Design of Multi-sensor Walking Aid for Blind People

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Abstract

The project describes the development of smart blind aid that is aimed to help visually impaired people leading a life without any assistance from others. This comprises of ultrasonic sensor to detect any obstacle, IR sensor to avoid any holes or pits , flame sensor to avoid any fire danger and water detector to avoid any water to avoid slipping in path. With this blind aid, a blind person can get alert through audio signal and vibration sense if any danger is detected through sensors. This project is proposed at initial model however the further changes are in progress to implement. The progress is expected to include RF transmitter module to locate the blind aid if gets lost / stolen from the user. In order to provide convenience to the family and acquaintances to the user, there would be implemented a feature of GPS modem to locate the user and send its live location alert to his family members. The prime purpose is to introduce it in market at an affordable price with quality features to meet the customer demand of every social class group .

Keywords : Ultrasonic Sensor, Flame , Water , Holes, Blind People , GPS module, RF modem.

Introduction

Blindness is termed as lack of visual perception . It may also refer to a loss of vision that is impossible to be corrected with glasses or contact lenses. Physical mobility is often faced challenge for visually impaired persons, since it can become perplexing to distinguish obstacles appearing in front of them, and they are not able to move from one place to another. They depend on their families for mobility and financial support. [1]. The prevalence of people that have distance visual impairment is 3.44%, among which 0.49% are blind and 2.95% have MSVI. A further 1.1 billion people are estimated to have functional presbyopia. As described by World Health Organization (WHO), 10% of the visually impaired have no functional eyesight at all to assist them in movement without support with guaranteed safety. [3] Generally, we have observed that white cane is widely used among visually impaired person due to its easily availability and economical price. But many time this white cane is not useful. In any unfamiliar surrounding or environment, visually impaired person get confused so this restricts their mobility.[2] . An alternative to the common walking stick is the Smart Blind Stick. This aid can identify an object in front of a user and respond by giving audio signal to alert the user. With this cane, a person can walk with more assurance. [4] Smart walking stick is specially designed for visually impaired for the detection of obstacles to move freely care-free. The audio messages in this smart blind stick will keep the user alert and thereby accidents are avoided . [4] The range of this is limited due to its own size since

the designed model is proposed at such initial stage. However, there would be further considerations required when modelled at an advanced level. [5]

Requirements

Arduino UNO Micrcocontroller

Arduino Uno is a microcontroller board based on the ATmega328P . This consists of 14 digital input/output pins (6 can be used for Pulse Width Modulation output), 6 analog inputs, a 16 MHz ceramic oscillator (CSTCE16M0V53-R0), a USB connection, a power jack, an ICSP header and a reset button. It consists of everything needed to support the microcontroller and provides convenience to simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or batter as shown in Fig 1 . The Arduino IDE is an open source software programmed in Java and able to work with variety of platforms of windows, linux etc. The IDE enables you to write code in a specialized environment with syntax highlighting and other features that makes coding feasible, and then easily load your code onto the device with a simple click.

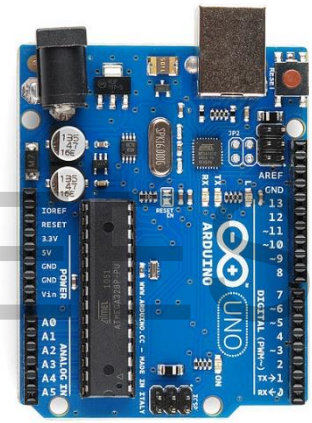

Fig 1 : Arduino UNO Microcontroller

Ultrasonic Sensor HC-SR04

The ultrasonic sensor HC-SR04 is an economical and easy to use distance measurement sensor which has a range from 2cm to 400cm. The sensor is composed of two ultrasonic transducers shown in Fig 2 . One is transmitter which gives output of ultrasonic sound pulses and the other one is receiver which listens for reflected waves. It's basically a SONAR which is used in submarines for detecting underwater objects. It emits an ultrasound at 40,000 Hz frequency which travels through the air and bounces back to module in the presence of any obstacle in its path. Considering the travel time and the speed of the sound the distance is calculated as

Fig 2 : Ultrasonic Sensor HC-SR04

Distance = Speed x Time

The working mechanism follows when the trigger pin is set HIGH for 10µs. In response, the sensor transmits an ultrasonic burst of 8 pulses at 40 kHz. This 8-pulse pattern is specially designed so that the receiver can distinguish the transmitted pulses from ambient ultrasonic noise. These 8 ultrasonic pulses travel through the air away from the transmitter. Meanwhile the echo pin goes HIGH to initiate the echo-back signal. If those pulses are not reflected back, the echo signal times out and goes low after 38ms (38 milliseconds). Thus a pulse of 38ms indicates no obstruction within the range of the sensor.

