



SIGN LANGUAGE DETECTION FOR DEAF AND DUMB USING FLEX SENSOR

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Abstract: The ability to communicate is fundamental to the human experience, but for the deaf and mute communities, this can be a challenge. Sign language is an essential tool for communication among these communities, but it requires a certain level of expertise to comprehend and use it. To address this issue, we propose a Sign Language Detection system that utilizes various sensors such as Flex Sensor, Gyroscope Sensor, and a Bluetooth Module, along with a Mobile Application and an LCD Module. The system operates by detecting the movements of the hand and wrist using the Flex Sensor and Gyroscope Sensor. These sensors detect the angle and bend of the fingers and wrist, respectively, and convert these movements into digital signals. The system is built on an Arduino platform and aims to enhance communication between the hearing and the deaf/mute communities. The proposed Sign Language Detection system is a significant step towards bridging the communication gap between the hearing and deaf/mute communities. By utilizing various sensors and a Mobile Application, the system can accurately detect and translate sign language into text, making communication more accessible and efficient. It allows for real-time communication, as the system processes the signals and translates them instantly. Finally, it is cost-effective and easy to use, making it accessible to a wide range of users.

KEYWORDS: Arduino uno, Flex sensor, Gyroscope sensor, Mobile Application, Bluetooth module, Sign Language

INTRODUCTION:

Sign language is a visual language that uses hand gestures, facial expressions, and body language to communicate. It is used by deaf and hard-of-hearing individuals to convey information, emotions, and ideas. The use of sign language is crucial in enabling deaf individuals to communicate effectively and participate fully in society. However, sign language is not universally understood, and many people lack the necessary knowledge and skills to communicate in sign language. In recent years, there has been an increasing interest in developing technology that can bridge the communication gap between deaf and hearing individuals. One such technology is sign language detection systems. These systems use various sensors and algorithms to recognize and interpret sign language gestures, translating them into text or spoken language. The use of sign language detection systems is not limited to the deaf community; it can also be beneficial for hearing individuals who wish to learn sign language. These systems can be used as teaching aids, allowing individuals to practice and improve their sign language skills.

The development of sign language detection systems has been made possible by advancements in sensor technology, particularly the development of flexible sensors and gyroscopes. These sensors can detect the movement and positioning of the hands and fingers, which is crucial in interpreting sign language gestures. Other sensors, such as accelerometers and depth sensors, can also be used to improve the accuracy of sign language detection systems. Sign language detection systems can be implemented using various hardware and software components. The hardware components include sensors, microcontrollers such as Arduino, and Bluetooth modules. The software components include mobile applications and computer programs that can recognize and translate sign language gestures. • This system is to identify this pattern or combinations electronically.

hang loose creator: unknown 	call me creator: unknown 	loser creator: unknown 	high-five creator: unknown 
talk to the hand creator: unknown 	good job creator: unknown 	hitchin' a ride creator: unknown 	dislike creator: unknown 
world's smallest violin creator: unknown 	peace, man creator: unknown 	shocker creator: unknown 	you creator: unknown 
bang bang creator: unknown 	a-ok creator: unknown 	a-hole creator: unknown 	check, please creator: unknown 
power to (fill in the blank) creator: unknown 	F-YOU creator: unknown 	good luck creator: unknown 	ROCK creator: Ronnie James Dio 

The implementation of sign language detection systems can vary depending on the intended application. For example, a system intended for use by deaf individuals may focus on translating sign language gestures into text, while a system intended for use by hearing individuals may focus on teaching sign language and providing feedback on the accuracy of the user's gestures. There are several challenges associated with the development and implementation of sign language detection systems. One of the primary challenges is the wide variation in sign language across different regions and cultures. Sign language detection systems must be trained on a diverse dataset of sign language gestures to accurately recognize and interpret them. One of the key benefits of sign language detection systems is that they can facilitate more effective communication between deaf and hearing individuals. By translating sign language gestures into text or spoken language, these systems can enable more efficient and accurate communication, which can improve the quality of life for deaf individuals. Additionally, these systems can promote the learning of sign language among hearing individuals, which can foster greater understanding and inclusion.

