EC382: Mini Project in Analog System Design

Design of IR based audio Transmitter and Receiver

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Introduction :

An IR based audio transmitter and receiver system is a device that allows audio signals to be transmitted wirelessly over short distances using infrared (IR) light. The transmitter converts audio signals into IR light signals that are then transmitted to the receiver. The receiver converts the IR light signals back into audio signals, which can be played through a speaker or headphones.

IR based audio transmitter and receiver systems are commonly used in situations where wired connections are impractical, such as in home theatre systems, gaming consoles, and portable audio devices. They offer a convenient and reliable way to transmit high-quality audio signals without the need for cables or wires.

Overall, an IR based audio transmitter and receiver system is a useful tool for anyone who wants to enjoy high-quality audio without being tethered to a wired connection.

Problem Statement :

The problem addressed in this project is the need for a reliable and efficient IR based audio transmission and reception system. While IR based systems have been used for many years, the current technology available for audio transmission and reception still faces several challenges. These challenges include limited range, interference from other light sources, and poor sound quality.

The current IR based audio transmission and reception systems on the market often suffer from these issues, resulting in poor audio quality and unreliable transmission. This can be particularly frustrating for users who are looking for a seamless and high-quality audio experience.

Therefore, this project aims to develop an IR based audio transmission and reception system that overcomes these challenges and provides a reliable, high-quality audio experience. The system will need to be designed to have a longer range, be resistant to interference, and provide excellent sound quality. By addressing these issues, this project will contribute to the development of an advanced IR based audio transmission and reception system that can be used in a wide range of applications.

Motivation :

The motivation for doing this project on IR based audio transmitter and receiver is to provide a reliable and efficient wireless audio transmission and reception system that offers high-quality sound without the limitations of wired connections. IR technology has been used for many years in various applications, including audio transmission and reception. However, the current technology available for audio transmission and reception still faces several challenges, such as limited range, interference from other light sources, and poor sound quality.

Developing a robust and efficient IR based audio transmission and reception system would offer several benefits. Firstly, it would provide a wireless audio transmission solution that is immune to interference from other wireless signals, such as Wi-Fi and Bluetooth, which can be problematic in crowded environments. Secondly, it would eliminate the need for complex wiring setups, which can be expensive, time-consuming, and difficult to manage. Thirdly, it would offer a high-quality audio experience, free from the distortion and noise that can be introduced by wired connections.

Methodology:

The methodology for developing an advanced IR based audio transmission and reception system would involve the following steps:

1) Requirements Analysis: This step involves identifying the functional and non-functional requirements of the system. The requirements include the desired range, sound quality, supply voltages,bandwidth of transmission,sensitivity of receiver.

2) Circuit Design: Based on the requirements analysis, the hardware circuit design will be developed.

3) Component Selection: The selection of the hardware components would be based on the circuit design and requirements analysis. This includes selecting the IR light source, the receiver ,comparators, operational amplifiers, voltage regulators, speaker, transistors(BJT), batteries(9v), Zener diode (3.3v) etc.

