Two-way Intercom System

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ABSTRACT

Many institutes and business need to have some sort of communications between each department or groups in order for them to work efficiently. Most companies use telephones to do this but this can be a hassle as you need to reach for the receiver, enter numbers and hold the receiver next to you in order for the microphone to capture your voice. Instead, intercoms were introduced. Intercoms are communication devices which usually does not need a receiver and can be used while having your hand free to do other work. In this project we make a simple two-way intercom system using an audio amplifier, speakers, resistors, capacitors, push-buttons, 555 IC and microphones.

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01. Introduction

1.1 Project overview

An internal communication system is a system that basically transfers information in the form of electrical signal from one spot to the other within a confirmed location. It is also a private telecommunication system that allows typically two or more location to communicate with each other .An intercom is also a personal telecommunications device which facilitates the exchange of messages between two or more locations where standard vocal communication would be difficult or impossible due to distance or obstructions. This two way intercom system consist of stations linked to each using wires. It uses half duplex mode a process whereby one can transmit and receive voice calls but, not at the same time. The transmission medium are the wires between the two nodes and typical headers on the nodes (separate speaker and microphone, good isolation from sound coming from speaker to the mic element)

We connect two microphones to an operational amplifier through a two push buttons. The output of the amplifier is then sent to the receiver's speaker. This is a very simple circuit for a simple communication.

1.2 Novelty of the proposed project

We have included a flashing LED which indicates if the circuit is ON, which is controlled by IC-555 timer and included two push buttons to the two users. Users can talk any time while pressing the push button.

1.3 Problem statement

In a business organization, shop or store it is stressful to relate or deliver information between each other within a particular building. The servant finds it laborious going to the boss always whenever he or she has information to deliver or wants to carry out action(s) with respect to the master's authority. Therefore, this project work is to address this issue, looking forward to eliminating the stressful manpower involved and to facilitate information delivery, making communication easier.

1.4 Objective

(1) The main objective of this project is to construct a two way wired intercom that will help two people or more to communicate with each other within a particular domain, like offices, homes, warehouses and so forth

(2) To build an intercom system that will transmit and receive voice signals via a medium at no cost.

(3) To immensely help the engineering students understand the technology behind two way simple intercom and its practical development.

1.5 Scope of work.

The scope of this project work design of simple two way intercom system is too limited to the design, construction and test on a two station simple intercom system with specification that;

1. The small audio amplifier must provide an undistorted signal, and be able to drive a speaker of 8 ohms impedance.

2. A +5 volt dc power supply is to be design and employed to power the simple intercom for operation.

3. Result shall fully be discussed and suggestions for further

02. Background

2.1 Any pre-existing work

Speaking Tubes

Nineteenth-century businesses developed several methods of interoffice communication before Kellogg's patent. Early in the century, engineers built speaking tubes to carry voices between two people in the same building; some systems worked at distances of several hundred feet. The tubes become common business technology in the second half of the century. By the 1880s, the systems were elaborate enough that one speaker could connect to any of 25 different offices. Some executives favoured an alternative, a system of room-to-room buzzers to summon staff to their office.

Telephones

Telephone-based intercoms developed in the 1890s. Simple systems linked two phones in two separates offices, but companies soon developed more complicated arrangements. With a radial system, users called a central station to connect with other offices, butintercom networks made it possible to communicate without an operator. By 1912, if not earlier, users had the choice between a telephone-style handset or a desktop loudspeaker that let users keep their hands free. As late as the 1930s, many intercoms still resembled telephones.

20th Century

Starting in the 1950s, intercoms took on a new role as an electronic doorman for apartment buildings. To gain entrance through the electronically locked front door, you buzz the

8person you want to see, then talk to herand identify yourself when she replies. If she decides you're acceptable, she hits the button that opens the front door, and you enter. The invention of transistors led to more changes as intercom manufacturers switched to the use of solid-state circuits in their machines.

Changes

The transistor, and the development of digital communications technology, led to further intercom improvements. Starting in 1982, manufacturers began offering door-answering systems that incorporate video as well as audio to identify visitors. Wireless intercoms that communicate by radio frequencies became available starting in the late1940s. Intercom technology has found new niches, for example in baby monitors parents use to check up on their children. In the 21st century, systems use digital technology rather than analog to transmit sound.By the time the 1950's arrived an intercom replaced a doorman and was used to buzz visitors through an electronically controlled door.There are two types of intercom systems available and they are:

Permanent systems

They are mainly composed of analogue systems but in recent years have moved over to digital connections. Digital connections carry voice and video signals.

Portable systems

These types of systems are mainly used by special events production crews, theatres, concert halls, sports teams and even at motor racing events. It is especially convenient at places where a lot of movement is required.The two types can be further divided into categories and they are:

Wiring Intercoms

Wiring intercoms can be divided into; 2–wired intercoms and 4-wired intercoms.

Wireless Intercoms

As its names suggests, it functions without wires. These intercoms are easier to move around.

Video Intercoms

Video Intercoms are increasing in popularity. It is ideal, because you have the ability to see and speak to the visitor at the same time. Some video door phones have the ability to store snapshots of the person in the memory of the device.

The present and the future:

The intercom is no longer being used as just a two-way messaging system. Its functions have been improved to include but not limited to;

Door entry system –A push of a button allows the electronically operated door to open.

Provides security –By requesting a visitor to identify themselves before entering, you have some assurance of safety.

2.2 Requirement of the project

Capacitors
Resistors
Push-Button s
Microphones
Speakers
555 IC
LM386 Amp
LED

2.3 Supporting organizations

We didn't get any supports from organizations. We got information from the internet.

