ABSTRACT

Communicating through hand gestures is one of the most common forms of non-verbal and visual communication adopted by speech-impaired people all around the world. The problem existing at the moment is that most of the people are not able to comprehend hand gestures or convert them to enough for the listener to understand. A large fraction of India's population is speech impaired. In addition to this communication to sign language is not a very easy task. This problem demands a better solution that can assist the speech-impaired population in conversation without any difficulties. As a result, it reduces the communication gap for the speech-impaired. Sign language is an essential form of communication for individuals with hearing impairments. However, it can be challenging for those who don't understand sign language to communicate effectively with sign language users. To bridge this communication gap, we can use technology to convert sign language gestures into audible speech. In this project we will explore how to build a sign language to speech conversion system using Arduino, a flex sensor, and a 16x2 LCD with I2C.

INTRODUCTION

Currently we always hear about new technology that improves our life, which makes our life easier. Technology has revolutionized the mortal humanity. Mortal race has put a gear in technology and they are not in a mood to move the pedals down from this gear. There's huge exploration on colourful technology sectors similar as Artificial Intelligence, Smart phones and numerous further. This exploration leads to new inventions and making one's life easier. But there has been a veritably lower exploration for Deaf and Dumb people. This content has got lower attention as compared to other sectors. The Main challenges that this special person facing is the communication gap between-special person and normal person. The Deaf and Dumb people always find difficulties to communicate with normal person. This huge challenge makes them uncomfortable and they feel discerned in society. Because of miss communication Deaf and Dumb people feel not to communicate and hence they no way suitable to express their passions. HGRVC (Hand Gesture Recognition and Voice Conversion) systems localize and track the hand gestures of the dumb and deaf people in order to maintain a communication channel with the other people. The discovery of hand gestures can be done using web camera. The film lands are also converted into standard size with the help of pre-processing. The end of this design is to develop a system that can convert the hand gestures into textbook. The focus of this design is to place the film land in the database and with database matching the image is converted into textbook. The discovery involves observation of hand movement. The system gives affair in textbook format that helps to reduce the communication gap between deaf-mute and people.

About nine billion people at intervals the earth unit of dimension dumb. The communication between a dumb and hearing person poses to be an important disadvantage compared to communication between eyeless and ancient visual people. This creates an extremely little house for them with communication being associate degree abecedarian aspect of mortal life. The eyeless people can speak freely by implies that of ancient language whereas the dumb have their own primer-visual language appertained to as language. Language is also an on-verbal form of intercourse that is set up among deaf communities at intervals the earth. The languages have not got a typical origin and thence hard to interpret. A Dumb communication practitioner is also a tool that interprets the hand gestures to sensibility speech. The gesture in associate degree extremely language is also a certain movement of the hands with a particular kind created out of them. Facial expressions inclusively count toward the gesture, at constant time. A posture on the other hand is also a static variety of the hand to purpose a hallmark. Gesture recognition is codified into a brace of main orders vision grounded substantially} and sensor grounded. The disadvantage of vision grounded completely ways includes advanced algorithms for process. Another challenge in image and

videotape system includes varied lighting conditions, backgrounds and field of check-up constraints and occlusion. The sensor grounded completely fashion provides larger quality.

In present days, everyone is very much excited in new technologies and innovations. The new technologies make the life very much easier and smarter. But it is not useful for every one like the deaf and the dumb people. These people cannot communicate properly with the normal people. They have an alternative language called sign language, but they can only communicate with the people who knows the sign language, these dissimilarities create a communication gap between the normal people and the deaf and dumb people. They are not able to express their needs and requirements. To overcome this problem, we are using the Sign Recognition and Voice Conversion for deaf and dumb people.

The person with speaking disability faces difficulty in communicating with the rest of the population. This device is developed to ameliorate the life of a person who has speaking disability. Device converts the gesture to speech i.e. gives voice to a mute person. Speech is one of the important factors needed for the humans to convey their dispatches. In this design, Flex detectors play the major part. They're sutured to the gloves. Which are used to convey the feelings and emotions to other people.

1.1Overview:

The main objective of this proposal is to recognize signs of dumb people and convert into voice commands which very useful to dumb people to express their feelings, expressions to normal people and to meet their basic needs. This proposal helps dumb people can interact with normal people by communicating with them and share their emotions, feelings to normal people. This proposal helps dumb people to live life like a normal people.

1.2 Scope:

The scope of the proposal is to convert signs of dumb people and convert into voice commands to communicate with normal people. This proposal helps dumb people to share their feelings, emotions and expressions with normal people. It establishes communication between dumb people and normal people.

EXISTING SYSTEM

3.1 Existing Model:

The current existing system is based on two traditional ways of communication between deaf person and hearing individuals who do not know sign language exist through interpreters or text writing. The interpreters are very expensive for daily conversations and their involvement will result in a loss of privacy and independence of a dumb person. Thus, a low-cost, more efficient way of enabling communication between normal person and dumb person is needed. But in this method computer vision is working fine but mostly all the people in the world cannot be able to afford the computer because most of the world's population is not that much rich who can be able to afford a computer or a laptop. Suppose, if they had somehow managed to buy a computer or a laptop but how many of them can be able to understand the working of the computer or the laptop, most of the people are not able to understand the speech or the voice conversion that has given by the computer in its display. So, it is only useful to those who are able to read and write and cannot be useful for those who can't, which means it is helpful for the literate people only