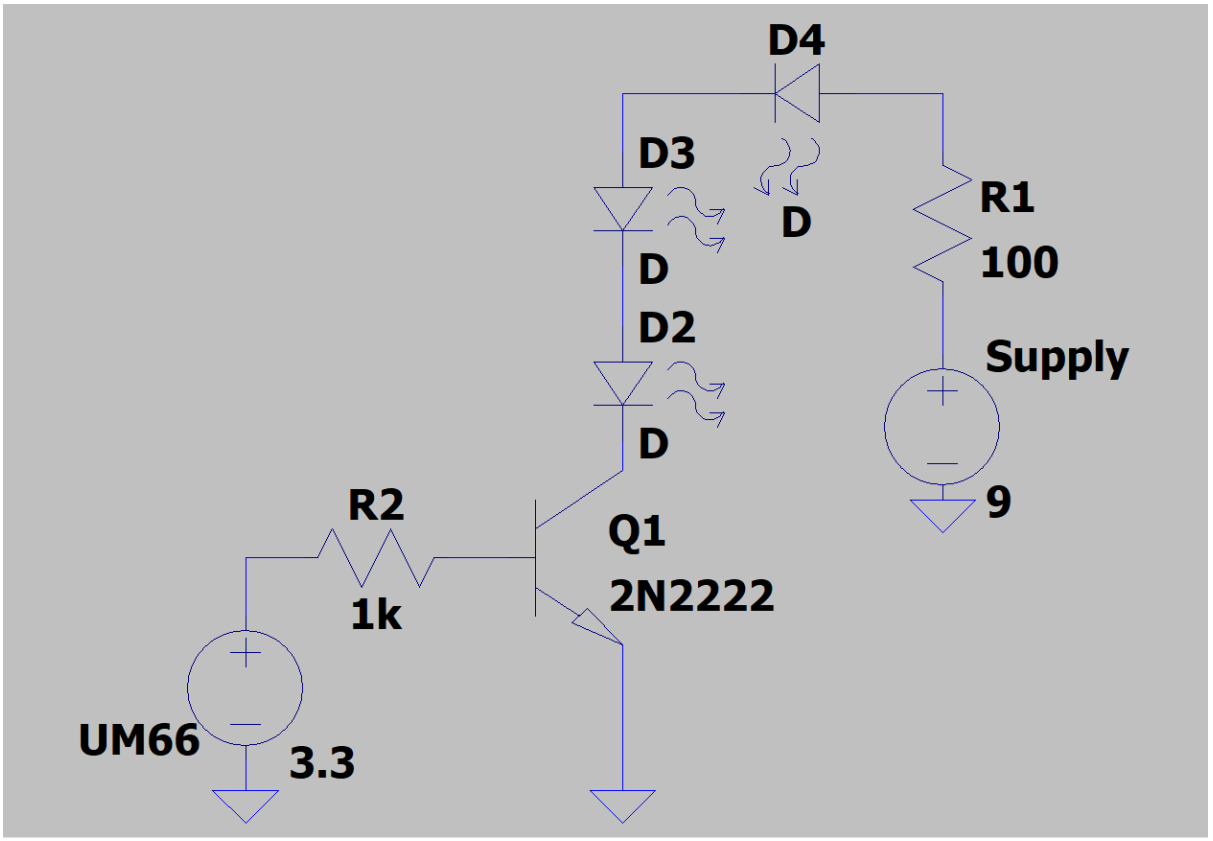
4) Prototyping: A prototype circuit is developed to test the design and component selection. This involves building the hardware for the circuit.

5) Testing and Evaluation: The prototype circuit will be tested to evaluate its performance, including its range, sound quality. The results of the tests would be used to refine the system design and identify any areas for improvement.