2.4 Market survey

We found top leading organizations in market nowadays.

1) QUANZHOU KOQI ELECTRONIC CO.,LTD (https://www.ycallpager.com/)
2) Akuvox (https://www.akuvoxsmartplus.com/)

03. Preliminary Studies.

3.1 Literature review

This chapter will emphasize on the research carried, intricate on ways in which this assist the design at the end.

3.2 History

The audio amplifier which was converted into a two way intercom was invented in 1959 by Lee de Forest when he invented the vacuum tube. The triode was a three terminal device with a control grid that can modulate the flow of electrons from the filament to the plate. The triode vacuum amplifier was used to make the first audio AM radio.

Early audio amplifiers were based on vacuum tubes also known as (valves), and some of these achieved notably high quality (for example the Williamson amplifier of 1747-9). Most modern amplifiers are based on solid state devices (transistors such as BJTs and MOSFETs), but there are still some who prefer tube-based amplifiers, due to a perceived 'warmer' valve sound.

Audio amplifiers based on transistors became practical with the wide availability of inexpensive transistors in the late 1960s. Key design parameters for audio amplifiers are frequency response, gain, noise, and distortion.

These are interdependent; increasing gain often leads to undesirable increases in noise and distortion. While negative feedback actually reduces the gain, it also reduces distortion. Most audio amplifiers are linear amplifiers operating in class AB (ONOH G.N 2005). Historically, the majority of commercial audio preamplifiers made had complex filter circuits for equalisation and tone adjustment due to the far from ideal quality of recordings, playback technology and speakers of the day. Using today's high quality (often digital) source material, speakers, and so forth such filter circuits are usually not needed. Audiophiles generally agree that filter circuits are to be avoided wherever possible today's audiophile amplifiers do not have tone controls or filters.

Since modern digital devices, including CD and DVD players, radio receivers and tape decks already provide a "flat" signal at line level, the preamp, is not needed other than as volume control. One alternative to separate a preamp is to simply use passive volume and switching controls, sometimes integrated into a power amplifier. To form an "integrated" amplifier. For some years following the introduction of solid state amplifiers, their perceived sound did not have the excellent audio quality of the best valve amplifiers. This led audiophiles to believe that valve sound had an intrinsic quality due to the vacuum tube technology itself. In 1972, Matti Otala demonstrated the origin of a previously unobserved form of distortion: transitory intermodulation distortion (TIM), also called slew rate distortion. TIM distortion was found to occur during very rapid increases in amplifier output voltage. TIM did not appear at steady state sine tone measurements, helping to hide it from design engineers prior to 1972. Problems with TIM distortion stem from reduced open loop frequency response of solid state amplifiers. Further works of Otala and other authors found the solution for TIM distortion, including increasing slew rate, decreasing preamp frequency bandwidth, and the insertion of a lag compensation circuit in the input stage of the amplifier. In high quality modern amplifiers the open loop responses at least 20KHz, cancelling TIM distortion however, TIM distortion is still present in most low price home quality amplifiers. The next step in advanced design was the Baxandall Theorem, created by peter Baxandell in England. This theorem introduced the concept of comparing the ratio between the input distortion and the output of an audio amplifier. This new idea helped audio design engineers to better evaluate the distortion processes within an audio amplifier. Important applications include public address systems, theoretical and concert sound reinforcement, and domestic sound systems. The sound card in a personal system contains several audio amplifiers (depending on number of channels), as does every stereo or home-theatre system

3.3 Background and Mathematical theory of work

The element microphone receive the signal which is the human voice and its frequency falls within a limited band of 300HZ to 3.4KHz approximately and convert it into audio frequency voltage signal which is very small and has to be amplified. This design uses the LM386 audio amplifier which receives the audio signal from the microphone, amplifies it and plays it on the speaker. The LM386 has a gain range from 20-200, by default the value of gain is 20 but can be increased up to 200 by using a capacitor across the pins 1 and 8. Here we have used a capacitor of 20μF to get the maximum gain of 200. The resistor R2 is used to control the volume of the speaker, here we limited the volume to medium level using a 4.7k resistor. You can experiment with values from 1k-100k to get the volume of your choice.

The output of the amplifier (pin 5) is connected to both speakers. One speaker will be used in set-1 and the other in set-2 as shown in the circuit diagram. The input of the amplifier is the microphone. We

cannot amplify the sound from both the microphones at the same time, so we use a two push-buttons for each user. The push-button will connect only one microphone to the amplifier at a time. So only one person can talk at a time, this type of communication is called half-duplex communication and this is what we see in walki-talkies.

3.4 Calculation.

Using Ohm's law to determine the current and power in a circuit using the 8Ω speaker.

$$I=V/R$$

Maximum output voltage=1/2 (supply voltage of the IC) of any amplifier circuit. All the semiconductors in this project are powered using +5 volts battery. This implies that:

Maximum output voltage of the audio IC=1/2×5=2.5V

$$I = V/R$$

$$=2.5\div 5$$

$$=0.5 \text{ Amps}$$

$$=VI$$

$$2.5\times 0.5$$

$$=1.25 \text{ watts}$$

3.5 LM386 audio amplifier

The integrated chip LM386 is a low power audio frequency amplifier requiring a low level power supply (most often batteries). It comes in an 8-pin.

The venerableLM386by Texas Instruments, has been with us since 1983, and can still be found in low power, battery driven applications all around the world. And being...

1.easy to power (using a single supply)

2.low heat (no heat sink required)

3.efficient

4.available in the prototyping-friendly DIP package

The pins

<u>1, 8 -Gain</u>

Pins 1 and 8 are used to adjust the gain level from the default 20x using specific values of connected capacitors.

