Device for Helping The Blind

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Abstract: We design a device for helping a blind person. By using this device, the blind doesn’t need to use stick or dog for helping him or her. The device will help the blind person for figuring the obstacle in front of him or her. We use microcontroller, an ultrasonic sensor as an input, and an electromechanical buzzer as an output. The device is proved accurate when we tried it for the distance 150 centimeters, 100 centimeters, and 50 centimeters between the user and the object.

Keywords: blind, microcontroller, ultrasonic sensor, electromechanical buzzer, glasses

1. Introduction

The blind person can’t see. That is his or her disability. Usually the blind person will use stick or dog for helping them to walk. Because of that, we have an idea for helping the blind; therefore, he or she can walk without using stick or dog. The purpose of this experiment is for helping the blind person. By using this device, the blind can walk like common people. The device can help the blind person to overcome his or her disability. This device can be used by the blind to assist them in their ways without any human assistance. It will be used by the blind to let them walk independently. The device can help a blind person to figure the environment and the device will be installed on glasses. We use the ultrasonic sensor as the input to the microcontroller, and the device can determine whether there is obstruction or not in front of it. If there is an obstruction, the device will produce a beeping sound for alerting the blind as a user.

Before us, there is also glasses for the blind which will be available in market in 2016. They were created by researchers at the University of Oxford, who linked up with the Royal National Institute of Blind People (RNIB). At the moment, the glasses are rather bulky. They are also fairly expensive and participants have to carry around a connected laptop with them [1]. There are not many research studies related to this topic. However there are few references that may be used. Hermann Schweizer wrote his paper “Smart Glasses: Technology and Applications” [2]. Andrea Colaco wrote “Sensor Design and Interaction Techniques for Gestural Input to Smart Glasses and Mobile Devices” [3]. M. Iftekhar Tanverr and Mohammed E. Hoque wrote “A Google Glass App to help the Blind in Small Talk” [4]. M. Karthikeyan & SC. Vijayakuma wrote their paper :”Embedded System Using Ultrasonic Wave and Voice Biometric to Build an E-Glass for the Blinds” [5].

2. Research Method

Since most of the blind person use glasses and it inspires us for installing the device on glasses. The ultrasonic sensor is installed on the glasses, but the main unit which including the minimum system, power supply, and the main switch are placed on a box, and the blind person can put in his/her pocket. Compare with the device from the University of Oxford, this device is more practical and easier to use.

Figure 1 shows the glasses with the ultrasonic sensor which is installed on the glasses and the box for the main unit. Figure 1 shows the actual form.
A. The Block Diagram

The block diagram is shown in Figure 2.

![Figure 2. The Block Diagram](image)

The Power Supply block provides the power for each of the block. It is generated from the batteries, and it is regulated by the LM 7805 for producing a 5 volt [6].

The ultrasonic sensor block provides the input for the microcontroller. Ultrasonic is sound with a frequency greater than the upper limit of human hearing (greater than 20 kHz). Ultrasonic is used to detect objects and measure distances in this project.

Ultrasound sensors are very versatile in distance measurement. They are also providing the cheapest solutions. Ultrasound waves are useful for both the air and underwater. Ultrasonic sensors are also quite fast for most of the common applications [7].

The speed of sound depends on the medium the waves pass through, and is a fundamental property of the material. For example, the speed of sound in gases depends on temperature. The speed of sound at 20 °C (68 °F) air at sea level is approximately 343.37 m/s [8].

The sound spectrum is shown in Figure 3.

![Figure 3. The Sound Spectrum](image)

The Parallax PING))) sensor is used in this project. It provides precise, non-contact distance measurements from about 2 cm to 3 meters. The Parallax PING sensor detects objects by emitting a short ultrasonic burst and then receiving the echo. Under control of a host microcontroller (trigger pulse), the sensor emits a short ultrasonic burst (40 kHz). This burst travels through the air at about 1130 feet per second, hits an object and then bounces back to the sensor. The sensor provides an output pulse to the host that will terminate when the echo is detected, and the width of this pulse corresponds to the distance to the target. The Parallax PING sensor has a male 3-pin header used to supply power (5V), ground (GND), and signal [9].
Figure 4 is showing The PING))) sensor.

