A Blind Assistive Device

The Mini Project Final Report

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Abstract

The number of visually impaired people across the globe are over 37 million. One of the main challenges faced by them is the lack of awareness of their surroundings. It requires some time for them to adapt to the obstacles present in the surroundings, especially if it is a new place. Hence they are easily prone to accidents and their safety is imperilled.

The main objective of our project is to overcome this problem by developing a hat. It assists the visually impaired person by providing the information regarding the whereabouts of the obstacles present in their path, thereby reducing the chance of collision with them.

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Chapter 1

Introduction

There are many methods which can be used to avoid obstacles, an old but reliable method is by using a walking stick which avoid nearby obstacles but it cannot be used to avoid or detect obstacles which are at a distance greater than the length of the stick unless circuitry is involved on stick.Also we need to hold the stick and carry it with us which can be a tiresome job as we may be carrying other objects along with the stick.

Bats and dolphins use a method called "echolocation" to avoid obstacles.Echolocation involves transmitting a signal, if an obstacle is present in its path the wave reflects and reaches it. When it senses the received signal, it estimates the time difference between the transmitted and received waves and hence estimates the distance of obstacle present.

The same idea can be implemented by human technology where we can send ultrasonic waves of particular frequency and detect the received waves. We use a micro-controller to calculate the time difference and thus distance between transmitter and obstacle.

So, we are trying to implement a similar kind of prototype that resembles bat-like communication to detect obstacles.Our project basically includes an ultrasonic transmitter which sends signals, ultrasonic receiver to collect the transmitted signals, circuitry to control and analyze these signals, a haptic circuit to give the sensation about the distance of obstacle.

The major steps in this project have been identified and it has been divided into three major sections:

1. Transmitter Circuit

2. Receiver Circuit
3. Software coding

In transmitter,we produce a sine wave of 40kHz and pass it through ultrasonic transmitter.This transmitted wave is received by ultrasonic receiver and it is processed further to remove any noise and that signal is modified in such a way that it can be given as input to microcontroller.

In software part,we calculate the time difference between the input signal and the received,thus getting the distance of obstacle.

We arranged a buzzer such that its sound intensity varies according to the distance of obstacle.The farther the distance,the less will be the intensity.

Chapter 2

Design of Transmitter

We have designed transmitter as discussed in interim report.As discussed,we switched from 741 to 353 because of bandwidth and slew rate constraints.

Bandwidth of 741 is 0.435Mhz to 1.5Mhz.But our input is of 40Khz i.e 0.04Mhz. Also slew rate of 741 is about 0.8V/μs which is very low for high frequency operations.

So,we designed the entire transmitter by using LM353.

Also,passing a sine wave through ultrasonic sensor gives higher range than passing square wave.Therefore,we planned to convert square wave to sine wave at transmitter before giving the signal to transmitter module.

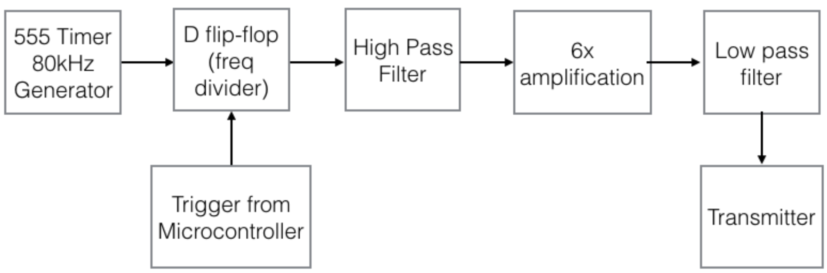

Figure 2.1: Block Diagram Of Transmitter

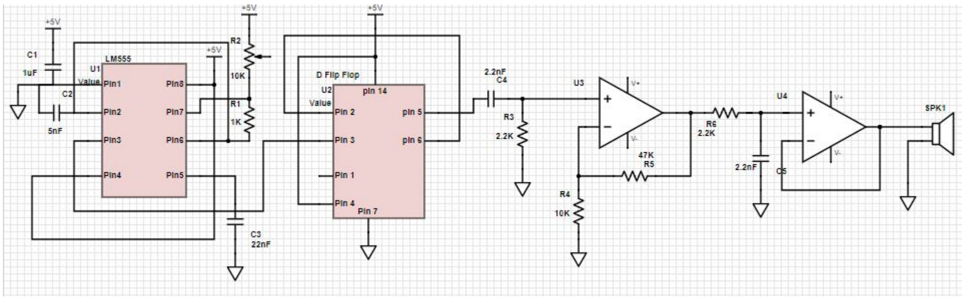

Figure 2.2: Circuit Diagram Of Transmitter

2.1 555 timer

We designed a 555 timer which runs in astable mode and generates 80kHz square wave.