2 -Negative Input

3 -Positive Input

These are the standard op-amp inputs. Typically, in a simple LM386 circuit, the negative input will be tied to ground while the positive input will receive the audio signal from the source.

4 - GND

5 -Vout

Pin 5 is the op-amp output, in our case the amplified signal which we send on to the speaker.

6 -Vs

The Voltage Supply pin receives the power required to operate the amplifier.

7 -Bypass

This pin provides direct access to the signal input, primarily used to remove power supply noise (preventing noise from being amplified).

Specifications

The LM386N ("N" signifying the preferred DIP package for our purposes) comes in 4 flavours: LM386N-1, -2, -3 and -4. The "3" and "4" versions have slightly higher output power, with the "4" version more so given its ability to handle more input voltage (at the cost of a higher minimum voltage requirement). For the rest of this article I'll refer to the LM386N-1, as it's the chip I had laying around and represents the most basic of the variants.

Supply Voltage (Vcc):

The chip requires a minimum of 4V to operate, with a maximum of 12V.

Speaker impedance:

The LM386 was primarily designed for a 4Ω speaker load, but is rated for 8Ω and 32Ω loads as well.

Distortion:

Under ideal conditions, 0.2% total harmonic distortion (THD) when driven with 6V of power into an 8Ω speaker at low power ratings, and up to ~10% THD closer to maximum power.

Output power:

Under ideal conditions you can expect about ~700mW of clean output power, or 0.7W

3.6 555 timer IC

The 555 timer IC is a very cheap, popular and useful precision timing device which can act as either a simple timer to generate single pulses or long time delays, or as a relaxation oscillator producing a string of stabilised waveforms of varying duty cycles from 50 to 100%

The 555 Timer IC got its name from the three 5KΩ resistors that are used in its voltage divider network. This IC is useful for generating accurate time delays and oscillations.

Pin 1 - Ground (GND) This pin is connected to circuit ground.

Pin 2 - Trigger (TRI)

A low voltage (less than 1/3 the supply voltage) applied momentarily to the Trigger input causes the output (pin 3) to go high. The output will remain high until a high voltage is applied to the Threshold input (pin 6).

Pin 3 – Output (OUT)

In output low state the voltage will be close to 0V. In output high state the voltage will be 1.7V lower than the supply voltage. For example, if the supply voltage is 5V output high voltage will be 3.3 volts. The output can source or sink up to 200 mA (maximum depends on supply voltage).

Pin 4 – Reset (RES)

A low voltage (less than 0.7V) applied to the reset pin will cause the output (pin 3) to go low. This input should remain connected to Vcc when not used.

Pin 5 – Control voltage (CON)

You can control the threshold voltage (pin 6) through the control input (which is internally set to 2/3 the supply voltage). You can vary it from 45% to 90% of the supply voltage. This enables you to vary the length of the output pulse in monostable mode or the output frequency in astable mode. When not in use it is recommended that this input be connected to circuit ground via a 0.01uF capacitor.

Pin 6 – Threshold (TRE)

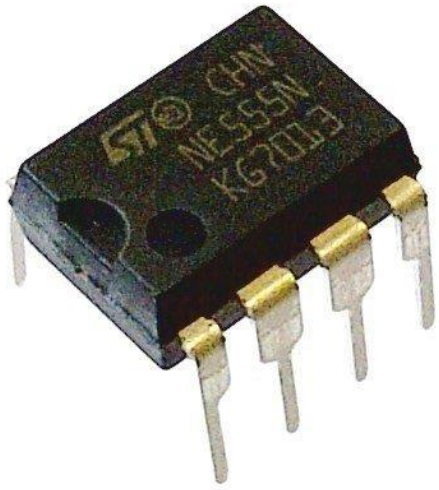
In both astable and monostable mode the voltage across the timing capacitor is monitored through the Threshold input. When the voltage at this input rises above the threshold value the output will go from high to low.

Pin 7 – Discharge (DIS)

when the voltage across the timing capacitor exceeds the threshold value. The timing capacitor is discharged through this input

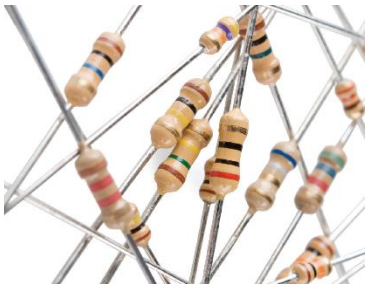
Pin 8 – Supply voltage (VCC)

This is is the positive supply voltage terminal. The supply voltage range is usually between +5V and +15V. The RC timing interval will not vary much over the supply voltage range (approximately 0.1%) in either astable or monostable mode.



3.7 Resistors

Resistors are electronic components which have a specific, never-changing electrical resistance. The resistor's resistance limits the flow of electrons through a circuit.



3.8 Speakers

The basic aim of an intercom system is to successfully transmit or receive voice (speech) with minimum interference. This speech being an electrical signal which has a voltage of varying amplitude cannot be seen, hence there must be a device which will produce the equivalent of the electrical signal being transmitted. This device is the speaker and it does that by converting the electrical signal into mechanical vibration

3.9 Microphone

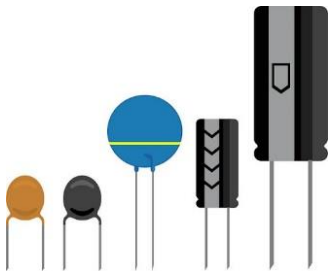
The input source contains the transducer which converts the sound (speech) in form of mechanical vibration to electrical signal. The electrical signal has a voltage which its amplitude varies linearly with time. The transducer in this block is a capacitor (condenser) microphone

3.10 Push-Buttons

The push button switch is usually used to turn on and off the control circuit, and it is a kind of control switch appliance that is widely used.

