VISVESVARAYA TECHNOLOGICAL UNIVERSITY

Jnana Sangama, Belagavi- 590018

A Project report on

"DESIGN AND FABRICATION OF LOW-COST MEMS BASED LISTENING DEVICE FOR HEARING IMPAIRED"

A dissertation submitted in the partial fulfillment of the requirement for the Award of Degree of

BACHELOR OF ENGINEERING
in
ELECTRONICS & COMMUNICATION ENGINEERING

Submitted by

Project Associates

1. Ms. SEEMA P — 3VC17EC062
2. Ms. K SWETHA — 3VC17EC025
3. Ms. TRIVENI — 3VC17EC078
4. Ms. SONIA S — 3VC17EC069

Under the Guidance of
Mrs. Dr. Savita Sonoli

V.V.SANGHA'S
RAO BAHADUR Y. MAHABALESWARAPPA ENGINEERING COLLEGE
DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
BALLARI- 583 104

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V.V SANGHA'S

RAO BAHADUR.Y.MAHABALESWARAPPA
ENGINEERING COLLEGE
BALLARI – 583 104
(Affiliated to Visvesvaraya Technological University, Belagavi and approved by AICTE, New Delhi)

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

CERTIFICATE

Certified that the Project Work entitled **"Design and Fabrication of Low-Cost MEMS Based Listening Device for Hearing Impaired"** is a bonafide work carried out by **Seema P-3VC17EC062, K Swetha-3VC17EC025, Triveni-3VC17EC078, Sonia S- 3VC17EC069** in partial fulfillment for the Award of Bachelor of Engineering in Electronics & Communication Engineering of Visvesvaraya Technological University, Belagavi during the year 2020-2021. It is certified that all corrections/suggestions indicated for Internal Assessment have been incorporated in the report deposited in the departmental library. The project report has been approved as it satisfies the academic requirements in respect of project work prescribed for the said Degree.

Savita

Dr. Savita Sonoli
Vice Principal & HOD
Project Guide

Savita

Dr. Savita Sonoli
Vice Principal & HOD

T. [signature]

Dr. T. Hanumantha Reddy
Principal

External Viva

Name of the Examiner	Signature with date
1. Dr S. Prabhavathi	[signature] 09/08/2021
2. A. Vijay	[signature]

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Project Associates:

Seema P (3VC17EC062)
K Swetha (3VC17EC025)
Triveni (3VC17EC078)
Sonia S (3VC17EC069)

DECLARATION

We, **SEEMA P, K SWETHA, TRIVENI, SONIA S** students of eight semester BE, in the Department of Electronics and Communication Engineering, RYMEC, Ballari declare that the Project entitle **"DESIGN AND FABRICATION OF LOW COST MEMS BASED LISTENING DEVICE FOR HEARING IMPAIRED"** has been carried out by us at **Dept of ECE RYMEC Ballari,** and submitted in partial fulfillment of the course requirements for the award of degree in **Bachelor of Engineering in Electronics & Communication Engineering**, of Visvesvaraya Technological University, Belagavi during the year 2021-2021.

Project Associates:

Seema P (3VC17EC062)
K Swetha (3VC17EC025)
Triveni (3VC17EC078)
Sonia S (3VC17EC069)

ABSTRACT

MEMS-based capacitive microphone and low-cost amplifier are designed for low-cost power-efficient hearing aid application. The developed microphone along with the associated circuitry is mounted on a common board in the form of pocket-type (body-worn) device. The incident acoustic waves on the sensor cause defection of the diaphragm to alter the air gap between the perforated back plate and the diaphragm which causes a change in capacitance. The acoustic pressure applied to the microphone is from 0 to 100 Pa for an operating range of 100 Hz–10 kHz which corresponds to the audible frequency range in case of human beings. The main purpose of this work is to increase the longevity of battery used in conventional hearing aids. The designed MEMS microphone with diaphragm is capable of identifying acoustic frequencies (100 Hz to 10 kHz) which correspond to a specific change in absolute pressure from 0 to 100 Pa for 2-micron-thick diaphragm with a sensitivity of about 0.08676 mV/ Pa. The design of the sensor.Finally, the prototype is designed using MEMS microphone and low-cost amplifier ICs with biasing components in the form of pocket-type (body-worn) hearing aid.

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CHAPTER 1

INTRODUCTION

There are many types of hearing aids depending upon how they are worn by the patient, i.e., behind the ear (BTE), in the ear (ITE), in the canal (ITC), and completely in the canal (CIC). The hearing aids commercially available have the problem of directionality, sensitivity, and audio range. Based on the sensing element, a microphone can be capacitive (condenser), piezoelectric, and piezoresistive. A capacitive microphone computes the change in acoustic pressure by the change in capacitance. The most common capacitive microphones are electret capacitive microphone (ECM) and MEMS capacitive microphone (MCM). In this work, MCM is selected because of its ultra-small fabrication geometries, excellent stability to temperature, and low power consumption along with the ability to fabricate the underlying amplifier circuitry on the same substrate. Driven by aging populations and a pronounced increase in hearing loss, the market for hearing aids continues to grow, but their conspicuous size and short battery life turn many people off. As hearing loss becomes ever more common, people will look for smaller, more efficient, higher quality hearing aids. At the start of the hearing aid signal chain, microphones sense voices and other ambient sounds, so improved audio capture can lead to higher performance and lower power consumption throughout the signal chain.

Microphones are transducers that convert acoustical signals into electrical signals that can be processed by the hearing aid’s audio signal chain. Many different types of technologies are used for this acoustic-to-electrical transduction, but condenser microphones have emerged as the smallest and most accurate. The diaphragm in condenser microphones moves in response to an acoustic signal. This motion causes a change in capacitance, which is then used to produce an electrical signal.

Electret condenser microphone (ECM) technology is the most widely used in hearing aids. ECMs implement a variable capacitor with one plate built from a material with a permanent electrical charge. ECMs are well established in today’s hearing industry, but the technology behind these devices has remained relatively unchanged since the 1960s. Their performance, repeatability, and stability over temperature and other environmental conditions are not very good. Hearing aids, and other applications that value high performance and consistency, present an opportunity for a new microphone technology that improves on these shortcomings, allowing manufacturers to produce higher quality, more reliable devices.

Microelectromechanical systems (MEMS) technology is driving the next revolution in condenser microphones. MEMS microphones take advantage of the enormous advances made in silicon technology over the past decades—including ultrasmall fabrication geometries, excellent stability and repeatability, and low power consumption—all of which have become uncompromising requirements of the silicon industry. Until now, the power consumption and noise levels of MEMS microphones have been too high to make them appropriate for use in hearing aids, but new devices that meet these two key specifications are now enabling the next wave of innovation in hearing aid microphones.

MEMS Microphone Operation

Like ECMs, MEMS microphones operate as condenser microphones. MEMS microphones consist of a flexibly suspended diaphragm that is free to move above a fixed backplate, all fabricated on a silicon wafer. This structure forms a variable capacitor, with a fixed electrical charge applied between the diaphragm and backplate. An incoming sound pressure wave passing through holes in the backplate causes the diaphragm to move in proportion to the amplitude of the compression and rarefaction waves. This movement varies the distance between the diaphragm and the backplate, which in turn varies the capacitance, as shown in Figure 1. Given a constant charge, this capacitance change is converted into an electrical signal.

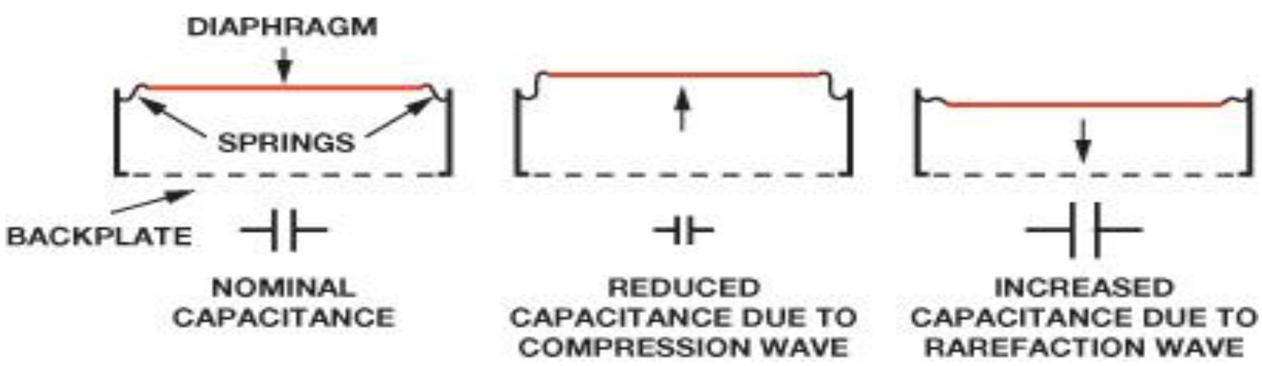


Fig. 1 *– Capacitance of MEMS microphone varies with amplitude of acoustic wave.*

The microphone sensor element is constructed on a silicon wafer using similar manufacturing processes to other integrated circuits (ICs). Unlike ECM manufacturing technologies, silicon manufacturing processes are very precise and highly repeatable. Each MEMS microphone element fabricated on a wafer will perform like every other element on that wafer—and like every element on different wafers produced across the many years of the product's lifetime.

Silicon fabrication uses a series of deposition and etching processes in a tightly controlled environment to create the collection of shapes in metal and polysilicon that form a MEMS microphone. The geometries involved in the construction of MEMS microphones are on the order of microns (µm). The holes in the backplate through which sound waves pass can be less than 10 µm in diameter and the diaphragm thickness can be on the order of 1 µm. The gap between the diaphragm and the backplate is on the order of several microns. Figure 2 shows a SEM image of a typical MEMS microphone transducer element, looking at it from the top (diaphragm) side; Figure 3 shows the cross section through the middle of this microphone element. In this design, sound waves enter the microphone through the cavity in the bottom of the element and pass through the backplate holes to excite the diaphragm.

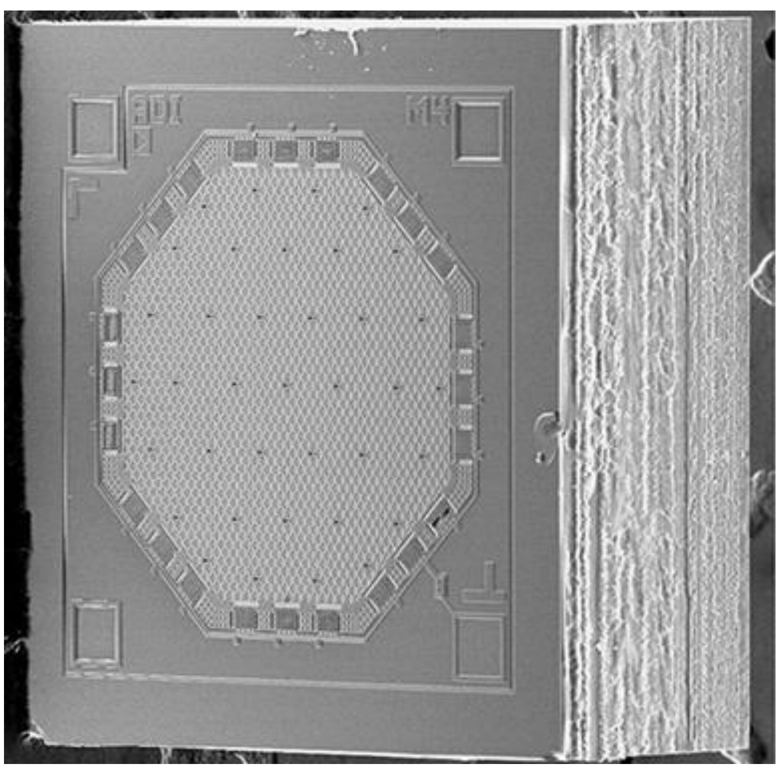


Fig. 2 *– SEM image of MEMS microphone.*

Because the geometries are tightly controlled during the manufacturing process, the measured performance from microphone to microphone is highly repeatable. Another advantage of using MEMS technology to build microphones is that the diaphragm is extremely small, resulting in very low mass and making a MEMS microphone much less susceptible to vibration than an ECM, which has a much more massive diaphragm.