$$T_{ON} = 0.693(R_1 + R_2)C_3 \tag{2.1}$$

$$T_{OFF} = 0.693R_1C_3 \tag{2.2}$$

Assuming capacitance as $1nF$ and desired frequency as 80kHz, we can get resistance values as

$$R_1 = 8.2k\Omega, R_2 = 100\Omega(app.)$$

2.2 D flip flop

The output of 555 timer is connected to D flip flop which runs as frequency divider,by shorting 2^{nd} and 6^{th} pins,thus providing 40kHz square wave.Instead of directly making 555 to run in astable mode of 40kHz,we have made it to pass through D flip flop because,

1. We will have control whether to on or off the pulses that are to be send to ultrasonic sensor.
2. Any edge corrections will be made if we use D flip flop.Also there will be some setup time for 555 which is absent in D flip flop

The CLR pin of D flip flop is connected to microcontroller and can be used to turn on or off D flip flop thus passing ultrasonic signals accordingly.

2.3 High Pass Filter

A high pass filter of cutoff frequency 40kHz is arranged by passive components to reduce the effect of noise components.

$$\frac{1}{(2\pi RC)} = 40kHz \tag{2.3}$$

We assumed R = 2kΩ and C = 2nF

2.4 Amplifier

A non inverting amplifier is arranged which amplifies the signal.

$$Gain = 1 + \frac{R_2}{R_1} \tag{2.4}$$

We designed the circuit for a gain of 6.

$$R_2 = 53K\Omega, R_1 = 10K\Omega$$

2.5 Low Pass Filter

A low pass filter of cutoff frequency 40kHz is arranged to remove any noises that are present in signal.
This signal,which is passed through a low pass and high pass will more or less look like a sine wave of single frequency i.e 40kHz.

$$\frac{1}{(2\pi RC)} = 40kHz$$

We assumed R = 2kΩ and C = 2nF to pass 40kHz signal

2.6 Buffer

Before connecting this sine wave to ultrasonic transmitter,a buffer has been arranged to avoid impedence mismatching and problems related to that.
Output of this is connected to ultrasonic transmitter

Chapter 3

Design of Receiver

3.1 Ultrasonic receiver

When a wave that is been transmitted hits an obstacle,it reflects and that reflected wave is being captured by this receiver and is being further processed.

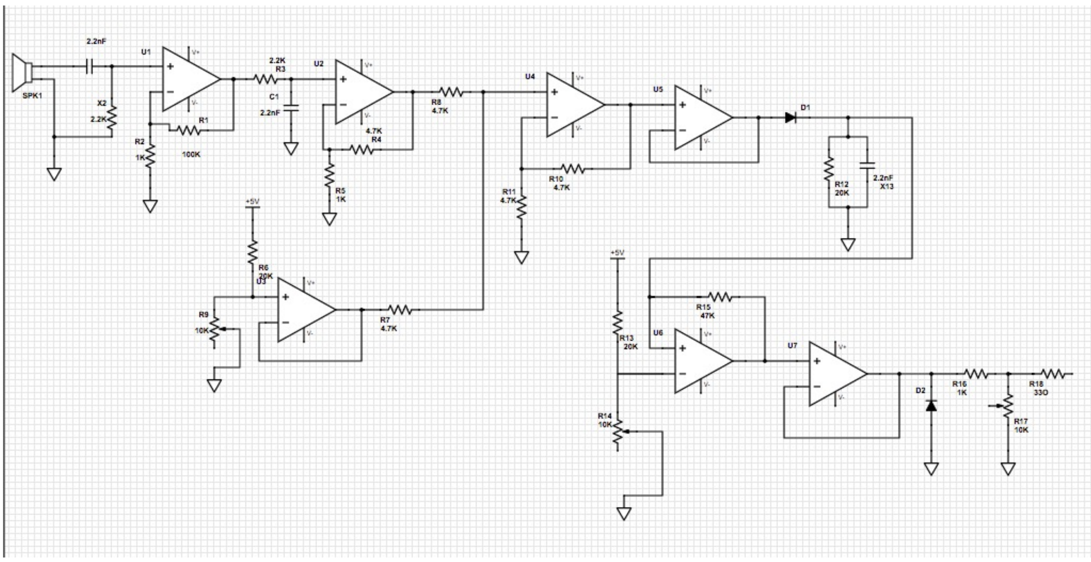

Figure 3.1: Circuit Diagram Of Receiver

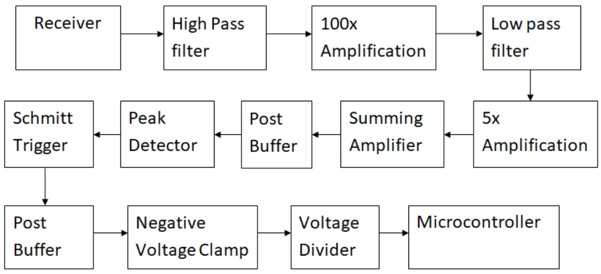

Figure 3.2: Block Diagram Of Receiver

3.2 Band pass filter and amplifier

These series of stages make sure that noise that has been added during the journey of the wave is been removed and the signal is amplified to further process.