Flame Sensor

This sensor detects flame of the wavelength within the range of 760 nm – 1100 nm from the light source. This sensor is highly sensitive and can be easily damaged to high temperature, so this sensor should be cautionary placed at a certain distance from the flame. The flame detection can be done from a 100cm distance. This flame sensor includes a YG1006 Phototransistor sensor which has high sensitivity & high speed presented in Figure 3 . The output of this sensor is an analog signal or digital signal depending upon your requirement. These sensors are used in fire fighting robots like as a flame alarm. It includes an alarm system, a natural gas line, propane & a fire suppression system. This sensor is used in industrial boilers. Flame-sensors are classified into four types

- IR single frequency
- IR multi-spectrum
- UV flame detectors
- UV/ IR flame detectors

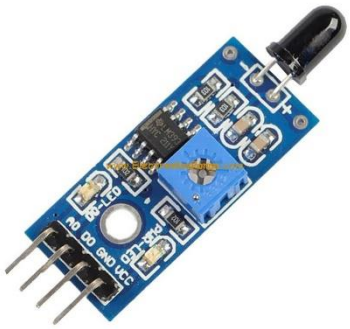

Fig 3 : Flame Detection Sensor

Infrared Sensor

An infrared sensor (IR sensor) is a radiation-sensitive optical-electronic component shown in Figure 4 with its spectral sensitivity within infrared wavelength ranging from 780 nm - 50 µm. The sensor elements detects the heat in the form of radiation that changes over a period of time and space due to the movement of objects within its surrounding . An IR sensor can measure the radiation of an object as well as detects the motion. It is invisible to the human visual perspective , since its wavelength is longer than that of visible light range although it is

still within the same electromagnetic spectrum. The IR spectrum can be divided into three regions like near-infrared, mid infra-red , and far-infrared.

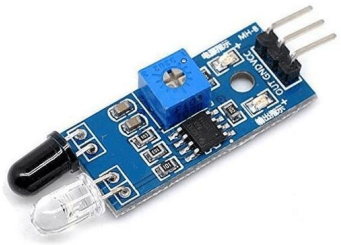

Fig 4 : Infrared Sensor

Water detector Sensor

It can be used to detect the presence, the level, the volume and/or the absence of water. The sensor has 10 exposed copper traces, five of which are power traces while the remaining five are sense traces. These traces are interlaced so that there is one sense trace between every two power traces. The water detector sensor capable of interfacing with Arduino is presented in Figure 5.

Normally, power and sense traces are not connected, but when exposed to water, they get connected. The operation of the water level sensor is simple.

The power and sense traces form a variable resistor, whose resistance varies based on how much they are exposed to water. This resistance varies inverse to the depth of immersion of the sensor in water. The more water the sensor is immersed in, the better the conductivity and the lower the resistance or vice versa. The sensor generates an output voltage proportional to the resistance; by measuring this voltage, the water level can be determined.

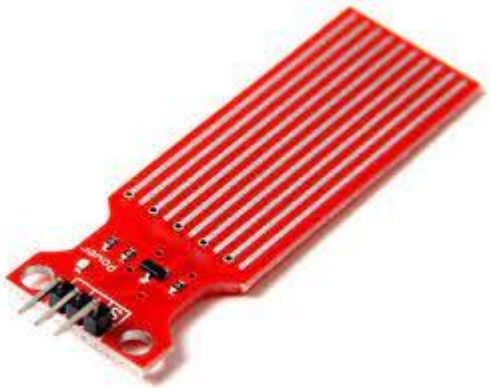

Fig 5 : Water detector Sensor

Piezoelectric Buzzer

A buzzer or beeper is an audio signaling device that can be mechanical, electromechanical, or piezoelectric . A piezo buzzer is an electric device used to produce an audio. These lightweight and simply constructed buzzers are inexpensive yet reliable and come in a range of sizes and frequencies to meet the needs of nearly any application. A piezoelectric buzzer used in our model is shown in Figure 6.