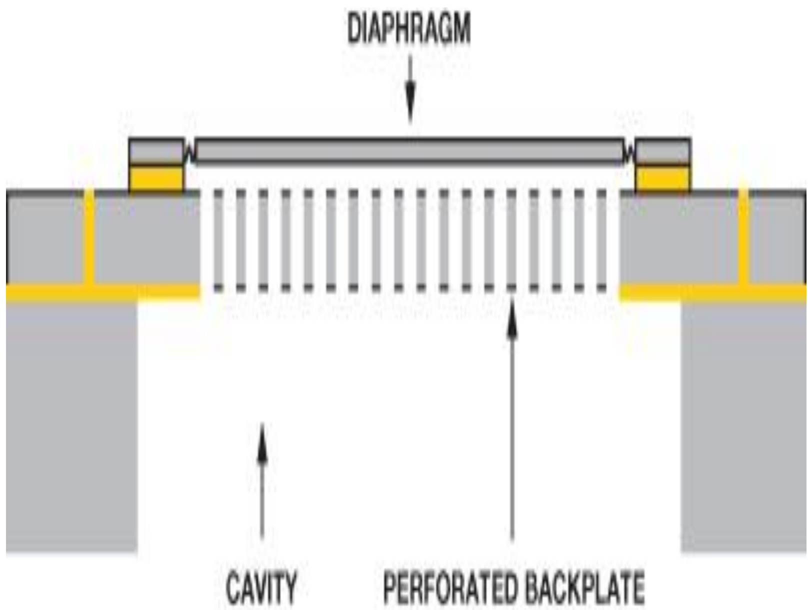


Fig. 3 *– Cross section of a MEMS microphone.*

CHAPTER 2

LITERATURE SURVEY

The progress in the field of hearing aid technology is at its peak. A lot of work has been done by the pioneers in the field of MEMS technology. Hearing aid has evolved from analog variable gain amplifiers ,Electret microphones and then finally to implants.

Diego Calero, Stephan paul. Andre Gesing, Fabio alves and Julio A. Cordioli evaluated a technical review of implantable sensors for hearing devices .Most commercially available cochlear implants and hearing aids use microphones as sensors for capturing the external sound field .These microphones are in general located in the external element ,which is also responsible for processing the sound signal. MEMS sensors coupled to the middle ear ossicular chain is proposed as the future for implantable sensors .

Ilker Deligoz, Syed R .Naqvi, Tino copani, Sayfi Kiaei, Bertan Bakkaloglu, Sang-soo je,and Junseok chae developed a dual channel directional digital hearing aid front end using micro electro mechanical- systems microphones, and an adaptive power analog processing signal chain are presented. The MEMS microphones are fabricated using the standard surface micromachining technology. The proposed system cannot be integrated in a multichip module, it does not offer a superior battery life and background noise suppression and it is not cost effective.

Shih Hsorng Shen, Shuenn-tsong Young and Weileun fang developed a MEMS filter bank for hearing aids applications .It directly processes the sound signals by separating the sound into specific frequency bands .Therefore ,the filter bank can replace some function of the microphone and the processor within the modern hearing aids .Such a MEMS filter bank works as a passive component, and it has the advantages of lower energy consumption and without computation time .The proposed system structure material and geometry should be modified for reducing the mechanical size and residual stress .Besides ,the gauge factor of the piezoresistive material should also be investigated and improved .

Sang-soo Je ,Fernando rivas ,Rodol fo E.diaz,Jiuk Kwon and Jeonghwan kim developed a micro electro mechanical systems (MEMS)- based electro magnitically actuated loud speakers to reduce form factor ,cost, and power consumption, and increase energy efficiency in hearing aid applications.The MEMS loud speaker has multilayer copper coils, an nife soft magnet on a thin poly imide diaphragm, and an permanent magnet on the perimeter.the macro-sized permanent magnet is used in the proposed systems which can be replaced with micro-size sol-gel permanent magnet.

Jered Lewis and Dr Brian Moss demonstrated a comparision study between a Electret condenser microphone (ECM) technology and Microelectromechanical systems (MEMS) technology. The proposed system demonstrates a low-power MEMS microphone which will be the future of hearing aids. MEMS microphones can compete in performance with many hearing aids ECMs and can surpass ECM technology in many areas, such as repeatability, stability, size, manufacturability, and power consumption .Hearing aids and other applications that value high performance and consistency, present an opportunity for a new microphones technology that improves on these shortcomings ,allowing manufacturers to produce higher quality devices

CHAPTER 3

EXISTING SYSTEM

A hearing aid is a battery-powered electronic device designed to improve your hearing. Small enough to wear in or behind your ear, they make some sounds louder. Several forms of hearing loss can be treated through the use of hearing devices, such as hearing aids (HAs), middle ear implants (MEIs) or cochlear implants (CIs).In general, a sensor for a hearing device requires a broad frequency response, but not extending to very low frequencies (not below 200 Hz), in order to minimize the response to vibrations produced by body movements. Capturing high frequency sounds (between 4 and 8 kHz) is important for speech understanding, particularly in noisy situations. In line with these requirements most of the microphones currently used inconventional HAs and CIs have a frequency range from 100 Hz to 8 kHz, and for implantable sensors, a bandwidth from 250 Hz to 8 kHz has been proposed. Nevertheless,taking into account that several important environmental sounds are at lower frequencies (below 200 Hz), the lower frequency limit has been defined to be 100,but it should be noted that there exists an overlap of environmental and body sounds between 100 and 200 Hz and this overlap can be an intrinsic limitation of the implantable sensor. Concluding, ideally the frequency range would therefore comprise frequencies from around 100 Hz to 8 kHz and frequency response should be flat within this range in order to avoid the use of compensation filters and therefore reduce DSP power consumption.

Overview of sensors used in hearing aid

The classification is based, primarily on the sensor positioning: subcutaneous or implanted in the ME ossicular chain, Secondly, the classification considers the transduction mechanism: capacitive, electromagnetic, optical, piezoresistive and piezoelectric. Finally, the classification accounts for the sensor type: microphone, accelerometer, displacement sensor and force transducer. Implantable sensors described in the literature are listed in alongside the most significant references, their research status and evaluation methods used to assess sensor performance. An alphanumerical code was added to identify the sensors and will be used throughout the text, where a capital letter represents the sensor type, and a number for each specific example is added. Each sensor is described in this section, and their performance is analysed and compared in the following section.

Subcutaneous microphone

The conventional capacitive microphone comprises a diaphragm that, when deformed by sound pressure, generates an electrical signal through a capacitive mechanism. Capacitive sensing for microphones usually works by measuring changes in capacitance between two conductive plates, or a backplate and a membrane, when a voltage difference is applied to them.

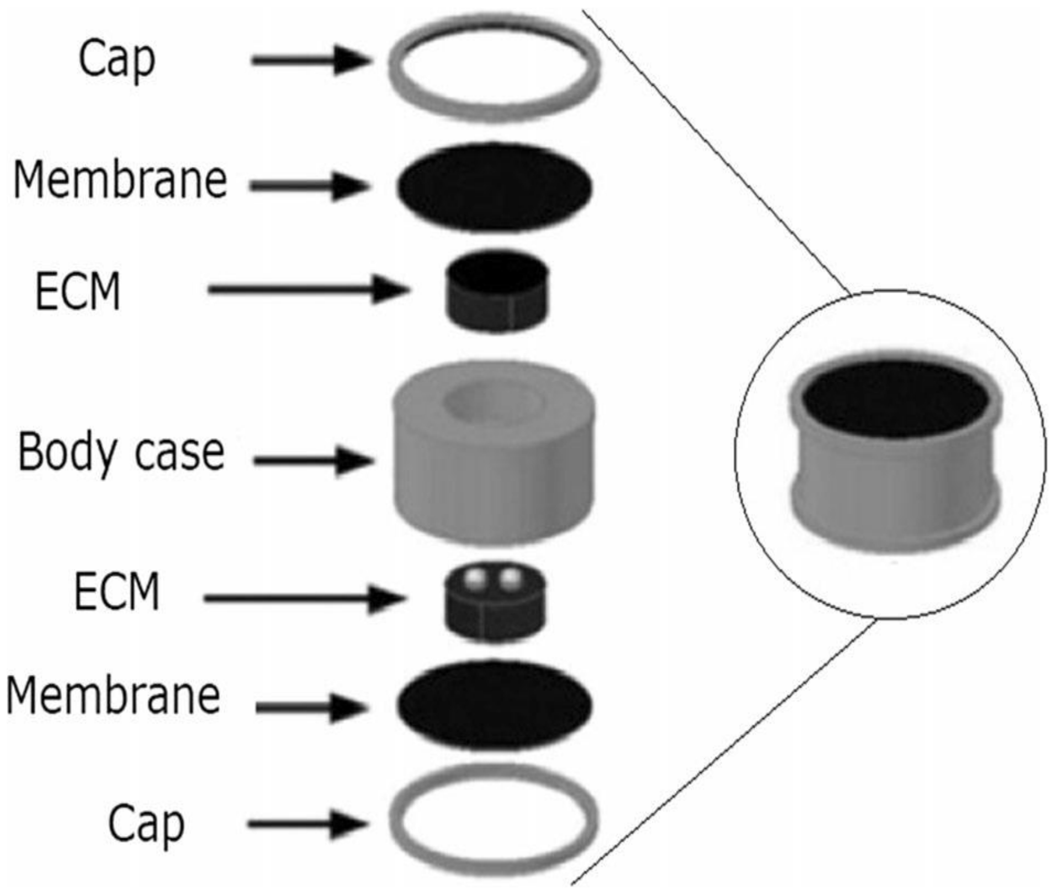


Fig. 4 *– Subcutaneous microphones scheme of combined subcutaneous microphones*

Electromagnetic sensors

One of the first sensors implanted in the ME was an electromagnetic displacement sensor prototype presented by Maniglia et al. in 2001 as an implantable sensor for a TICI. The 29 mg displacement sensor consists of a small titanium encapsulated neodymium–iron–boron magnet glued to the head of the malleus. The magnet interacts with an electric coil placed on a titanium shaft supported in the TB at a distance of 0.5 to 1 mm from the magnet. Its prototype was tested in a laboratory set-up, using a piezoelectric diaphragm simulating the tympanic membrane and ossicular chain, and in fresh human TBs . No further tests in patients have been reported.

Optical sensors

Another, quite different, implantable sensor solution is an optical sensor implanted in the ME cavity, as proposed by Vujanic et al. in 2002. A prototype was tested in a laboratory set-up, using a piezoelectric actuator to simulate the ossicles' vibration. The device measures the vibration of the tympanic membrane (or one of the ossicles) through the reflection of a laser beam radiated by an elastic optical fiber with a diameter of 0.125 mm. The incident and reflected beams are captured by two photo-diodes, transforming them into electrical signals to be processed in a DSP.

Piezoresistive MEMS sensors

Advances in manufacturing procedures, biocompatible materials and encapsulation have qualified MEMS sensors to be used in biomedical applications. MEMS sensors are made using materials and micro-machining techniques originated in the microelectronics industry, and are based primarily on silicon.

Capacitive sensors

Another mechanism used for sensors implanted in the ME is capacitive transduction, used in many applications including vibro-acoustical sensors. These include the microphone approach described previously, but also more specific sensors, like acoustical directivity sensors or vibration sensors that are sensitive to displacement, velocity or acceleration.

Piezoelectric sensors

Piezoelectric materials generate electrical voltage when deformed (direct piezoelectric effect) and show mechanical deformation when an electrical voltage is applied (inverse piezoelectric effect), which enables the piezoelectric transducer to act as sensor or actuator, respectively. The piezoelectric principle can be used in force transducers, accelerometers and microphones, and have also been proposed for implantable sensors. Piezoelectric force transducers usually employ a cantilever bimorph (two layers of piezoelectric ceramic on either side of a stiffening material). The first prototype of a piezoelectric force sensor (H1) to be used as TIHA sensor was proposed by Javel et al. in. In the study, a prototype was constructed from raw piezoelectric bimorph material cut into rectangular cantilever shapes (7 × 1mm2). The sensor was implanted on the malleus of adult cats, and its response was compared with the vibration measured with a LDV with its laser pointed to the tip of the beam.