Cutoff frequency of low pass and high pass is 40kHz.So,it looks like a bandpass filter having only one frequency ideally.

A similar design is followed to design passive RC filters.Therefore,
R = 2kΩ and C = 2nF.

3.3 Summing amplifier

This stage is used to add an offset of 0.7V which is used to turn on the diode which is placed in peak detector.

3.4 Buffer

This is used to avoid impedence mismatching between summing amplifier and peak detector.

3.5 Peak detector

The peak detector is used to follow the positive envelope of the amplified 40 kHz sine wave precisely at the rising edge of the signal.Output of the peak detector when no signal is present is 0V, and the output reacts as soon as any positive voltage fluctuation occurs.The input of the peak detector is offset by +0.7V because this is the turn on voltage of the peak detector.

This stage is used to create a threshold voltage which predefines the presence of obstacle in the given range of module.

3.6 Schmitt trigger

Because the output of the signal needs to trigger a software interrupt,we need to limit the number of rising edges triggered by the fast oscillations of a signal crossing the reference voltage.The output of the Schmitt trigger is +12V for a signal that is above the reference voltage and -12V for a signal that is below the threshold voltage.

3.7 Negative voltage clamp

Microcontroller cannot accept negative voltage values.Therefore we clamped -12V to ground through a diode.Therefore,the output will be from -0.7V to +12V.

3.8 Voltage Divider

Microcontroller cannot accept voltage value above +5V.Therefore,we scaled voltages in the ranges of 0 to +5V.

