returned and saved in a file called ― stt.txt‖.

E. FORWARD GEOCODING

It is also called forward Geocoding is the procedure of advancing a description of an area, most normally a postal address or place name, with geographic coordinates from spatial reference information, for example, road location, and postal codes and so on. A Geocoder is a piece of software programming which helps to implement a Gecoding procedure. A basic system for Gecoding is location insertion. This strategy makes utilization of information from a road geographic data framework where the road system is now mapped inside of the geographic direction space. Every road section is attributed with location ranges (for example house numbers starting with one segment then onto the next). Geocoding precedes a location, equals it to a road and particular fragment.

F. REVERSE GEOCODING

Reverse Geocoding is the process of reverse coding of a point location to a readable address or place name. The identification of a point of interest in a given geographical area, utilizing GPS services includes the help of reverse geocoding process at any given specific point, the place of interest may not actually reflected using GPS services but the point of interest in a geographical area can be attained comparing with a known location, street, state or country or a popular nearby landmark. There are various agencies like API's or Google, which encodes and maps a particular geographical area ,using latitude and longitude localization of landmarks, steer address ,state country for the benefit of GPS users .When a person switches on GPS services a person's location is reflected through a process of reverse geocoding which determines his location compared to already pre- programmed.

G. RASPBIAN JESSIE OS

The Raspbian operating system is based on Debian Linux, and there are different versions of Debian are named after characters from the toy story films.

H. ANDROID

Google developed the mobile operating system called Android ,it is based on the Linux kernel and designed

mainly for touch screen mobile devices such as smart phones and tablets.

IV. BLOCK DIAGRAM

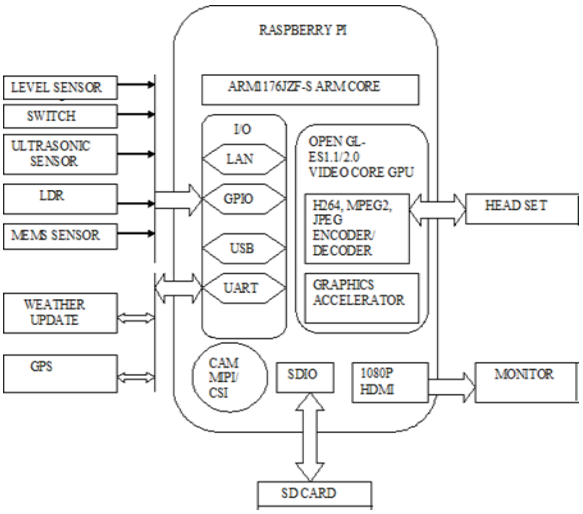

Figure 1: Block diagram for smart cane

V. RESULTS AND DISCUSSION

The voice module is used in the obstacle detection module, to give outputs as a substitute for buzzer. From the existing aids we have seen in the papers, we have concluded that continuous buzzing or beeping may cause irritation and stress to the user. Hence we tried to improve on that with voice announcements. Voice announcements are used to differentiate the position of the obstacle as two different sensors are used to detect. Average speed of normal person is 1.3 m/s or 4 feet/ s. According to some papers, the average speed of blind people without a helping aid is 0.3m/s and that of blind person with the aid is 0.5m/s. We introduced our system to some of the novice users to analyze the user adaptability.

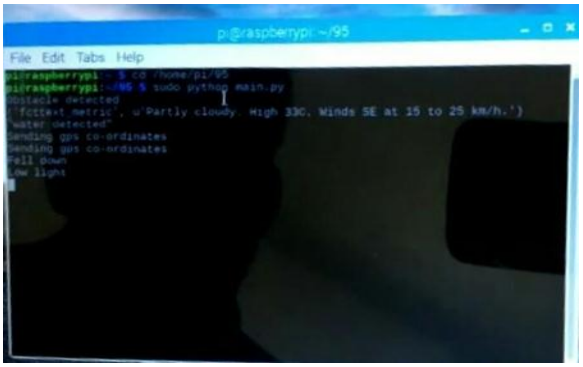

Figure 2: output of Ultrasonic sensor, Water sensor, MEMS, GPS and LDR

Figure 3: SMS Output

The user was able to attain a speed of 0.6m/s and was able to get well acquainted with the system in 2 or 3 attempts. The accuracy of the system is better compared to the existing aids. The vertical coverage of the detection system is up to 2 feet from the ground level, as it includes top and bottom sensors. The GPS module used in the system has a Dilution of Precision (DOP) of < 2 which is an ideal precision. On comparison with the already existing systems that have a DOP of around 5, it is clear that this is a better system. The GPS module of this system has a DOP of around 5, it is clear that this is a better system. The GPS module of this system has a reacquisition time of <1s which when compared to the other existing systems that have a reacquisition time of <2s is better. And the message can be immediately send to the friend or relative without any delay and the corresponding receiver was able to successfully open the Google maps of that particular location.

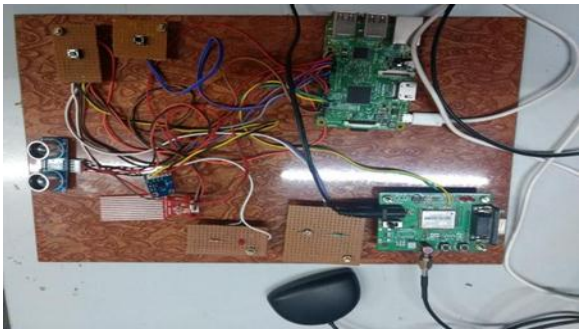

Figure 4 Hardware

VI. CONCLUSION

This paper has been made the compactness and which portable and it is designed for visually impaired people. It allows the visually impaired person to travel through an unfamiliar environment with ease. It can be said that the project provides Silicon Eye for visually impaired people. The new concept of Smart Electronic Travel Aid Stick for blind people made easier with the design. The advantage of the system lies in the fact that it can prove to be a very low cost solution to millions of blind persons worldwide.. This system is intended to provide overall measures object detection and real-time assistance via Global Positioning System (GPS).The system consist of ultrasonic sensor, water sensors, MEMS sensor, GPS Module, GSM Module and vibratory circuit (speakers or head phones). When the object is detected near to the blinds stick it alerts them with the help of vibratory circuit (speakers or head phones). Global System for Mobile communications and Global Position System is used to find the location of the blind people. The indication about the wet surface floor was found to be detected with high priority. Overall the project has been a success with the entire project requirement. The future scope for this project is to improve the capabilities by this system by incorporating landmark as saved destination. We would like find a more accurate cost effective GPS receiver as well as faster portable Linux computer. We would also like develop an algorithm for position and velocity so that other methods of navigation such as dead reckoning can be implemented accurately. And to use the online route, for obtaining the route from the Google maps, so that the blind person can travel to the places which are not stored in the database.

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