However, there are also several challenges associated with the development and implementation of sign language detection systems. One of the primary challenges is the wide variation in sign language across different regions and cultures. Sign language detection systems must be trained on a diverse dataset of sign language gestures to accurately recognize and interpret them. Another challenge is the need for real-time processing of sign language gestures, which requires systems to be capable of processing gestures quickly and accurately.

LITERATURE SURVEY:

[1] A system is proposed here, in which few flex-sensors are connected to a glove used on a hand. There is an interface for the flex sensors utilized to monitor the movements of the slider as well as interior gadgets and hence transmitting the command to the computer by using only the signals or gestures made by the user's hand. By the utilization of this method, the sensors are able to send the instructions to the microcontroller. These instructions are sent by the transmitter in the later stage. The signals that are captured by the receiver are given as input to the PIC-microcontroller. These microcontrollers with the help of relays are able to monitor any applications. By utilizing MAX 232 as well as by creating an interface with a computer, movements of the sliders are controlled by it.

[2] The proposed smart glove is wireless and is connected with flex sensors as well as accelerometer. These sensors are included to be able to recognize the user input which is in the form of change in position and posture of fingers and hands. LPC2148 Microcontroller is connected to this device to process the input. To convert the input in the form of movement into voice, speech synthesizer unit is implemented. This unit will give the output in the form of speech in real-time. To provide a text output, a display unit is utilized, facilitating more gesture recognition. Keil Microvision 4 IDE and Flash Utility 2000 have been made use of to implement the proposed system. In emergency conditions, the GSM modem provides a major help. The disabled people are helped to control the home appliances easily by the home automation system, making use of this technology

[3] Smart glove for the conversion of movements into speech and text involves a data glove connected to an accelerometer and flex sensors to recognize the change in posture and position of the fingers and hands. A high-performance Voice OTP aP8942A fabricated with Standard CMOS process is used as a speech synthesizer in the system. This speech synthesizer is used to convert the input which involves change of position or posture of fingers or hand into a real-time speech output. Additionally, a display unit is implemented to provide the text output for the corresponding input which is in the form of gesture. As the output is converted into the form of text and speech in English, an effective way of transferring information for both abled as well as deaf and dumb people is obtained. The major advantage of this proposed device is that it is portable, allowing users to carry it to different places.

[4] A hand gesture and speech recognition system using an image processing technique has a camera to record the input which is in the form of change in position and posture of hand and figures. The recorded input gestures are analyzed by making use of various algorithms used to recognize what a particular input in the form of a gesture means. MATLAB, being used as an image

processing tool, can compare the captured image with previous templates to decide the output. The output when ready to be presented is displayed on the LCD. The drawback of the techniques using image-processing is that it requires the development of complex computational algorithms to be able to detect the gestures. Furthermore, the technology using image processing makes use of certain lighting conditions as well as proper backgrounds. This technique also has field of view limitations.

[5] Gesture vocalizer presented here includes a transmitter block consisting of a digital glove, an analog to digital processing device, and an RF Transceiver. The data gloves collect gestures using the flex sensors in the form of signals. These signals are then converted from analog to digital form and are further transmitted to AVR Microcontroller. The microcontroller analyses and fetches the meaning of each signal received and stores it into the memory buffer. These values are transmitted to the receiver block. The Microcontroller at the receiver end makes the data ready for output on the screen as well as on the speaker.

[6] A system which is dynamic and recognizes gesture is presented here. This system identifies the English Language letters and converts them into speech and text output. For this to be obtained, few processes such as acquisition of video, pre-processing of the acquired data, conversion of colour, localization of colour, processing of template, and detection of gesture are performed. The Colour pointer technique is used so that an accurate pattern is obtained. In this paper, concepts of human-computer interface, image processing, and conversion of gesture to text, and then text into speech are discussed in-depth. A gesture which is dynamic is performed in-front of a web-camera. This is performed in the air in-front of the web-camera. To make the image smoother, an algorithm known as Gaussian Blur on the frames is performed.