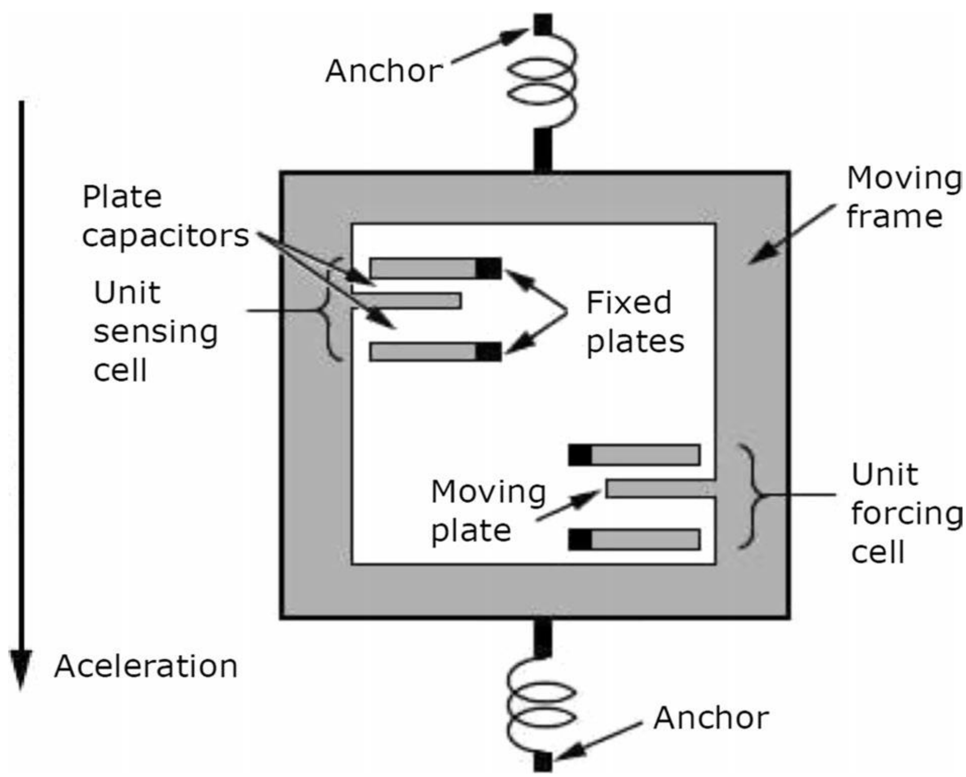


***Fig. 5** – Typical operating scheme of a capacitive MEMS accelerometer*

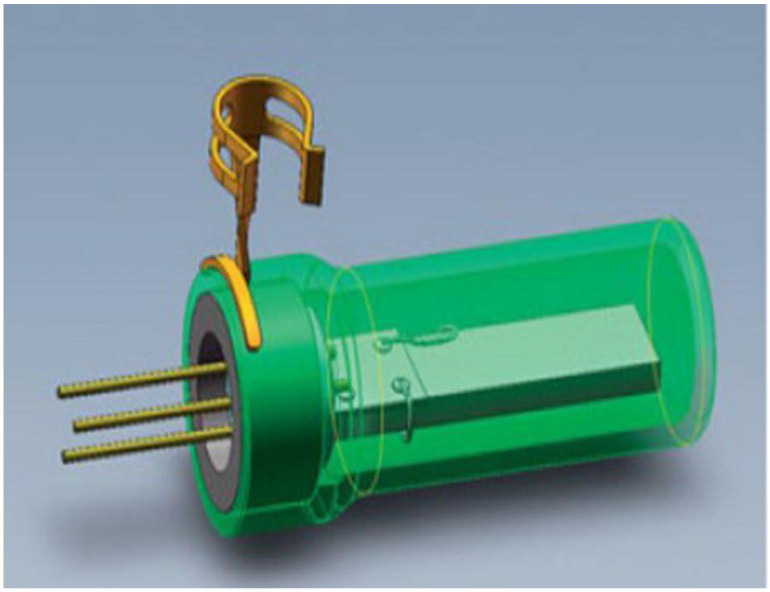


Fig. 6 ***Fig. 7***

Fig. 6 *– Scheme of the Piezoelectric accelerometer*

Fig. 7 *– Photograph of the piezoelectric prototype*

In this way, the user has the greatest possible resolution when choosing the sensors for hearing aids. The piezoelectric force transducer H3 exhibits a prominent result regarding EIN, yet allying low power consumption, which can explain that a similar sensor is being used in the commercial device Esteem. However, surgical difficulty is high with this sensor and device, as two support points in the middle ear are required, and alignment should be very accurate. Some of the problems reported for the Esteem are associated with these aspects, such as the need for repositioning and removal of the sensor ,temporary facial paralysis and partial loss of taste after surgery, the latter being due to the necessity of opening a large insertion in the temporal bone in order to fit this larger sensor. The other non-MEMS piezoelectric sensor, microphone I, also exhibits a promising result regarding piezoelectric transduction, being able to measure 40 ±8 dB SPL between 200 Hz and 5 kHz consuming little power, although its larger dimensions and previously related problems associated to implantable microphones must be considered.

CHAPTER 4

PROBLEM STATEMENT, OBJECTIVE AND MOTIVATION

PROBLEM STATEMENT

Since Electret condenser microphone (ECM) technology in hearing aids limits the repeatability stability, size, manufacturability, and power consumption characteristics of hearing aid. Inspite of these limitations ECM technology is not cost effective. Our project addresses the problems caused due to ECM technology hearing aids. We intend to make the hearing loss patient effectively use of the hearing aid by surpassing the limitations of ECM technology hearing aids.

OBJECTIVES

This project deals with the hearing aid system for analyzing the voice signal using MEMS microphone. LM386 amplifier circuit for amplify the low signal into high signal and after amplify signal microcontroller and LCD display for process signal and display to user for different use and application.

MOTIVATION

A microelectromechanical-systems (MEMS)-based electromagnetically actuated system to reduce form factor, cost, and power consumption, and increase energy efficiency in voice related applications. The MEMS mic has multilayer copper coils, an NiFe soft magnet on a thin polyimide diaphragm. This project is implemented using an atmega328 microcontroller. We are using Arduino IDE software for program it. Lm386 amplifier is implemented for amplify the low signal. So based on voice input the LM358 amplifier will amplify the low signal and the amplified signal will get analyzed by the microcontroller section. After analysis the user will be able to see the signal with an interfaced LCD screen. Variable pot interfaced for control the signal level.

CHAPTER 5

REQUIREMENTS

COMPONENTS USED

1. **MEMS Microphone**
2. **Arduino nano**
3. **OLED Display**
4. **LM386 audio amplifier**
5. **Battery bank**
6. **LSD 1820 voice recorder module**
7. **Relay switch**
8. **Variable Pot**
9. **Speaker**

1. MEMS Microphone

Micro-Electro-Mechanical Systems, or MEMS, is a technology that in its most general form can be defined as miniaturized mechanical and electro-mechanical elements (i.e., devices and structures) that are made using the techniques of microfabrication. The critical physical dimensions of MEMS devices can vary from well below one micron on the lower end of the dimensional spectrum, all the way to several millimeters.

Likewise, the types of MEMS devices can vary from relatively simple structures having no moving elements, to extremely complex electromechanical systems with multiple moving elements under the control of integrated microelectronics. The one main criterion of MEMS is that there are at least some elements having some sort of mechanical functionality whether or not these elements can move.

The term used to define MEMS varies in different parts of the world. In the United States they are predominantly called MEMS, while in some other parts of the world they are called "Microsystems Technology" or "micromachined devices". While the functional elements of MEMS are miniaturized structures, sensors, actuators, and microelectronics, the most notable (and perhaps most interesting) elements are the microsensors and microactuators. Microsensors and microactuators are appropriately categorized as "transducers", which are defined as devices that convert energy from one form to another. In the case of microsensors, the device typically converts a measured mechanical signal into an electrical signal.

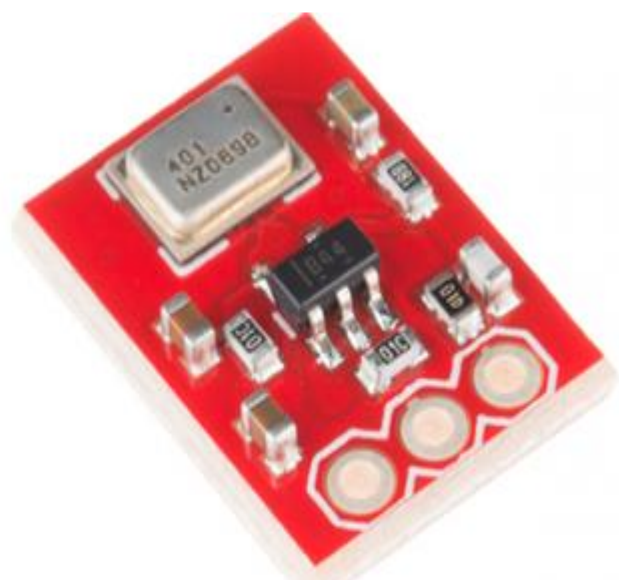


***Fig. 8** – MEMS microphone*

The ADMP4011 is a high quality, high performance, low power, analog output, bottom-ported omnidirectional MEMS microphone. The ADMP401 consists of a MEMS microphone element, an impedance converter, and an output amplifier. The ADMP401 sensitivity specification makes it an excellent choice for both near field and far field applications. The ADMP401 has a high

SNR and flat wideband frequency response, resulting in natural sound with high intelligibility. Low current consumption enables long battery life for portable applications. The ADMP401 complies with the TIA-920 standard, Telecommunications Telephone Terminal Equipment Transmission Requirements for Wideband Digital Wireline Telephones. The ADMP401 is available in a thin, 4.72 mm × 3.76 mm × 1.0 mm surface-mount package.

2. ARDUINO NANO

- **Arduino Nano** is a small, compatible, flexible and breadboard friendly Microcontroller board, developed by Arduino.cc in Italy, based on ATmega328p (Arduino Nano V3.x) / Atmega168 (Arduino Nano V3.x).
- Arduino Nano is simply a smaller version of Arduino UNO, thus both has almost same functionalities.
- It comes with an operating voltage of 5V, however, the input voltage can vary from 7 to 12V.
- **Arduino Nano Pinout** contains 14 digital pins, 8 analog Pins, 2 Reset Pins & 6 Power Pins.
- Each of these Digital & Analog Pins are assigned with multiple functions but their main function is to be configured as input or output.
- They are acted as input pins when they are interfaced with sensors, but if you are driving some load then use them as output.
- Functions like pinMode() and digitalWrite() are used to control the operations of digital pins while analogRead() is used to control analog pins.
- The analog pins come with a total resolution of 10bits which measure the value from zero to

5V.

- Arduino Nano comes with a crystal oscillator of frequency 16 MHz. It is used to produce a clock of precise frequency using constant voltage.
- There is one limitation using Arduino Nano i.e. it doesn't come with DC power jack, means you can not supply external power source through a battery.
- This board doesn't use standard USB for connection with a computer, instead, it comes with Mini USB support.
- Tiny size and breadboard friendly nature make this device an ideal choice for most of the applications where a size of the electronic components are of great concern.
- Flash memory is 16KB or 32KB that all depends on the Atmega board i.e Atmega168 comes with 16KB of flash memory while Atmega328 comes with a flash memory of 32KB. Flash memory is used for storing code. The 2KB of memory out of total flash memory is used for a bootloader.
- You can download Arduino Nano Datasheet by clicking below button:
- The SRAM can vary from 1KB or 2KB and EEPROM is 512 bytes or 1KB for Atmega168 and Atmega328 respectively.
- This board is quite similar to other Arduino boards available in the market, but the small size makes this board stand out from others.
- Following figure shows the specifications of Arduino Nano Board.

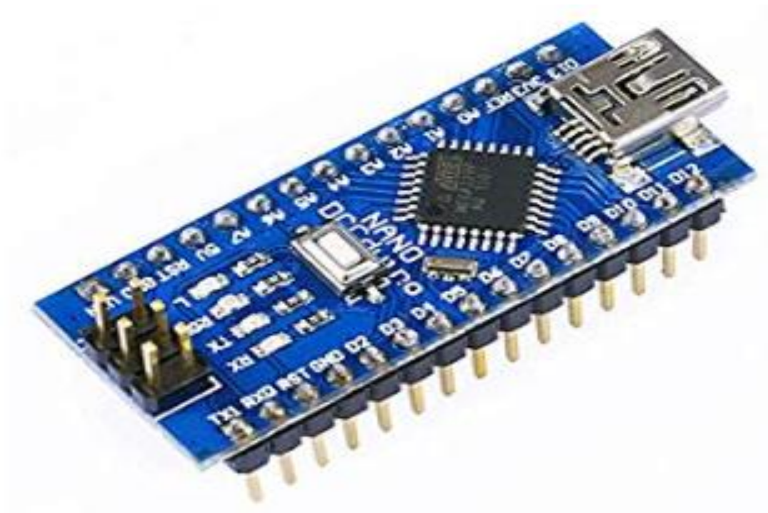


Fig. 9 *– Arduino Nano*

Microcontroller	Atmega328p/Atmega 168
Operating Voltage	5V
Input Voltage	7 – 12 V
Digital I/O Pins	14
PWM	6 out of 14 digital pins
Max. Current Rating	40mA
USB	Mini
Analog Pins	8
Flash Memory	16KB or 32KB
SRAM	1KB or 2KB
Crystal Oscillator	16 MHz
EEPROM	512bytes or 1KB
USART	Yes

Table 01 *– Arduino nano specifications*

- It is programmed using Arduino IDE which is an Integrated Development Environment that runs both offline and online.

- No prior arrangements are required to run the board. All you need is board, mini USB cable and Arduino IDE software installed on the computer. USB cable is used to transfer the program from computer to the board.
- No separate burner is required to compile and burn the program as this board comes with a built-in boot-loader.

