Smart Cane: Assistive Cane for Visually-Impaired People

REVIEW - 3

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ABSTRACT

The study hypothesizes that a smart cane that alerts visually-impaired people over obstacles in front could help them in walking with less accident. The aim of the project is to address the development work of a cane that could communicate with the users through voice alert and vibration, which is named Smart Cane. The development work involves coding and physical installation. A series of tests have been carried out on the smart cane and the results are discussed. This study found that the Smart Cane functions well as intended, in alerting users about the obstacles in front.

OBJECTIVE

The objective of this project is used to help blind people and that they can easily interact with the physical world by using this smart blind stick. If you notice them, you can very well know about it that they can't walk without the help of other. One must ask guidance to reach their destination. Using this blind stick, a person can walk more confidently. This stick with ultrasonic sensor detects the object in front of the person and give response to the user by alarm from the buzzer. So, the person can walk without any fear. This device will be best solution to overcome their difficulties and help them to live the better life.

This stick will set an alarm off as soon as it comes in proximity of an obstacle which will warn the blind person and prevent him from falling. As soon as the human comes near to an obstacle a beep sound will occur which will warn him of the danger and prevent him from falling down and injuring himself. The principle of echo is used here in which the ultrasonic sensors with the help of ultrasonic waves will detect an obstruction. The ultrasonic waves after hitting the target will return to the sensor in a particular time which will cause the sensor to send a signal to the speaker. The one of the main stakeholders are obviously the blind people. Even partially visually impaired people and to those who can't see nearby objects clearly and those who have other optical disabilities. Also some people who have undergone eye related operation can temporarily use this stick for walking.

KEYWORDS:

Assistive technology, visually-impaired, functional test, Arduino, ultrasonic sensor

INTRODUCTION

The increasing number of people with disabilities in India attracts the concern of researchers to invent various technologies, hoping that these technologies can assist the disabled people in carrying out their tasks in everyday life like normal people. The increasing trend of people with disabilities has been reported by Country Report Malaysia, the 7th ASEAN and Japan High Level Officials Meeting on Caring Societies in 2009. As stated in the report, in 2008, there were only 30,522 children with disabilities detected. The amount increased to 13.7% in 2009 where 35,368 people with disabilities were registered with the Department of Social Welfare. Therefore, technologies are considered the best solution to assist this community to perform tasks as the normal people. The objective of the paper is to discuss the development work of a cane that could communicate with the users through voice alert and vibration, which is named Smart Cane which involves coding and physical installation.

NOVELITY OF THE PROJECT IDEA

The prime reason behind selecting this idea is to provide help to visually impaired people while walking. The motive behind this project is to provide a new way of walking for blind and visually impaired people. This smart walking stick will make these people self-dependent and will make way for an easy and a happy way of life. We have updated an already existing project in which the user will get to know the direction of obstacle – forward, left, right. Whereas the original project only warned the person about the obstacle.

LITERATURE REVIEW

The white cane originated in Europe in 1921 when James Biggs, a photographer who had lost his vision, began to paint his walking cane white to alert others to his presence. When veterans of World War II returned to America with vision impairment and blindness they wanted to have the same level of independence as they had before the war. Because of this, the white walking cane was altered into the long cane form that is still prevalent today. At present, 82% of the world's blind population are at the age of 50 and above. Approximately 90% of the world's visually impaired live in developing nations due to the lack of healthcare and medical treatments. These figures are important when considering the population that the Smart Cane will be addressing.

PROJECT SCOPE

The project can be of great commercial value. This smart cane can be sold in the market which will help blind people to walk easily. Also, commercially this can be a great success as according to the literature review and studies taken no such very popular alternate stick has been developed till date. If this can be mass produced with less production cost then, it can be sold.

SCENARIOS

When a blind person is trying to walk on a footpath and suppose some stones or trees (obstruction) come in his or her way he would get warned of it because of the beep sound and he would get to know the direction of obstruction and thus wouldn't get hurt. A person who has hurt his eyes in an accident after his treatment can use this stick for obstacle prevention since immediately after his treatment the doctors suggest him to use the black specs and not to use his eyes much so for that duration of time, he can use this stick. A person who is not able to see nearby objects clearly can also make a good use of this stick.