[7] A data glove which is sensory is developed by utilizing flex sensors. This device is used for the recognition of a sign language known as American Sign Language. The four flex sensors require a voltage of +5v each. When power is ON, each flex sensor gets a +5v supply. When a user makes the gesture of any letter, the four signals coming from each flex sensor goes to the microcontroller. These signals are then converted from analog to digital values. The converted output in text form is then displayed on the LCD.

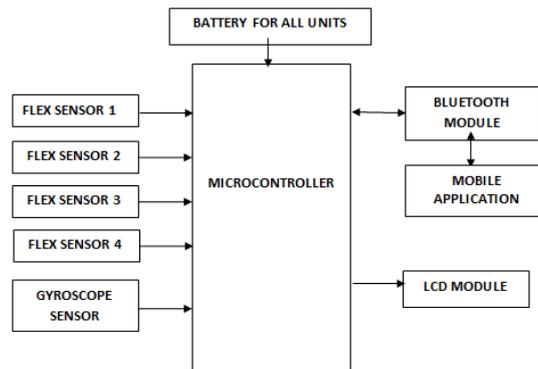
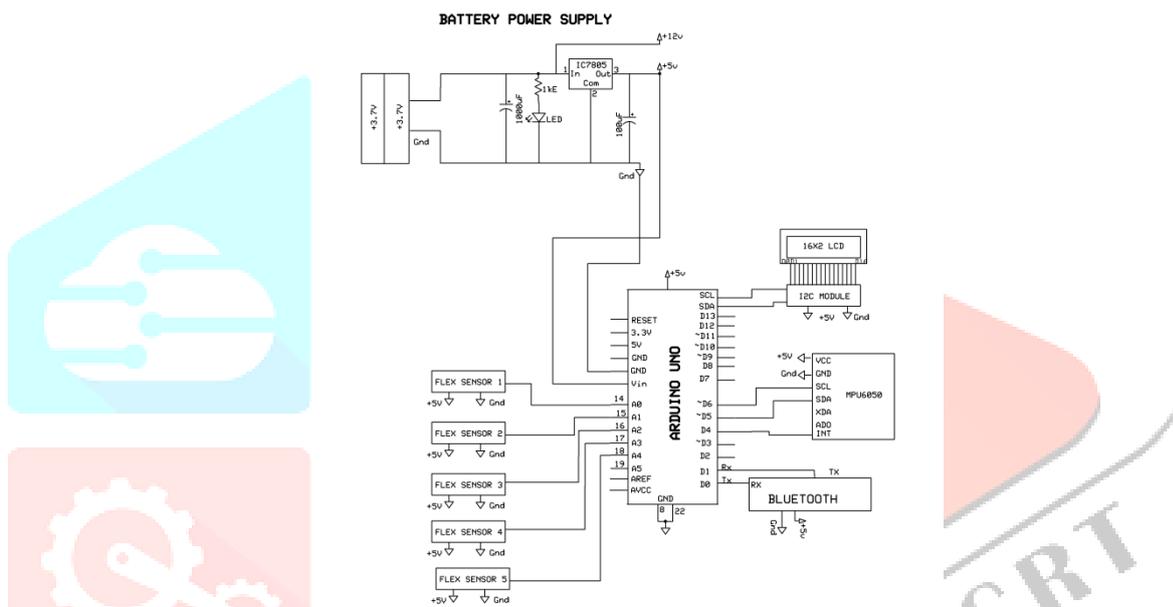
[8] The technology used to find the hand gesture consists of a glove which has flex sensors and an Inertial Measurement Unit (IMU) inbuilt in it. In order to recognize the input provided in the form of gesture, these sensors are implemented. To determine the posture and position of fingers as well as hand in a three dimensional space, the obtained values from the module of IMU and flex sensors are used. The proposed algorithm is segmented into two divisions namely, detection of finger orientation and three dimensional orientation. Here, different gesture movements are obtained as the input and are processed to produce voice assistance using the data estimation method.

