SMART BLIND STICK USING ARDUINO

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ABSTRACT

This project presents smart electronic aid for blind people. It uses ultrasonic sensor, IR remote transmitter and receiver sensor, buzzer and Arduino Uno. According to World Health Organization (WHO), 30 million people are permanently blind and 2.85 million people with vision impairment. If you notice blind persons they can't walk properly without the help of others. They struggle a lot in their daily life. Every blind person has to ask guidance to reach their destination. The life of blind people is very difficult and challenging, they can't see an object in front them and sometimes they can get hit by object even human and it actually can lead to injured. The numbers of visually impaired people are expected to grow in the future due to various reasons. Visual information is the support for most navigational tasks, so visually impaired people are facing difficulties because of lack of necessary information about the surrounding environment and atmosphere. One of the initiatives is for blind person to make them feel save when they walk outside without a guardian is Smart Stick. The Smart Stick is intended to help reduce the difficulties faced by blind people. This stick will be embedded by sensor to senses any object or human in front of them. This stick detects the object in front of the person and gives response to the user by buzzer. Whenever an obstacle is found in the path of blind person, it alerts him through a buzzer. So, the person can walk without any fear. This device will be best solution to overcome their difficulties. In this project, ultrasonic sensors are used. So now, this smart stick will have an ultrasonic sensor to sense distance from any obstacle and a IR sensor uses the blind man to remotely locate his stick.

KEYWORDS

Arduino Uno, Micro Controller, IR Remote Transmitter, IR Receiver

1. INTRODUCTION

Vision is the most important part of human physiology as 83% of information human being gets from the environment is via sight. Based on report Sinar Harian on 4 October 2018, at least one individual in the country is at risk of having blindness every week due to eye diseases such as diabetes Retinopathy (diabetes eye disease), Glaucoma (eye disorders due to high intraocular pressure) and cataract. Head of Ophthalmology Department of Sultanah Aminah Hospital Johor Bahru Dr Francesa Martina Vendargon said the average risk of blindness often attacks individuals aged 40 years and over.

Visually impaired persons have difficulty to interact and feel their environment. They have little contact with surroundings. Physical movement is a challenge for visually impaired persons, because it can become tricky 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. Their mobility opposes them from interacting with people and social activities. In the past, different systems are designed with limitations without a solid understanding of the nonvisual perception. Researchers have spent the decades to develop an intelligent and smart stick to assist and alert visually impaired persons from obstacles and give information about their location. Over the last decades, research has been conducted for new devices to design a good and reliable system for visually impaired persons to detect obstacles and warn them at danger places.

One of the initiatives is for blind person to make them feel save when they walk outside without guardians is Smart Stick. The Smart Stick is intended to help reduce the difficulties faced by blind people. This stick will be embedded by sensor to senses any object or human in front of them.

2. OVERVIEW

Smart walking stick is specially designed to detect obstacles which may help the blind to navigate care-free. The buzzer will keep the user alert and considerably reduce accidents. The proposed system contains the ultrasonic sensor, IR remote transmitter and receiver, buzzer.

The Stick measures the distance between the objects and smart walking stick by using an ultrasonic sensor. When any objects or obstacles come in range of an ultrasonic sensor then it alerts him through a buzzer. It also helps to find the blind stick remotely. As IR remote transmitter will send the signal to IR receiver, if receiver receives the signal then the buzzer will alter the user and help the blind person to find the stick.

The smart walking stick is a simple and purely mechanical device to detect the obstacles on the ground. This device is light in weight and portable. But its range is limited due to its own size. It provides the best travel aid for the person. The blind person can move from one place to another independently without the others help. The main aim of the system is to provide easy and user-friendly electronic aid which will help the blind to move around peacefully.

3 .SYSTEM CONFIGURATION

3.1 HARDWARE REQUIREMENTS

- PROCESSOR : Intel CORE i3 5th Gen and above
- RAM : 4GB and above
- HARD DISK DRIVE : 512GB HDD and above
- Arduino UNO R3
- Ultrasonic sensor
- Buzzer
- IR remote transmitter and receiver

3.2 SOFTWARE SPECIFICATION

- OPERATING SYSTEM - Window 7(x32 bit) and above
- PROGRAMMING - Arduino
- LANGUAGE - C

3.3 SOFTWARE DESCRIPTION

ARDUINO:

- Arduino IDE is an open-source software, designed by Arduino.cc and mainly used for writing, compiling & uploading code to almost all Arduino Modules.
- It is an official Arduino software, making code compilation too easy that even a common person with no prior technical

knowledge can get their feet wet with the learning process.