The core characteristic that defines this type of buzzer is its piezoelectric component. These are constructed of special materials that exhibit the piezoelectric effect (where the material can transduce some energy from applied mechanical strain into an electric charge). These materials also exhibit the reverse piezoelectric effect where the material deforms when an electric charge is applied. Ppiezo buzzers are regularly used in alarms, warning devices and automobile alerts. These devices are well suited for use in portable, battery powered equipment, and are employed in a wide variety of products, including timers, smoke alarms, games, telephone ringers, metal detectors, watches, automobile alarms, and many others

Fig 6 : Piezoelectric Buzzer

Vibrator Motor

Vibration motor is a DC motor in a compact size that is used to inform the users by vibrating on receiving signals. It has no sound. Mainly they are used in mobile phones, joysticks etc whose size can be estimated as given in Fig 7 . Such type of mini DC motors are widely used in Home Applications, Office Equipment, Health-Care Application, Sanitation Industry, High-Class Toy, Banking System, Electronic and Electrical Tools, Automation Industry, Bank Equipments Payment equipment, Vending Machines, Power Door Lock, Electric Door Lock.

Fig 7 : Vibrator Coin Motor

Methodology

Microcontroller Arduino UNO is programmed to interact with ultrasonic sensor , flame sensor, and Water detector sensor at input side while the output is received through buzzer for auditory sense and servo motor for tactile sensation. The block diagram provided in Fig 8 shows input and output sources while circuit diagram given in Fig 9 illustrates that Vibrator motor is connected at D11, Buzzer at D12,Ultrasonic sensor is connected at D10 , Infrared Sensor at D9, IFlame sensor at D8 and Water sensor at D7.

There is specified an auditory signal and vibration sense whenver any difficulty is observed in terms of any obstacle , water or fire. The set of instructions provided to microcontroller to respond upon detection of any obstacle is specified in Fig 10

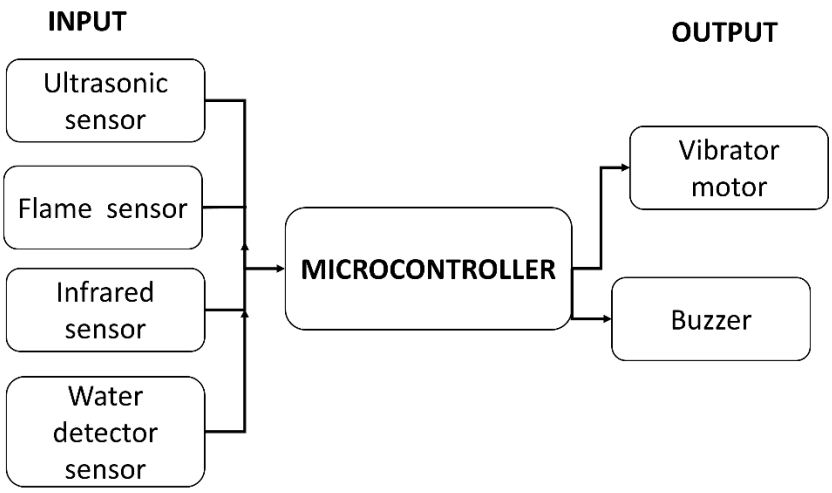

Fig 8 : Block diagram representation of different sensors interfaced with microcontroller