3.11 Capacitors

A capacitor is a passive two-terminal electrical component that stores potential energy in an electric field. The effect of a capacitor is known as capacitance. While some capacitance exists between any two electrical conductors in proximity in a circuit, a capacitor is a component designed to add capacitance to a circuit. The capacitor was originally known as a condenser. We used 0.1μF and 10μF capacitors.



3.12 Breadboard

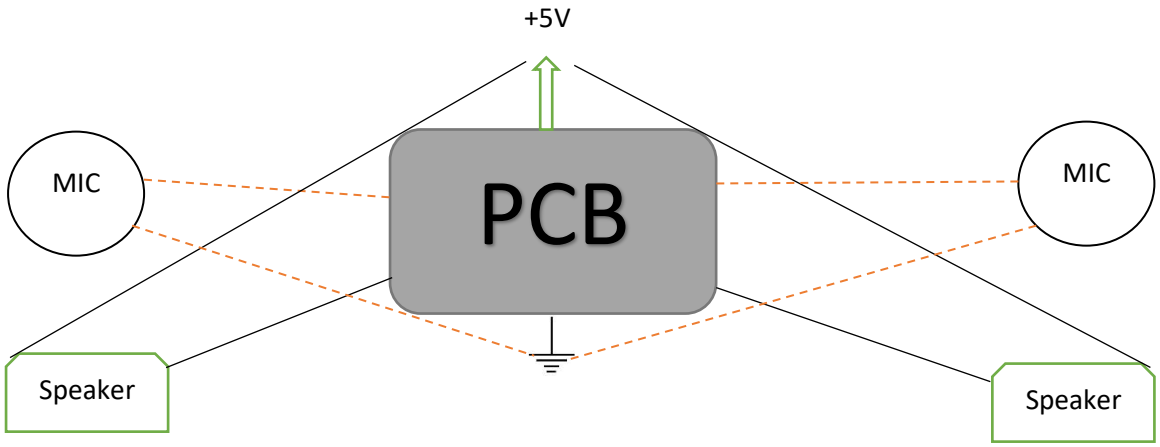
A breadboard is a solderless device for temporary prototype with electronics and test circuit designs. Most electronic components in electronic circuits can be interconnected by inserting their leads or terminals into the holes and then making connections through wires where appropriate. The breadboard has strips of metal underneath the board and connect the holes on the top of the board. The metal strips are laid out as shown below. Note that the top and bottom rows of holes are connected horizontally and split in the middle while the remaining holes are connected vertically.

04. Research Methodology

4.1 Introduction

This chapter deals with the design methods and then analysis employed in the design of a simple two way intercom system. The project design was illustrated in a block diagram and each block explained. The steps involved in coming with a working system were described sequentially.

4.2 Block diagram of the system



4.3 Theory of operation and explanation of the block diagram

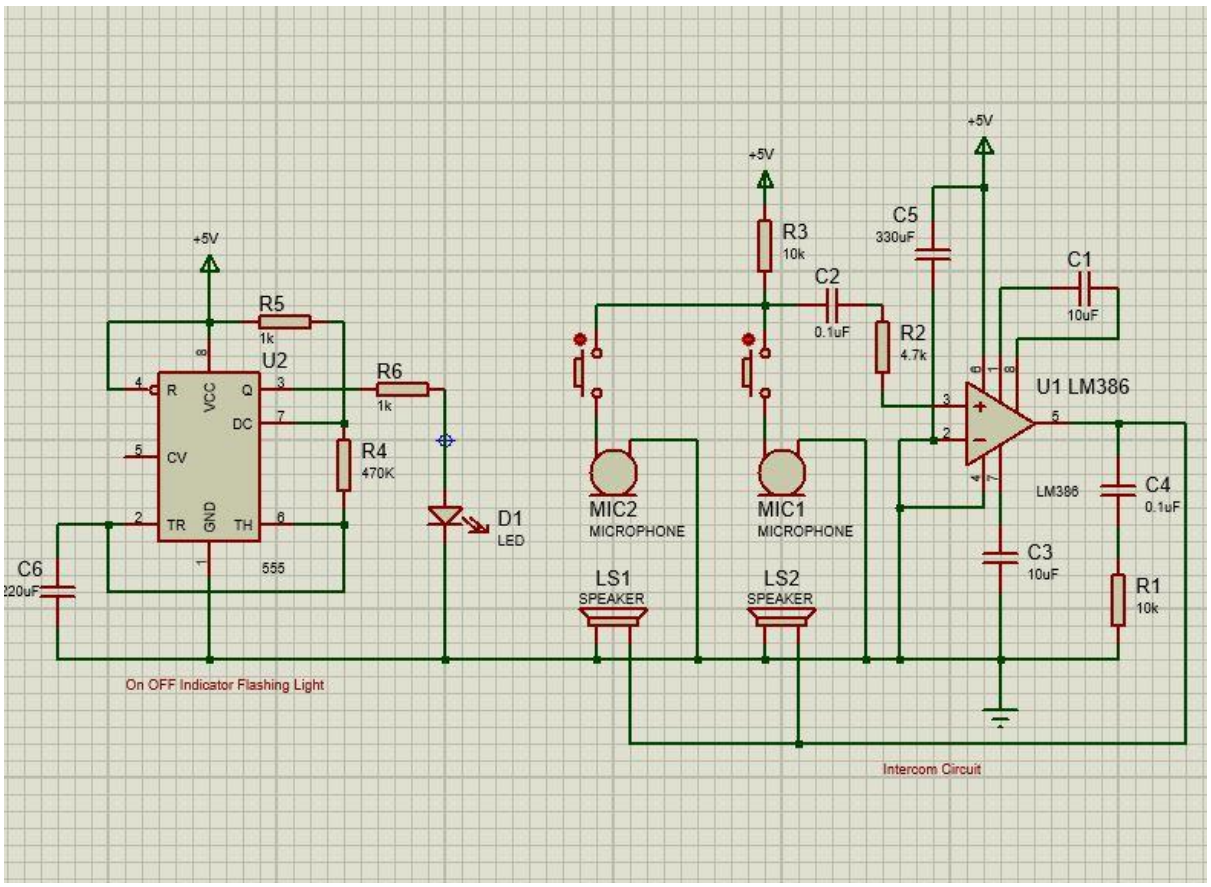
To solve the communication problems within an organisation or in some of university Laboratory , we proposed a system that uses simple electronic components like a mic which will work as the transducer which coverts sound in form of mechanical vibrations to electrical signals, speakers to output sound using an electromagnetic coil and a diaphragm and an LM386 audio amplifier to drive the 8ohms speakers.