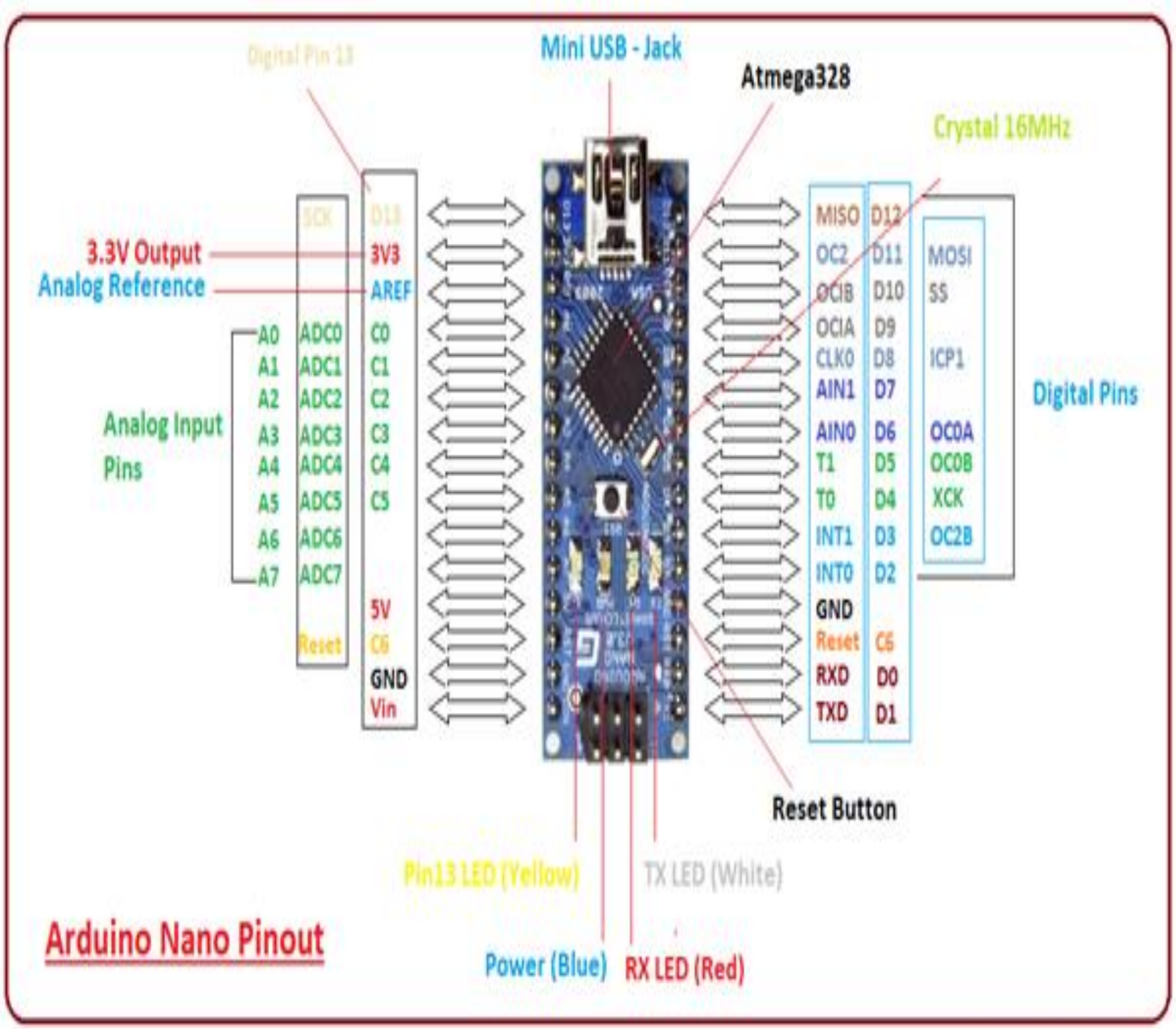
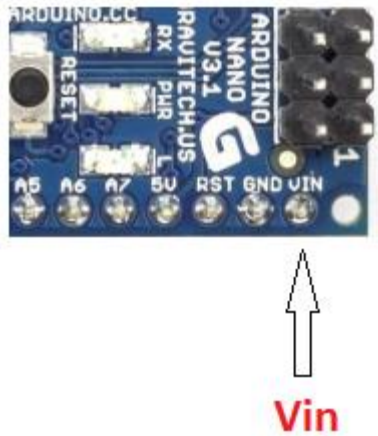
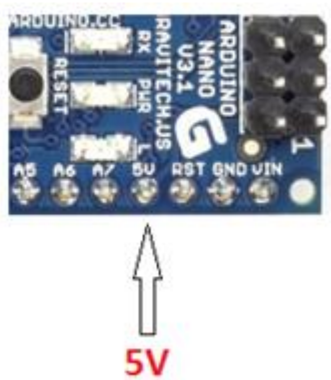


***Fig. 10** – Arduino nano pinout*



- **5V.** It is a regulated power supply voltage of the board that is used to power the controller and other components placed on the board.

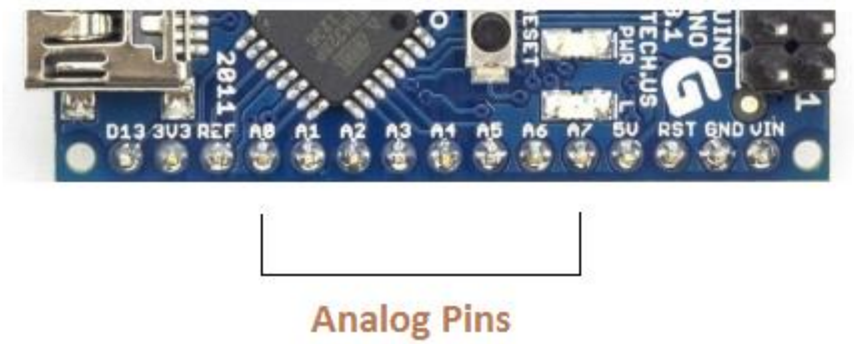


- **3.3V.** this is a minimum voltage generated by the voltage regulator on the board.

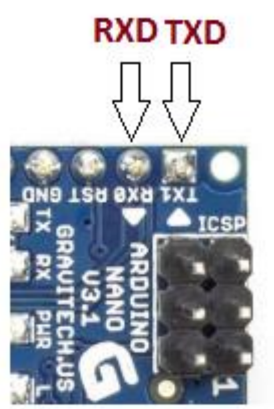
- **GND.** These are the ground pins on the board. There are multiple ground pins on the board that can be interfaced accordingly when more than one ground pin is required.

- **Reset.** Reset pin is added on the board that resets the board. It is very helpful when running program goes too complex and hangs up the board. LOW value to the reset pin will reset the controller.

- **Analog Pins.** There are 8 analog pins on the board marked as A0 - A7. These pins are used to measure the analog voltage ranging between 0 to 5V.



- **Rx, Tx.** These pins are used for serial communication where Tx represents the transmission of data while Rx represents the data receiver.



- **13.** This pin is used to turn on the built-in LED.

- **AREF.** This pin is used as a reference voltage for the input voltage.

- **PWM.** Six pins 3,5,6,9,10, 11 can be used for providing 8-pit PWM (Pulse Width Modulation) output. It is a method used for getting analog results with digital sources.
- **SPI.** Four pins 10(SS),11(MOSI),12(MISO),13(SCK) are used for SPI (Serial Peripheral Interface). SPI is an interface bus and mainly used to transfer data between microcontrollers and other peripherals like sensors, registers, and SD card.
- **External Interrupts.** Pin 2 and 3 are used as external interrupts which are used in case of emergency when we need to stop the main program and call important instructions at that point. The main program resumes once interrupt instruction is called and executed.
- **I2C.** I2C communication is developed using A4 and A5 pins where A4 represents the serial data line (SDA) which carries the data and A5 represents the serial clock line (SCL) which is a clock signal, generated by the master device, used for data synchronization between the devices on an I2C bus.

3. OLED DISPLAY

Organic light-emitting diodes or Oleds. These were developed during the 20th century the very first commercial device to use old LEDs was a Kodak camera in 2003 in 2013 Samsung became the first company to release OLED televisions and they're now the biggest manufacturer in the world of OLED television screens now, the Oled we're going to be using is not as big as TV Screen, but very small one as you can see in the picture below. The Oled displays are the kinds of devices you'll see on items like mp3 radios and smart watches and they're very nice These things have a lot of excellent properties to use with an Arduino as a display, they are very easy to read, they take a very small current and you can read them from different angels.

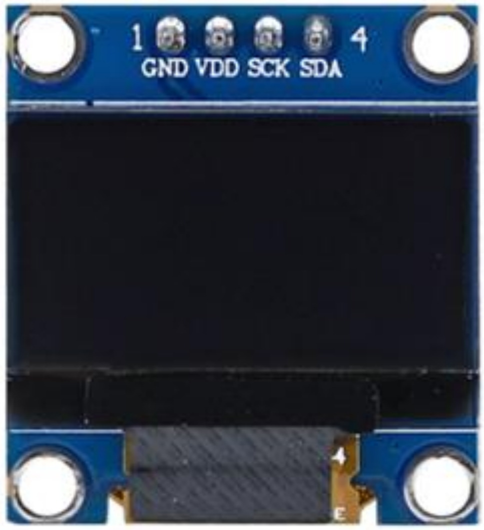


***Fig. 11** – OLED display*

This is a mono color, 0.96-inch with 128×64 pixels Oled i2c display module. OLED stands for Organic light emitting diode. There are two different models of the same Oled display module which are SSD1306 and SH1106. Only by looking at the Oled display it's really hard to tell whether this is SSD1306 or SH1106 model. Which I will tell you in a minute how to find this.

Unlike the 16×2 liquid crystal display module, the Oled display does not require backlight, which results in a very nice contrast and moreover the Oled display consumes less power when compared with other displays.

4. LM386 AUDIO AMPLIFIER

The IC LM386 is a low-power audio amplifier, and it utilizes low power supply like batteries in electrical and electronic circuits. This IC is available in the package of mini 8-pin DIP. The voltage gain of this amplifier can be adjusted to 20, and the voltage gain will be enhanced to 200 by employing external components like resistors as well as capacitors among the pins 1 & 8. When this amplifier uses a 6V power supply for the operation then the static power drain will be 24 milliwatts to make the amplifier for an ultimate operation of the battery. This amplifier consists of 8-pins where pin-1 and pin-8 are gain control pins of the amplifier, and this IC is most widely used IC that allows a customer to increase volume.

IC LM386 Pin Configuration

The IC LM386 audio amplifier consists of 8-pins where each pin of this IC is discussed below.

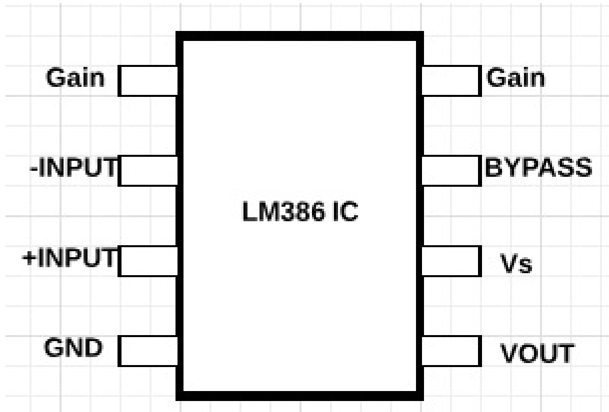


***Fig. 12** – LM386 IC*

IC LM386 Pin Configuration

- Pin1 (Ga+-gain Pin): Pin-1 is gain pin, used adjust the amplifier gain by connecting this IC to an external component capacitor.
- Pin2 (+IN-Non-inverting): Pin-2 is the non-inverting pin, is used to provide the audio signal.
- Pin3 (+IN): Pin-3 is the inverting terminal and it is normally connected to ground.
- Pin4 (GND): Pin-4 is a ground pin connected to the ground terminal of the system
- Pin5 (Vout): Pin-5 is the output pin, used to provide amplified output audio, and allied to the speaker.
- Pin-6 (VCC or VSS): Pin-6 is connected to the power
- Pin-7 (Bypass): Pin-7 bypass pin is used to connect a decoupling capacitor.
- Pin-8 (Gain): Pin-8 is the gain setting pin

LM386 Audio Amplifier Circuit Diagram and Working

The Audio amplifier can be built with LM386 IC, capacitors like 0.05 µF, 10 µF, Potentiometer – 10 KΩ, resistor-10 KΩ, power supply, breadboard, and connecting wires.

Basically, this Audio Amplifier includes 3-functional blocks such as Power as well as Output, Bypass, gain control. Designing of this circuit design is so simple. At first, connect the two power supply pins namely pin4 & pin6 to GND as well as voltage correspondingly.

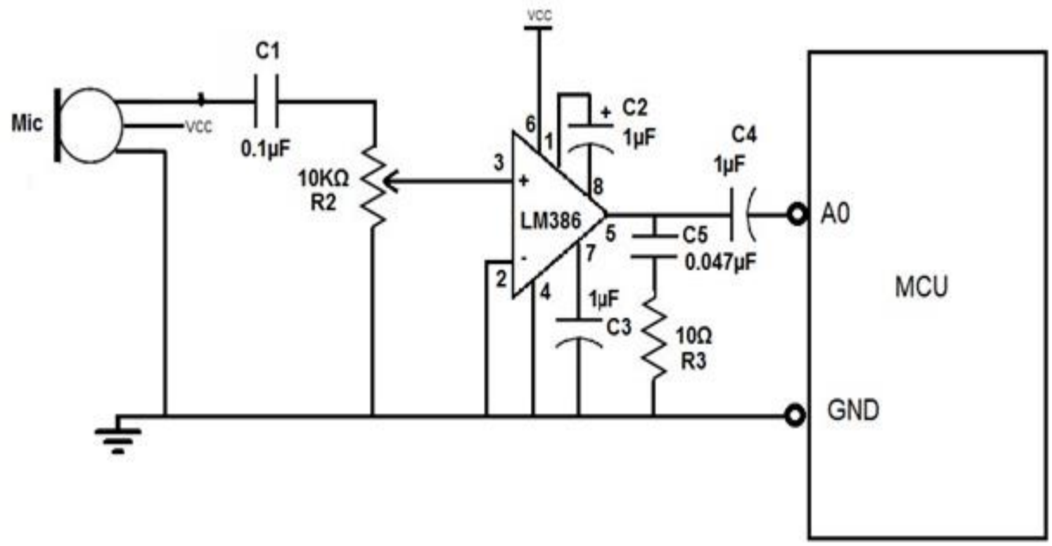


Fig 13- LM386 Audio Amplifier Circuit

After that, connect the input from any kind of audio sources such as a mobile phone or a microphone. Here this circuit uses a mobile phone as the audio source with the help of the 3.5mm connector. This connector will be having three connections like the ground right and left audio. This LM386 IC is a simple amplifier and connects the right or left audio to this amplifier using an audio source with the ground terminal. The input level in this circuit can be controlled by connecting a potentiometer to the input. In addition, a capacitor will be connected to the input in series to remove the DC components. This IC gain will be adjusted to 20, and connect a capacitor (10 µF) between the two pins 1 & 8 of this IC then the gain will be enhanced to 200.