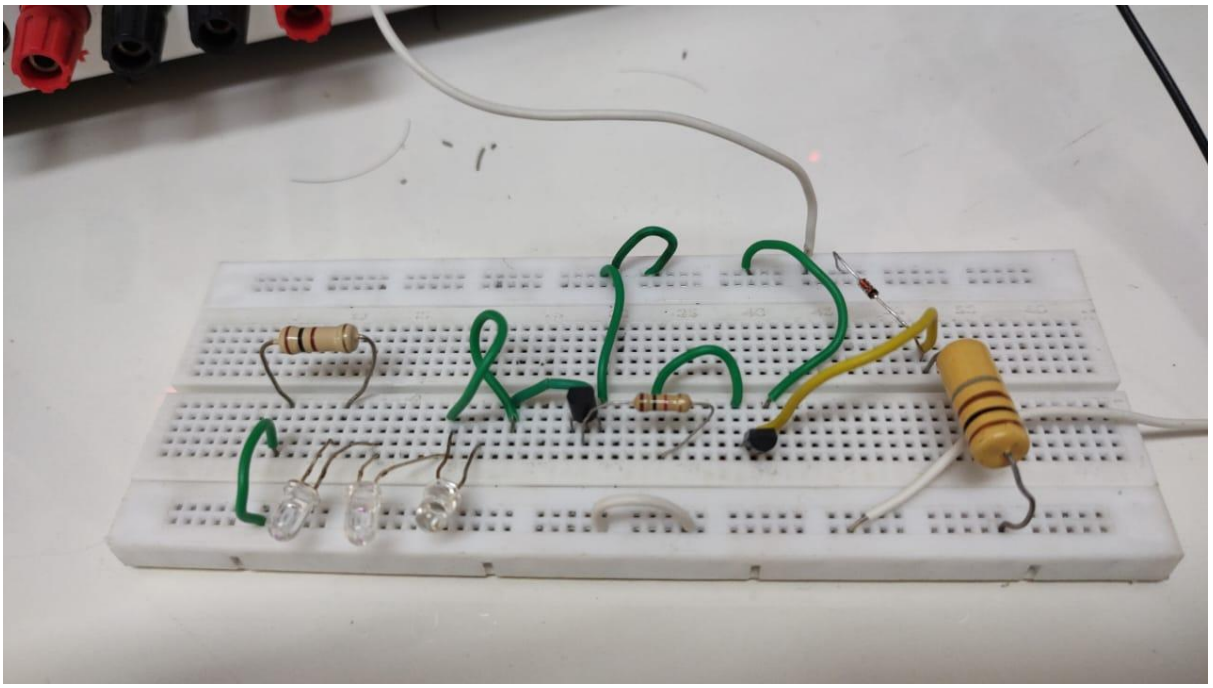
6) Circuit Integration and Optimization: Based on the testing and evaluation, the circuit will be optimised to improve its performance and ensure compatibility with existing circuit design.

Implementation :

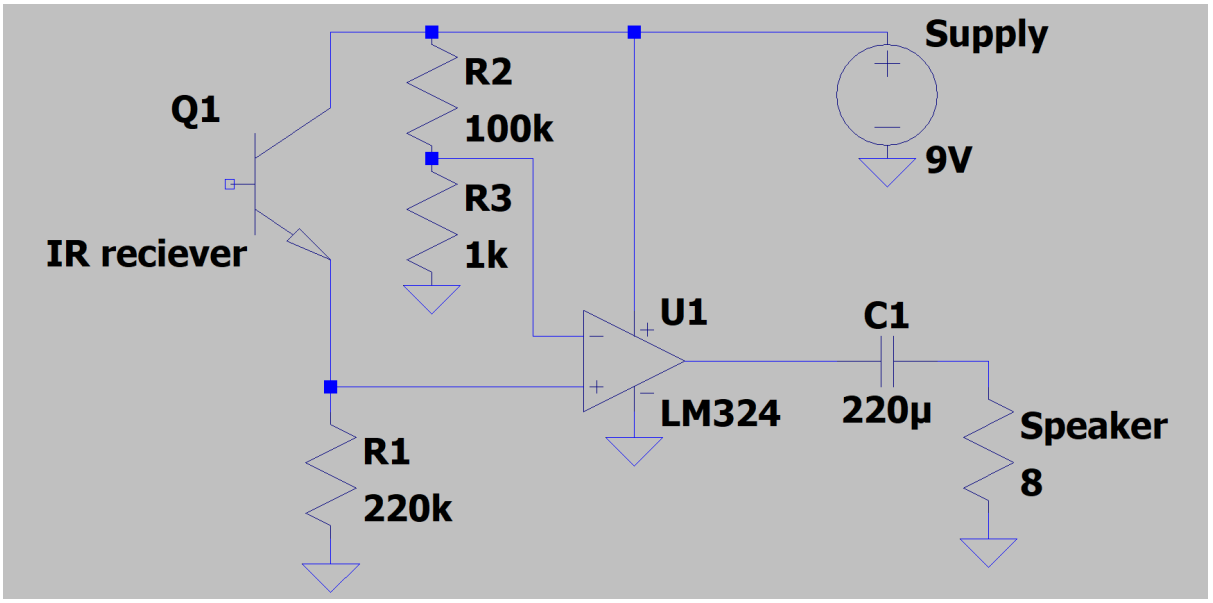
Transmitter :