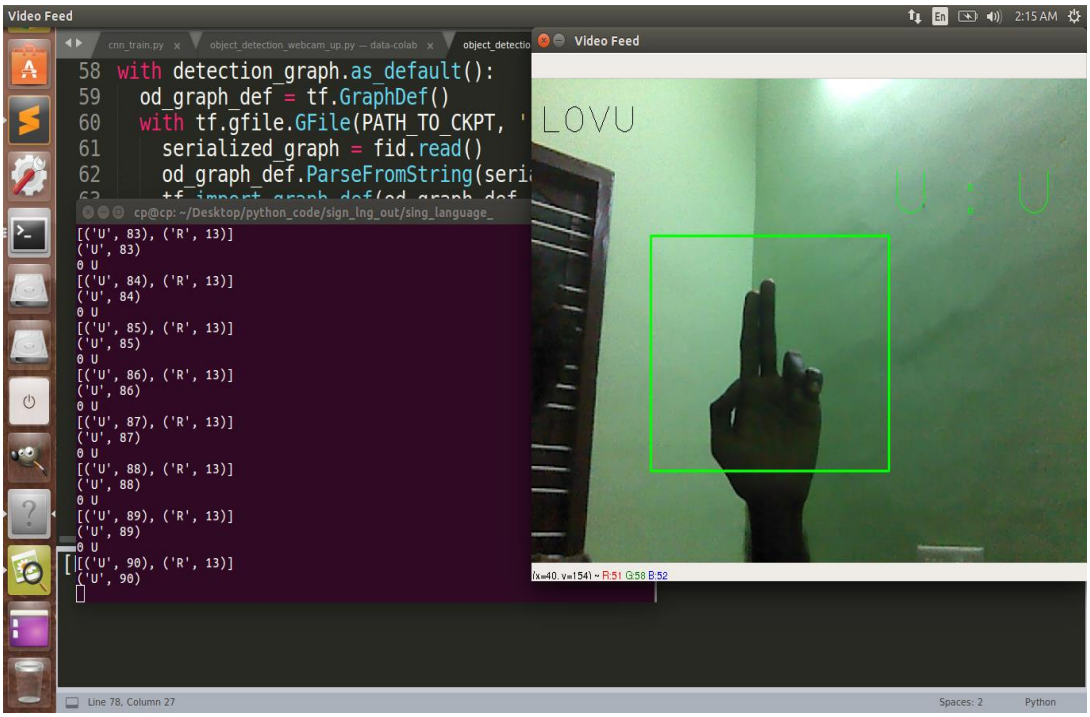

Fig 3.1: Sign recognition for deaf and dumb using Computer vision.

PROPOSED SYSTEM

4.1 Proposed Model:

In this system the circuit is implemented to recognise the hand movement of a user. The circuit is having flex sensors along each finger and the thumbs. The flex sensor is a device it generates output that depends upon degree of bend. These gesture movements are considered as analog outputs from the sensors are given to microcontroller. It processes the analog output and perform analog to digital signal conversion. The gesture is recognized and the respective text information is identified. The user needs to know each gesture movement of respective message and he need to stand on the sign for three seconds. If we want to introduce more number of gestures, yes we can there is no restrictions, even it encourages us to introduce some new gestures to the supporting library. These sensors are placed on each finger and thumb. By bending the finger and thumb it generates the output as voltage variation, this voltage output is processed by microcontroller to produce required voice output is obtained by speaker and text message is obtained by LCD display. A pair of gloves along with sensors and microcontroller are used to mute people to communicate with the public in the required language.