As per the power requirement of the hardware of the simple intercom system, supply of +5V with respect to GND is developed. The complete circuitry is operated with TTL logic level of 5V to 12V.

In this intercom system we will use 8ohms speakers to produce an audio output that can be heard by the listener. The speaker will convert electrical signals into mechanical vibration.

input source, the transducer will convert sound (speech) in form of mechanical vibration to electrical signal.

4.4 Schematic diagram



4.5 Schematic explanation

It consists of:

1.Speakers

2.Mic

3.LM386 audio amplifiers

4.Resistors

5.Capacitors

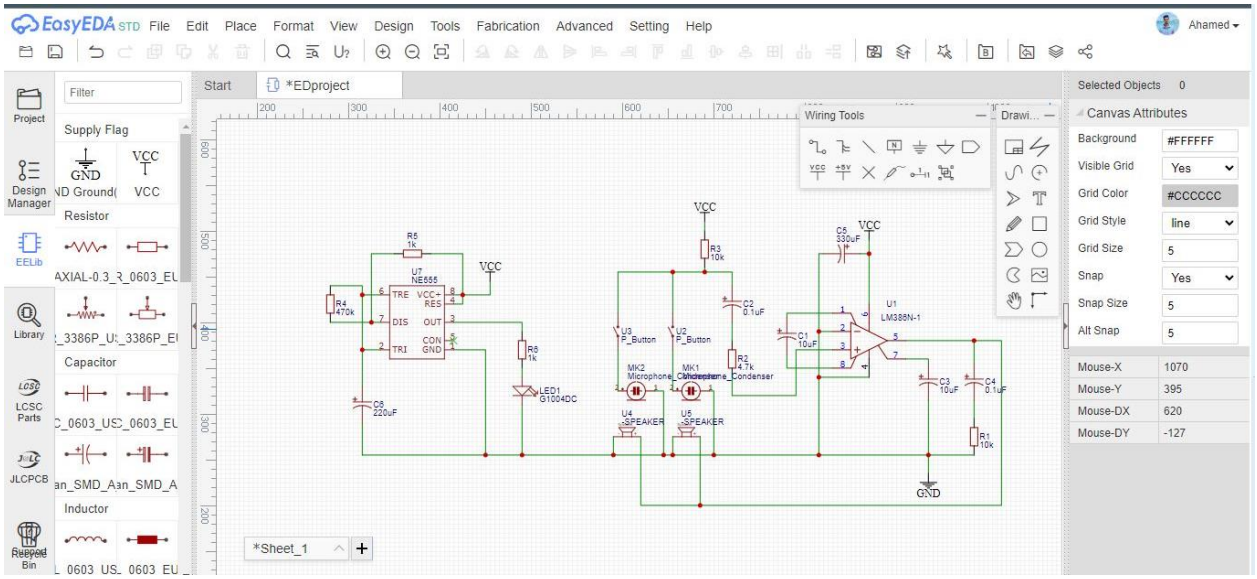
6.Push-Buttons

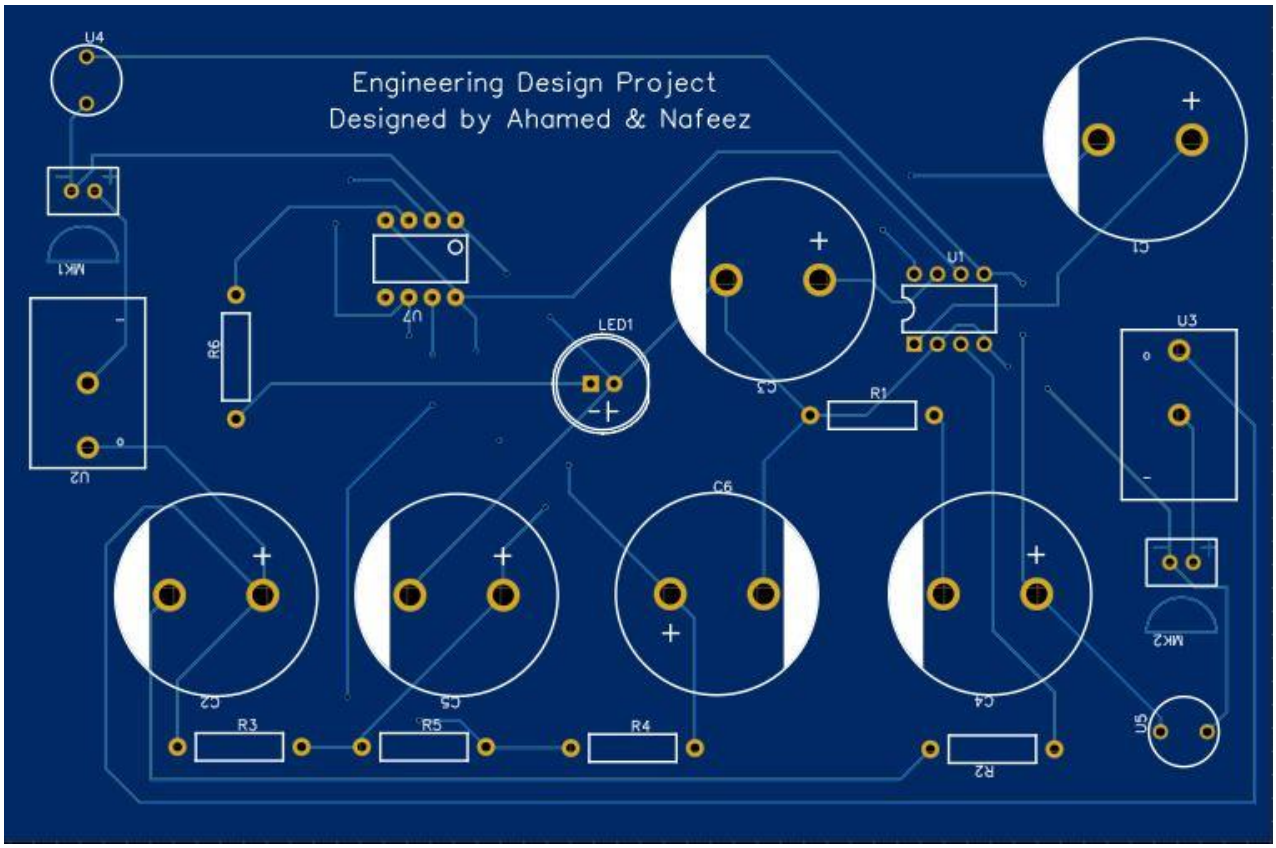
7.555 Timer IC

This circuitry uses an LM386 audio amplifier to amplify the sound or speech from the mic so it can be heard on the speakers. The audio amplifier will drive the 8 ohms speakers. The volume is medium, but it can be increased by trying different resistors from 1-100 ohms.555 timer is an Astable mode it creates clock pulses to the LED.

4.6 Project design

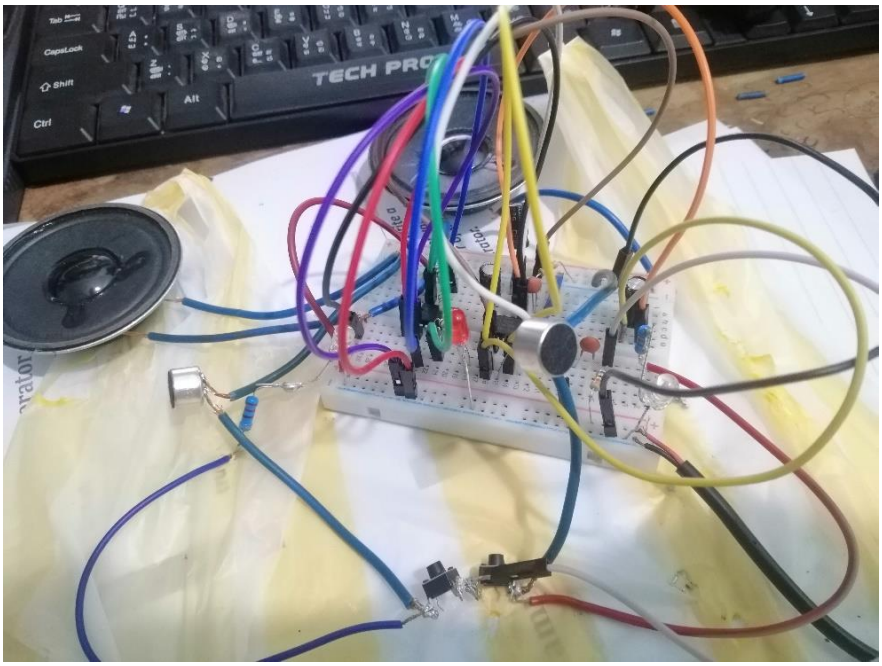
We designed the circuit using EasyEDA software.





