Ultrasonic Aided Voice Based Smart Stick

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Abstract: The study is focused on finding an easy way to detect a hindrance and a path by the help of ultrasonic sensors that can detect drench or steps with a maximum diameter of 2 meters. 30 million people are permanently visually impaired and 285 billion people have vision impairment, says WHO. As we see visually impaired people are likely to have trouble in making their living habits because they do not see even one thing. Using the blind stick, visually impaired people can walk confidently. This ultrasonic-aided smart stick has a few features that can help these visually impaired people to navigate on their trails and observe the obstacle. It also incorporates a GSM and GPS module to provide the GPS location of visually challenged people when they were lost in a remote place.

Keywords: Ultrasonic Sensor, Visually impaired People, Ultrasonic aided smart stick, Hindrance, GPS and GSM module

1 Introduction

Communication and hearing are challenging for visually impaired people. They have less opportunity to interact with the surroundings. Visually impaired people find it difficult to walk about. They are unable to migrate from one location to another or to another location. For travel and financial support, they rely on their family. In interpersonal and social activities, their movements are opposing. Different systems have been built with restrictions in the past without a thorough grasp of non-existent problems. Researchers have spent decades inventing a clever and ingenious stick to aid visually impaired persons become more aware of their surroundings and deliver information about their location.The smart walking stick is particularly designed to detect hindrance that can help the visually impaired to walk-without indifference. Voice messages will keep the user awake and greatly reduce risks. This program presents the idea of providing smart

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electronic assistance to the visually impaired, public and private. The system consists of an ultrasonic sensor, Arduino Nano, DF mini Player module, GPS & GSM Module, and speaker. The smart walking stick is a simple and pure ground detection machine. This device is small and light, making it ideal for personal travel assistance. A visually impaired individual can go from one location to another without the assistance of others. The program's major goal is to develop effective visual aids for visually impaired persons that provide a sensation of sight by presenting information about their surroundings and the objects in their environment. The GPS module informs the guardian of the visually impaired person's whereabouts.

2 Problem Statement

Visually impaired people cannot easily observe objects on their path or steps while using a normal stick . A visually impaired traveler must depends on any other guide such as the blind stick, human knowledge, trained dogs, etc. There are no safety features on a standard blind stick. To overcome these issues smart navigation is required for the visually impaired people.

Table 1. Indicators used and its percentages.

INDICATORS BASED ON BETTER EYE VISUAL ACQUITY	**PERCENTAGE (%)**
Blindness	1.99
Severe Visual Impairment	1.96
Moderate Visual Impairment	9.81
Early Visual Impairment	12.92
Moderate Severe Visual Impairment	11.77
Visual Impairment	13.76
Functional Low Vision	1.03
Blindness (Pinhole)	1.75

3 Components

In the Ultrasonic aided voice based smart stick the components used are

3.1 Arduino Nano: The Arduino Nano is a tiny, bread-board friendly component. It is uses ATmega328 chip as it's microcontroller. It is powered via a Mini-B- USB cable. Operating voltage of Arduino Nano is 5V. It has a 8 analog pins, 22 digital pins and out of 8 analog 6 can be used as digital pins too. In count of 22 digital pins there are 6 PWM pins(pulse width Modulation). Those 6 PWM can be used to get a digital output of analog inputs. And Arduino Nano uses AVR Architecture, and has 32 KB of flash memory in which 2 KB is used for boot loader. It has a Static Random Access Memory of 2 KB and clock speed of 16 MHz. In Arduino Nano some of digital pins and analog pins can be used vice-versa as per the user need this makes it more usable. Due to its compact size and easy installation it is used by connecting four Ultrasonic sensors, GSM, GPS and DF Player Mini. Signal from Ultrasonic sensors are computed and given as distance by Nano and as per those data a warning for visually impaired person is delivered.

