

Smart Walking Stick for the Visually Impaired

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Abstract - In this paper, we introduced a smart electronic aid for visually impaired. The smart cane provides a solution to visually impaired who face complications in detecting obstacles and changes in environment. The smart cane comprises of three sensors: infrared sensor, ultrasonic sensor and flame sensor. These sensors are implemented and programmed using microcontroller (Arduino UNO R3). This stick can detect obstacles which lie in the range of about 2m from the user. The aim of this system is to provide an affordable and a reliable smart cane which would help visually impaired to navigate freely.

Key Words: Arduino Uno R3, Flame sensor, Infrared sensor, Smart cane, Ultrasonic sensor

1. INTRODUCTION

The definition of vision impairment by the Centers for Disease Control and Prevention (CDC) says a visually impaired person’s eyesight cannot be corrected to a “normal level”. It is said that visual impairment is the functional limitation of the eye or eyes or the vision system [1]. According to the WHO definition, blindness implies visual sharpness less than 3/60, or corresponding visual field loss

to less than 10 degrees in the better eye, with the best available spectacle correction.[2] India currently has around 12 million blind people against 39 million globally- which makes India home to approximately one-third of the world’s blind population(March 2017). Previously, the techniques used by the blind were white cane and dog assist. The disadvantage of white cane is that it gets stuck in the pavement which leads to injury to the user and dog assist method is not cost effective. With the rapid growth of technology many different devices have been invented to support the movability of blind. The main objective of this project is to design a smart cane which is used to detect the depth and the presence of obstacle. This allows the user to walk independently.

2. SYSTEM AND DESIGN

2.1 Architecture

The proposed system design of smart cane, as shown in figure 1, consist of following units.

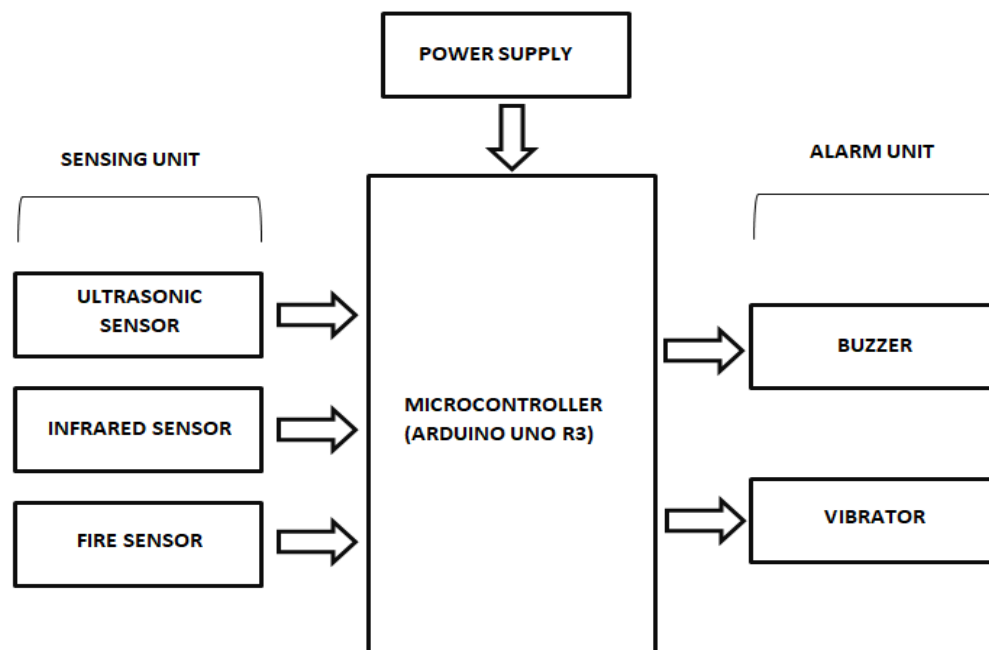


Fig. 1. Proposed system design of smart cane.