- It is available for all operating systems i.e. MAC, Windows, Linux and runs on the Java Platform that comes with inbuilt functions and commands that play a vital role in debugging, editing and compiling the code.
- A range of Arduino modules available including Arduino Uno, Arduino Mega, Arduino Leonardo, Arduino Micro and many more.
- Each of them contains a microcontroller on the board that is actually programmed and accepts the information in the form of code.
- The main code, also known as a sketch, created on the IDE platform will ultimately generate a Hex File which is then transferred and uploaded in the controller on the board.
- The IDE environment mainly contains two basic parts: Editor and Compiler where former is used for writing the required code and later is used for compiling and uploading the code into the given Arduino Module.
- This environment supports both C and C++ languages.

4. SYSTEM ANALYSIS

4.1 EXISTING SYSTEM

Nowadays, visually impaired persons suffer from serious visual impairments preventing them from travelling independently. Accordingly, they need to use a wide range of tools and techniques to help them in their mobility. So normal stick won't help them to move around.

Existing system won't help you to know the obstacle or remotely locate the stick. This makes difficulty for them so the existing system has lot of difficulties for the blind. It is also not helpful too. So existing system must be developed.

4.2 PROPOSED SYSTEM

In the proposed system, the ultrasonic sensor is used to sense the obstacle distance from the user. This reference distance can be used to decide whether the user can move or not. The ultrasonic sensors work on the basis of sound. The sound waves are transmitted ahead from the sensors towards the obstacle which can sense the distance up to a distance of 12 feet with a resolution of 0.3cm. IR or infrared communication is also helps to remotely locate the stick if in case you dropped your stick or missed your stick. The IR remote sends the signal if the user can't find the stick. IR receiver modules are used to receive IR signals. These modules work in 3, 8KHz frequency.

In this proposed project first, it uses ultrasonic sensors to detect obstacles ahead using ultrasonic waves. On sensing obstacle, the sensor passes this data to the microcontroller. Then microcontroller processes this data and calculates if the obstacle is close enough. If the obstacle is not that close the circuit does nothing. If the obstacle is close, then the microcontroller sends a signal to sound a buzzer. If IR receiver finds the signal from transmitter, then sensor passes this data to the microcontroller. The microcontroller then processes the data and sends the signal to buzzer.

5. LIST OF COMPONENTS

5.1 ARDUINO UNO R3

Fig1 – Arduino UNO R3

The Arduino UNO R3 is a microcontroller board based on a removable, dual-inline-package (DIP) ATmega328 AVR microcontroller. It has 20 digital input/output pins of which 6 can be use as PWM outputs and 6 can be used as computer program. The Arduino has an extensive support community, which makes it a very easy way to get started working with embedded electronics. The R3 is the third and latest revision of the Arduino UNO.

5.1.1 ARDUINO UNO R3 SPECIFICATIONS

The Arduino Uno R3 board includes the following specifications.

- It is an ATmega328P based Microcontroller
- The Operating Voltage of the Arduino is 5V
- The recommended input voltage ranges from 7V to 12V
- The i/p voltage (limit) is 6V to 20V
- Digital input and output pins-14
- Digital input & output pins (PWM)-6
- Analog i/p pins are 6
- DC Current for each I/O Pin is 20 mA
- DC Current used for 3.3V Pin is 50 mA
- Flash Memory -32 KB, and 0.5 KB memory is used by the boot loader
- SRAM is 2 KB
- EEPROM is 1 KB
- The speed of the CLK is 16 MHz
- In Built LED
- Length and width of the Arduino are 68.6 mm X 53.4 mm
- The weight of Arduino board is 25 g

5.1.2 ARDUINO UNO R3 PIN DIAGRAM

The Arduino Uno R3 pin diagram is shown below. It comprises 14-digit I/O pins. From these pins, 6-pins can be utilized like PWM outputs. This board includes 14 digital input/output pins, Analog inputs-6, a USB connection, quartz crystal-16 MHz, a power jack, a USB connection, resonator-16Mhz, a power jack, an ICSP header an RST button.