3.2 DF Mini Player Module: DF Mini Player is a tiny portable MP3 Module and cost effective board. They has a simplified output which can be directly given to Speaker of 8Ω speaker. They can be used in combination with any boards with RX/ TX capabilities or it can also be used as a separate module. It completely supports a file type FAT16 and FAT32. This module can support a SD card upto 32 GB. It plays a song of a folder with 255 songs and maximum supports up to 100 folders. This module has a adjustable volume level of 30 and 6 EQ levels. As its RX and TX pins follows UART to communicate with other boards. Arduino Nano is made connection with receiving and transmitting pins of DF Player Module and input voltage of 5V and Ground connection is feed to module from Arduino nano. The output pins(SPK1 and SPK2) of DF Mini Player is directly connected to the speaker. Whenever the Obstacle is detected by Ultrasonic sensors the signal is sent from Nano to DF Player Mini Module with function and parameter. That parameter says the module to play a particular sound for a once. And this cycle continues till the smart stick gets switched off.

3.3 Ultrasonic Sensor: Ultrasonic sensor HC-SR04 has been used to observe the obstacles on the paths of visually impaired persons. They have four pins of VCC, GND, Trig, Echo.The detectable range of ultrasonic sensor HC-SR04 is minimum of 2cm and maximum of 4m as it is indicated in the name of sensor with accuracy of 3mm. The operating voltage 5V is given as a input voltage for Ultrasonic sensor, the VCC and GND are taken from arduino Nano. Trig Pin and Echo Pin are connected to Analog Pins of Arduino Nano and those pins are used as Digital Pins except A6 and A7. The sound pulses from an ultrasonic sensor are triggered by the Trig or Trigger Pin. Echo Pin makes a pulse when the reflected signal is received. Echo signal gets timeout after 38 milliseconds

which indicate as a no obstacle is detected. And the speed of sound in air to travel a centimeter is taken as 0.034cm/µs. The formula to calculate distance from time and speed is of

$$\boldsymbol{Distance = Speed * Time}$$

If time taken by a Ultrasonic sensor is of 380µs then distance is as follows:

$$\boldsymbol{Distance = \left(0.034 \frac{cm}{\mu s}\right) * 380\ \mu s}$$

$$\boldsymbol{Distance = 12.92\ cm}$$

Echo pulse indicated the reflected pulse so it indicates the time taken to reach the obstacle and time taken to reach the ultrasonic sensor. Then distance of the observed obstacle is half of the calculated distance.

$$\boldsymbol{Distance = (Speed * Time) \div 2}$$

$$\boldsymbol{Distance = 6.46\ cm}$$

We used four Ultrasonic sensors to detect obstacle on ground of center, right and left. Remaining one is used to detect the Rigid and Groove and it can be used to identify the staircase. Due to limitation of Analog to Digital Pins the Ultrasonic sensor for staircase detection is connected to the digital pins Arduino Nano.

3.4 Global Positioning System: GPS of Neo-6M make of U-Blox is used which supports both cool start and hot start. As 6M in the name indicates the version of the module. This module has backup battery to make a hot start. As we supplied a operating voltage from Arduino Nano. On once the GPS module receives power it starts to make connection with satellites for gaining location. On Cool Start the GPS module takes few seconds to make a connection if it is in open space and has a good weather. If connection is made then last known location of the user is saved to the program and not be deleted unless a new location is detected or system gets shutdown. The Module has a active antenna which should be placed in a horizontal position for accuracy. On initial stage the GPS module gives as a raw data which doesn't have correct longitude and latitude. After over a time a fix LED on GPS module gets blink which indicate as GPS gets fixed and fix data is given to Arduino Nano and we use the TinyGPS++ library to extract the longitude and latitude of the user from GPRMC line of Fix data. Now Arduino Nano is ready with user location to share the data with Guardians of the User if user presses the push button on emergency case or confused state.