2.2 Arduino Uno R3 Microcontroller

The Arduino Uno R3 is a microcontroller board based on the ATmega328P [3]. It consists of 20 digital input-output pins out of which 6 pins can be used as Pulse Width Modulation (PWM) pins. These pins are configured to take analog input. Logic based programs are created in the Arduino compatible software and fired into the microcontroller.

2.3 Sensing Unit

It comprises of three sensors:

2.3.1 Flame sensor

A flame detector is a sensor designed to detect and respond to the presence of a flame or fire, allowing flame detection. [4] The flame sensor is shown in the figure 2 along with the pin configuration of the sensor. The sensor consists of four pins Vcc, GND, Analog input and Digital output.

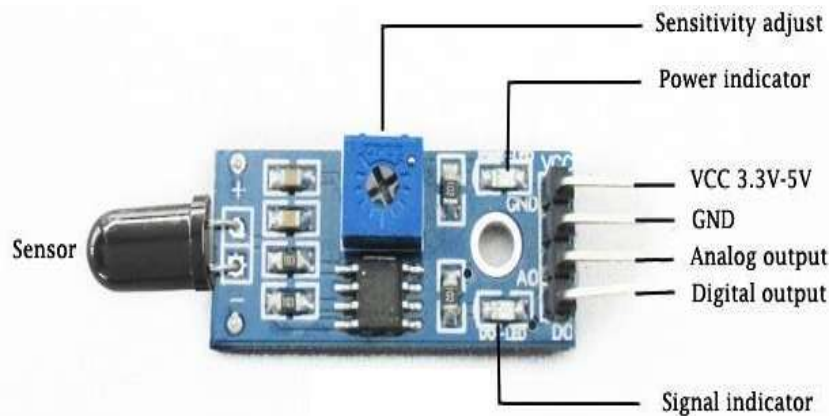


Fig. 2. Flame sensor

2.3.2 Infrared sensor

An IR sensor is based on emitting and absorbing the infrared radiations to detect any obstacle in nearby vicinity. The IR radiation emitted by the sensor strikes the object, some amount of radiation is reflected to the IR sensor module where a receiver is present to absorb it. The amount of radiation that is reflected to the receiver determines the distance of the obstacle. It is used for pot holes and staircase detection. The infrared sensor description and working is illustrated in the figure 3.

2.3.3 Ultrasonic sensor

The sensor works with the simple high school formula stated in equation 1 that:

$$\text{Distance} = \text{Speed} \times \text{time} \quad \text{-----(1)}$$

The Ultrasonic transmitter transmits an ultrasonic wave, this wave travels in air and when it gets objected by any material it gets reflected toward the sensor this reflected wave is observed by the Ultrasonic receiver module.[5] Now, to calculate the distance using the above formulae, we should know the Speed and time. Since we are using the Ultrasonic wave the universal speed of it at standard conditions is 330m/s.[6] The inbuilt circuitry on the module will calculate the time taken for the ultrasonic waves to travel and come back to turn on the echo pin high for that same amount of time, the time taken is recorded.[7] Now simply calculate the distance. The ultrasonic sensor used is shown in the figure 4 and its pin configuration is depicted in table 1.

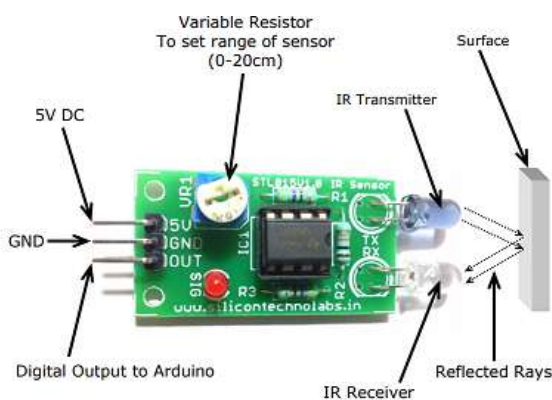


Fig. 3. Infrared sensor



Fig. 4. Ultrasonic sensor

Table 1: Pin Description of the Ultrasonic sensor

Pin Number	Pin Name	Description
1	Vcc	The Vcc pin powers the sensor, typically with +5V
2	Trigger	Trigger pin is an input pin. This pin is kept high for 10us to initialize measurement by sending US wave.
3	Echo	Echo pin is an Output pin. This pin goes high for a period of time which will be equal to the time taken for the US wave to return back to the sensor.
4	Ground	This pin is connected to the ground of the system.