![Figure 4. The PING))) sensor](image)

The theory of Operation of The PING))) Sensor is shown in Figure 5.

![Figure 5. The Theory of Operation of The PING))) Sensor](image)

Figure 6 is showing The dimensions of the PING))) sensor.

![Figure 6. The Dimensions of the PING))) Sensor](image)

The PING))) sensor can’t accurately measure the distance to an object that has its reflective surface at a shallow angle so that sound will not be reflected back towards the sensor. ATTINY2313 receives the input from the ultrasonic sensor then process the data according to the code program and deliver the output condition to the buzzer.

The output of the buzzer is in form of a beeping sound. There are four beeping conditions produced: fast-pace beeping sound (beeps on and off every 200 milliseconds), medium-pace beeping sound (beeps on and off every 400 milliseconds), slow-pace beeping sound (beeps on and off every 600 milliseconds), and no beeping sound.

B. The Circuits

Figure 7 shows the electronic circuits schematic. For the power, we use four 1.5 V batteries in series, which gives us a 6 V power source. It is connected to a main switch to control the on/off condition of the device. It will be regulated in the LM7805 for getting 5 Volts as power.
supply for microcontroller and ultrasonic sensor. The microcontroller and ultrasonic sensor needs a 5 Volts power source. The LED indicator will give the information that there is electricity in from the voltage regulator.

The external clock frequency for the microcontroller is provided from the crystal oscillator circuit. The circuit is connected to XTAL1 and XTAL2 of the ATTINY2313 port. For preventing overshoot from the oscillating signal, two capacitors are connected between the crystal oscillator and ground.

![Electronic Circuits Schematic](image)

**Figure 7. The Electronic Circuits Schematic**

In this device, we use five I/O ports of the microcontroller. PD 5 for interfacing the microcontroller with the electromechanical buzzer. PD 6 for providing a bursting signal to
initiate the ultrasonic sensor and receive input signal from the sensor itself. For the In System Programmable, we use PB 5, PB 6, PB 7 alternate function (MOSI, MISO, and SCK).

The reset is another important feature of microcontrollers, which are often deployed under environmental condition that can lead to software or hardware failures (bit failures due to radiation in space applications). Under such circumstances, a reset of the system is a simple means to return it to a well-known state and to failure-free operation. Hence, a microcontroller can react to diverse reset conditions, and the cause of a reset is generally stored in dedicated reset flags.

The circuit use external reset whenever a system failures, whether hardware or software failures. External reset is triggered through a dedicated pin. If no reset is needed, the pin should be kept high. If it is set to low, a reset is initiated. The reset pin is sampled by the controller using an internal oscillator and so whenever the pin is set to low, it needs to meet the minimum duration to be recognized assuredly. The reset pin should always be connected, even if it is not used for an external reset.

The In System Programmable (ISP) is a way to program the ATTINY2313 microcontroller and other ATMEL microcontrollers. The ISP header consists of connection to VCC, GND, Tx, Rx, MOSI, MISO, SCK, and RESET. VCC and GND function as the power source for the microcontroller when programming. MOSI, MISO, SCK, and RESET are the main lines for ISP. MOSI line functions as data input line, SCK line functions as clock input line. MISO line is used as data output line for reading and for code verification and it is only used to output the code from the FLASH memory of the microcontroller. The RESET line normally used to reset the device, in ISP the RESET line is used to activate the three pins (MOSI, MISO, and SCK). ISP programming is described in ATMEL datasheets, and below is the explanation.

The Code memory array can be programmed using the serial ISP interface while RST is pulled to VCC. The serial interface consists of pins SCK, MOSI (input) and MISO (output). After RST is set high, the Programming Enable instruction needs to be executed first before other operations can be executed. Before a reprogramming sequence can occur, a Chip Erase operation is required. The Chip Erase operation turns the content of every memory location in the Code array into FFH. Either an external system clock can be supplied at pin XTAL1 or a crystal needs to be connected across pins XTAL1 and XTAL2. The maximum serial clock (SCK) frequency should be less than 1/16 of the crystal frequency. With a 33 MHz oscillator clock, the maximum SCK frequency is 2 MHz.