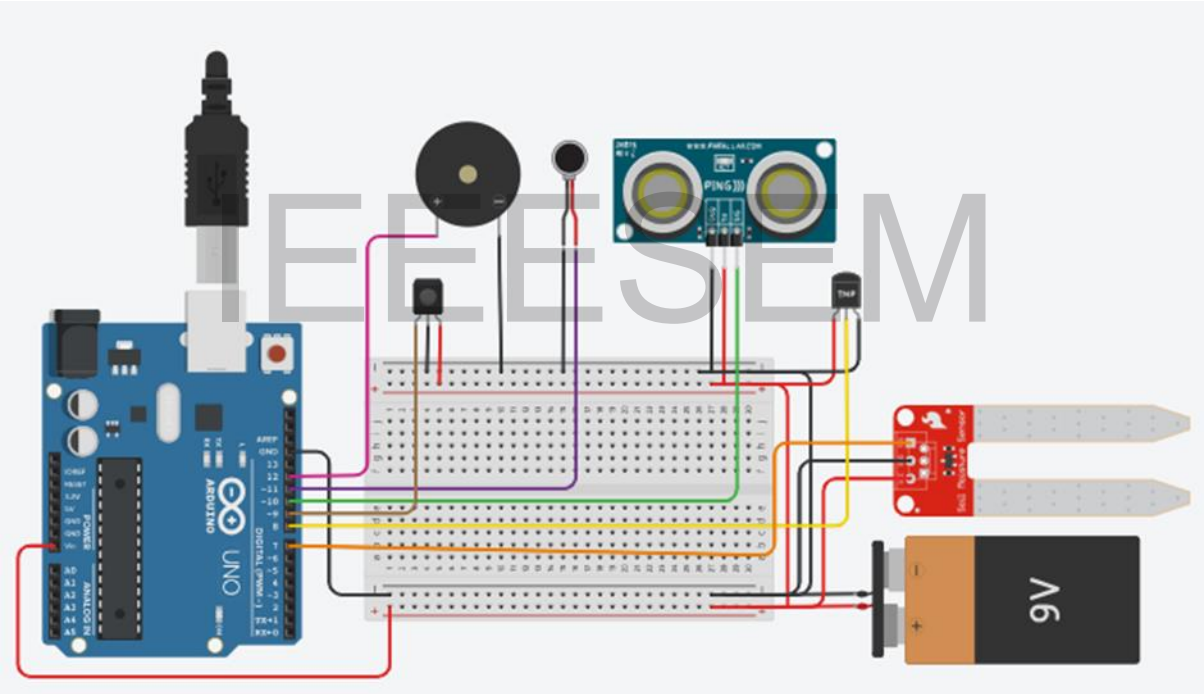

Fig 9 : Schematic Presentation of Sensors connected with Arduino

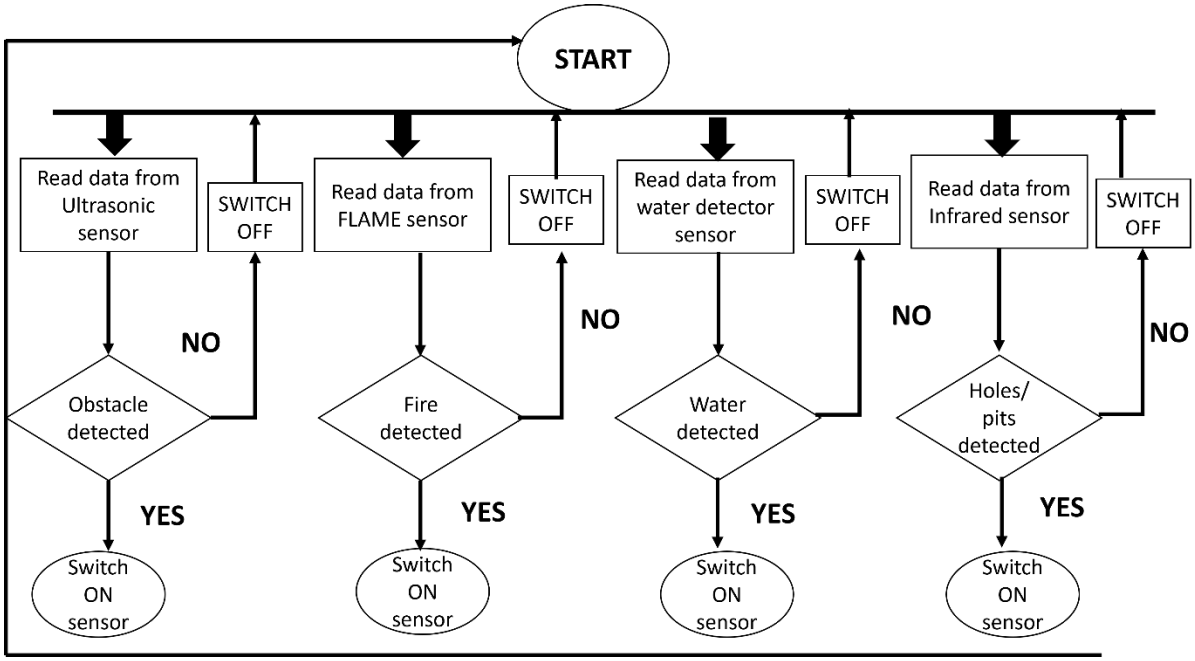

Fig 10 : Set of Instructions to Micrcontroller upon detection of Particular Signal