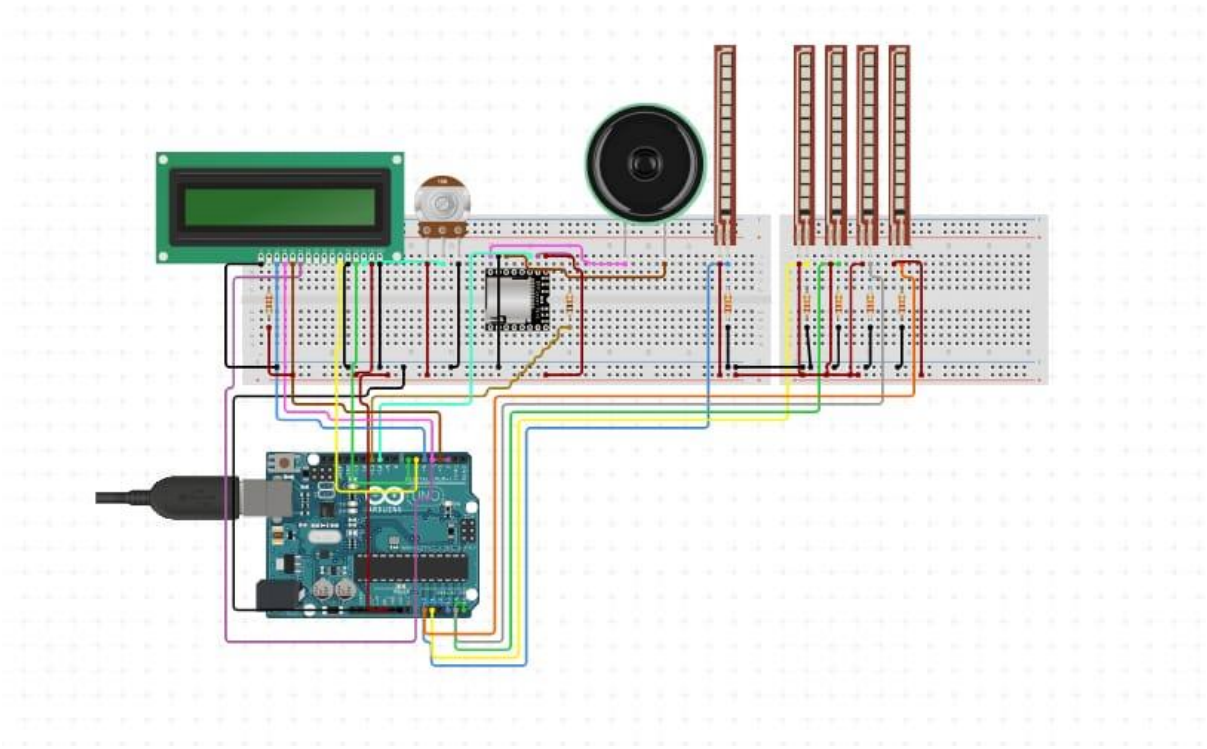

Fig 4.1: Software implementation of the Proposed model

4.2 Working of Proposed model:

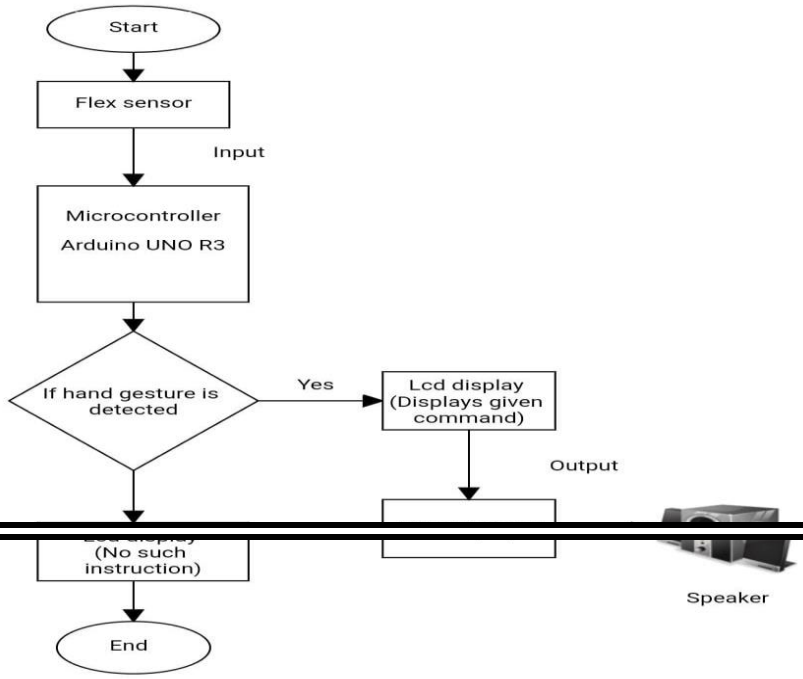

Fig 4.2: Working principle of the proposed model

The person with the disability wears the glove equipped with the flex sensors and the remaining equipment and leaves the signs from the flex sensors the input is given to the Arduino and to DF mini player and finally the output will be displayed on the led screen and sound will be coming out from the speaker.

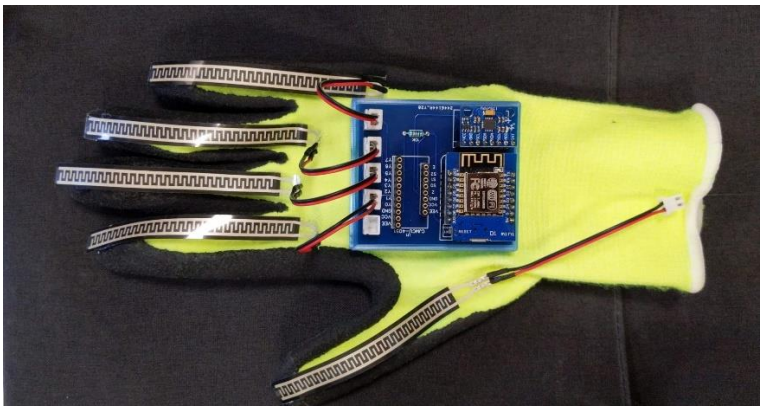

Fig 4.3: Physical representation of the Proposed model

HARDWARE COMPONENTS

5.1 ARDUINO UNO BOARD:

The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs,a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

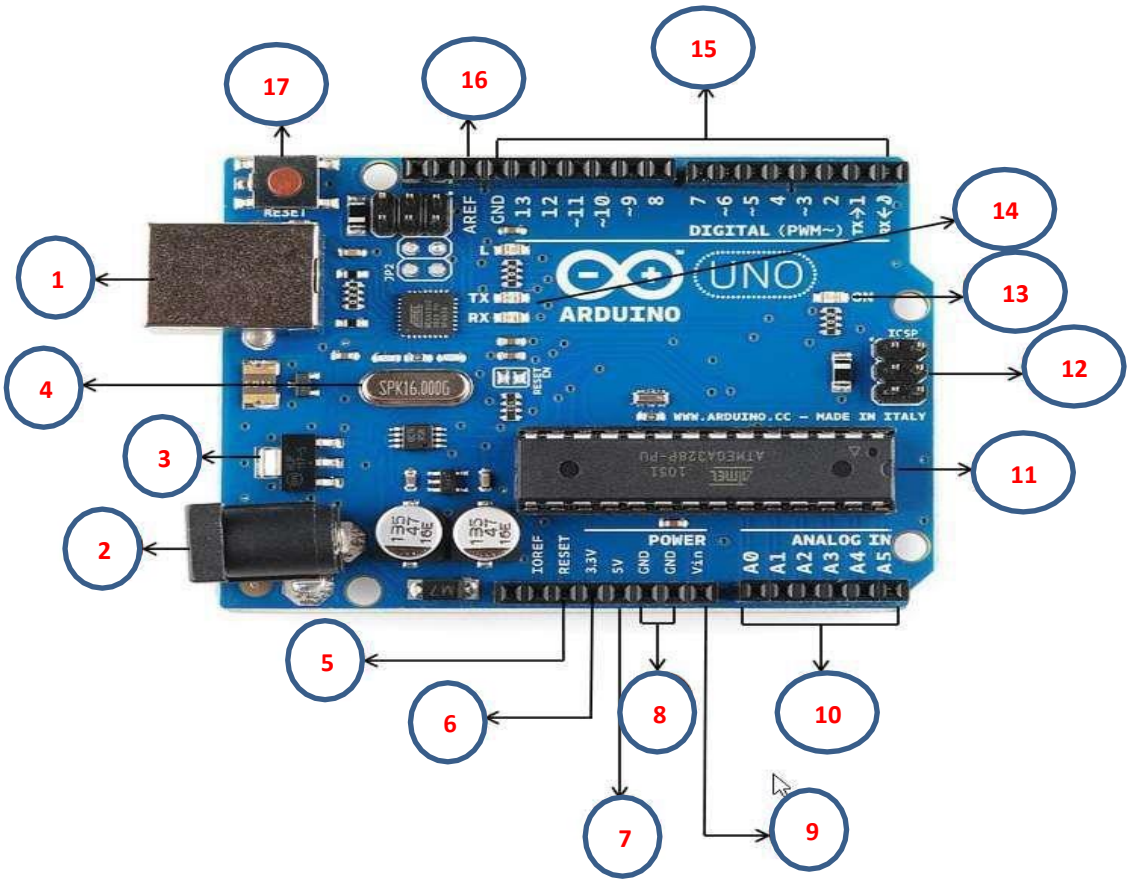

Fig 5.1: Arduino Uno board

The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as USB-to-serial converters.