Even though the datasheet of audio amplifier advises that the bypass-capacitor at the 7th pin is an option, we form that connecting a capacitor (100 µF) was truly helpful because it assists in the noise reduction. For the connection of output, a capacitor (0.05 µF) and a resistor (10 Ω) will be connected in series among the GND as well as a 5th pin of the IC.

The main features of LM386 chip include the following.

- IC LM386 is obtainable in the package of 8-pin MSOP
- Exterior components are minimum
- Operation of Battery
- Low static power drain- 4mA
- The range of supply voltage
- Input is referenced by ground

5. BATTERY BANK

Brand	Envie
Manufacturer	IMS Mercantiles Pvt. Ltd., 011 47074444
Model	ERB 9V MU
Model Name	Infinite
Product Dimensions	6 x 3 x 1.5 cm; 120 Grams
Batteries	1 9V batteries required. (included)
Item model number	ERB 9V MU
Special Features	Micro USB Charging

Mounting Hardware	Battery
Number Of Items	1
Voltage	9 Volts
Batteries Included	Yes
Batteries Required	Yes
Battery Capacity	500 Milliamp Hours
Battery Cell Composition	Lithium

Table 02- Battery bank specification

Fig 14- Battery bank

6. ISD1820 VOICE RECORDER

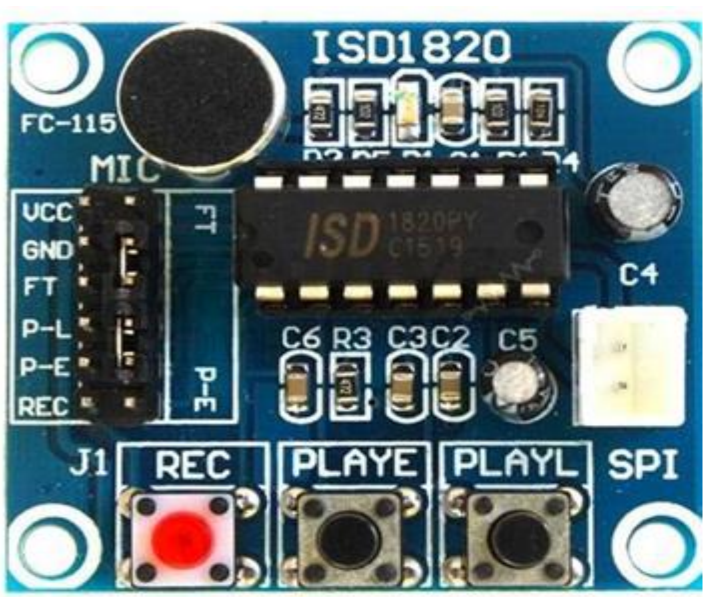


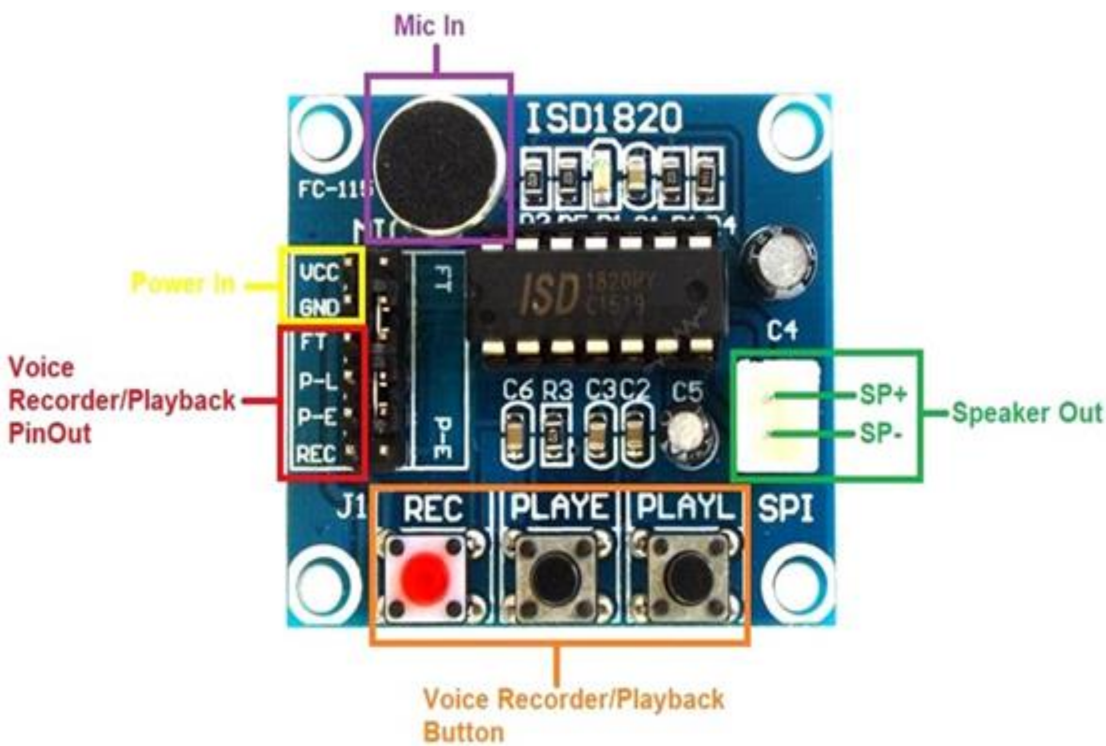
Fig 15- ISD1820 Voice recorder

ISD1820 is a small Voice Recorder and Playback module that can do the multi-segment recording. The user can achieve a high quality of recording (for 8 to 20secs) for each application with the adjustment of the on-board resistor. This Voice Recorder/Playback module is designed with embedded-Flash memory, which can hold data for up to 100 years and erase/record the life cycle up to 100,000.

Table 03-Pin Description of ISD1820 Recorder/Playback Module

Pin Name	Description
VCC	DC 2.4-5.5V
GND	Ground
FT	FeedThrough: This mode enables the Microphone to drive the speaker directly.
REC/REC (Button)	The REC input is an active-HIGH record signal. The module starts recording whenever REC is HIGH. This pin must remain HIGH for the duration of the recording. REC takes precedence over either playback (PLAYLorPLAYE) signal.
P-E/PLAY-E (Button)	Playback, Edge-activated: When a HIGH-going transition is detected continues until an End-of-Message (EOM) marker is encountered or the end of the memory space is reached.

P-L/PLAY-L (Button)	Playback, Level-activated, when this input pin level transits for LOW to HIGH, a playback cycle is initiated.
SPI	The SP+ and SP- pins provide a direct drive for loudspeakers with impedances as low as8Ω. **Note: This is not Serial Parallel Interface Pins.**



Features of ISD1820 Recorder/Playback Module

- Operating Voltage: Wide power supply ranges from 2.4V to 5.5V DC.
- With the internal audio amplifier, this board can drive 8 Ohm 0.5W speakers directly.
- An on-board microphone.

7. RELAY SWITCH

Fig 16- Relay switch

An electric Relay switch is a device that interrupts the electron flow in a circuit. Switches are primarily binary devices: either fully on or off and light switches have a simple design. When the switch is turned off, the circuit breaks and the power flow is interrupted. Circuits consist of a source of power and load. A load is a power-powered device. The function of an electric Relay switch is to regulate the current between the load and source of power. The power source is the electrons that push through the circuits. The voltage is the quantity of force or pressure applied by the power source. Power sources must have a negative and positive endpoint. The negative terminal connects to the charge, and the electrons drive through the circuit. The load receives the current and returns it via the positive terminal to the power source. The electrical switch is inserted in this loop.

8. VARIABLE POT

Variable pot/Potentiometer is a three-terminal resistor with a sliding or rotating contact that forms an adjustable voltage divider. If only two terminals are used, one end and the wiper, it acts as a variable resistor or rheostat. Potentiometers are commonly used to control electrical devices such as volume controls on audio equipment. Potentiometers operated by a mechanism can be used as position transducers, for example, in a joystick. Potentiometers are rarely used to directly control significant power (more than a watt), since the power dissipated in the potentiometer would be comparable to the power in the controlled load.

Fig 17- Variable pot

9. SPEAKER

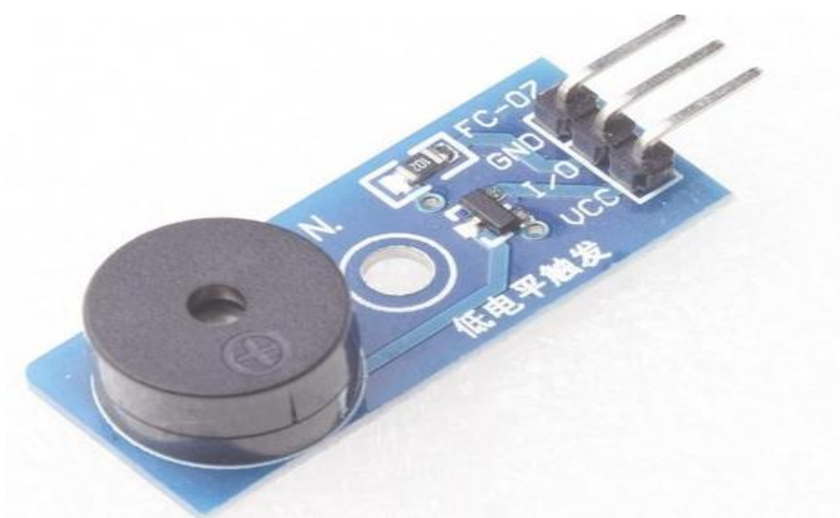


Fig 18- Speaker

A speaker driver mainly consists of a speaker and driver. It is generally called as a speaker, as this is the part that produces sound. The driver is actually a transducer that uses an electronically induced reciprocating motion to make pressure waves, which are used to create the original sound. The motion is created with the help of a diaphragm. The diaphragm is a flexible cone or also a dome which is usually made of paper or plastic. It also has two magnets out of which one is mounted to the diaphragm and is made up of tightly wound electrical wire. It is used to receive the electrical signals from the amplifier so as to move the voice coil. The voice coil then interacts with the second magnet which is a permanent magnet. The permanent magnet is usually larger than the moving magnet. The drivers produce lower frequencies when they are larger in size.

CHAPTER 6

METHODOLOGY

6.1 Block Diagram

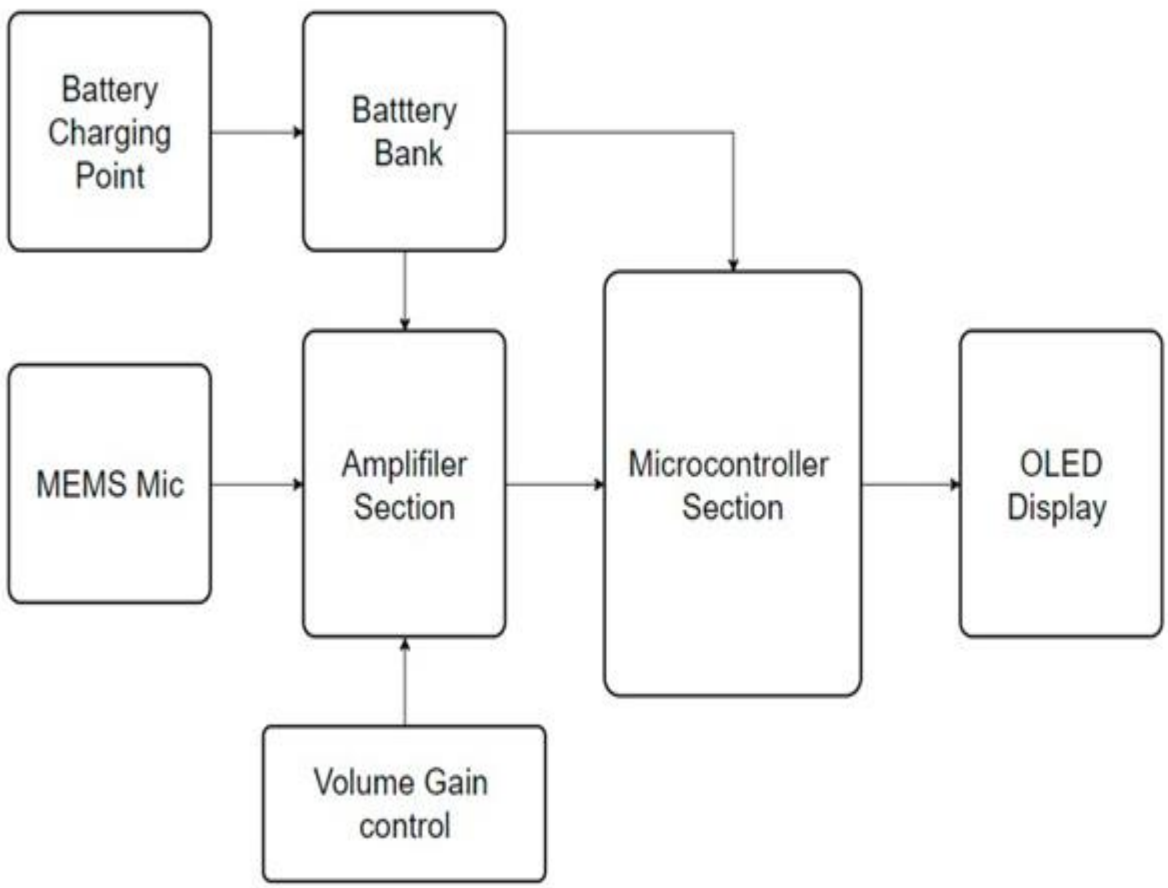


Fig 19- Block Diagram

- Circuit is getting power from rechargeable battery bank. We used 9 V rechargeable battery for compact size and based on requirements. MEMS microphone interfaced with LM386 Amplifier circuit. Based on voice input the MEMS mic will pass signal to amplifier circuit.
- Amplifier circuit will amplify the low signal into high signal based on Variable volume adjust pot.
- This signal will pass to microcontroller for analysis. Atmea328 microcontroller used in this implementation.