2.4 Alarming Unit

It comprises of:

2.4.1 Buzzer

A buzzer is a mechanical, electromechanical or piezoelectric audio signaling device. A piezo electric buzzer (as shown in figure 5) can be driven by an oscillating electronic circuit or other audio signal source. A click, beep or ring can indicate that a button has been pressed. In this system the buzzer is used to notify the visual impaired against the obstacle by generating an audio signal which will vary according to the distance of obstacle from the user.[8]



Fig. 5 Piezo buzzer

2.4.2 Vibrator

In this system it is used to enhance the alarming process. The vibration produced by the vibrator will be proportional to the distance from the obstacle. The vibrator is used is shown in the figure 6.



Fig. 6. Vibrator motor

3. IMPLEMENTATION AND RESULTS

3.1 Hardware Implementation

The working prototype of smart walking stick is successfully developed and shown in the figure 7. The length of the prototype is 1.21m which is approximately 4 feet. This is so kept so that it fits the requirement of all kind of users.



Figure 7: The smart blind stick prototype

Some assumptions were made during the final testing and they are listed below:

1. For ease of calculations the angle of inclination of the stick while using it is assumed to be 45 degrees.
2. The ultrasonic sensor is also placed at 45 degrees to make sure the range of obstacle detection is maximum with the inclined stick, i.e., while using the stick.
3. Arduino Uno R3 is placed at the center of the stick so that the connections were made properly.
4. The top of the stick has no sensors mounted to it other than a buzzer so that the user can make out or distinguish the sound easily in noisy environment.

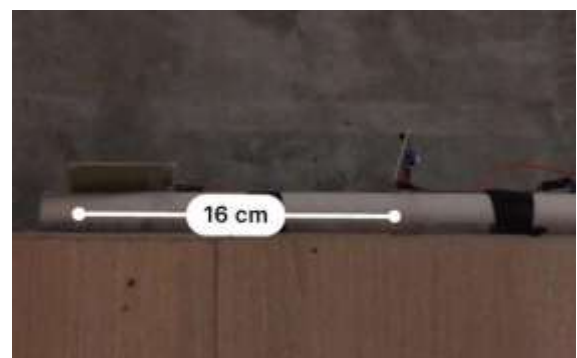


Figure 8: IR sensor placed on blind stick

The blind stick has the IR sensor placed on it nearly 16cms (shown in figure 8) away from the bottom of the stick. It is done so to have the maximum usability of the sensor as the working range is between 2cm to 20cms. Assuming the stick is inclined at 45 degrees the range at which the sensor can sense the height of the obstacle increases as per the calculations.

The calculation is performed below:

Let the angle of inclination of the stick (α) = 45 degrees

The height of the IR sensor from the bottom (l) = 16 cm

The range of the sensor is h.

Therefore, $h=l*\sin\alpha =16*\sin45= 16*0.709=11.34$ cm

The range of the sensor is 11.34 cm

4. CONCLUSION

In this paper, we have proposed a smart cane for visually impaired so they could navigate with ease. In this system, we have inculcated several sensors and microcontroller along with alarming unit which will warn the user in case of any obstacle and danger. The motive of this system is to improve movement and to reduce collision. The smart cane proposed is both cost effective and user friendly.

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BIOGRAPHIES



Raghav Mohindru completed his Bachelor of Engineering in Electronics Instrumentation and Control from Thapar Institute of Engineering and Technology. His research interest is in the field of implementation of sensors using microcontroller.



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