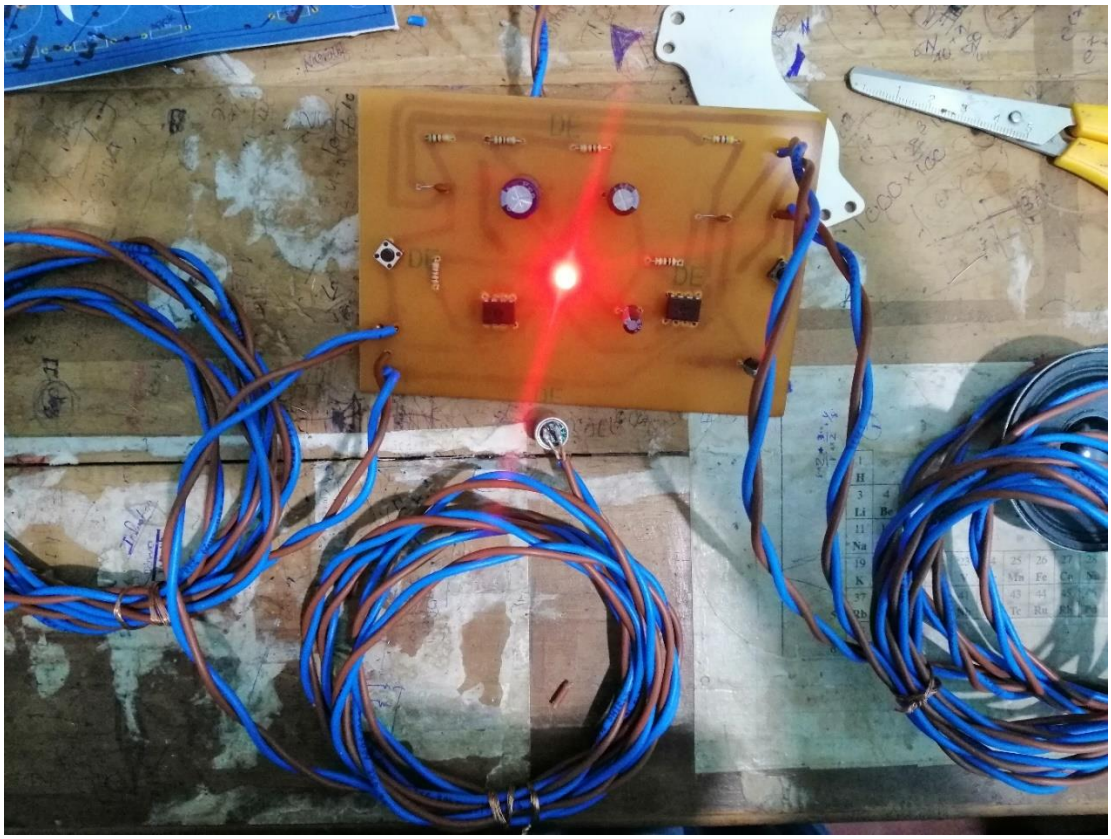
4.7 System testing

Before the system was actually constructed on a copper board the circuit was built on a breadboard and all the blocks were tested.



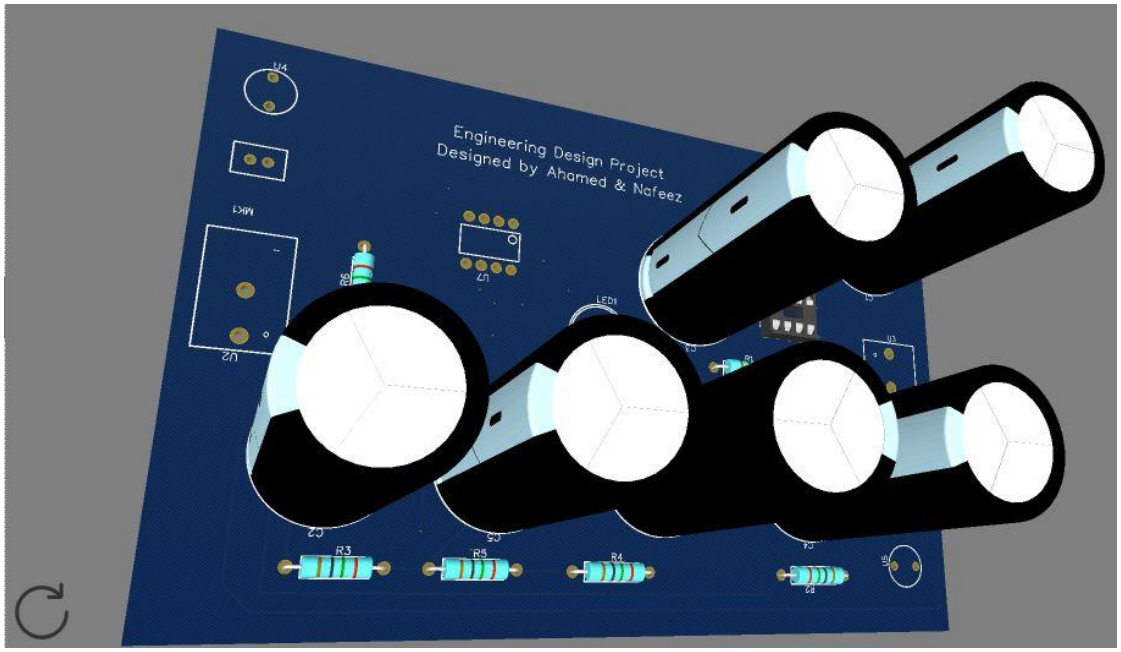
After that we got a printout of the circuit diagram and remarked to the copper board and constructed the PCB.

System is working and clear sounds.