- Based on Code, the microcontroller will analysis this signal and we interface OLD screen with microcontroller.
- User will able to see signal status on interfaced OLED Display screen.

6.2 Sound recorder section

We designed a sound recorder system for generating the voice signal. We used here ISD1820 module for sound recording and a speaker for voice.

The ISD1820 Voice Recorder Module is based on the ISD1820 IC, which is a single chip Voice recorder IC for single message record and playback. I am not sure about the availability of only the IC but it is frequently found in the module with all the necessary components and circuitry. A major feature of the ISD1820 Voice Recorder Module is that is can store the messages in its non-volatile memory and can be configured to store messages of length between 8 Seconds to 20 Seconds. The

ISD1820 Voice Recorder Module used in this project is shown below. As you can see, there are a lot of components on the board that help the ISD1820 IC in recording and playback.

6.3 IDE Software

- Arduino IDE is an open source software that is mainly used for writing and compiling the code into the Arduino Module.
- It is an official Arduino software, making code compilation too easy that even a common person with no prior technical knowledge can get their feet wet with the learning process.
- It is easily available for operating systems like MAC, Windows, and Linux and runs on the Java Platform that comes with inbuilt functions and commands that play a vital role for debugging, editing and compiling the code in the environment.
- A range of Arduino modules available including Arduino Uno, Arduino Mega, Arduino Leonardo, Arduino Micro and many more.

- Each of them contains a microcontroller on the board that is actually programmed and accepts the information in the form of code.
- The main code, also known as a sketch, created on the IDE platform will ultimately generate a Hex File which is then transferred and uploaded in the controller on the board.
- The IDE environment mainly contains two basic parts: Editor and Compiler where former is used for writing the required code and later is used for compiling and uploading the code into the given Arduino Module.
- This environment supports both C and C++ languages.

Arduino IDE

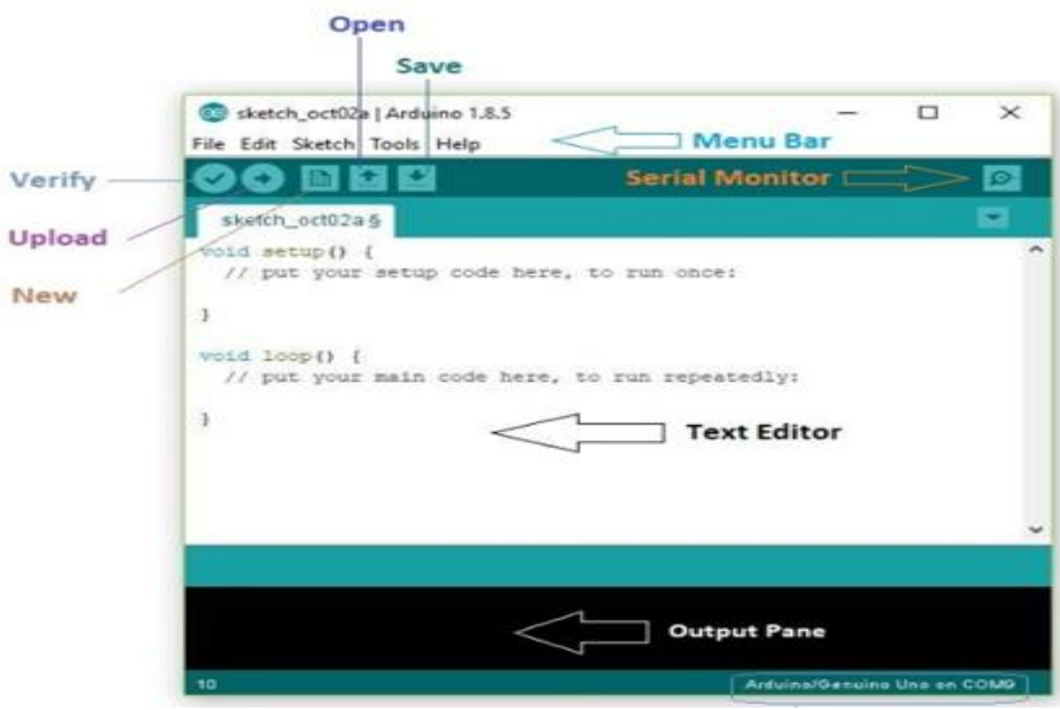
- Menu bar
- Text editor
- Output

The bar appearing on the top is called **Menu Bar** that comes with five different options as follow

- **File** –You can open a new window for writing the code or open an existing one. Following table shows the number of further subdivisions the file option is categorized into.
- **Edit** – Used for copying and pasting the code with further modification for font
- **Sketch** – For compiling and programming
- **Tools** – Mainly used for testing projects. The Programmer section in this panel is used for burning a bootloader to the new microcontroller.
- **Help** – In case you are feeling skeptical about software, complete help is available from

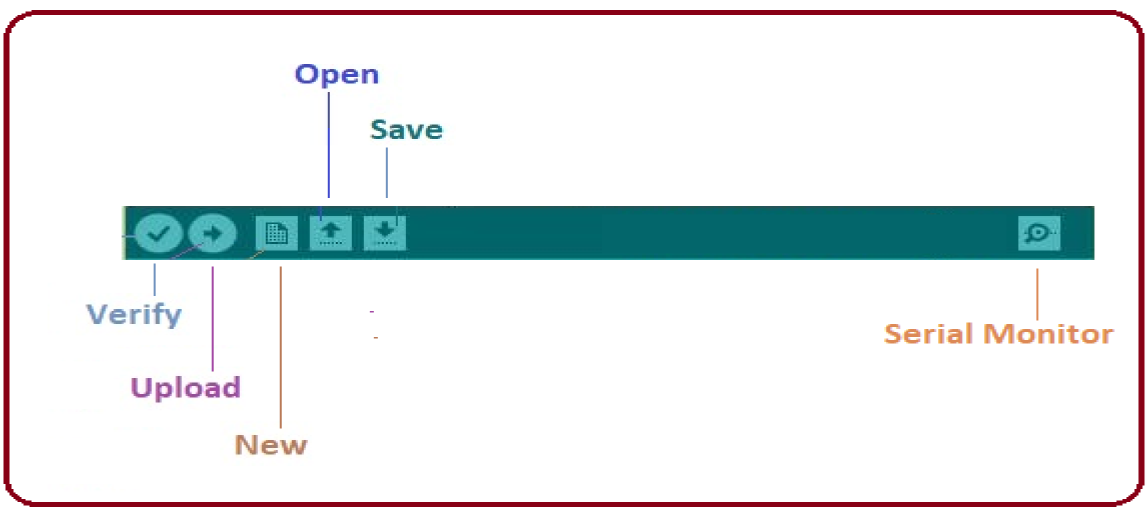
getting started to troubleshooting.

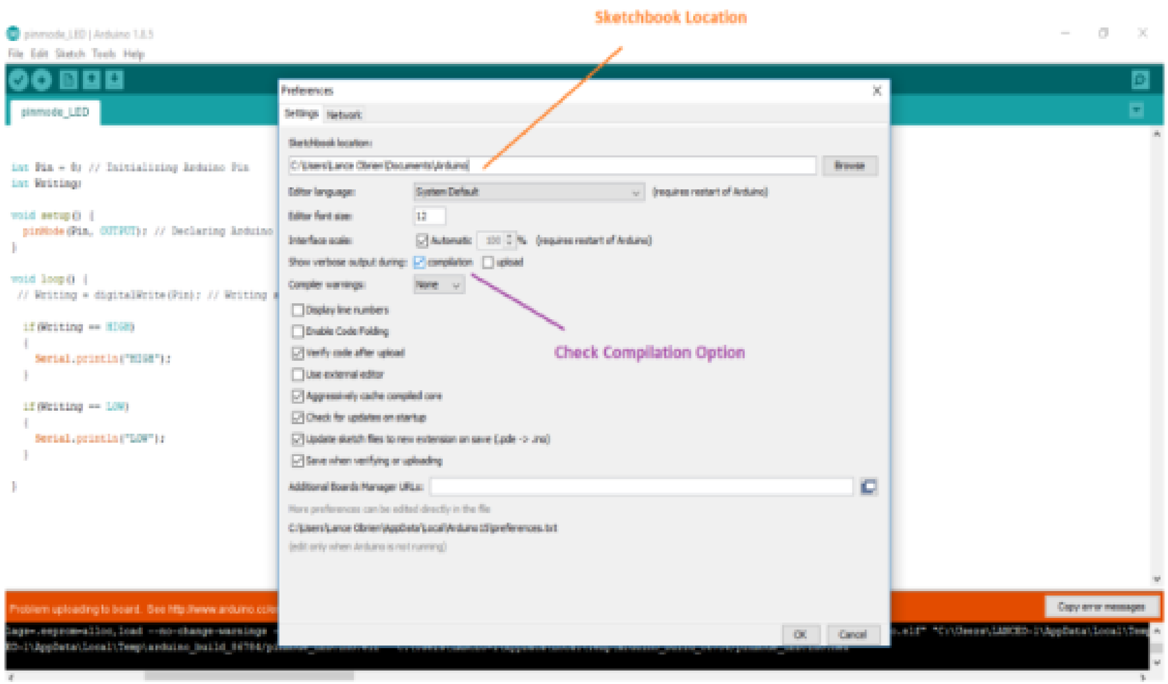
File	
New	This is used to open new text editor window to write your code
Open	Used for opening the existing written code
Open Recent	The option reserved for opening recently closed program
Sketchbook	It stores the list of codes you have written for your project
Examples	Default examples already stored in the IDE software
Close	Used for closing the main screen window of recent tab. If two tabs are open, it will ask you again as you aim to close the second tab
Save	It is used for saving the recent program
Save as	It will allow you to save the recent program in your desired folder
Page setup	Page setup is used for modifying the page with portrait and landscape options. Some default page options are already given from which you can select the page you intend to work on
Print	It is used for printing purpose and will send the command to the printer
Preferences	It is page with number of preferences you aim to setup for your text editor page
Quit	It will quit the whole software all at once



The **Six Buttons** appearing under the Menu tab are connected with the running program as follow.

- The check mark appearing in the circular button is used to verify the code. Click this once you have written your code.
- The arrow key will upload and transfer the required code to the Arduino board.
- The dotted paper is used for creating a new file.
- The upward arrow is reserved for opening an existing Arduino project.
- The downward arrow is used to save the current running code.
- The button appearing on the top right corner is a **Serial Monitor** – A separate pop-up window that acts as an independent terminal and plays a vital role for sending and receiving the Serial Data. You can also go to the Tools panel and select Serial Monitor, or pressing Ctrl+Shift+M all at once will open it instantly. The Serial Monitor will actually help to debug the written Sketches where you can get a hold of how your program is operating. Your Arduino Module should be connected to your computer by USB cable in order to activate the Serial Monitor.




Sketchbook Location
Check Compilation Option


Hex File Generated

CHAPTER 7

RESULT AND DISCUSSION

This Project is implemented based on MEMS microphone and atmega328 microcontroller. With help of the Lm386 amplifier circuit we are able to successfully amplify low signal into high signal. An Atmega328 microcontroller is able to read and analyze that signal without any error. Users will be able to see the signal on the LCD display screen successfully. It's getting power from the battery and user will able to recharge it.