[9] A device is proposed here which consists of flex sensors that are four in number. The input is given to the microcontroller in the form of resistance corresponding to the bend angle of the flex sensors. This input in the form of resistance is displayed with the help of a 16 bit LCD after being transformed into text form. Any abled person will be able to view this text from the LCD and will be able to understand the message conveyed by the deaf or mute using the device. If the one who has to get the message has blindness and is unable to read the text displayed, then the earphones or speaker in the device will be able to transmit the message which would be converted into voice form using a device that is based on APR 33A3 IC which can do voice recording as well as playback. The proposed device can be used in bio-medical applications in hospital wards for example in operation theaters or in Intensive Care Units (ICU).

[10] Methodologies effective for the spotting and validation of detection of gesture are presented here. When there is a presence of noise in the input image, or any kind of real-time hitch, the gesture of the hand of the person using the system is recorded and only those attributes are extracted which are considered as important. These attributes are observed to be distinctively associated with every user's uniqueness, who are making use of this system and are stored as a template in a storage unit such as a database. The gesture performed by a user is recorded and the attributes drawn from it is made to be compared with either every database recognition template or the templates which correspond to the verification of identity that states to be claimed.

EXISTING SYSTEM:

The existing system is smart glove is proposed which includes components such as flex sensors, Arduino, APR33A3 Voice Playback module, transmitter, and receiver. This technology helps the user to provide input in order to control his/her home appliances if he/she cannot walk towards the switchboard, which can be considered as an advantage. The disadvantage of this technology is that the device is bulky, and has too many components, making it hard to be a portable one. The working of the device commences as soon as there is an input in the form of a movement of hand or fingers. The gloves are connected to the flex sensors and if there is any input gesture given, then the sensor value changes as a result of the bend in the flex sensors. The changing value of the flex sensor corresponds to the applied bending angle as well as the resistance, according to the input given.

BLOCK DIAGRAM:**CIRCUIT DIAGRAM:****PROPOSED SYSTEM:**

The proposed system for sign language detection for deaf and dumb using flex sensor, gyroscope sensor, Bluetooth module, and LCD module Arduino Uno is a comprehensive solution that utilizes a combination of hardware and software components to recognize and interpret sign language gestures in real-time. The hardware components of the system include flex sensors and gyroscope sensors that are attached to a hand glove. The flex sensors are resistive sensors that change their resistance when they are bent. These sensors are attached to the fingers of the glove and detect the bending of the fingers. The gyroscope sensors, on the other hand, detect the orientation of the hand and the speed and direction of hand movements.

These sensors work together to detect the movement and positioning of the hand and fingers, which is critical in recognizing and interpreting sign language gestures. The data collected by the sensors is then processed by the Arduino Uno microcontroller, which uses algorithms to recognize specific gestures and translate them into text. The algorithms are developed based on the patterns of sign language gestures, and they are programmed into the Arduino Uno board. Once the Arduino Uno has recognized a gesture, it sends the data to a Bluetooth module, which enables the Arduino Uno to communicate with a mobile application installed on a smartphone or tablet.

The mobile application is designed to receive the data sent by the Bluetooth module, read the recognized sign language gesture, and convert it into spoken language output. The mobile application is designed to have a user-friendly interface that displays the recognized sign language gesture on the screen in real-time. The mobile application uses a text-to-speech engine to convert the recognized sign language gesture into spoken language output, allowing the wearer to communicate with hearing individuals who do not know sign language.

To use the system, the wearer simply puts on the hand gloves and connects the Bluetooth module to the mobile application installed on a smartphone or tablet. The wearer can then perform sign language gestures, and the system will recognize and translate them in real-time. The recognized gestures are displayed on the screen of the mobile application and converted into spoken language output, allowing the wearer to communicate with hearing individuals who do not know sign language.

Circuit Connections:**Flex sensors connections:**

- Connect the first flex sensor to the analog input pin A0 of the Arduino Uno board. Connect one end of the flex sensor to the A0 pin, and the other end to ground.
- Connect the second flex sensor to the analog input pin A1 of the Arduino Uno board. Connect one end of the flex sensor to the A1 pin, and the other end to ground.