PROPOSED METHODOLOGY

The Arduino is programmed in such a way that on switching 'ON' the Arduino, it sends a LOW to HIGH signal on the TRIG pin of all the three Ultrasonic sensors. These ultrasonic sensors will send an Ultrasonic wave using the ultrasonic transmitter of the sensor. These ultrasonic waves travel through air and on colliding with an obstacle, get reflected back. Programming is done in such a manner, that when this obstacle is in the range of 1.4 m of the sensor, the Arduino will play the buzzer with different delay for obstacles located on the sides, and no delay for the straight ones. To further enhance its performance, if the obstacle is too close (less than 0.7 m from sensor) then the vibrating motor is also activated.

The sensor would give an electrical response at the ECHO pin of the sensor. This response is the time taken by the wave for a round journey from sensors to obstacle and back to the sensors. For our calculation, we need only the one-way distance. This can be calculated by Arduino using the following formula:

Formula Used:

$$Distance = \frac{\frac{Duration}{2}}{29.1}$$

Here, Duration = Echo output;
and since we need only one-way distance, hence we divide this duration by 2.

Here the constant 29.1 is derived as follows:
The speed of sound is 343.5 m/s or 0.0345 cm/microseconds.
1/0.0345 cm/microseconds is 29.1 microseconds/cm.
Dividing the Duration (ms) by 29.1 (microseconds/cm) gives us the distance in (cm).

To distinguish between the direction of obstacle location, the following mechanism is followed:
For Left and Right side direction locations, the delay is 500 ms.
For Forward direction location, the delay is zero.
An additional provision of a motor that vibrates the stick is planted into the assembly for very near obstacles.

Experimentation study shows the optimum distance post assembly, to be 0.7m.

SOFTWARE

The Arduino integrated development environment (IDE) is a cross-platform application (for Windows, macOS, Linux) that is written in the programming language Java. It is used to write and upload programs to Arduino board.

The source code for the IDE is released under the GNU General Public License, version 2. The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub main() into an executable cyclic executive program with the GNU toolchain, also included with the IDE distribution. The Arduino IDE employs the program avrdude to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware

HARDWARE REQUIREMENT

Arduino UNO:

Arduino is a tool for making computers that can sense and control more of the physical world than the desktop computer. It's an open-source physical computing platform based on a simple microcontroller board, and a development environment for writing software for the board. The boards can be assembled personally or purchased and open-source IDE can be downloaded for free. The Arduino programming language is an implementation of wiring a similar physical computing platform, which is based on the processing multimedia programming environment.
Microcontroller is a single chip that contains the processor (CPU), non-volatile memory for the program (ROM or flash), volatile memory for input and output (RAM), a clock and an I/O control unit and time . It is designed for a small set of specific function to control a particular system. For example, microcontroller is used in wheelchair to controller the motion using remote control . The reason of using microcontroller is because the microcontroller has the ability to store and run unique programs make it extremely versatile .

Ultrasonic Sensor:

Ultrasonic sensors are used in pair as transceivers. One device which emits sound waves is called as transmitter and other who receives echo is known as receiver. These sensors work on a principle similar to radar or sonar which detects the object with the help of echoes from sound waves. This detect the object and alarm to warn the blind people.
Ultrasonic sensors generate high frequency sound waves and evaluate the echo which is received back by the sensors. Sensors calculate the time interval between sending the signal and receiving the echo to determine the distance to an object. Ultrasonic is like an infrared where it will reflect on a surface in any shape. However, the ultrasonic has a better range detection compared to infrared.

In robotic and automation industry, ultrasonic has been accepted well because of its usage . Magori and Walker state that the endurance and accuracy of the sensor is not affected by physical contact. Comparing with other sensors, the ultrasonic is more accurate. Han and Hahn have proven that the distance and angle measurements of ultrasonic are highly reliable by proving that the relative errors and variances of the measurements are within a reasonably small range . These discussions explain that the ultrasonic is suitable for developing the Smart Blind Cane.