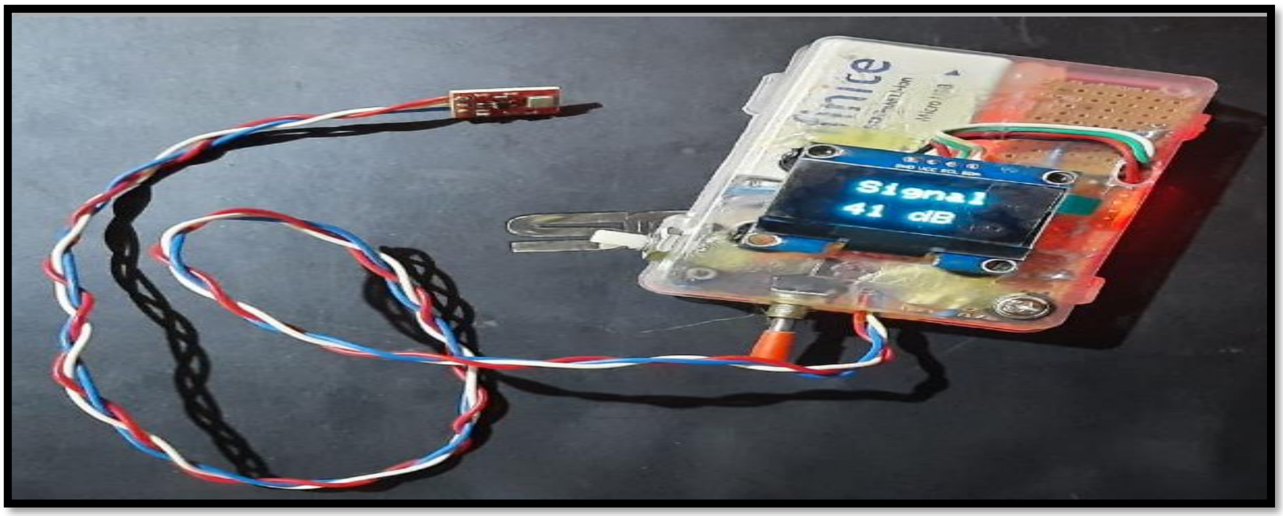


Fig 20- Hearing aid box front view

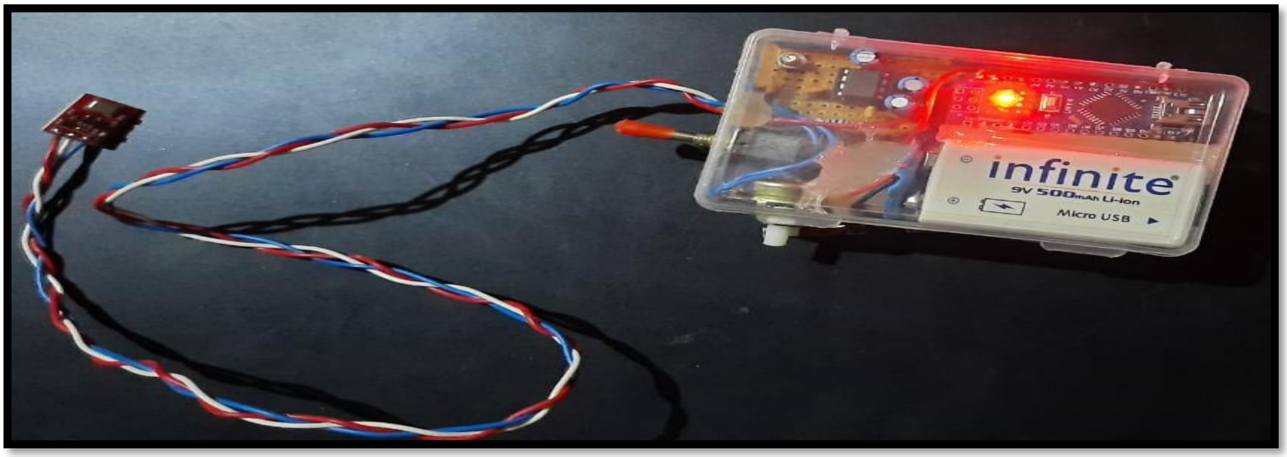


Fig 21- Hearing aid box rear view

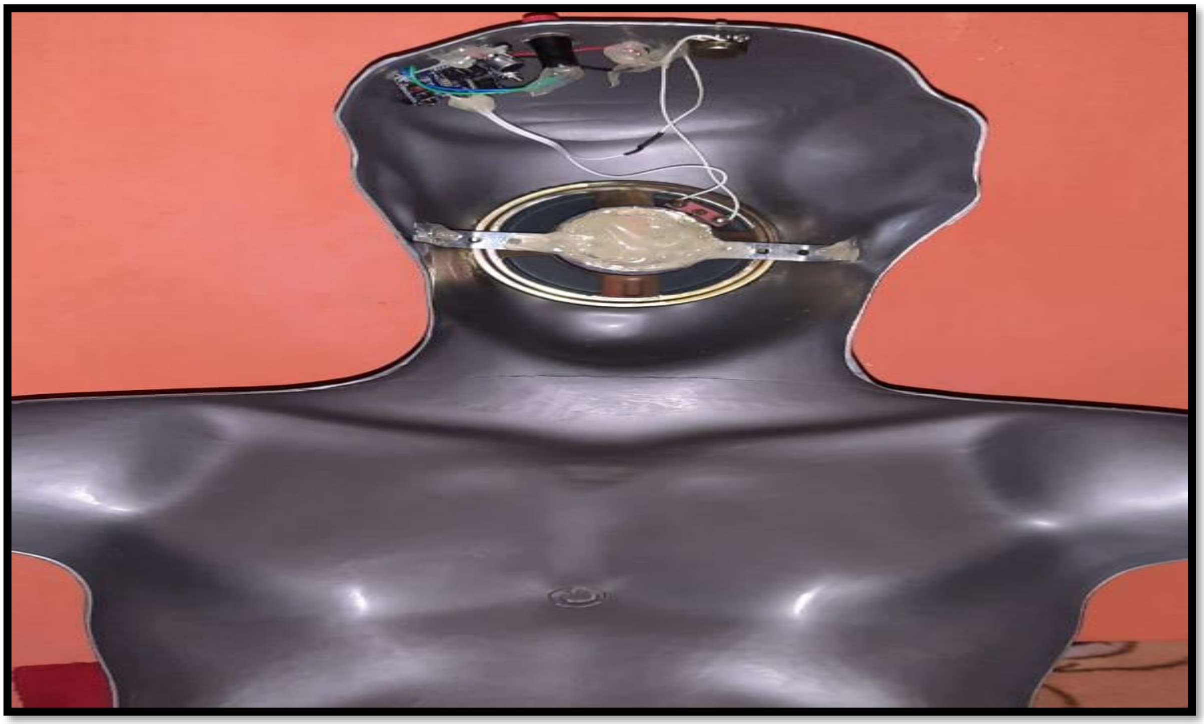


Fig 22- Amplifier section at the rear of the prototype model

Fig 23- Prototype front view

CHAPTER 8

ADVANTAGES, DISADVANTAGES AND APPLICATION

8.1 Advantages

- Low Power Consumption
- Easy to use
- Noise less system
- Volume control
- LCD screen for user

8.2 Disadvantage

- Circuit complexity

8.3 Applications

- Hearing aid
- Loudspeaker
- Public address system
- Mobile phone
- Walkie talkie

CHAPTER 9

CONCLUSION AND FUTURE SCOPE

9.1 Future scope

New high-performance, low-power MEMS microphones demonstrate that they will be the next generation of microphone technology for hearing aids. MEMS microphones can compete in performance with many hearing aid ECMs and can surpass ECM technology in many areas, such as repeatability, stability, size, manufacturability, and power consumption. MEMS microphones are the future for hearing aids, and that future is here now.

9.2 Conclusion

We present an electromagnetically actuated MEMS-based loudspeaker as a highly compact, low-power, low-cost technology suitable for improving the performance of CIC-type hearing aids.
This Project is implemented based on MEMS microphone and atmega328 microcontroller. With help of Lm386 amplifier circuit we are able to successfully amplify low signal into high signal. And Atmega328 microcontroller able to read and analysis that signal without any error. User will able to see the signal on LCD display screen successfully. It's getting power from battery and user will able to recharge it.

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Seema P

has presented his/her research paper titled

Design and fabrication of low-cost MEMS based listening device for hearing impaired.

which has been awarded as **BEST RESEARCH PAPER PRESENTATION** in ICFTEN - 2021
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This is to certify that **TRIVENI K** of Rao Bahadur Y Mahabaleswarappa Engineering College, Ballari presented his/her research paper titled Design and fabrication of low cost MEMS based listening device for hearing impaired in the "2nd International Conference on Futuristic Trends in Embedded Systems and Networking (ICFTEN 2021)" Organized by Department of Electronics and Communication Engineering & IQAC, Rao Bahadur Y.Mahabaleshwarappa Engineering College, Ballari, Karnataka held on 07th & 08th July 2021.

Dr. T. Hanumanth Reddy	**Dr. Savita Sonoli**	**Dr. Prabhavathi S**	**Mr. Rudra B. Satpathy**
Patron | ICFTEN 2021	Conference Chair | ICFTEN 2021	Convenor | ICFTEN 2021	CEO & Founder
Principal	Vice Principal & HOD (E&CE)	Professor (E&CE)	Institute For Engineering Research
RYMEC, Ballari	RYMEC, Ballari	RYMEC, Ballari	and Publication (IFERP)

V.V.Sangha's

Rao Bahadur Y. Mahabaleswarappa Engineering College, Ballari.

Department of Electronics & Communication Engineering

CERTIFICATE OF PARTICIPATION

This is to Certify that Seema P Bearing USN 3VC17EC062 From RYMEC Has Participated in "PROJECT EXHIBITION & COMPETITION 2021" Organised by Department of Electronics & Communication Engineering, RYMEC, Ballari on 3rd August 2021.

DR. T. HANUMANTHA REDDY
Principal

DR. SAVITA SONOLI
Vice Principal & HOD-ECE

MR. L VIRUPAKSHAPPA
VAsst. General Manager(Retired) BSNL, Ballari

DR. S PRABHAVATHI
Professor
Dept. of ECE

MR. T NAGARAJU
Asst. General Manager, Airport Authority of India, Ballari

V.V.Sangha's

Rao Bahadur Y. Mahabaleswarappa
Engineering College, Ballari.

Department of Electronics & Communication Engineering

CERTIFICATE OF PARTICIPATION

This is to Certify that Sonia S Bearing USN 3VC17EC069 From RYMEC Has Participated in "PROJECT EXHIBITION & COMPETITION 2021" Organised by Department of Electronics & Communication Engineering, RYMEC, Ballari on 3rd August 2021.

DR. T. HANUMANTHA REDDY Principal	**DR. SAVITA SONOLI** Vice Principal & HOD-ECE	**MR. L VIRUPAKSHAPPA** VAsst. General Manager(Retired) BSNL, Ballari	**DR. S PRABHAVATHI** Professor Dept. of ECE	**MR. T NAGARAJU** Asst. General Manager, Airport Authority of India, Ballari

V.V.Sangha's
Rao Bahadur Y. Mahabaleswarappa
Engineering College, Ballari.

Department of Electronics & Communication Engineering

CERTIFICATE OF PARTICIPATION

This is to Certify that K Swetha Bearing USN 3VC17EC025 From RYMEC Has Participated in "PROJECT EXHIBITION & COMPETITION 2021" Organised by Department of Electronics & Communication Engineering, RYMEC, Ballari on 3rd August 2021.

DR. T. HANUMANTHA REDDY	DR. SAVITA SONOLI	MR. L VIRUPAKSHAPPA	DR. S PRABHAVATHI	MR. T NAGARAJU
Principal	Vice Principal & HOD-ECE	VAsst. General Manager(Retired) BSNL, Ballari	Professor Dept. of ECE	Asst. General Manager, Airport Authority of India, Ballari

V.V.Sangha's

Rao Bahadur Y. Mahabaleswarappa Engineering College, Ballari.

Department of Electronics & Communication Engineering

CERTIFICATE OF PARTICIPATION

This is to Certify that Triveni Bearing USN 3VC17EC078 From RYMEC Has Participated in "PROJECT EXHIBITION & COMPETITION 2021" Organised by Department of Electronics & Communication Engineering, RYMEC, Ballari on 3rd August 2021.

DR. T. HANUMANTHA REDDY	DR. SAVITA SONOLI	MR. L VIRUPAKSHAPPA	DR. S PRABHAVATHI	MR. T NAGARAJU
Principal	Vice Principal & HOD-ECE	VAsst. General Manager(Retired) BSNL, Ballari	Professor Dept. of ECE	Asst. General Manager, Airport Authority of India, Ballari

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BB Road, Chickballapur – 562101

Certificate of Appreciation

This certificate of appreciation is awarded to **SEEMA P** of **RAO BAHADUR Y MAHABALESHWAR APPA ENGINEERING COLLEGE, BALLARI** in recognition of "**Best Project**" entitled **DESIGN AND FABRICATION OF LOW COST MEMS BASED LISTENING DEVICE FOR HEARING IMPAIRED** in the Symposium cum Project Exhibition on ***Recent Advances in Engineering Science*** organized by **S J C Institute of Technology In association with Karnataka Science and Technology Academy** on **19th July 2021**.