- Connect the third flex sensor to the analog input pin A2 of the Arduino Uno board. Connect one end of the flex sensor to the A2 pin, and the other end to ground.

Gyroscope sensor connections:

- Connect the VCC pin of the gyroscope sensor to the 5V pin of the Arduino Uno board.
- Connect the GND pin of the gyroscope sensor to ground.
- Connect the SDA pin of the gyroscope sensor to the A4 pin of the Arduino Uno board.
- Connect the SCL pin of the gyroscope sensor to the A5 pin of the Arduino Uno board.

Bluetooth module connections:

- Connect the VCC pin of the Bluetooth module to the 5V pin of the Arduino Uno board.
- Connect the GND pin of the Bluetooth module to ground.
- Connect the TX pin of the Bluetooth module to the RX pin (pin 0) of the Arduino Uno board.
- Connect the RX pin of the Bluetooth module to the TX pin (pin 1) of the Arduino Uno board.

LCD module connections:

- Connect the VCC pin of the LCD module to the 5V pin of the Arduino Uno board.
- Connect the GND pin of the LCD module to ground.
- Connect the SDA pin of the LCD module to the A4 pin of the Arduino Uno board.
- Connect the SCL pin of the LCD module to the A5 pin of the Arduino Uno board.

Flex sensors and gyroscope sensors connections:

Connect each flex sensor and gyroscope sensor to the hand glove using conductive thread. The sensors should be positioned on the hand glove such that they can detect the hand movements and finger flexion.

Power supply:

Connect a 9V battery or DC power supply to the power jack of the Arduino Uno board. Make sure to connect the positive (+) terminal of the battery to the positive terminal of the power jack, and the negative (-) terminal to the negative terminal.

Once all the connections are made, you can upload the Arduino code to the board and test the system. The system should detect the hand movements and finger flexion using the flex sensors and gyroscope sensor, and display the corresponding sign language letters on the LCD module. The Bluetooth module should also be able to transmit the data to the mobile application on the smartphone or tablet, which will then read the sign language letters and speak them out loud.

METHODOLOGY:

The methodology for a sign language detection for deaf and dumb this system involves both hardware and software components.

HARDWARE EXPLANATION:

The system will utilize a combination of technologies such as flex sensor, gyroscope sensor, Bluetooth module, and LCD module Arduino Uno. it is a comprehensive solution that utilizes a combination of hardware and software components to recognize and interpret sign language gestures in real-time..

COMPONENTS LIST:

- Battery Power supply system
- Arduino uno
- Bluetooth Module
- Flex Sensor
- Gyroscope Sensor
- I2C Module
- LCD Module

HARDWARE COMPONENTS DESCRIPTION

BATTERY POWER SUPPLY SYSTEM:

18650 battery is a Li-ion rechargeable battery with a 2500 mAh Battery Capacity. This is not a standard AA or AAA battery but is very useful for applications that require continuous high current or high current in short bursts like in cameras, DVD players, iPod, etc. A 18650 cell can be charged and discharged up to 1000 cycles without much loss in battery capacity. They are safe to use, environment friendly and have long battery life. It comes with high energy density and provides excellent continuous power sources to your device. It should be used with a protection circuit board that guards the battery against over-charge, over-discharge of the pack, and avoid over-current drawn.

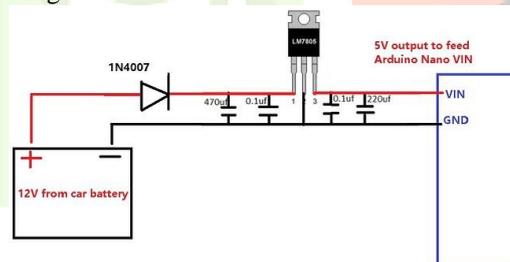
Specifications :-

- Voltage: 3.7 Volts
- Capacity: 2500 mAh
- Rechargeable: Yes
- Battery Size: Diameter- 18mm x Length- 67mm
- Charging Method CC-CV
- Weight 45grams
- Maximum safe discharge current 4400mA (2C)
- Maximum charging voltage 4.2V (Do not overcharge the cell, it may explode or be internally damaged.)
- Maximum charging current 1000mA



A 7V to 5V battery power supply is a device that converts a 7V voltage source to a 5V voltage source, typically used to power electronic devices that require a 5V power supply. This conversion is achieved using a DC-DC step-down converter or voltage regulator.

