Ultrasonic Sensor Based Smart Blind Stick

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Naiwrita Dey
Applied Electronics & Instrumentation Engineering,
RCC Institute of Information Technology,
Kolkata, India
naiwritadey@gmail.com

Ankita Paul,
Applied Electronics & Instrumentation Engineering,
RCC Institute of Information Technology,
Kolkata, India
paulbabin13@gmail.com

Pritha Ghosh,
Applied Electronics & Instrumentation Engineering,
RCC Institute of Information Technology,
Kolkata, India
pritha.ghosh95@gmail.com

Chandrama Mukherjee,
Applied Electronics & Instrumentation Engineering,
RCC Institute of Information Technology,
Kolkata, India
cmukherji4@gmail.com

Rahul De
Applied Electronics & Instrumentation Engineering,
RCC Institute of Information Technology,
Kolkata, India
rahul.de.15.11@gmail.com

Sohini Dey
Applied Electronics & Instrumentation Engineering,
RCC Institute of Information Technology,
Kolkata, India
sohiniray17@gmail.com

Abstract: **This paper presents design and implementation of an ultrasonic sensor based walking stick for visually impaired person. An ultrasonic sensor module,HC-SR04 is used for obstacle detection in the path of the blind person and a buzzer is used to make the person alert. The proposed system is implemented using PIC microcontroller 16F877A. Blind persons can use this walking stick for safe navigation. It can detect obstacle within 5 to 35 cm range of distance**

Keywords— Smart , Blind stick, Ultrasonic sensor, HC-SR04, PIC Microcontroller 16F877A.

I. INTRODUCTION

The power of vision is one of the most significant parts of human physiology. Our eyes are the key to our surroundings. Unfortunately, approx 285 million people are estimated to be visually impaired worldwide, of which 39 million are blind, according to a report published by the World Health Organization (WHO).82% of blind people are of the age of 50 and above. Moreover, 90% of visually impaired people belong to the developing countries. The earliest form of navigation tool for the blind has been in the form of a walking stick[1-2]. But the drawbacks of using it are the lack of necessary skills, Cost and training period. With the advances in technology, it has become possible to design and develop technological solutions that can help a visually impaired person to navigate freely. Various research works have been carried out for developing such smart blind stick. This chapter contains a review on such blind sticks as follows:

A navigation tool was developed that uses GPS, voice module and an ultrasonic sensor for obstacle detection. It guides the person using the stick by providing directions. It uses an ARM processor which contains more memory and has a high operating speed. But, this system cannot be used indoors since there will be no GPS detection[3].Another proposes a navigation tool using proximity sensors, ultrasonic sensors , GPS module, stereo cameras and dual feedback system- auditory as well as vibratory circuit. The stereo cameras are mounted on a helmet to inform about the height of the objects in the path. The proximity sensor and ultrasonic sensor unit are for the detection of obstacles. The GPS module determines the location of the obstacle with respect to the blind. There is a voice navigation system to give directions to the blind man. The complexity of the circuit makes it difficult to design. And the tool is costly[4].The blind stick is comprised of detachable unit of an ultrasonic ranger and vibrator which provides an increased range of 3m and detects obstacles above knee level. Distance information is conveyed to the user through vibratory patterns varying incrementally with changing obstacle distance. The drawback with this system is its cost, which is not affordable for people living in developing or underdeveloped countries [5].A smart stick has been developed where the hardware consists of a microcontroller incorporated with ping sonar sensor, proximity sensor, wet detector, a micro pager motor and additional equipment. This system has a new innovation for wet sensing circuit that makes it unique yet complicated and somewhat unnecessary[6].The Infrared Smart stick that has been developed uses IR sensors to detect the presence of staircases in the path of the blind man within a range of two meters. An earphone has been connected for voice warnings on detection of obstacles.

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The problem with this tool is the noise inclusion that makes it difficult to assure the authenticity of its functionalities [7].A sound and touch based smart cane has been developed using ultrasonic rangers to detect obstacles or blocking object. The distance between the blocking object and the visually impaired person is sent to an Android device using Bluetooth in the form of voice notifications and warnings . Haptics module is used to notify the user of the presence of any moving object. The problem with the project lies in its cost and complexity [8].