C. The Device Algorithms

The Algorithms Flowchart is shown in Figure 8. The first step is the initialization of I/O port, Timer/Counter register, buzzer, ultrasonic sensor, and variable for the math operation. We use PORTD.5 and PORTD.6. PORTD.5 for controlling the electromechanical buzzer and PORTD.6 is the communication line between the ultrasonic sensor and the microcontroller. Timer/Counter register is used for calculating the travel time of the ultrasonic frequency from the sensor – hits an object – and travel back to the sensor. Variable used in the math operation of the program are: xtimer, Time, and Distance.

To activate the ultrasonic sensor is by sending a bursting “high” logic signal to the PING ultrasonic sensor., and that is by transmitting output signal with logic value = “1” within 5 microseconds. Then, the output signal is set to “low” logic value again to stop the bursting signal. After that, by changing the I/O port to operate as an input. Before receiving any input, a pull up resistor in the input port needs to be activated first.

The next step is the alerting to the user if there is any object. Alerting the user is done by triggering electromechanical buzzer if an object is detected within a certain distance. To differentiate how the buzzer produce sound, we make four conditions, which are: close-range, medium-range, far-range, and very far-range. The first condition is the close-range condition. In this range if there is an object less than or equal to 50 centimeters and the buzzer will produce a fast-pace beeping sound (beeps on and off every 200 milliseconds). The second condition is the medium-range condition. In this range if there is an object greater than 50 centimeters but
less than or equal to 100 centimeters and the buzzer will produce a medium-pace beeping sound (beeps on and off every 400 milliseconds). The third condition is the far-range condition. In this range if there is an object greater than 100 centimeters but less than or equal to 150 centimeters and the buzzer will produce a slow-pace beeping sound (beeps on and off every 600 milliseconds). The fourth condition is the very far-range condition, in this condition if the object is more than 150 centimeters and the buzzer is not triggered.

![Figure 8. The Algorithms Flowchart](image)

3. Results and Analysis

A. Distance Accuracy

<table>
<thead>
<tr>
<th>Testing Distance (cm)</th>
<th>Device Beeping Respond</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1st Experiment</td>
</tr>
<tr>
<td>30</td>
<td>Fast-Pace</td>
</tr>
<tr>
<td>50</td>
<td>Fast-Pace</td>
</tr>
<tr>
<td>80</td>
<td>Medium-Pace</td>
</tr>
<tr>
<td>100</td>
<td>Medium-Pace</td>
</tr>
<tr>
<td>130</td>
<td>Slow-Pace</td>
</tr>
<tr>
<td>150</td>
<td>Slow-Pace</td>
</tr>
<tr>
<td>180</td>
<td>No Respond</td>
</tr>
</tbody>
</table>

When we experience the device, with the variant distance between the user and the obstacle, we find the results as we want. Table 1 shows the results of the experiments. We can see that if there is an object with the distance 30 centimeters and 50 centimeters, the device will respond...
with fast-pace beeping sound (beeps on and off every 200 milliseconds). The device will respond with medium-pace beeping sound (beeps on and off every 400 milliseconds) if there is an object 80 centimeters and 100 centimeters. The device will respond with slow-pace beeping sound (beeps on and off every 600 milliseconds) if there is an object 130 centimeters and 150 centimeters. The device will not respond if there is an object 180 centimeters.

**B. Testing of PING Sensor Angle**

This testing is done for knowing the good angle position of PING))) sensor which can detect an object. The testing is done with putting the PING))) sensor at angle of 0˚ until 90˚ from wall. According to the testing that has done, we can get the good angle position and the comparison of the distance read by PING))) sensor at every angle with the distance of object in reality. The comparison of the distance read by PING))) sensor at every angle with the distance of object in reality is shown in Table 2.

According to Table 2, knowing the good angle position for PING))) sensor is angle of 90˚, when the PING))) sensor is placed at angle of 90˚ from object, the PING))) sensor can measure the distance of object appropriate with the distance of object in reality. When the PING))) sensor is placed between angle of 50˚ until 80˚ from object, the PING))) sensor can measure the distance of object but the result of that measurement is not correct. And when the PING))) sensor is placed between angle 0˚ until 40˚ from object, the PING sensor cannot measure the distance of object. The result of PING))) sensor measurement when is placed at angle 90˚ from object gives the best results.