This signal is then rectified and filtered to produce a stable output voltage. Voltage regulators, on the other hand, use a feedback loop to adjust the output voltage to a constant value regardless of input voltage fluctuations. When selecting a converter, it is important to consider the input voltage range, output voltage, and output current requirements of the device being powered. The input voltage range of the converter should be able to handle at least 12V to accommodate the 12V battery. The output voltage should be 5V to match the device's power requirements. The converter's output current rating should be higher than the device's maximum current draw to avoid overloading the converter.



To use the converter, the positive and negative wires from the 7V battery are connected to the input terminals of the converter. The positive and negative wires from the output terminals of the converter are then connected to the device that requires 5V power. It is important to follow the manufacturer's instructions for the specific converter being used and take necessary precautions to avoid electric shock or short circuits.

Voltage Regulator: The voltage regulator is the fourth and final component in the power supply system. Its function is to regulate the output voltage to a constant 5V DC voltage. The voltage regulator uses a feedback mechanism to adjust the output voltage to a constant value, even if the input voltage or load current changes.

ARDUINO UNO:

Arduino/Genuino Uno is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, 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.. You can tinker with your UNO without working too much about doing something

Arduino is an open source, computer hardware and software company, project, and user community that designs and manufactures microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical world. The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). 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.. The microcontrollers are typically programmed using a dialect of features from the programming languages C and C++.

HARDWARE

Arduino is open-source hardware. The hardware reference designs are distributed under a Creative Commons Attribution Share-Alike 2.5 license and are available on the Arduino website. Layout and production files for some versions of the hardware are also available.

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 bootloader SRAM 2 KB (ATmega328) EEPROM 1 KB (ATmega328) Clock Speed 16 MHz

Input and Output

Each of the 14 digital pins on the Arduino Uno can be used as an input or output, using `pinMode()`, `digitalWrite()`, and `digitalRead()` functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default of 20-50 kOhms).

In addition, some pins have specialized functions:

Serial: pins 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip.

External Interrupts: pins 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the `attachInterrupt()` function for details.

PWM: 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the `analogWrite()` function.

SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication using the SPI library.

LED: 13. There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

TWI: A4 or SDA pin and A5 or SCL pin. Support TWI communication using the Wire library. There are a couple of other pins on the board:

AREF. Reference voltage for the analog inputs. Used with `analogReference()`.

Reset. Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

Digital Pins :

In addition to the specific functions listed below, the digital pins on an Arduino board can be used for general purpose input and output via the `pinMode()`, `digitalRead()`, and `digitalWrite()` commands. Each pin has an internal pull-up resistor which can be turned on and off using `digitalWrite()` (w/ a value of HIGH or LOW, respectively) when the pin is configured as an input. The maximum current per pin is 40 mA.

- **Serial: 0 (RX) and 1 (TX).** Used to receive (RX) and transmit (TX) TTL serial data. On the Arduino Diecimila, these pins are connected to the corresponding pins of the FTDI USB-to-TTL Serial chip
- **External Interrupts: 2 and 3.** These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the `attach Interrupt()` function for details.
- **PWM: 3, 5, 6, 9, 10, and 11.** Provide 8-bit PWM output with the `analogWrite()` function. On boards with an ATmega8, PWM output is available only on pins 9, 10, and 11.
- **BT Reset: 7.** (Arduino BT-only) Connected to the reset line of the Bluetooth module.
- **SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK).** These pins support SPI communication, which, although provided by the underlying hardware, is not currently included in the Arduino language.