In this paper the design of a walking stick is proposed to detect the presence of obstacles in the path of a blind person. The aim is to make the system less sensitive to environmental noise. The technology is relatively inexpensive and small enough to be accommodated on a walking stick.

II. METHODOLOGY

The design of the Ultrasonic Walking Stick for the Blind system involves the incorporation of the following steps-

1. Three ultrasonic sensors are incorporated- to sense objects on the right, left and in front respectively.
2. The PIC microcontroller has to be programmed in order to calculate the distance of any object from the sensor.
3. The programming of the microcontroller is done in C language.
4. On detection of an obstacle, a buzzer is sounded.

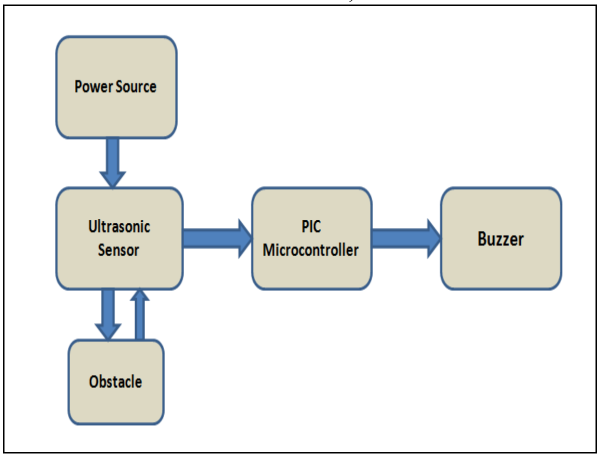

Fig .1. Block Diagram of the total system

III. DESIGN AND IMPLEMENTATION OF THE PROPOSED SYSTEM

Testing of HC-SR04Module

The noncontact measuring range for the ultrasonic module HC-SR04 is 2cm – 400 cm. The maximum ranging accuracy can be extended upto 3mm. Ultrasonic transmitters, receiver and control circuit is thee in the module. Fig 2 shows the waveforms. The working principle as follows:

1. IO trigger is used for at least 10 us high level signal.
2. Ultrasonic sensor module transmits 8 no of 40 kHz signal and detect if there is a pulse signal received back.
3. Though high level if the signal is back then time duration of high output is the measure of the time taken by the ultrasonic senor from transmitting a pulse and receiving it back. It can be formulated as below

Test distance = (high level time * velocity of sound)/2

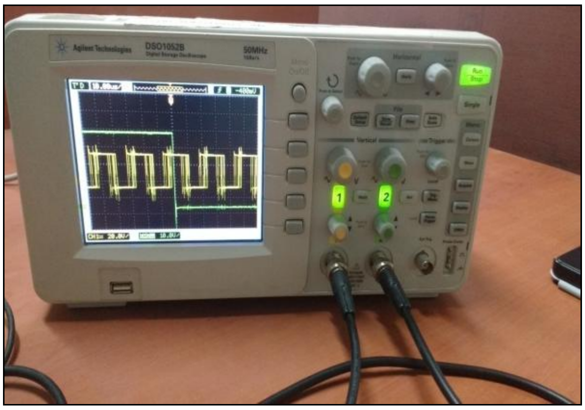

Fig. 2. Trigger and Echo waveforms generated by the oscilloscope

Microcontroller Programming

For the proposed system code is in C- language using MPLAB.