TECHNICAL SPECIFICATIONS:

Table 1: Arduino Uno specifications

FEATURE	SPECIFICATION
Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328) of which 0.5 KB used by boot loader
SRAM	2 KB (ATmega328)
EEPROM	1 KB (ATmega328)
Clock Speed	16 MHz

The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

1.USB Interface:

Arduino board can be powered by using the USB cable from your computer. All you need to do is connect the USB cable to the USB connection.

2. External power supply:

Arduino boards can be powered directly from the AC main power supply by connecting it to the power supply (Barrel Jack).

3.Voltage Regulator:

The function of the voltage regulator is to control the voltage given to the Arduino board and stabilize the DC voltages used by the processor and other elements.

4. Crystal Oscillators:

The crystal oscillator helps Arduino in dealing with time issues. How does Arduino calculate time? The answer is, by using the crystal oscillator. The number printed on top of the Arduino crystal is 16.000H9H. It tells us that the frequency is 16,000,000 Hertz or 16 MHz's.

5. Arduino Reset:

It can reset your Arduino board, i.e., start your program from the beginning. It can reset the UNO board in two ways. First, by using the reset button (17) on the board. Second, you can connect an external reset button to the Arduino pin labelled RESET (5).

6-9 Pins (3.3, 5, GND, Vin):

- **3.3V (6):** Supply 3.3 output volt
- **5V (7):** Supply 5 output volt. Most of the components used with Arduinoboard works fine with 3.3 volt and 5 Volt.
- **GND (8) (Ground):** There are several GND pins on the Arduino, any ofwhich can be used to ground your circuit.
- **Vin (9):** This pin also can be used to power the Arduino board from anexternal power source, like AC mains power supply.

10. Analog pins:

The Arduino UNO board has five analog input pins A0 through A5. These pins can read the signal from an analog sensor like the humidity sensor or temperature sensor and convert it into a digital value that can be read by the microprocessor.

11. Main microcontroller:

Each Arduino board has its own microcontroller (11). You can assume that it is the brain of your board. The main IC is different from board to board. The microcontrollers are from ATMEL company.

The Atmega8U2 programmed as a USB-to-serial converter. "Uno" means "One" in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno isthe latest in a series of USB Arduino boards, and the reference model for the Arduino platform; for a comparison with previous versions, see the index of Arduino boards.

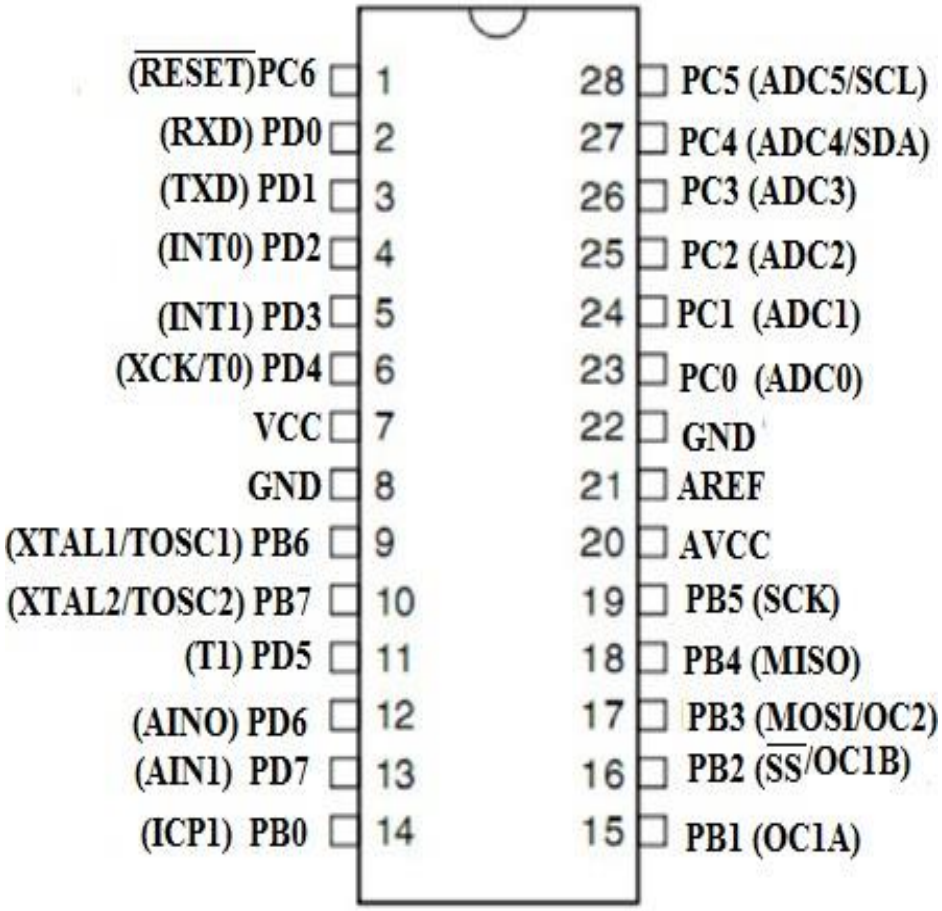

Fig 5.2: Pin Diagram

Pin Description:

VCC: Digital supply voltage

GND: Ground

Port B (PB [7:0]) XTAL1/XTAL2/TOSC1/TOSC2:

Port B is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port B output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port B pins that are externally pulled low will source current if the pull-up resistors are activated. The Port B pins are tri- stated when a reset condition becomes active, even if the clock is not running.

Depending on the clock selection fuse settings, PB6 can be used as input to the inverting Oscillator amplifier and input to the internal clock operating circuit.

Depending on the clock selection fuse settings, PB7 can be used as output fromthe inverting Oscillator amplifier.

If the Internal Calibrated RC Oscillator is used as chip clock source, PB [7:6] is used as TOSC [2:1] input for the Asynchronous Timer/Counter2 if the AS2 bit in ASSRis set.