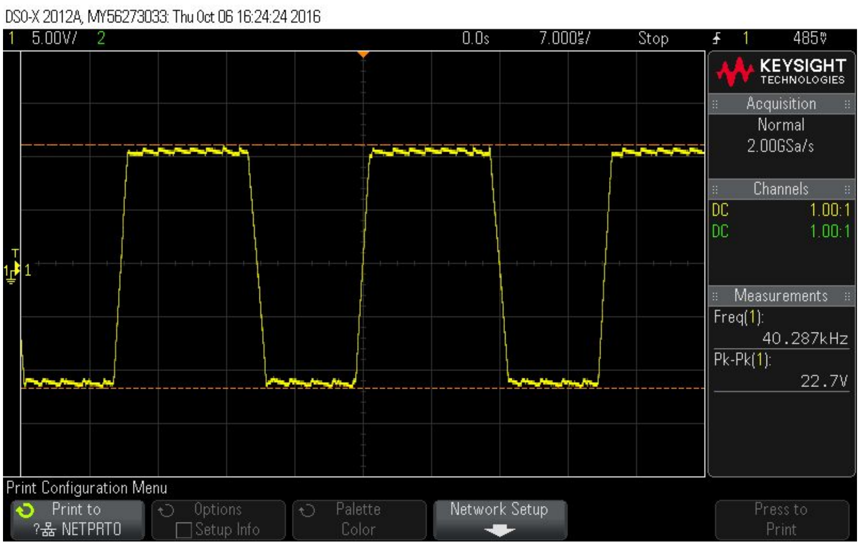

Figure 3.3: Output when an obstacle is placed near ultrasonic sensor

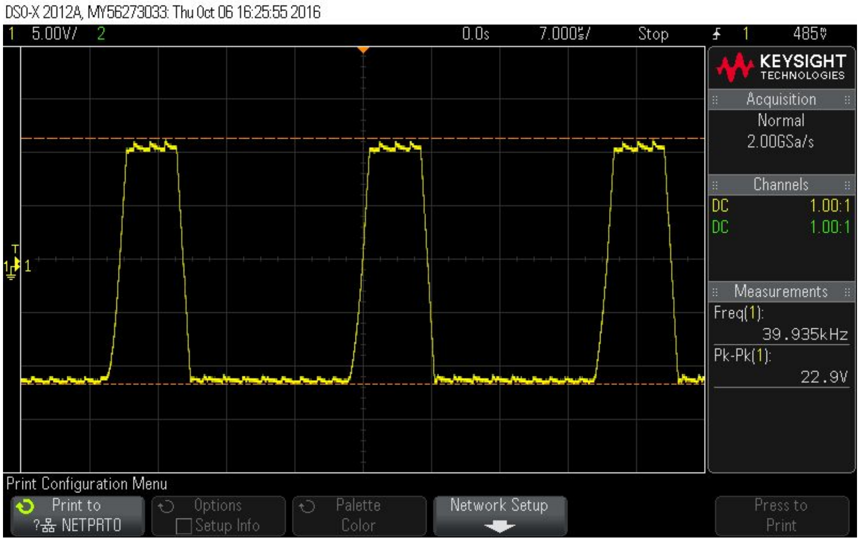

Figure 3.4: Output when an obstacle is placed just away from ultrasonic sensor

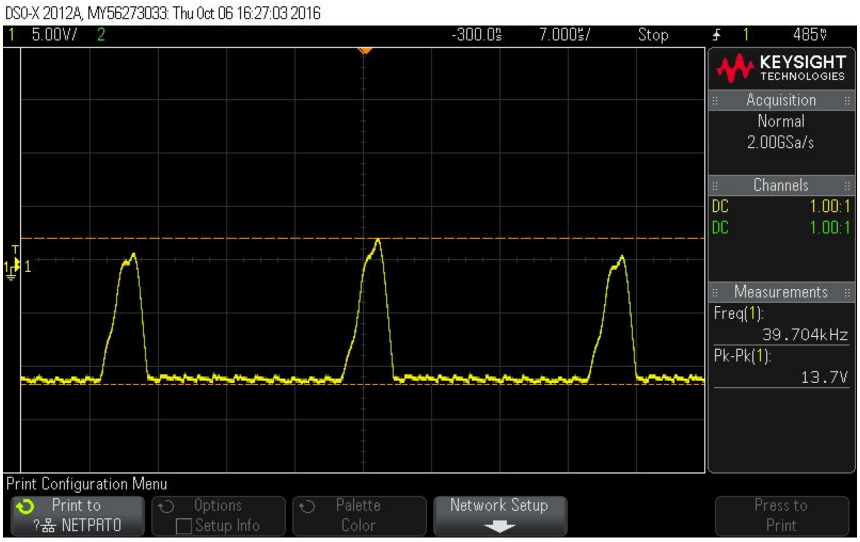

Figure 3.5: Output when an obstacle is placed too far from ultrasonic sensor

Figure 3.6: Output obtained at transmitter when we give a trigger to D flip flop at input.Top waveform indicates the output at transmitter while bottom waveform represents the trigger given to D Flip flop

Figure 3.7: Output obtained at receiver when we give a trigger to D flip flop at input.

Figure 3.8: Output obtained at receiver when we give a trigger to D flip flop at input.The time difference between the start of the two events determines the distance of the obstacle from the sensor module.

Chapter 4

Software

The final output from voltage divider is fed into a pin through 330Ω which is declared as input in IDE. In IDE,we run a timer when the state of trigger pin changes.Timer keeps on counting till the state of input pin remains the same.When the input pin toggles for the first time,the timer will be stopped and that time value is taken by the program for further calculations. We assumed sound travels at the speed of 340 m/s.From,

$$v = \frac{2d}{t} \tag{4.1}$$

we can get the distance travelled by the wave.A "2" is included,as the wave goes to and fro before reaching receiver.

Chapter 5

Problems faced

5.1 Transmitter

1. In transmitter,we need to send signals of 40kHz wave.There is a potentiometer which needs to be tuned perfectly,otherwise the frequency of transmitted signal changes which results in malfunctioning of the entire system.

5.2 Receiver

1. The transmitter and receiver module should be in same plane.Otherwise,its difficult to properly communicate between those two.

5.3 Software

1. Though we were able to successfully get a distinguished waveform from receiver,when it is fed in microcontroller,we were not able to get the time from microcontroller.

Chapter 6

Applications and future scope

This device can be used by blind persons to avoid hitting obstacles.Some extensions can be made once a basic module is completed such as

1. Text to speech module can be placed which gives the voice output of the distance which can be very useful for the blind person

2. Pit detection can be implemented by one of the following ways

    (a) Arrange another ultrasonic sensor inclined to another plane which can be further processed to get distance of pit similar to an obstacle.We will calculate the distance at the start and store it.When walking,if the observed distance is greater than our stored value,it means there is a pit in front of the observer.If the observed distance is less than the stored value,it means the observer is facing some upward slope.There may be interference between both ultrasonic sensors as they are operating at same frequency,but it can be avoided by placing them at perpendicular planes

    (b) IR sensor can be implemented and in a similar fashion,we can get distance of the floor initially and proceed further.Problem may arise as IR sensor works on detecting emitted heat,the values that it gives may not be relied completely.

Chapter 7

Conclusions

Some important points to be noted are

1. Selecting an op-amp according to our specification by looking at slew rate and bandwidth criterion.

2. Dependency of distance measurement of ultrasonic sensors by passing different waves varies accordingly.

3. We first connected a high pass filter and then a low pass filter.This is to avoid a high DC gain provided by 100x amplification.If we have connected in other way around,output of low pass signal has DC component,which gets amplified by 100x thus giving a very high offset.