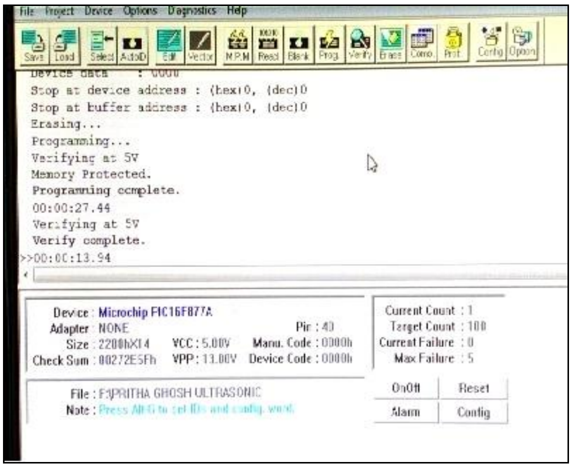

Fig.3. Hex file burning using ESA IUP-UXP

MPLAB X IDE is used for programming microcontroller, PIC 16F877A. It is named as a Integrated Development Environment (IDE).It is a compiler which provides an integrated environment to develop the code using Microchip microcontrollers for developing various applications. It needs to be installed on a PC . ESA IUP-

UXP, Intelligent Universal Programmer is used to burn the hex file of the program into the microcontroller. Fig 3 shows it.

Algorithm flowchart

The algorithm is discussed below and shown in Fig.4.

i) Once the sensor will receive the trigger pulse, the MCU waits to get a high edge on the ECHO line of the selected sensor. It waits until it gets a rising edge on the same line.

ii) If the bit is received the loop will continue else it will break.

iii) This is an indication for improper functioning of sensor, if it happens that for several iterations has been done without receiving a high edge pulse on the MCUs i/o line. Then to detect the fault one should check for the power line of the sensor whether it is connected properly or not or else the ECHO line from the sensor to MCU is damaged. The function returns zero if the sensor has encountered any fault.

iv) TIMER1 will be on when the high edge on the ECHO line is received .It will measure the width of this pulse. First 0 is to be written to the counter register (TMR1) and then 1 is to be written 1 to the TMR1ON bit to start the counter.

v) To configure Timer1 a prescaler value of 1:2 is to be selected. It indicates that its counting frequency is half the CPU frequency. At an 5MHz CPU frequency (crystal oscillator frequency, 20 MHz), the frequency of the timer is 2.5 MHz. Period is 0.4 microseconds.

vi) To detect the falling edge of the pulse , the i/o line connected to the ECHO signal which is an output from the sensor is to be checked. On the receiving of high on it , loop will be continued else it will break.

vii) To stop the timer o is to be written on TMR1ON bit. Then the counter register TMR1 is copied to the result variable. The value of result variable is returned after getting multiplied by 0.4 microsecond which is the period of timer.

viii) The length of the pulse in microsecond (uS) is returned by the function and it is converted into to cm

III. Experimental Setup

The simulation and circuit testing is done on the Labcenter Proteus 8.1 application. Proteus 8 is the best simulation software for various designs with microcontroller. Fig 5 shows the circuit simulation of the proposed system.

After simulating the circuit in Proteus 8 Software the hardware implementation is done. It can be observed from Fig .6. That three ultrasonic sensor module are placed in three different directions to sense the presence of any obstacle along with a buzzer.