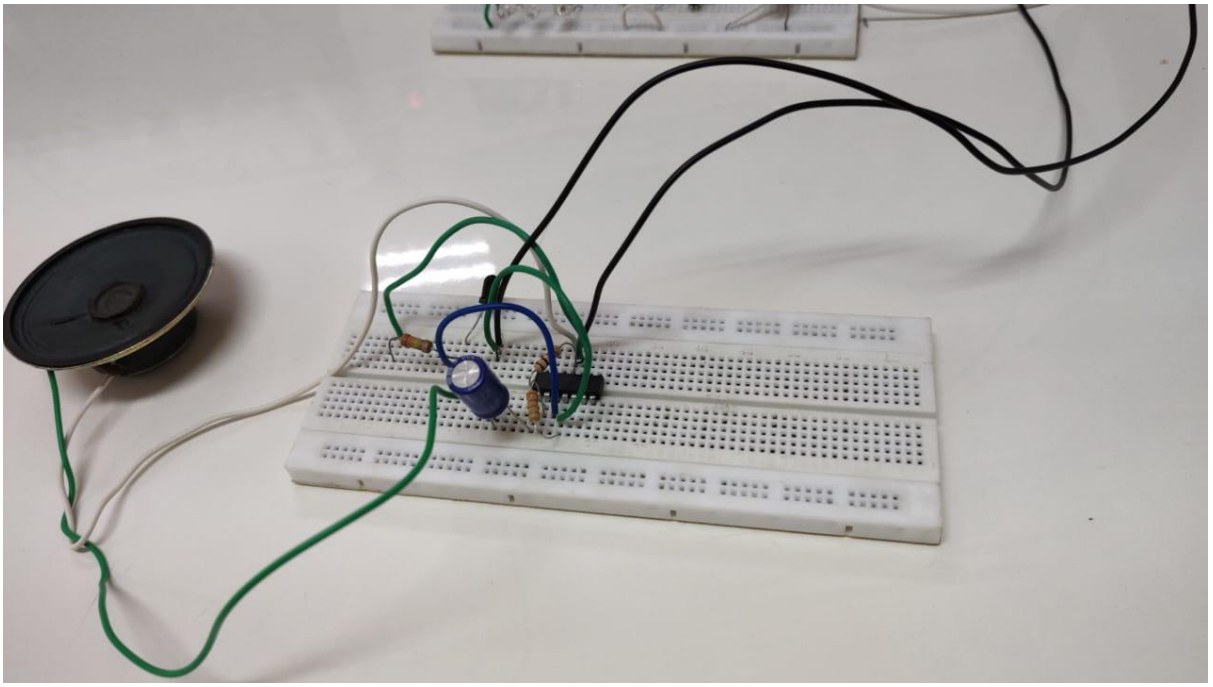
Audio Input: The audio input is taken from a tone generator UM66.This IC generates audio PWM signals of 3.3vpp which is then used as control signal to switch 3 IR LEDs arranged in series connected fashion using low sided driving from NPN transistor 2N2222.