Port C (PC [5:0]):

Port C is a 7-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The PC [5:0] output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs,

Port C pins that are externally pulled low will source current if the pull-up resistors are activated. The Port C pins are tri-stated when a reset condition becomes active, even if the clock is not running.

PC6/RESET:

If the RSTDISBL Fuse is programmed, PC6 is used as an I/O pin. Note that theelectrical characteristics of PC6 differ from those of the other pins of Port C. If the RSTDISBL Fuse is un programmed, PC6 is used as a Reset input. A low level on this pin for longer than the minimum pulse length will generate a Reset, even if the clock is not running. Shorter pulses are not guaranteed to generate a Reset.

Port D (PD [7:0]):

Port D is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port D output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port D pins that are externally pulled low will source current if the pull-up resistors are activated. The Port D pins are tri- stated when a reset condition becomes active, even if the clock is not running.

AVCC:

AVCC is the supply voltage pin for the A/D Converter, PC [3:0], and PE [3:2].It should be externally connected to VCC, even if the ADC is not used. If the ADC is used, it should be connected to VCC through a low-pass filter. Note that PC [6:4] use digital supply voltage, VCC.

AREF: AREF is the analog reference pin for the A/D Converter.

ADC [7:6] (TQFP and VFQFN Package Only):

In the TQFP and VFQFN package, ADC [7:6] serve as analog inputs to the A/Dconverter. These pins are powered from the analog supply and serve as 10-bit ADC channels.

12.ICSP pin:

Mostly, ICSP (12) is an AVR, a tiny programming header for the Arduino consisting of MOSI, MISO, SCK, RESET, VCC, and GND. It is often referred to as an SPI (Serial Peripheral Interface), which could be considered as an "expansion" of the output. Actually, you are slaving the output device to the master of the SPI bus.

13.Power LED indicator:

This LED should light up when you plug your Arduino into a power source to indicate that your board is powered up correctly. If this light does not turn on, then there is something wrong with the connection.

14.TX and RX LEDs:

On your board, you will find two labels: TX (transmit) and RX (receive). Theyappear in two places on the Arduino UNO board. First, at the digital pins 0 and 1, to indicate the pins responsible for serial communication. Second, the TX and RX led (13). The TX led flashes with different speed while sending the serial data. The speed of flashing depends on the baud rate used by the board. RX flashes during the receivingprocess.

15.Digital I / O:

The Arduino UNO board has 14 digital I/O pins (15) (of which

6 provide PWM (Pulse Width Modulation) output. These pins can be configured to work as input digitalpins to read logic values (0 or 1) or as digital output pins to drive different modules likeLEDs, relays, etc. The pins labeled "~" can be used to generate PWM.

16.AREF:

AREF stands for Analog Reference. It is sometimes, used to set an external reference voltage (between 0 and 5 Volts) as the upper limit for the analog input pins working.

5.1.1 Specifications:

- Microcontroller: ATmega328P
- Operating Voltage: 5 volts
- Input Voltage (recommended): 7-12 volts
- Input Voltage (limit): 6-20 volts
- Digital I/O Pins: 14 (of which 6 provide PWM output)
- Analog Input Pins: 6
- DC Current per I/O Pin: 20 mA
- DC Current for 3.3V Pin: 50 mA
- Flash Memory: 32 KB (ATmega328P), of which 0.5 KB is used by bootloader
- SRAM: 2 KB (ATmega328P)
- EEPROM: 1 KB (ATmega328P)
- Clock Speed: 16 MHz
- USB Interface: ATmega16U2

5.1.2 Features:

- Open-source hardware and software: The Arduino UNO is based on open- source hardware and software, which means that the design and code are freelyavailable for anyone to use

and modify. This has led to a large community of developers and enthusiasts who contribute code and projects to the Arduino ecosystem.

- Versatile: The Arduino UNO is compatible with a wide range of sensors, modules, and other components, which can be connected to the digital and analog pins. It can also communicate with other devices using protocols such as I2C, SPI, and UART.
- Low cost: The Arduino UNO is relatively low cost, making it accessible to a wide range of users, including hobbyists, students, and professionals.

5.2 Flex sensors:

A **flex sensor** or **bend sensor** is a sensor that measures the amount of deflection or bending. Usually, the sensor is stuck to the surface, and resistance of sensor element is varied by bending the surface. Since the resistance is directly proportional to the amount of bend it is used as goniometer, and often called flexible potentiometer.