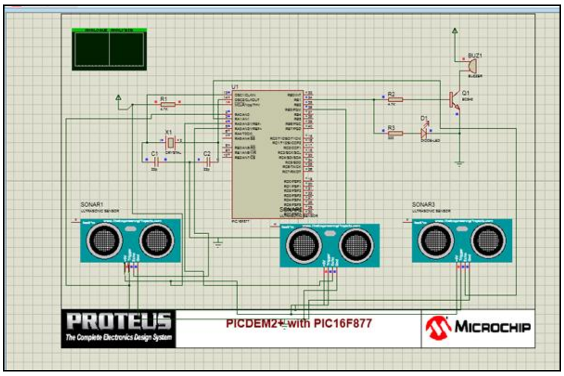

Fig .5. Circuit simulation in Proteus

IV. Result and Discussion

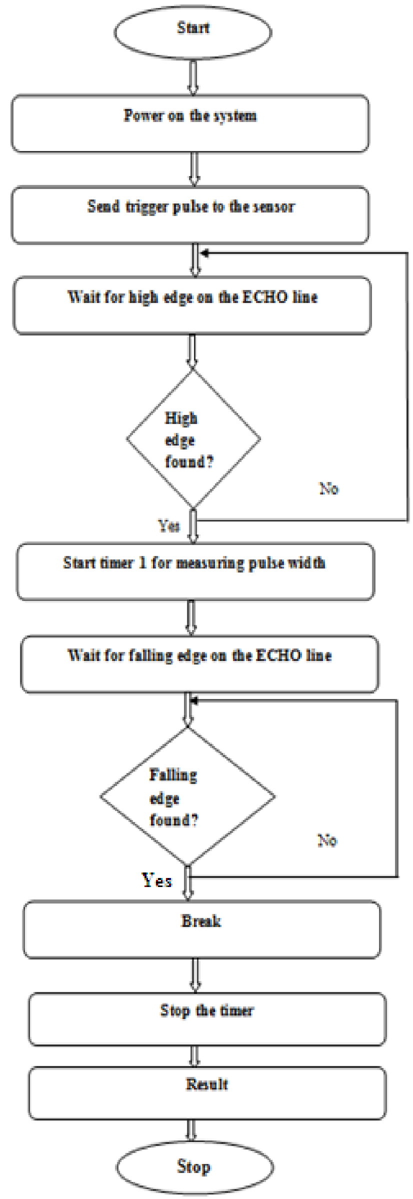

Fig .4. Flow chart of the proposed system.

Different obstacles has been placed at different distances from the blind stick and the output voltage received on the ECHO pins of the sensors. In Fig .7.distance vs. voltage graph is shown. It can be observed that with the increase of distance of the obstacles from the blind stick results in the decrease of the output voltage decreases. From 5-35 cm can be chosen as linear working range of the proposed blind stick.

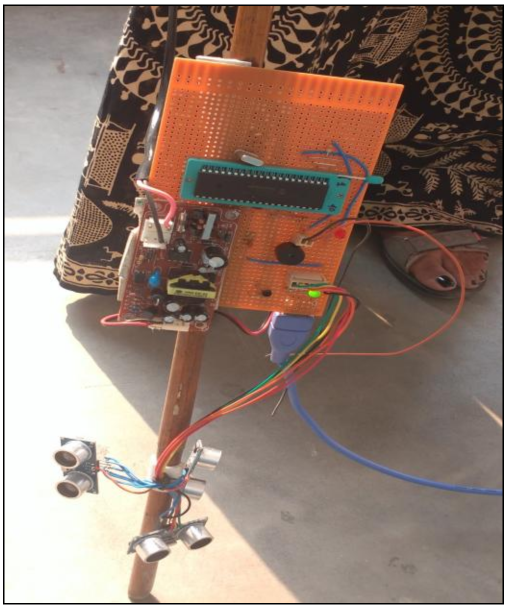

Fig .6. Ultrasonic Sensor Based Smart Blind Stick

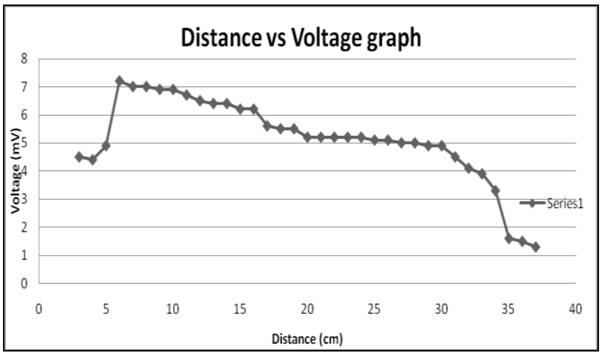

Fig.7. Distance versus voltage graph

V. Conclusions

In this paper design of a smart blind stick based on ultrasonic sensor is proposed and implemented successfully. It can be used as an effective navigation tool for blind persons. On the detection of obstacle in the path of the concerned person the smart blind stick sounds a buzzer to make an alert. The implemented system can detect any obstacle within the range of 5-35cm.This work can be extended to increase the range of obstacle detection and to send this information for further assistance along with integrated GPS feature, which will provide voice directions on detection of obstacles in the path.

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