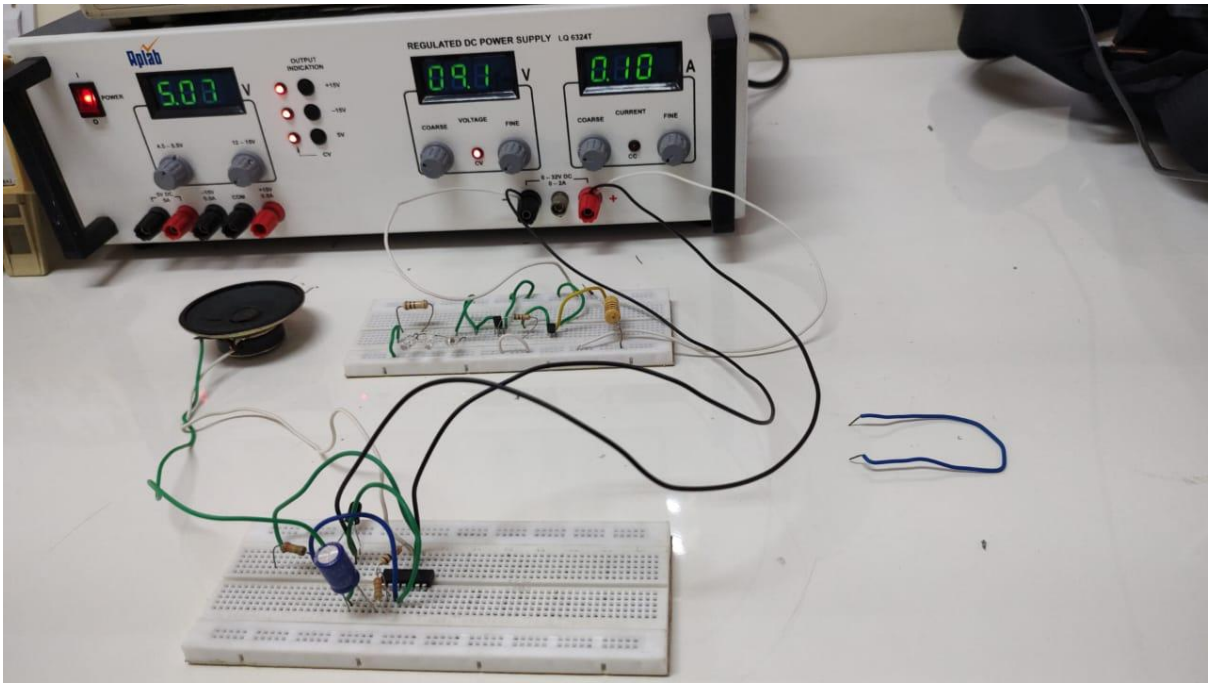


Receiver :



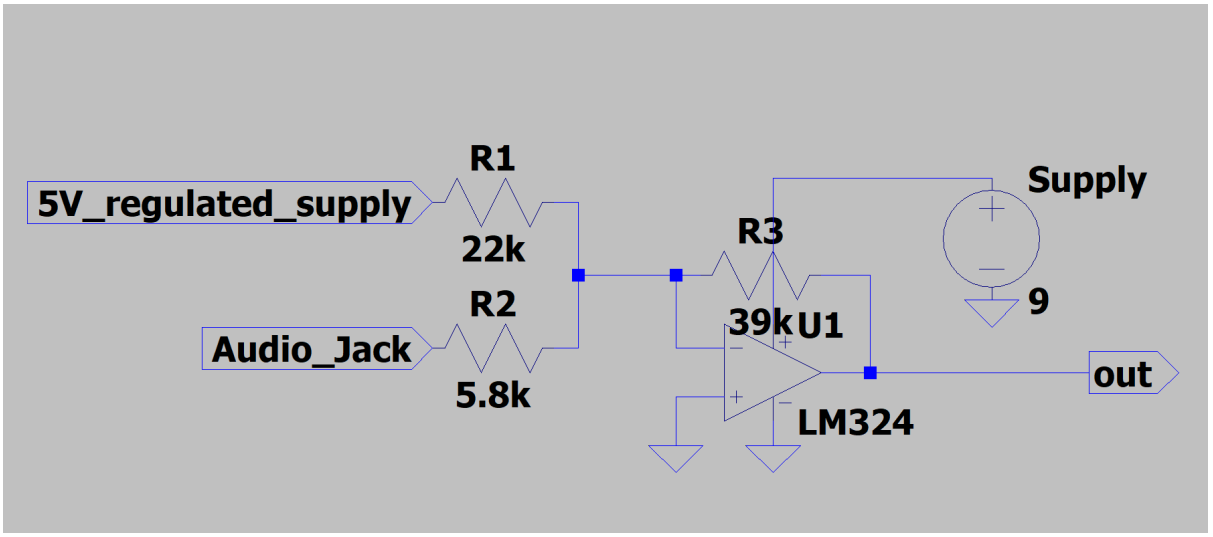
The receiver circuit consists of a phototransistor which is connected to a comparator circuit to retrieve PWM signal from the transmitter.This PWM signal is applied to the speaker through a 220uF capacitor to get the audio/tone transmitted.