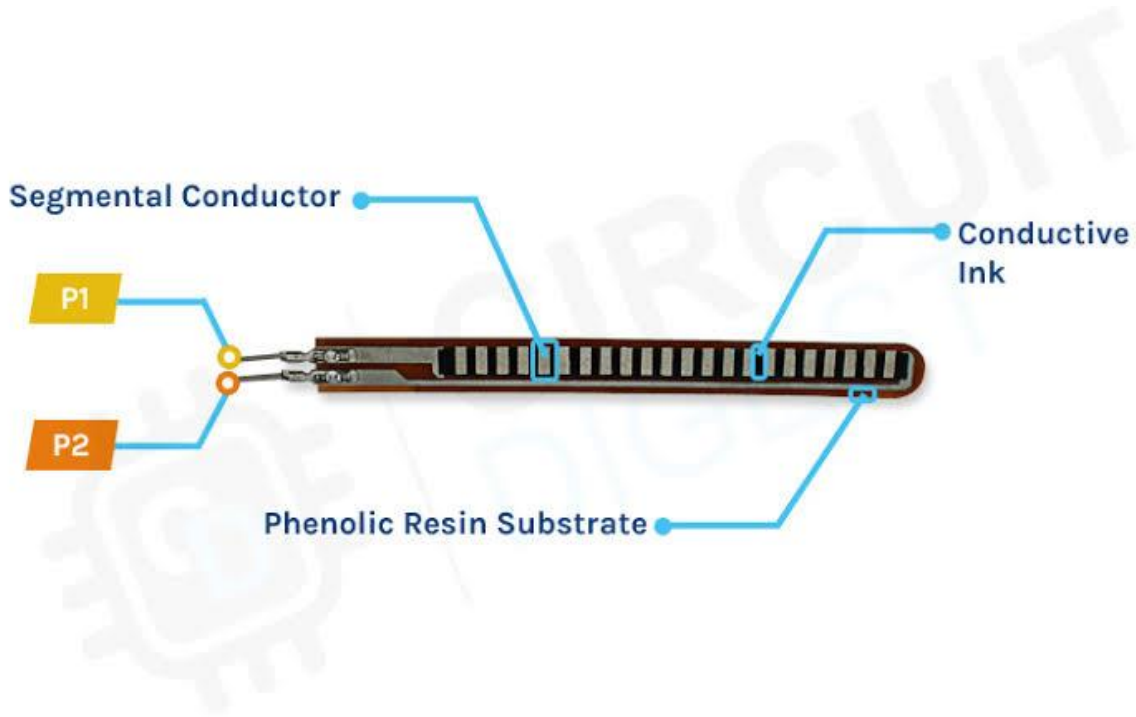

Fig 5.2.1: Flex sensor

What is a Flex Sensor?

A flex sensor is a kind of sensor which is used to measure the amount of defection otherwise bending. The designing of this sensor can be done by using materials like plastic and carbon. The carbon surface is arranged on a plastic strip as this strip is turned aside then the sensor's resistance will be changed. Thus, it is also named a bend sensor. As its varying resistance can be directly proportional to the quantity of turn thus it can also be employed like a goniometer.

Types of Flex Sensor

These sensors are classified into two types based on its size namely 2.2-inch flex sensor & 4.5-inch flex sensor. The size, as well as the resistance of these sensors, is dissimilar except the working principle.

Therefore the suitable size can be preferred based on the necessity. Here this article discusses an overview of 2.2-inch flex-sensor. This type of sensor is used in various applications like computer interface, rehabilitation, servo motor control, security system, music interface, intensity control, and wherever the consumer needs to modify the resistance throughout bending.

Pin Configuration

The pin configuration of the flex sensor is shown below. It is a two-terminal device, and the terminals are like p1 & p2. This sensor doesn't contain any polarized terminal such as diode otherwise capacitor, which means there is no positive & negative terminal. The required voltage of this sensor to activate the sensor ranges from 3.3V -5V DC which can be gained from any type of interfacing.

Pin P1: This pin is generally connected to the +ve terminal of the power source.

Pin P2: This pin is generally connected to GND pin of the power source.

Where to Use?

The flex-sensor can be used in the following two cases.

This sensor is used wherever you need to test the exterior of a device otherwise thing is planed or not. A flex-sensor could be used to check a door or window is opened or not. This sensor can be arranged at the edge of the door and once the door opens then this sensor also gets flexed. When the sensor bends than its parameters automatically change which can be designed to give an alert.

This sensor is used wherever you need to measure the Bent, Flex, otherwise, change of an angle for any device otherwise any instrument. The internal resistance of this sensor alters approximately linear with the angle of its flex. Thus, by connecting the sensor to the device, we can have the flex angle within resistances of electrical parameter.

Working Principle

This sensor works on the bending strip principle which means whenever the strip is twisted then its resistance will be changed. This can be measured with the help of any controller.

This sensor works similar to a variable resistance because when it twists then the resistance will be changed. The resistance change can depend on the linearity of the surface because the resistance will be dissimilar when it is level.

When the sensor is twisted 450 then the resistance would be dissimilar. Similarly, when this senor is twisted to 900 then the resistance would be dissimilar. These three are the flex sensor’s bending conditions.

According to these three cases, the resistance will be normal in the first case, the resistance will be double as contrasted with the first case, and the

resistance will be four-time when compared with the first case. So the resistance will be increased when the angle is increased.

Specifications & Features

The specifications and features of this sensor include the following.

- Operating voltage of this sensor ranges from 0V to 5V
- It can function on low-voltages.
- Power rating is 1 Watt for peak & 0.5Watt for continuous.
- Operating temperature ranges from -45ºC to +80ºC
- Flat resistance is 25K Ω
- The tolerance of resistance will be ±30%
- The range of bend resistance will range from45K -125K Ohms

Applications

The applications of the flex-sensor include the following.

- Medical Instruments
- Peripherals of Computer
- Robotics
- Physical Therapy
- Virtual Motion (Gaming)
- Musical Instruments

5.3LIQUID CRYSTAL DISPLAY:

INTRODUCTION TO LCD:

A liquid crystal display (LCD) is a thin, flat display device made up of any number of color or monochrome pixels arrayed in front of a light source or reflector. Each pixel consists of a column of liquid crystal molecules suspended between two transparent electrodes, and two polarizing filters, the axes of polarity of which are perpendicular to each other.

Without the liquid crystals between them, light passing

through one would be blocked by the other. The liquid crystal twists the polarization of light entering one filter to allow it to pass through the other.

A program must interact with the outside world using input and output devices that communicate directly with a human being. One of the most common devices attached to a controller is an LCD display. Some of the most common LCDs connectedto the controllers are 16X1, 16x2 and 20x2 displays. This means 16 characters per line by 1 line 16 characters per line by 2 lines and 20 characters per line by 2 lines, respectively.

Many micro controller devices use 'smart LCD' displays to output visual information. LCD displays designed around LCD NT-C1611 module, are inexpensive, easy to use, and it is even possible to produce a readout using the 5X7 dots plus cursorof the display.