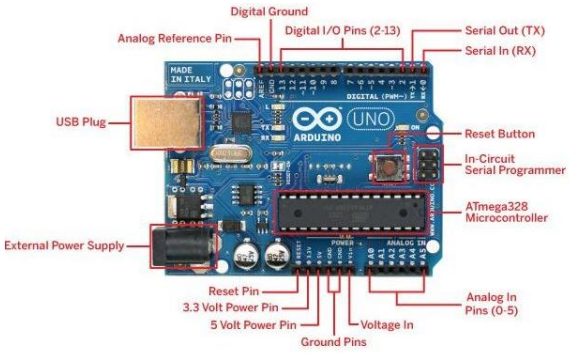

Fig2 – Arduino UNO R3 Pins

Power Supply: The power supply of the Arduino can be done with the help of an exterior power supply otherwise USB connection. The exterior power supply (6 to 20 volts) mainly includes a battery or an AC to DC adapter. The connection of an adapter can be done by plugging a center-positive plug (2.1mm) into the power jack on the board. The battery terminals can be placed in the pins of Vin as well as GND. The power pins of an Arduino board include the following.

Vin: The input voltage or Vin to the Arduino while it is using an exterior power supply opposite to volts from the connection of USB or else RPS (regulated power supply). By using this pin, one can supply the voltage.

5Volts: The RPS can be used to give the power supply to the microcontroller as well as components which are used on the Arduino board. This can approach from the input voltage through a regulator.

3V3: A 3.3 supply voltage can be generated with the onboard regulator, and the highest draw current will be 50 mA.

GND: GND (ground) pins

Memory: The memory of an ATmega328 microcontroller includes 32 KB and 0.5 KB memory

is utilized for the Boot loader), and also it includes SRAM-2 KB as well as EEPROM-1KB.

Input and Output: As arduino Uno R3 includes 14-digital pins which can be used as an input otherwise output by using the functions like pin Mode (), digital Read (), and digital Write (). These pins can operate with 5V, and every digital pin can give or receive 20mA, & includes a 20k to 50k ohm pull up resistor. The maximum current on any pin is 40mA which cannot surpass for avoiding the microcontroller from the damage. Additionally, some of the pins of an Arduino include specific functions.

Serial Pins: The serial pins of an Arduino board are TX (1) and RX (0) pins and these pins can be used to transfer the TTL serial data. The connection of these pins can be done with the equivalent pins of the ATmega8 U2 USB to TTL chip.

External Interrupt Pins: The external interrupt pins of the board are 2 & 3, and these pins can be arranged to activate an interrupt on a rising otherwise falling edge, a low-value otherwise a modify in value

PWM Pins: The PWM pins of an Arduino are 3, 5, 6, 9, 10, & 11, and gives an output of an 8-bit PWM with the function analog Write ().

SPI (Serial Peripheral Interface) Pins: The SPI pins are 10, 11, 12, 13 namely SS, MOSI, MISO, SCK, and these will maintain the SPI communication with the help of the SPI library.

LED Pin: An arguing board is inbuilt with a LED using digital pin-13. Whenever the digital pin is high, the LED will glow otherwise it will not glow.

TWI (2-Wire Interface) Pins: The TWI pins are SDA or A4, & SCL or A5, which can support the communication of TWI with the help of Wire library.

AREF (Analog Reference) Pin: An analog reference pin is the reference voltage to the inputs of an analog i/ps using the function like analog Reference ().

Reset (RST) Pin: This pin brings a low line for resetting the microcontroller, and it is very useful for using an RST button toward shields which can block the one over the Arduino R3 board.

Communication: The communication protocols of an Arduino Uno include SPI, I2C, and UART serial communication.

UART: An Arduino Uno uses the two functions like the transmitter digital pin1 and the receiver digital pin0. These pins are mainly used in UART TTL serial communication.

I2C: An Arduino UNO board employs SDA pin otherwise A4 pin & A5 pin otherwise SCL pin is used for I2C communication with wire library. In this, both the SCL and SDA are CLK signal and data signal.

SPI Pins: The SPI communication includes MOSI, MISO, and SCK.

MOSI (Pin11): This is the master out slave in the pin, used to transmit the data to the devices

MISO (Pin12): This pin is a serial CLK, and the CLK pulse will synchronize the transmission of which is produced by the master.

SCK (Pin13): The CLK pulse synchronizes data transmission that is generated by the master. Equivalent pins with the SPI library is employed for the communication of SPI. ICSP (in-circuit serial programming) headers can be utilized for programming ATmega microcontroller directly with the boot loader.