<table>
<thead>
<tr>
<th>Angle (˚)</th>
<th>Distance of Object (Cm)</th>
<th>Distance of Object in Labview (Cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>20</td>
<td>-</td>
</tr>
<tr>
<td>10</td>
<td>20</td>
<td>-</td>
</tr>
<tr>
<td>20</td>
<td>20</td>
<td>-</td>
</tr>
<tr>
<td>30</td>
<td>20</td>
<td>-</td>
</tr>
<tr>
<td>40</td>
<td>20</td>
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</tr>
<tr>
<td>50</td>
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<td>17</td>
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<td>60</td>
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<td>18</td>
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<td>70</td>
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<td>18</td>
</tr>
<tr>
<td>80</td>
<td>20</td>
<td>19</td>
</tr>
<tr>
<td>90</td>
<td>20</td>
<td>20</td>
</tr>
</tbody>
</table>

**C. Respond to Different Material Object**

The third experiment is we try to see the device respond to different material. The device should produce a beeping sound according to the distance, even the object are made from different materials. The result is shown in Table 3.

The results show that the device is able to operate even with different object materials. Most object material in the Table is found on everyday life. Unfortunately, the device cannot tell the user what the object and the material that is founded.

For this experiment, we didn’t do the observation for amplitude response of the reflected wave from different material, yet. We will do the experiment in our next step of experiments. In this experiment we only want to know that the device can detect there is an object although with different materials.
Table 3. Device Respond to Different Object Material

<table>
<thead>
<tr>
<th>Object and the material</th>
<th>Device operates?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1st</td>
</tr>
<tr>
<td>A sheet of paper</td>
<td>Yes</td>
</tr>
<tr>
<td>Clothes</td>
<td>Yes</td>
</tr>
<tr>
<td>Glass window</td>
<td>Yes</td>
</tr>
<tr>
<td>Human hand</td>
<td>Yes</td>
</tr>
<tr>
<td>Metallic desktop PC case</td>
<td>Yes</td>
</tr>
<tr>
<td>Motorcycle helmet</td>
<td>Yes</td>
</tr>
<tr>
<td>Plastic electric fan</td>
<td>Yes</td>
</tr>
<tr>
<td>Plastic ruler</td>
<td>Yes</td>
</tr>
<tr>
<td>Wall</td>
<td>Yes</td>
</tr>
<tr>
<td>Wooden door</td>
<td>Yes</td>
</tr>
</tbody>
</table>

4. Conclusion

In this project, we test the device and we get the results.

We try when there is an object with the distance 30 centimeters and 50 centimeters, then the device produces a fast-pace beeping sound (buzzer beeps on and off every 200 milliseconds). We also try when there is an object with the distance 80 centimeters and 100 centimeters, then the device produces a medium-pace beeping sound (buzzer beeps on and off every 400 milliseconds). The device produces a slow-pace beeping sound (buzzer beeps on and off every 600 milliseconds) when detect an object 130 centimeters and 150 centimeters from the device. When there is an object 180 centimeters from the device, the device doesn’t produce any beeping sound.

The good angle position for PING))) sensor is angle of 90˚, when the PING))) sensor is placed at angle of 90˚ from object, the PING))) sensor can measure the distance of object appropriate with the distance of object in reality.

The device can detect objects although the objects are made from different materials. However, the device can’t differentiate the object based on its materials.

5. References


Hartono Siswono, Graduated from Indiana Institute of Technology, Indiana, USA in January 1988, With the degree of Bachelor of Science in Engineering. In July 2000, graduated with the degree of Master of Science in Electrical Engineering from University of Indonesia. Got the Doctoral degree in Electrical Engineering from University of Indonesia in January 2006. Started as an instructor in University of Gunadarma since 1993, and since June 2011 as Head of Electrical Engineering Department University of Gunadarma. When studying in the United States of America, also work as an assistant for Electrical Engineering Department Indiana Institute of Technology, and also as the President of Indonesian Students Association in the United States of America for two periods. Also as an author of four books, which are: “Digital System Design by using XILINX (Perancangan Sistem Digital Simulator XILINX)”, “Signal Processing System (Sistem Pemrosesan Sinyal)”, “Control System (Dasar Sistem Kontrol)”, and “Digital Signal Processing (Pengolahan Sinyal Digital)”.

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