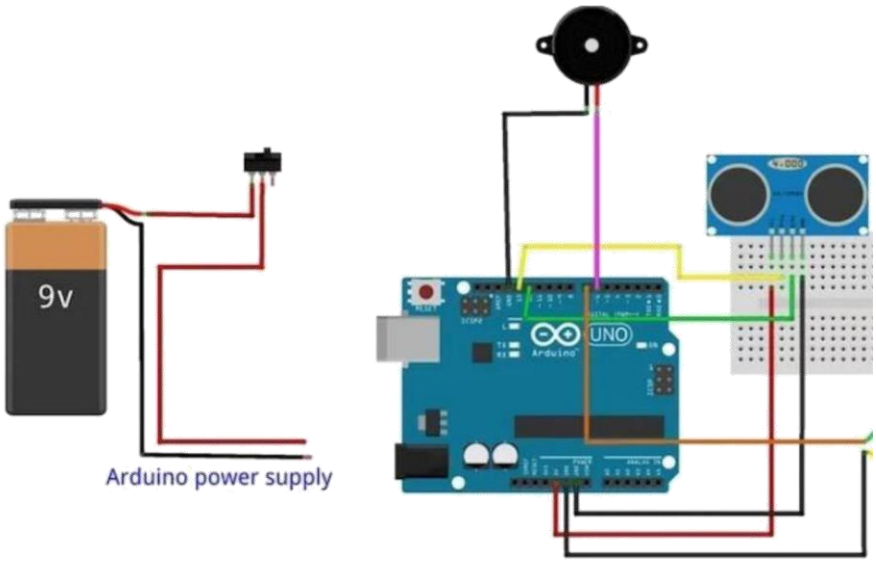
Buzzer:

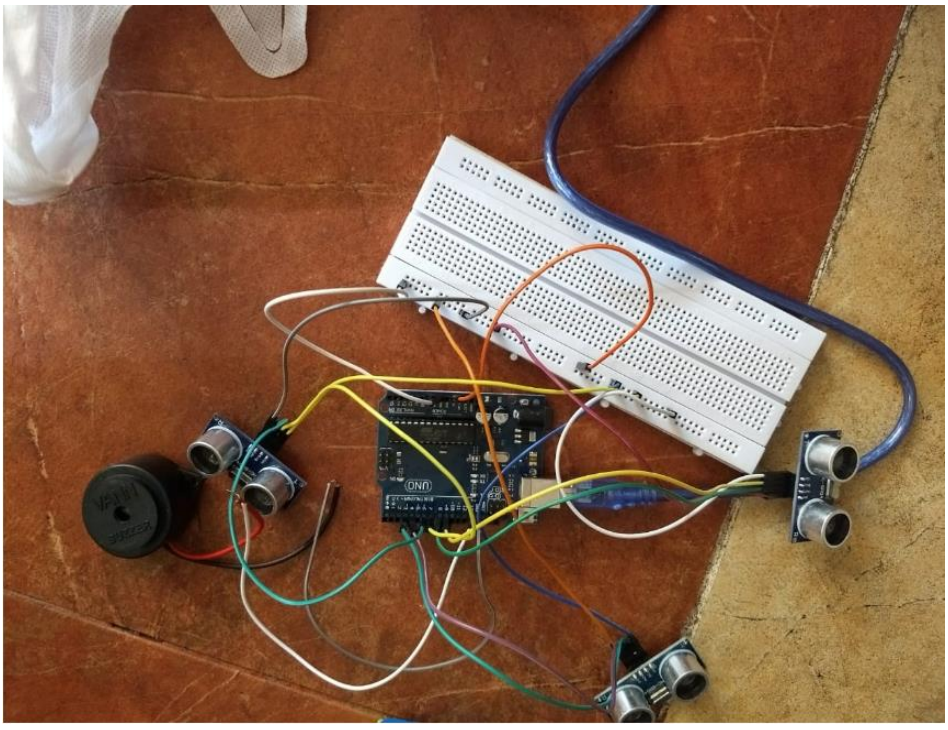
Buzzer will produce an alerting sound at different frequencies as a response to different proximity as well as different distances.
The buzzer is directly interfaced at the pin 9 of the Arduino. The buzzer is activated as any obstacle is detected by the ultrasonic sensors.