3.5 Global System for Mobile Communication: GSM of SIM 900A has AMR926EJ-S core which is integrated into a single chip. This chip is very powerful, small in size and gives as communication solution in low cost. It works in dual band of 900 and 1800 MHz automatically. The default baud rate of GSM SIM900A is 9600 baud. This module supports internet access, SMS, Voice call. It has a single SIM slot. As it has nearly 58 pins we used TX,RX,VCC and GND only. This module has ability to support connectivity with MIC and speaker without any other module interface. This module follows UART architecture to communicate with other modules. Operating Voltage of this module is 12V DC and this need is fulfilled by 12V DC power source which is rechargeable one. Voltage difference between Voltage Common Collector and Ground pin of GSM is of 5V DC, we used this to power up our all other modules which are all workable under 5V DC. By this we neglected a Buck Convertor which helped us in both weight and cost reduction. On power up, GSM network status is ON and it waits for Arduino Nano Signal which consists of data about location, message textand receivers contact number. Availability of network Status is purely depends on theSIM operators.

4 Methodology

Consider 7 cases for three Ground Level Sensors of Left, Right, Center and 2 cases for Staircase level sensor. The algorithm is created in a manner to receive the Ultrasonic sensor data for every 500ms and making a alerts as per the received data.

The Obstacles on three different sides are considered as:

Case 1 – Obstacles on all three sides within 40cm

Case 2 – Obstacles on Left and Right within 40cm

Case 3 – Obstacles on Left and Center within 40cm

Case 4 – Obstacles on Right and Center within 40cm

Case 5 – Obstacles on Left within 40cm

Case 6 – Obstacles on Right within 40cm

Case 7 – Obstacles on Center within 40cm

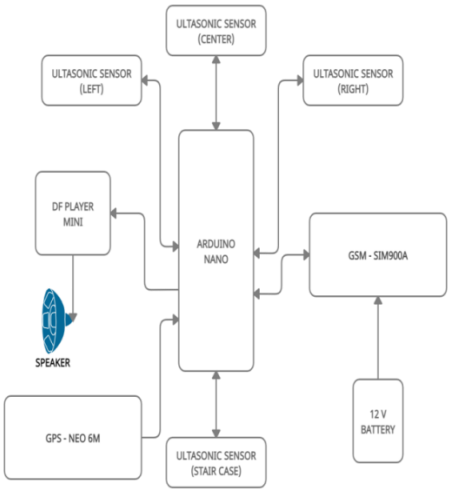

Fig. 1. Block diagram

The algorithm designed by considering these seven case for ground level obstacle detection.

Case 1 - Consider that the three sensors are surrounded by obstacles, distance between obstacle are on right 12cm, left 23 cm center 39cm. Then this case satisfy all condition for entering the loop which alerts the user by playing a recorded sound. The particular recorded sound can be chosen by function called object. play("song number").

Case 2, Case 3 and Case 4 -Consider that the any two sensors detected the obstacles on a distance of 10cm, 27 cm. Then these cases satisfy the conditions of loop that warns user about the obstacles on two sides. Here particular sounds are used to indicate the user in which both directions where obstacles are detected.

Case 5,Case 6 and Case 7 – Consider that the one sensor of three is detected on obstacle on its direction within 40 cm. Here the user is alerted by sound which indicates them that obstacle is on this side.

The Stair case Ultrasonic sensor is placed stick in a height of 9 cm from a plain ground surface. And while handling the stick in a sledding position the distance between plain ground and sensor is 11 cm.

The algorithm designed for the staircase has only two case – Groove or Ridge.

Case 1– If distance calculated is within 11 cm then it is considered a obstacle or groove. And indication to user is made through speaker.

Case 2 – If distance calculated is above 11 cm then it is considered that there is Ridge. And information about a ridge is given to user before they move forward towards ridge.

If visually impaired person can't guess him/her path or he/she feels that they were in trouble, they are supported with location sharing technology by GSM and GSM. This gets activated when user presses a push button. On pressing a push button their present location or last known location is sent to guardians of the visually impaired person. The location is shares via SMS in a format of Google map link and with a message text of 'I AM IN TROUBLE'.