5.2 ULTRASONIC SENSOR

Fig3 – Ultrasonic senor

The HC-SR04 ultrasonic sensor uses SONAR to determine the distance of an object just like the bats do. It offers excellent non-contact range detection with high accuracy and stable readings in an easy-to-use package from 2 cm to 400 cm or 1" to 13 feet. The operation is not affected by sunlight or black material, although acoustically, soft materials like cloth can be difficult to detect. It comes complete with ultrasonic transmitter and receiver module.

5.2.1 ULTRASONIC SENSOR PIN CONFIGURATION

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 has to be 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

5.2.2 ULTRASONIC SENSOR PIN FEATURES

1. Operating voltage : +5V

2. Theoretical Measuring Distance : 2cm to 450cm

3. Practical Measuring Distance : 2cm to 80cm

4. Accuracy : 3mm

5. Measuring angle covered : <15°

6. Operating Current : <15mA

7. Operating Frequency : 40Hz

5.2.3 HC-SR04 WORKING PRINCIPLE

HC-SR-04 has an ultrasonic transmitter, receiver and control circuit. In ultrasonic module HCSR04, ultrasonic sensor has to give trigger pulse through code, so that it will generate ultrasound of frequency 40 kHz. After generating ultrasound i.e. 8 pulses of 40 kHz, it makes echo pin high. Echo pin remains high until it does not get the echo sound back. So the width of echo pin will be the time for sound to travel to the object and return back. Once Arduino uno get the time through the code, distance can be calculated through it.

5.2.4 HC-SR04 PROCEDURE

When a pulse of at least 10 µS (10 microseconds) in duration is applied to the Trigger pin. Then the HC-SR04 automatically sends Eight 40 kHz sound wave and wait for rising edge output at Echo pin. When the rising edge capture occurs at Echo pin, start the Timer and wait for falling edge on Echo pin. As soon as the falling edge is captured at the Echo pin, read the count of the Timer. This time count is the time required by the sensor to detect an object and return back from an object.

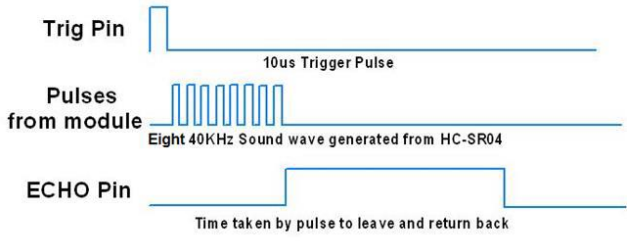

Fig4 – Timing Diagram of Ultrasonic Sensor

5.2.5 DISTANCE CALCULATION

Sound travels at approximately 340 meters per second. This corresponds to about 29.412µs (microseconds) per centimetre. To measure the

distance, the sound must be travelled from and forth, so distance formula is: Distance = (Time x Speed of Sound) / 2. The "2" is in the formula because the sound has to travel back and forth. First the sound travels away from the sensor, and then it bounces off of a surface and returns back. The easy way to read the distance as centimetres is to use the formula: Centimetres = ((Microseconds / 2) / 29). For example, if it takes 100µs (microseconds) for the ultrasonic sound to bounce back, then the distance is ((100 / 2) / 29) centimetres or about 1.7 centimetres.

5.3 BUZZER

A buzzer is a small yet efficient component to ad sound features to our project/system. It is very small and compact 2-pin structure hence can be easily used on breadboard, Perf Board and even on PCB which makes this a widely used component in most electronic applications. This Buzzer can be used by simply powering it using DC power supply ranging from 4V to 9V. A simple 9V battery can also be used, but it is recommended to use a regulated +5V or +6V DC supply.

Fig5 – Buzzer

5.3.1 BUZZER FEATURES AND SPECIFICATIONS

- Rated Voltage: 6V DC
- Operating Voltage: 4-8V DC
- Rated current: <30mA
- Sound Type: Continuous Beep
- Resonant Frequency: ~2300 Hz
- Small and neat sealed package
- Breadboard and Perf board friendly

5.4 IR REMOTE TRANSMITTER AND RECEIVER

Fig6 – IR remote transmitter and receiver

IR or infrared communication is one of the most common methods of wireless communication due to being easy to use and having an affordable price. Infrared light, with a wavelength longer than visible light, is not within the range of human vision. That's why it's a good option for wireless communications. When you press a button on your TV control, an LED on your control turns on and off continuously and causes a modulated infrared signal to send from the control to your TV. The command will execute after the signal is demodulated. IR receiver modules are used to receive IR signals. These modules work in 3, 8 KHz frequency. When the sensor is not exposed to any light at its working frequency, the Vout output has a value equal to VS (power supply). With exposing to a 38 kHz infrared light, this output will be zero.