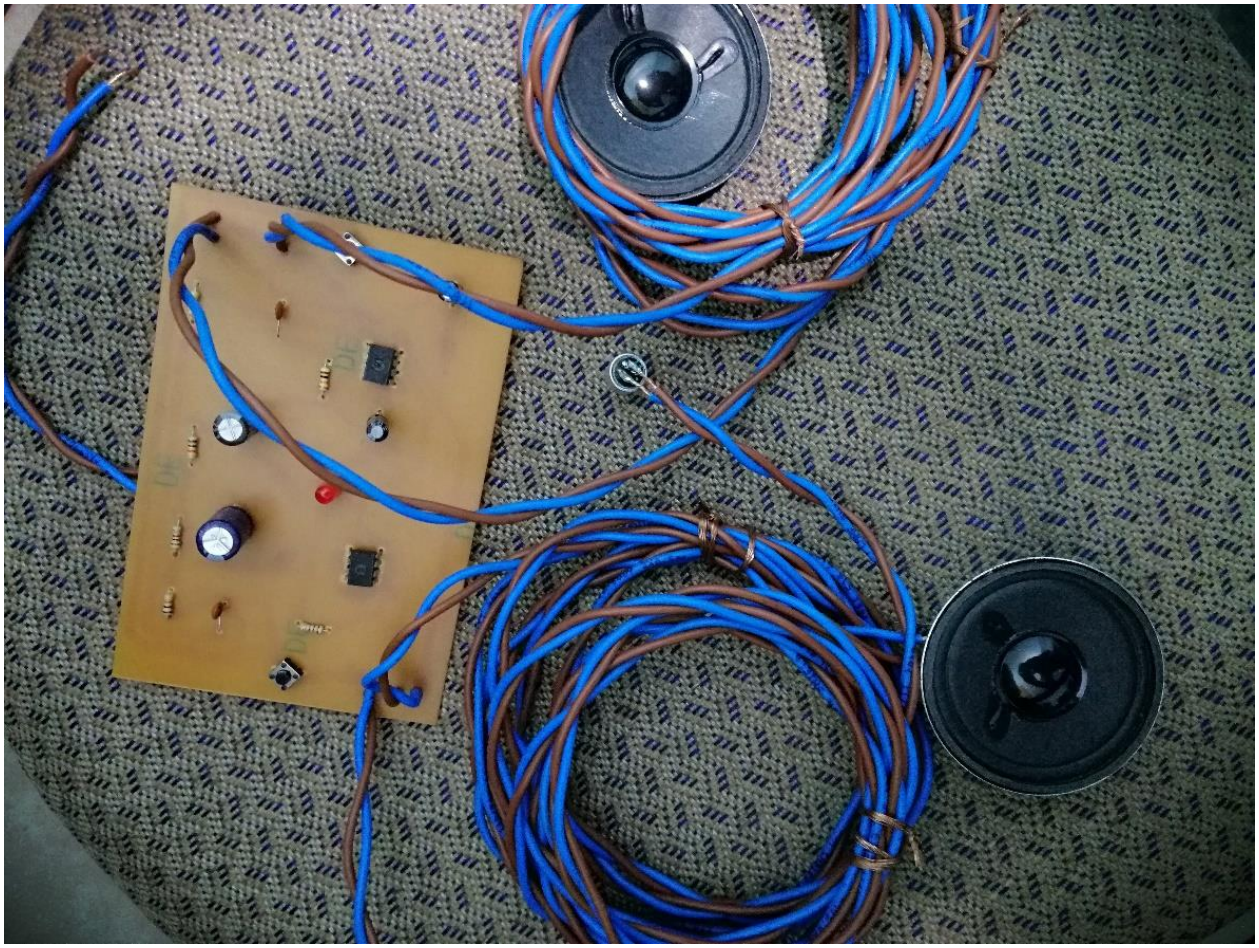


Final Output

3D Implementation



Physically constructed one



4.8 Distribution of workload

While Nafeez Lathiff did the circuit design, M.T. Ahamed obtained the components and built the circuit since both could not meet up to do the project together due to the COVID-19 pandemic. But both of us made it in breadboard. We take meeting to plan the project and do it in different way.

05. Gannt chart and responsibility matrix.

5.1 Project timeline including a Gannt Chart

Two-way Intercom system project															
Duration (14 Weeks)															
Task list	Weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Assembling a project team															
Literature Review															
Planning															
Gathering components															
Simulation of Design															
Project kick-off meeting															
Construction of circuit															
Testing of circuit															
Fault Rectification and Testing															
Documentation															

06. Budget

6.1 Cost analysis

Components	COST
Capacitor(0.1uF) ×2	Rs 2 * 2 = 4
Capacitor(330uF) ×1	Rs 3 * 1 = 3
Capacitor(220uF) ×1	Rs 2 * 1 = 2
Capacitor(10uF) ×2	Rs 2 * 2 = 4
Resistor (10k) ×3	Rs 1 * 3 = 3
Resistor (1k) ×2	Rs 1.5 * 2 = 3
Resistor (4.7k) ×1	Rs 1.5 * 1 = 1.5
Push-Button × 2	Rs 10 * 2 = 20
Microphone × 2	Rs 20 * 2 = 40
Speaker × 2	Rs 50 * 2 = 100
555 IC × 1	Rs 15 * 1 = 15
LM386 Amp × 1	Rs 20 * 1 = 20
LED × 1	Rs 2 * 1 = 2
Copper board	Rs 150 * 1 = 150
Wires	RS = 100
Total	Rs = 467.5

07. Risk Factors

The main Drawback we found in this project is, when first user talking, the all two users can hear their sounds. But it will not echo. To this disadvantage we couldn't find any solutions.

In this only one user can speak at a time. We can use SPDT switch. But it is very uncomfortable to the users. We introduce the two push buttons to each user. When they need to talk, they can push their switch and they can speak.

And the other one is the noise of LM386 AUDIO AMPLIFIER. We reduce it using 330uF capacitor connecting to the pin 6 and pin 2, and ground the pin 2.

And other one we found that, the channel noise. We reduce it using the twisted pair wires.

08. Conclusion

The basic idea of an intercom system is to enable two or more people to communicate in an organisation or in homes thereby reducing the labour of moving back and forth which is exhausting and time consuming. Therefore there is need for an inexpensive low cost device to be used for communication, and a simple intercom system is ideal since it does not incur additional costs as in the case of cell phones or phones.

The success of this project is a dividend of careful research and commitment, also it is a guarantee of sound knowledge in electronic components and their implementation in communication systems. During the execution of this project more knowledge was acquired on how analog systems operate especially for communication and this will help when designing more systems of this nature.

09. References

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