Results

The Figure 11 is the final prototype of designed blind aid which shows the proper arrangements of each sensor at specified position for better detection. The vibrator motor is installed within the handle of stick to feel tactile sensation better. The designed model worked better with obstacle detection within 2 meters range while IR sensor worked better with detection of holes within. The temperatrue sensor and water senser worked reliable while trail experiment. The stick is to be handled at some angle of 20° for better detection and to avoid any obstacle.

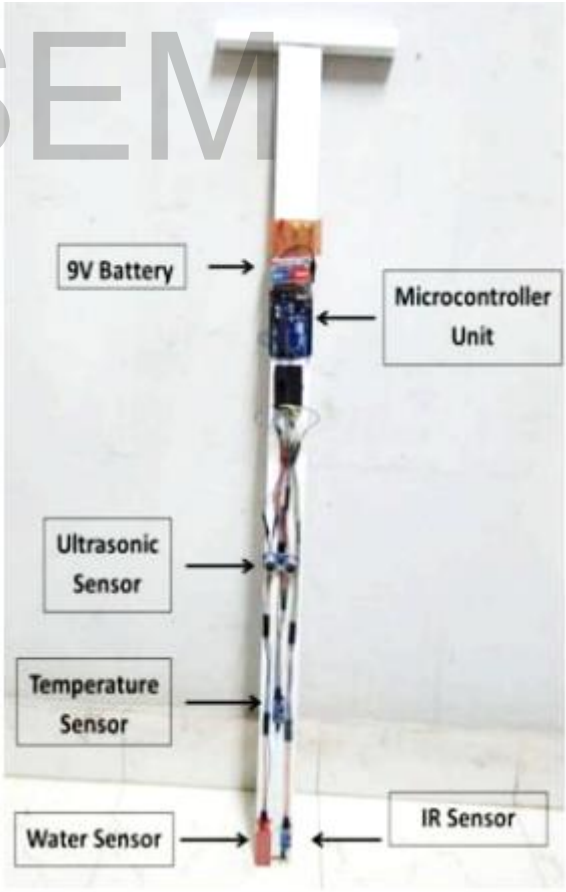

Fig 11 : Finalized Prototype Model

Discussion & Conculsion

The designed prototype is a successful attempt to model a blind aid for needy ones. This is a convenient model for blind aid proposition as it is :

- Ideal for Indoor and Outdoor environment Light and easy to handle while walking
- Distinguished beep(Buzzer) and rotation (servo motor) for each different sensor
- Vibration of servo motor to alert blind person about obstacles in outdoor/noise.
- Alerts blind to avoid obstacles
- Can be operated well in both daytime and night (Research on solar charger)
- Helps Blind person and Guardian communicate with each other through GSM/GPS

There is room of advancements in features to develop an advanced model which requires

- **Solar Charger**
  To design a solar charger that power this blind stick at daytime meanwhile charging the battery so as to operate this stick at night time by utilizing the power of battery.

- **RF Remote Control**
  It is based on 433 MHz RF transmitter and receiver module. The receiver module has a buzzer interfaced so that whenever the signal from transmitter is given, it beeps that sound so that blind person can locate his stick if it is lost within his near range.

- **GSM/GPS Module**
  It consist of GSM module interfaced with Microcontroller unit of this blind stick. It is used to help the guardian locate the position of blind person if he is lost (in case). Also it is used for assistance of blind person to call any of his family member when in need of emergency
- **CAD Model**
  We are in progress of working on the 3D CAD model of this blind stick which would be feasible to get 3D printed as an initial prototype for QA purposes by Research and Development sector.

Our prime purpose is to design this project as per compatible to the commercial market. We require financial assistance for further advancements In this project. This stick can be further modified by considering recent technologies and issues faced by blind person

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