Batter 9V:

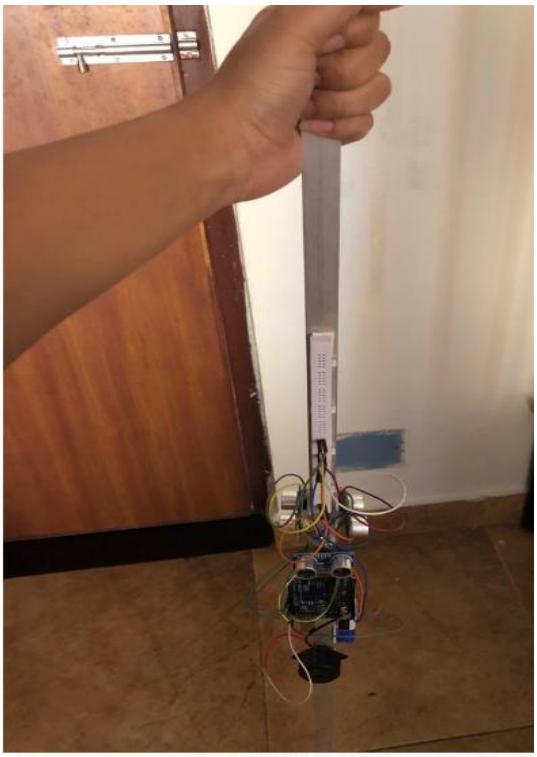
The battery 9V works well in the Arduino kit and simply connect the positive end of your battery to Arduino Vin and the negative end to Arduino ground**.**

CIRCUIT DIAGRAM





SNAPSHOTS:



SOURCE CODE:

```
#define trigPin3 7
#define echoPin3 6  //left
#define trigPin2 3
#define echoPin2 4  //middle
#define trigPin1 9
#define echoPin1 8 //right
#define buzzer 13

void setup()
{
Serial.begin (9600);
pinMode(trigPin1, OUTPUT);
pinMode(echoPin1, INPUT);
pinMode(trigPin2, OUTPUT);
pinMode(echoPin2, INPUT);
pinMode(trigPin3, OUTPUT);
pinMode(echoPin3, INPUT);
pinMode(buzzer,OUTPUT);
}

void loop()
{
long duration1, duration2, duration3, distance1 , distance2, distance3;

digitalWrite(trigPin1, LOW);
delayMicroseconds(2);

digitalWrite(trigPin1, HIGH);
delayMicroseconds(10);

digitalWrite(trigPin1, LOW);
duration1 = pulseIn(echoPin1, HIGH); //right


digitalWrite(trigPin2, LOW);
delayMicroseconds(2);

digitalWrite(trigPin2, HIGH);
delayMicroseconds(10);

digitalWrite(trigPin2, LOW);
duration2 = pulseIn(echoPin2, HIGH); //middle

digitalWrite(trigPin3, LOW);
```

```
delayMicroseconds(2);

digitalWrite(trigPin3, HIGH);
delayMicroseconds(10);

digitalWrite(trigPin3, LOW);
duration3 = pulseIn(echoPin3, HIGH); //left

distance1 = (duration1/2) / 29.1;
distance2 = (duration2/2) / 29.1;
distance3 = (duration3/2) / 29.1;

Serial.write(distance1);


if (distance1 < 10 )
{

tone(buzzer, 450, 50);

digitalWrite(buzzer,HIGH);

} else
{
  digitalWrite(buzzer,LOW);
}

if (distance2 < 70 and distance2>50 )
{

tone(buzzer, 100, 100);

digitalWrite(buzzer,HIGH);

}

else

if (distance2 < 50 and distance2>30 )
{

tone(buzzer, 500, 500);

digitalWrite(buzzer,HIGH);

}
```

```
else

if (distance2 < 30 )
{

tone(buzzer, 1000, 1000);

digitalWrite(buzzer,HIGH);

} else
{
  digitalWrite(buzzer,LOW);
}


if (distance3 < 10 )
{

tone(buzzer, 850, 100);

digitalWrite(buzzer,HIGH);

} else
{
  digitalWrite(buzzer,LOW);
}

}
```

RESULT AND CONCLUSION

The main purpose of this study is to produce a prototype that can detect objects or obstacles in front of users and feeds warning back, in the forms of voice messages and vibration, to users. From the tests carried out on its functions reveal that the developed prototype which is named Smart Cane has achieved its objectives. This study would recommend that a power supply meter reading can be installed to monitor its power status. An alarm system also can be incorporated for use in a situation of very congested areas and replace PVC with steel so that it will be more durable and robust. In addition, a buzzer timer can be added so the buzzer will activate at a specific duration. Smart cane can detect obstructions from 1.2 m away in all 3 directions. A warning alert is triggered when the obstruction is in close proximity.

APPENDIX:

https://www.researchgate.net/publication/220489558_Smart_Cane_Assistive_Cane_for_Visually-impaired_People

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