Dr. R Ranganatha	Dr. A M Ramesh	Dr. G T Raju
Convener	CEO, KSTA	Principal

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Dr. R Ranganatha
Convener

Dr. A M Ramesh
CEO, KSTA

Dr. G T Raju
Principal

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of **RAO BAHADUR Y MAHABALESHWAR APPA ENGINEERING COLLEGE, BALLARI**
in recognition of "**Best Project**" entitled **DESIGN AND FABRICATION OF LOW COST MEMS BASED LISTENING DEVICE FOR HEARING IMPAIRED**
in the Symposium cum Project Exhibition on ***Recent Advances in Engineering Science*** organized by **S J C Institute of Technology In association with Karnataka Science and Technology Academy** on **19th July 2021**.

Dr. R Ranganatha **Convener**	**Dr. A M Ramesh** **CEO, KSTA**	**Dr. G T Raju** **Principal**

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Dr. R Ranganatha **Convener**	**Dr. A M Ramesh** **CEO, KSTA**	**Dr. G T Raju** **Principal**

RAO BAHADUR Y. MAHABALESWARAPPA ENGINEERING COLLEGE, BALLARI
DEPARTMENT OF ELECTRONICS AND COMMUNICATION

VISION, MISSION, PROGRAM EDUCATIONAL OBJECTIVES and PROGRAM SPECIFIC OUTCOMES (PSO)

VISION OF THE INSTITUTION

To Produce Professionally Excellent, Knowledgeable, Globally Competitive and Socially Responsible Engineers and Entrepreneurs.

MISSION OF THE INSTITUTION

M1	To provide quality education in Engineering and Management.
M2	To establish a continuous industry-institute interaction, participation and collaboration to contribute skilled Engineers.
M3	To develop human values, social values, entrepreneurship skills and professional ethics among the technocrats.
M4	To focus on innovation and development of technologies by engaging in cutting edge research areas.

VISION OF THE DEPARTMENT

To Produce Professionally Excellent, Knowledgeable, Globally Competitive, Socially Responsible Electronics and Communication Engineers and Entrepreneurs.

MISSION OF THE DEPARTMENT

M1	To provide quality education in Electronics and Communication Engineering.
M2	To establish a continuous industry-institute interaction, participation and collaboration to contribute skilled Electronics and Communication Engineers.
M3	To develop human values, social values, entrepreneurship skills and professional ethics among the technocrats.
M4	To focus on innovation and development of technologies by engaging in Electronics and Communication Research areas.

Criteria 1 coordinator NBA coordinator HOD, ECE

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1	Graduates of Electronics & Communication Engineering course will have successful professional career.
PEO2	Graduates of Electronics & Communication Engineering course will pursue higher education or to become an Entrepreneur.
PEO3	Graduates of Electronics & Communication Engineering course will have ability for lifelong learning and to serve the society.

PROGRAM SPECIFIC OUTCOMES (PSO)

PSO 1	Ability to Design, Develop and Test the Electronics Circuits & Communication Systems.
PSO 2	Ability to Develop Excellent Programming and Problem Solving skills in the field of Embedded System.

Criteria 1 coordinator **NBA coordinator** **HOD, ECE**

PROGRAM OUTCOMES (POS)

Engineering Graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complexengineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

RAO BAHADUR Y. MAHABALESWARAPPA ENGINEERING COLLEGE, BALLARI
DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

PROJECT WORK 2020-21

COURSE OUTCOMES (CO's) Of PROJECT TITLED:

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CO	PROJECT OUTCOMES
C413.1	Identify and Analyze Problem through Literature Survey in the Field of Engineering and Technology.
C413.2	Design and Develop Prototype for Identified Problem using Modern Tools.
C413.3	Analyze, Interpret Data to Asses Social, Health & Safety Issues to Provide Valid Conclusion.
C413.4	Develop Communication, Documentation, Presentation Skills and Demonstrate it as a Team.
C413.5	Apply for Project Funding, Exhibition, Paper Presentation in Conference and Publishing in Journals for lifelong learning.

CO-PO/PSO MAPPING

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
413.1	2	2					3							
413.2			3		3							3	3	3
413.3				3		3							3	
413.4							3	3	3	3	3	3		
413.5								2	2	2	2	3		
AVG	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**2.5**	**2.5**	**2.5**	**2.5**	**3**	**3**	**3**

PROJECT EVALUATION RUBRICS-2020-21

RUBRICS: Rubrics are scoring or grading tools used to measure a student's performance and learning across a set of criteria and objectives.

Component	Marks[M]	Criteria	Exceptionally Well Executed [M>90%]	Good with room for improvement [70%<M<90%]	Meets minimum requirement [M<70%]	Course Outcome Mapping	PO Mapping	BTL Mapping
Literature Survey &Problem Identification	20	Refer	Refer more number of standard research papers & understand the technology.	Refer more number of research papers & understand the technology.	Refer research papers & understand the technology.	CO1	1,2,7	L2,L4
		Sustainability	Identify a problem integrating and balancing economic, environmental and social factors.	Identify a problem in which one factor out of three is missing.	Identify a problem in which more than two factors out of three are missing.			
		Ethics	Identify a unique problem.	Identify an existing problem to be extended.	Identify a very poor existing problem.			
Synopsis	20	Synopsis	Synopsis submitted with well and clearly identified problem and very good literature survey.	Synopsis with a problem identified and a literature survey.	Synopsis with poor problem and literature survey of few papers.	CO2	7,8,9,10,11 12	L3, L5
Objective & Methodology	20	Goal	Well defined Objective to meet the problem Identified.	Defined Objective nearly meets the problem Identified.	Objectives are poorly defined to meet the problem Identified.	CO1	1,2,7	L2, L4
		Functionality	Problem is broken into well thought out elements with good length, reusability and efficiency.	Problem is broken into elements. Length, reusability and efficiency need to be taken care.	Problem elements exist, no reusability and efficiency.			
		Use of Modern Technologies	Most recent and efficient technologies are used.	New technologies but not efficient technologies are used.	Old technologies and platform are used.			
Seminar on Synopsis	40	Demonstration	Team members were very well balanced and had clear articulation and power point presentation was excellent.	Team members are audible and fluent. Presentation was good.	Team members were inaudible but fluent. Poor presentation.	CO2	7,8,9,10,11 , 12	L3,L5

P.A.C. Electronics & Communication Engg.

Department of
Electronics & Communication Engg.
R.Y.M. Engineering College.
(Formerly Vijayanagar Engg. College)
BELLARY-583 104.

Component	Marks[M]	Criteria	Exceptionally Well Executed [M>90%]	Good with room for improvement [70%<M<90%]	Meets minimum requirement [M<70%]	Course Outcome Mapping	PO Mapping	BTL Mapping
Experimental observation	30	Validation	Hardware Program handles erroneous or unexpected input. Meets all requirements.	All error conditions are checked. May not meet all the requirements.	Some error conditions are checked does not meet all specified requirements.	CO2,CO3	3,5,12,PSO 1, PSO2	L3,L4, L5,L6
		Testing	Hardware Program / Testing is complete without being redundant..	All key items are tested, but testing may be redundant.	Testing was done, but is not sufficiently complete.			
Documentation	20	Thesis	The thesis is clearly stated with good flow and adequate content.	The thesis is clearly stated with adequate content. Flow was little difficult to follow.	The thesis is not clearly stated with inadequate content. Flow was little difficult to follow.	CO4	7,8,9,10,11 , 12	L3,L5
Demonstration Presentation & Discussion	30	Demonstration	Team members were very well balanced and had clear articulation and power point presentation was excellent.	Team members are audible and fluent. Presentation was good.	Team members were inaudible but fluent. Poor presentation.	CO4	7,8,9,10,11 , 12	L3,L5
Paper Presentation/ Project Exhibition	10	Paper Presentation/ Project Exhibition	Paper was presented in a very good conference or journal with good impact factor./ Participated in project Exhibition and won prizes	Paper was presented in a conference./ Participated in project Exhibition and not won prizes	Paper was presented in conference with no relevant data./ Not Participated in project Exhibition	CO5	8,9,10,11, 12	L4
Team Work	10	Time Management	No adjustments of deadlines. Ensured timely productions. Routinely met the guide.	Usually uses time well. Had to adjust deadlines.	Rarely gets things done by deadlines. Rarely meet the guide.	CO4, CO5	7,8,9,10,11 , 12	L3,L4, L5
		Team Work	Team worked with unity and mutual respect. Each member contributed well.	Team worked well with unity most of the times. Each member contributed to the project.	Team did not work well with unity and mutual respect. Contribution from few of the members was lacking.			

Electronics & Communication Engg. P.A.C. RYMEC, Ballari

Department of
Electronics & Communication Engg.
R.Y.M. Engineering College.
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BELLARY-583 104.

Rao Bahadur Y Mahabaleswarappa Engineering College,Bailari
Dept. of Electronics & Communication Engineering
Project Evalation sheet -2020-21 Phase2

Sem:8 Sec:A &B

Batch	Names	USN	DOMAINS	TITTLE	Experimental Observation (30M)	Documentation (20M)	Demonstration, E-Presentation & Discussion (30M)	Paper Presentation / Project Exhibition (10M)	Team Work (10M)	Total (100M)	GUIDE
1	Seema P	3VC17EC062	EMBEDDED / COMMUNICATION	Design And Fabrication Of Low Cost Mems Based Smart Electronic Listening Device For Hearing Impairment People	30	20	29	10	10	99	Dr Savita Sonoli
	Triveni	3VC17EC078			30	20	28	10	10	98	
	K Swetha	3VC17EC025			30	20	29	10	10	99	
	Sonia S	3VC17EC069			30	20	28	10	10	98	
2	B Manasa	3VC17EC031	IOT / COMMUNICATION	Raitha Bandava-An Autonomous Iot Agrobot Controlled Over A Google Assistant With Solar Powered Agricultural Machine	29	20	30	10	10	99	Rakhee Patil
	Chetana Gumaste Desai	3VC17EC015			29	20	30	10	10	99	
	K M Anjum	3VC17EC004			29	20	29	10	10	98	
	N Sowbhagya Shree	3VC17EC036			29	20	29	10	10	98	
3	Balaji.B	3VC17EC008	IOT / COMMUNICATION	ToI Stereopticon for Rural E-Learning Education System	30	20	30	10	9	99	Prashanth keni
	C.Ruchitha	3VC17EC011			30	20	30	9	10	99	
	G.S.Tanuja	3VC17EC017			30	20	29	10	10	99	
4	Vidyashree	3VC17EC080	IOT / COMMUNICATION	Smart vehicle with voice and gesture controlled for physically challenged integrated with home automation	30	20	30	10	9	99	Dr Prabhavathi S
	Sreelakshmi Desai	3VC17EC072			30	20	30	9	9	98	
	Asif Ayodhi	3VC17EC005			30	20	30	9	9	98	
	Anisha	3VC17EC003			30	20	30	9	9	98	

co-ordinator

HOD

Head of the Department, ... Communication En... ... Engineering College, (Formerly Vijayanagar Engg College) BELLARY-583 104.

Rao Bahadur Y Mahabaleswarappa Engineering College,Ballari
Dept. of Electronics & Communication Engineering
Project Evalation sheet -2020-21 Phase1

Sem:7 Sec:A &B

Sl.no	Names	USN	DOMAINS	TITTLE	Literature Survey &Problem Identification(20M)	Objective &Methodology(20M)	Synopsis(20M)	Seminar on Synopsis(40M)	Total	GUIDE
1	Seema P	3VC17EC062	EMBEDDED / COMMUNICATION	Design And Fabrication Of Low Cost Mems Based Smart Electronic Listening Device For Hearing Impairment People	20	20	20	39	99	Dr Savita Sonoli
	Triveni	3VC17EC078			20	20	20	37	97	
	K Swetha	3VC17EC025			20	20	20	37	97	
	Sonia S	3VC17EC069			20	20	20	37	97	
2	B Manasa	3VC17EC031	IOT / COMMUNICATION	Raitha Bandava-An Autonomous Iot Agrobot Controlled Over A Google Assistant With Solar Powered Agricultural Machine	20	20	20	39	99	Rakhee Patil
	Chetana Gumaste Desai	3VC17EC015			20	20	20	39	99	
	K M Anjum	3VC17EC004			20	20	20	39	99	
	N Sowbhagya Shree	3VC17EC036			20	20	20	39	99	
3	Balaji.B	3VC17EC008	IOT / COMMUNICATION	ToI Stereopticon for Rural E-Learning Education System	19	20	20	40	99	Prashanth keni
	C.Ruchitha	3VC17EC011			19	20	20	40	99	
	G.S.Tanuja	3VC17EC017			19	20	20	40	99	
4	Vidyashree	3VC17EC080	IOT / COMMUNICATION	Smart vehicle with voice and gesture controlled for physically challenged integrated with home automation	20	20	20	37	97	Dr Prabhavathi S
	Sreelakshmi Desai	3VC17EC072			20	20	20	39	99	
	Asif Ayodhi	3VC17EC005			20	20	20	39	99	
	Anisha	3VC17EC003			20	20	20	36	96	

co-ordinator

HOD