Fig 5.3.1: LCD Display

Pin Diagram of LCD Display:

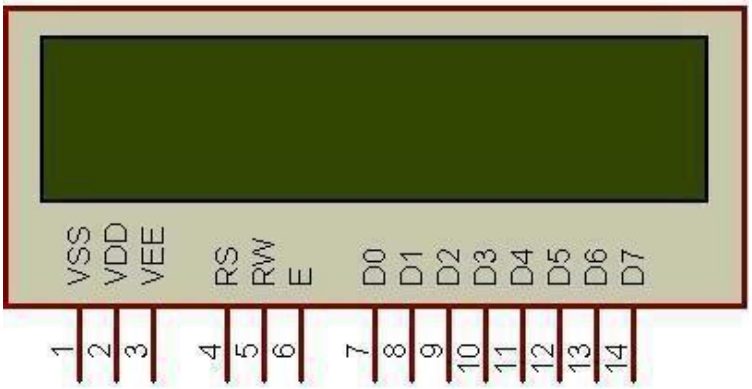

Fig 5.3.2: LCD Pin Diagram

Pin Symbol I/O Description:

Table 2: LCD pin symbol I/O description

PIN NO	Symbol	Fuction
1	VSS	GND
2	VDD	+5V
3	V0	Contrast adjustment
4	RS	H/L Register select signal
5	R/W	H/L Read/Write signal
6	E	H/L Enable signal
7	DB0	H/L Data bus line
8	DB1	H/L Data bus line
9	DB2	H/L Data bus line
10	DB3	H/L Data bus line
11	DB4	H/L Data bus line
12	DB5	H/L Data bus line
13	DB6	H/L Data bus line
14	DB7	H/L Data bus line
15	A	+4.2V for LED
16	K	Power supply for BKL(0V)

Control Lines:

EN:

Line is called "Enable." This control line is used to tell the LCD that you are sending it data. To send data to the LCD, your program should make sure this line is low (0) and then set the other two control lines and/or put data on the data bus. When the other lines are completely ready, bring EN high (1) and wait for the minimum amount of time required by the LCD datasheet (this varies from LCD to LCD), and endby bringing it low (0) again.

RS:

Line is the "Register Select" line. When RS is low (0), the data is to be treated as a command or special instruction (such as clear screen, position cursor, etc.). WhenRS is high (1), the data being sent is text data which should be displayed on the screen.

RW:

Line is the "Read/Write" control line. When RW is low (0), the information on the data bus is being written to the LCD. When RW is high (1), the program is effectively querying (or reading) the LCD. Only one instruction ("Get LCD status") is a read command. All others are write commands, so RW will almost always be low.

Logic Status On Control Lines:

- E - 0 Access to LCD disabled.

  1 Access to LCD enabled.
- R/W - 0 Writing data to LCD.

  1 Reading data from LCD
- RS - 0 Instructions.1 Character

Specifications:

- The operating voltage of this LCD is 4.7V-5.3V
- It includes two rows where each row can produce 16-characters.
- The utilization of current is 1mA with no backlight
- Every character can be built with a 5×8-pixel box
- The alphanumeric LCDs alphabets & numbers
- Is display can work on two modes like 4-bit & 8-bit
- These are obtainable in Blue & Green Backlight
- It displays a few custom generated characters.

Features:

- LCDs consumes less amount of power compared to CRT and LED
- LCDs consist of some microwatts for display in comparison to some mill wattsfor LED's
- LCDs are of low cost
- Provides excellent contrast
- LCDs are thinner and lighter when compared to cathode-ray tube and LED

5.4 potentiometer:

Variable resistors used as potentiometers have all **three terminals** connected. This arrangement is normally used to **vary voltage**, for example to set the switching point of a circuit with a sensor, or control the volume (loudness) in an amplifier circuit.If the terminals at the ends of the track are connected across the power supply, then the wiper terminal will provide a voltage which can be varied from zero up to the maximum of the supply.

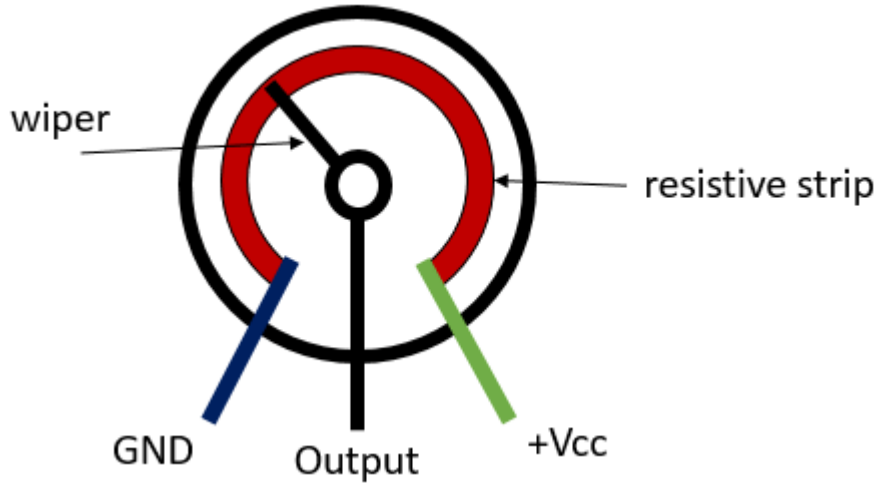

Fig 5.4.1: Potentiometer

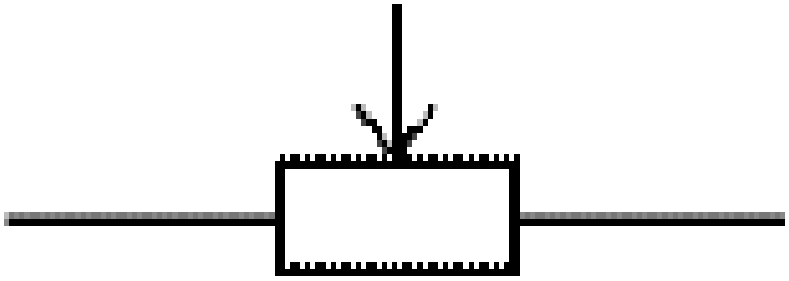

Fig 5.4.2: Potentiometer Symbol

Applications of Potentiometer

- In the electronic circuit, the potentiometer serves as a voltage divider.
- The potentiometer is employed in radio and television (TV) receivers to control volume, tone, and linearity.
- Potentiometers are found in medical equipment.
- It's found in woodworking machines.
- It's found in injection moulding machines.
- Potentiometers are extensively used as user controls and can be used to control a wide range of equipment functions.

Colour	Colour code

5.5 Resistor:

Resistor is defined as a passive electrical component with two terminals that are used for either limiting or regulating the flow of electric current in electrical circuits. The main purpose of resistor is to reduce the current flow and to lower the voltage in any particular portion of the circuit. It is made of copper wires which are coiled around a ceramic rod and the outer part of the resistor is coated with an insulating paint. The SI unit of resistor is Ohm.