5 Fritzing and Arduino IDE

5.1 Fritzing: For designers and artists who are ready to move beyond prototyping to building a more permanent circuit, Fritzing is an open-source initiative that intends to produce amateur or hobby CAD software for the design of electrical gear. At the Potsdam University of Applied Sciences, it was developed. Using the Processing programming language and the Arduino microcontroller, the software may be used to describe and build a PCB layout for an Arduino-based prototype. In addition to cutting manufacturing costs, draughts and experiences may be exchanged on the linked website. Using the Qt-framework, Fritzing's source code is developed in C++. GitHub repositories make it possible to obtain and modify the source code. Fritzing-App and Fritzing Parts are the two major repositories for the source code. Designers, artists, researchers, and electronic hobbyists are encouraged to employ interactive electronics in novel ways and to create electronic papers. Learn more about electronic circuits and prepare it for production with the help of Fritzing.

5.2 Arduino IDE: Arduino IDE is software free and open to the public. It is used to develop and upload code to any Arduino Boards. Codes those are written in the IDE are called as sketches. The file format of saving files will be .ino. They have a serial monitor which can be used to see the output from Arduino Boards. Baud rate should match the begin baud rate. If a third party library is need in our project they can be added to Arduino IDE easily. They have a simple user interface with buttons for verify, upload, save, open, new.

6 Equivalent Diagram

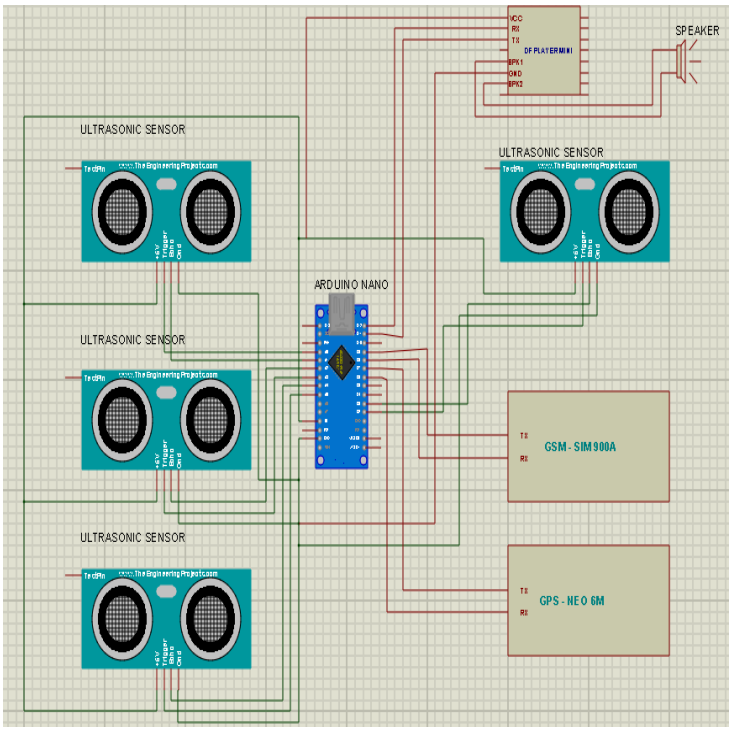

Fig. 2. Equivalent Diagram

This is an equivalent diagram of our ultrasonic aided voice based smart stick. For the making equivalent diagram we used Proteus software. Proteus supports for third party libraries. We have options to create our required components in this software.

7 Result and Discussion

The development of an ultrasonic-assisted voice-based smart stick has been successful. This idea presents the design and architecture of a new Smart Stick concept for those who are blind or visually impaired. This system presented the design and architecture of a new Smart Stick concept for those who are blind or visually impaired. The system's advantage is that it can prove to be a very low-cost option for millions of blind people around the world.

Millions of visually impaired people around the world will benefit from the suggested system. The device allows visually impaired individuals to move with the same ease and confidence as sighted individuals. In a confused situation, the user can press the push button to summon the Guardians.

Fig. 3. Proposed Hardware Model

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