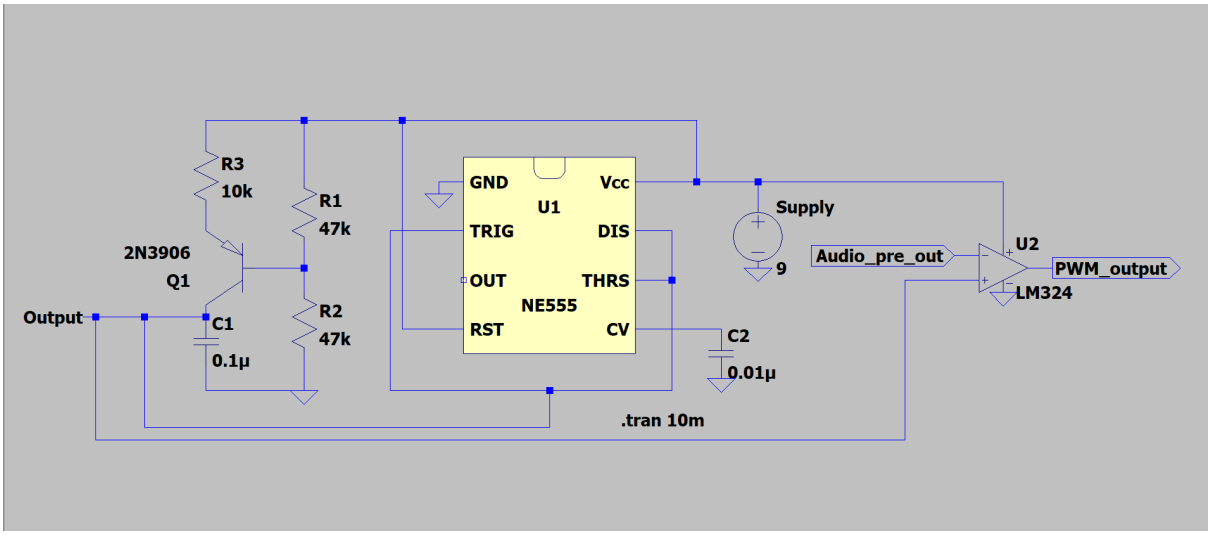


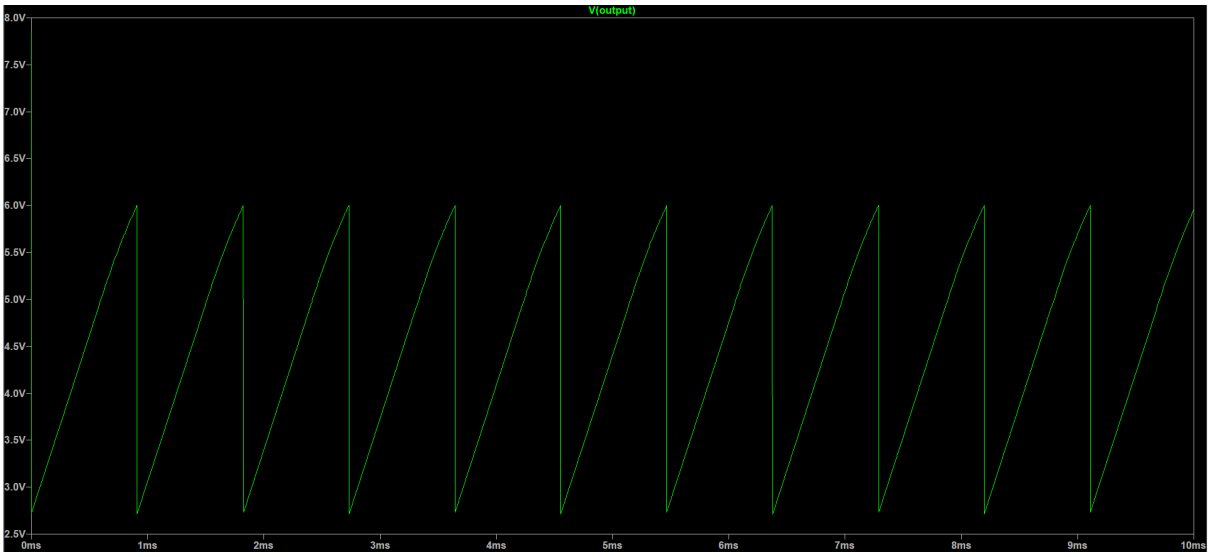
Audio pulse width modulation :

Audio preamplifier:



DC offset of audio input is removed and amplification of audio signal is done in just a single LM324 op amp in inverting configuration.Offset of 2v is removed and the signal is amplified by nearly 6 times so that it becomes compatible for PWM generation which is discussed below.





Above is the application of the NE555 timer as a monostable multivibrator where instead of charging the capacitor exponentially, we charge in a controlled manner using a constant current source.Constant current source is implemented using BJT biassed using resistive feedback circuit.During charging if current is constant ,voltage across capacitor increases linearly and for the trigger same voltage across capacitor is given as input which will discharges capacitor through discharge pin of NE555 timer IC.

Now to generate PWM signal this is given to the non-inverting terminal of opamp LM324 and the preprocessed audio is given as input to the inverting terminal of opamp LM324.

(idea: PWM generation using timers in arduino).

Work done up to now with real audio and music :

1) Built one bit ADC using a comparator to digitise the processed audio and observed the quality of audio and bandwidth of digital signal.Quality was not good so we thought of shifting to the better ADCs which offers less bandwidth because we hardly got 8khz of bandwidth for transmission.

2) As delta modulation is bandwidth efficient because of 1 bit ADC used, we tried with the delta modulation (inspired by a communication lab experiment).Delta modulation was no problem but in in demodulation reconstruction circuit after 2 orders of reconstruction our reconstructed signal was not able to drive the speaker load hence we need to test with power amplifier IC LM386.

3) Side by side we were trying with PWM generation of corresponding input.At first we did PWM conversion using arduino and we wrote code for that and used timer register and inbuilt ADC to generate PWM.After understanding the working we prototyped it using hardware equipments which we had such as NE555 timer IC , comparator etc.

Future work :

1) Fine tuning of the PWM circuit so that we can transmit good quality audio with less bandwidth.

2) Comparison of delta modulation output to the PWM and analysing efficiency of both in terms of quality of audio, power consumption,bandwidth etc.

3) Increasing the bandwidth and range of transmission with the help of some research conducted on IR transmission.

4) Soldering the things on perfboard .

5) If time permits we will go with PCB design for this IR based audio transmission and reception.

REFERENCE(S) :-

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[4] Suha I. Al-nassar, Haraa Raheem Hatem, Jinan N. Shehab. “Design and Implementation of Infrared (IR) Communication System”.