Types of Resistors

There are two basic types of resistors as follows:

- Linear resistor
- Non-linear resistor

Linear resistors

The resistors whose values change with change in applied temperature and voltage are known as linear resistors. There are two types of linear resistors:

Fixed resistors: These resistors have a specific value and these values cannot be changed. Following are the different types of fixed resistors:

- Carbon composition resistors
- Wire wound resistors
- Thin film resistors
- Thick film resistors

Variable resistors: These resistors do not have a specific value and the values can be changed with the help of dial, knob, and screw. These resistors find applications in radio receivers for controlling volume and tone. Following are the different types of variable resistors:

- Potentiometers
- Rheostats
- Trimmers

Colour Coding of Resistors

Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Grey	8
White	9

Table: Colour code of resistors

Resistors may not display the value outside but their resistance can be calculated through their colour pattern PTH (plated-through-hole) resistors use a colour-coding system (which really adds some flair to circuits), and SMD (surface-mount-device)resistors have their own value-marking system.

Applications of Resistors

- Wire wound resistors find applications where balanced current control, high sensitivity, and accurate measurement are required like in shunt with ampere meter.
- Photoresistors find application in flame detectors, burglar alarms, in photographic devices, etc.
- Resistors are used for controlling temperature and voltmeter.
- Resistors are used in digital multi-meter, amplifiers, telecommunication, and oscillators.
- They are also used in modulators, demodulators, and transmitters.

5.6 Speaker:

What is speaker?

The speaker is a type of transducer that converts electrical signals to auditory signals. The sound quality is greatly influenced by the speaker's performance. The speaker is the most significant component for audio effects while being the weakest element in audio equipment. There are numerous varieties of speakers available, with a wide range of pricing. Through electromagnetic, piezoelectric, or electrostatic effects, the audio electric energy causes the cone or diaphragm to vibrate and resonant (resonate) with the surrounding air to produce sound.

The structure of the speaker

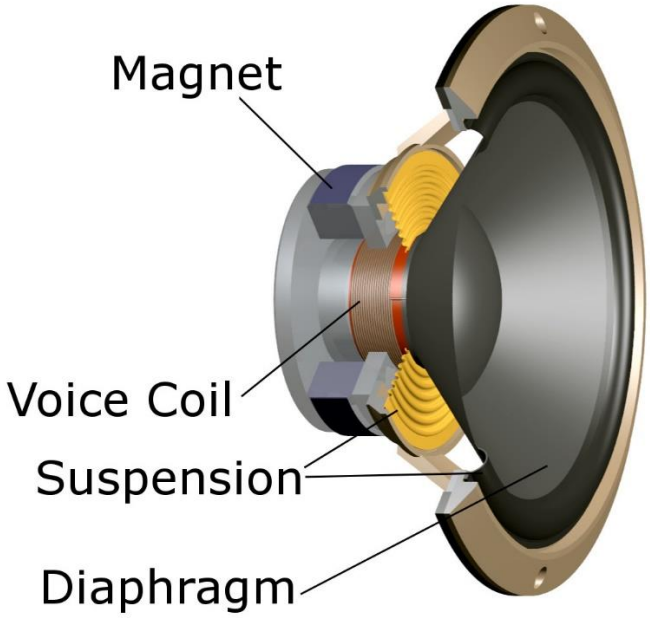

Fig 5.6.1: Structure of speaker

Magnet

Ferrite: The most common and traditional mineral, with big size and low price. The magnetic of neodymium iron is seven times that of ferrite, but it is unstable and easily demagnetized, therefore it cannot be used in place of ferrite. Strontium magnets have high efficiency, but because of their small volume, they are exclusively utilized in tweeters.

Voice coil

The majority of the voice coil frame is made of aluminium sheets. Because the voice coil structure must account for heat dissipation, the aluminium skin provides excellent heat dissipation, is light, and does not distort. It was also available on paper, but that option has since been discontinued. There is also a type of KISV epoxy resin board that performs better.

Dust cap

The primary purpose is to keep dust and debris out of the magnetic gap. Paper, cloth, aluminum, plastic, or carbon fiber fabric are among the materials utilized. A hemisphere is the most common shape.

Sound cone

The cone's vibration is employed to cause the air to vibrate, resulting in the sound's heavy death. As a result, the cone's substance influences the speaker's individuality.

How does a speaker work?

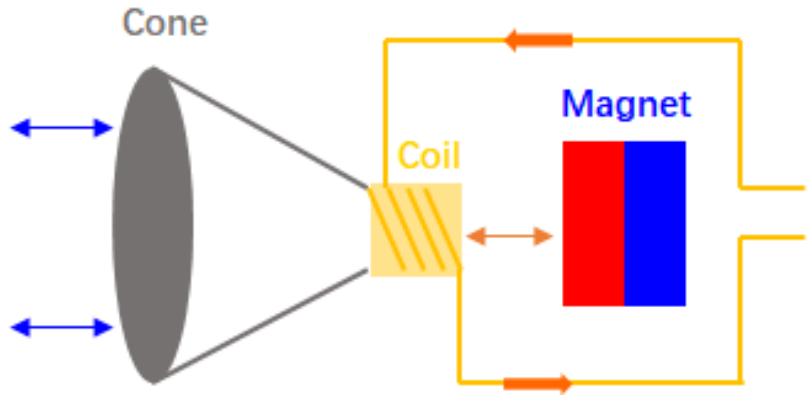

Fig 5.6.2: Working principle of a speaker

A speaker's basic idea is to transform electrical energy into mechanical energy (movement). Air is compressed by mechanical energy, which translates motion into sound energy or sound pressure level (SPL). A magnetic field is created as current passes through the coil. Current is passed through the voice coil in the speaker, and the voice coil generates an electric field that interacts with the magnetic field of a permanent magnet attached to the speaker. Charges of the same type repel each other, while charges of different types attract each other. The permanent magnet attracts and repels the voice coil when the audio signal is delivered through it and the music waveform goes up and down. The cone attached to the voice coil moves back and forth as a result of this. Moving back and forth in the air produces pressure waves, which we refer to as sound.