6. SYSTEM DESIGN AND IMPLEMENTATION

6.1 SYSTEM FLOW DIAGRAM

System flowcharts are a way of displaying how data flows in a system and how decisions are made to control events. To illustrate this, symbols are used. They are connected together to show what

happens to data and where it goes.

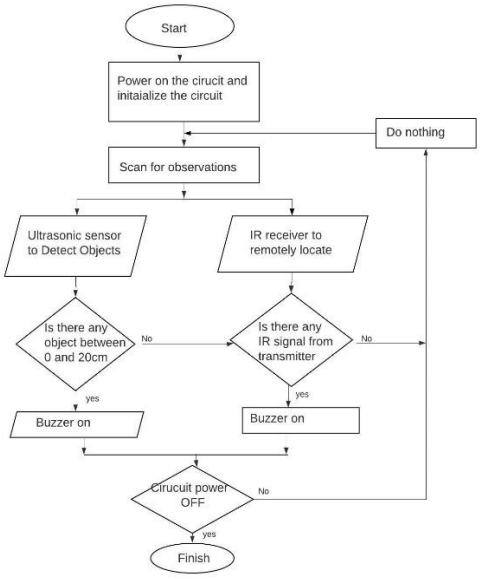

Fig7 – System flow Diagram

6.2 BLOCK DIAGRAM

A block diagram is a specialized, high-level flowchart used in engineering. It is used to design new systems or to describe and improve existing ones. Its structure provides a high-level overview of major system components, key process participants, and important working relationships.

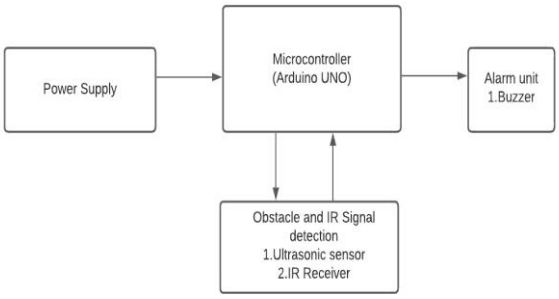

Fig8 – Block diagram

The main modules of the systems are follows:

- Arduino UNO R3
- Ultrasonic sensor
- Buzzer
- IR Remote transmitter
- IR Receiver

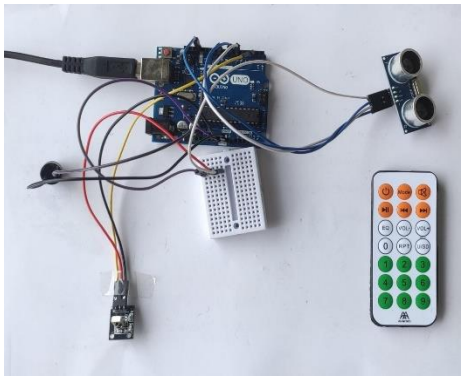

Fig9 – Circuit

Fig10 – Stick

7. CONCLUSION

It is worth mentioning at this point that the aim of this study which is the design and implementation of a smart walking stick for the blind has been fully achieved. The Smart Stick acts as a basic platform for the coming generation of more aiding devices to help the visually impaired to navigate safely both indoor and outdoor. It is effective and affordable. Through this project, it can reduce the number of risk and injuries for the visually impaired person when walking at public. The goal of the ultrasonic walking sticks for visually impaired is to reduce the difficulty faced by the visually impaired while maintaining its affordable price. In a developing country like India, there is a need for a cost-effective solution so that most of the people can have an effective product as proposed in this paper.

8. SCOPE FOR FUTURE ENHANCEMENT

The proposed model can be extended in terms of providing Voice intimations regarding the information of the obstacle in front of the blind person. Using latest android applications which features text-to-speech conversion mechanisms can be used so that the system can have a connected interaction with both the ultrasonic sensor and the android application to keep signaling the blind person about the obstacles in his path. Upgrade the stick to detect water and stair, it will more help to blind people to walk. With help from Node MCU, the guardian can know exactly the location of blind people, they just need to observe from their smartphones. The keeper or guardian doesn't need to worry about where blind people want to go, because they can track it through their phone using the application that has been developed.

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