- **LED: 13.** On the Diecimila and LilyPad, there is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

Analog Pins

In addition to the specific functions listed below, the analog input pins support 10-bit analog-to-digital conversion (ADC) using the analogRead() function. Most of the analog inputs can also be used as digital pins: analog input 0 as digital pin 14 through analog input 5 as digital pin 19. Analog inputs 6 and 7 (present on the Mini and BT) cannot be used as digital pins.

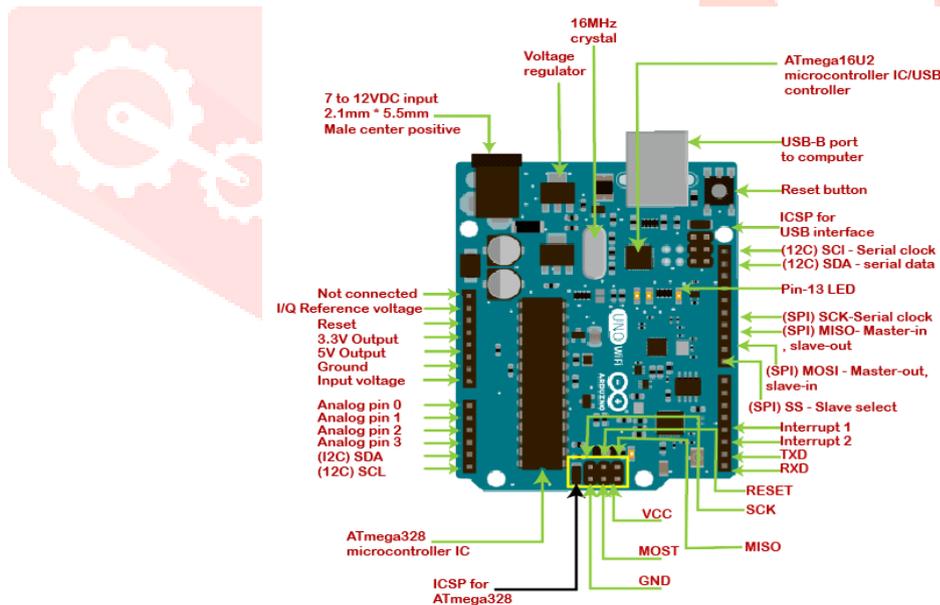
- **I²C: 4 (SDA) and 5 (SCL).** Support I²C (TWI) communication using the Wire library (documentation on the Wiring website).

Power Pins

- **VIN** (sometimes labelled "9V"). The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source).
- **5V.** The regulated power supply used to power the microcontroller and other components on the board. This can come either from VIN via an on-board regulator, or be supplied by USB or another regulated 5V supply.
- **3V3.** (Diecimila-only) A 3.3 volt supply generated by the on-board FTDI chip.
- **GND.** Ground pins.

Other Pins

- **AREF.** Reference voltage for the analog inputs. Used with analogReference().
- **Reset.** (Diecimila-only) Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.
- Many Arduino-compatible and Arduino-derived boards exist. Some are functionally equivalent to an Arduino and can be used interchangeably. Many enhance the basic Arduino by adding output drivers, often for use in school-level education, to simplify making buggies and small robots. Others are electrically equivalent but change the form factor, sometimes retaining compatibility with shields, sometimes not. Some variants use different processors, of varying compatibility..



BLUETOOTH MODULE (HC-05)

- It is used for many applications like wireless headset, game controllers, wireless mouse, wireless keyboard, and many more consumer applications.
- It has range up to <100m which depends upon transmitter and receiver, atmosphere, geographic & urban conditions.
- It is IEEE 802.15.1 standardized protocol, through which one can build wireless Personal Area Network (PAN). It uses frequency-hopping spread spectrum (FHSS) radio technology to send data over air.
- It uses serial communication to communicate with devices. It communicates with microcontroller using serial port (USART).

HC-05 Bluetooth Module

- HC-05 is a Bluetooth module which is designed for wireless communication. This module can be used in a master or slave configuration.



HC-05 Bluetooth Module Pin Diagram



HC-05 Bluetooth Module Pin Diagram

Bluetooth serial modules allow all serial enabled devices to communicate with each other using Bluetooth.

It has 6 pins,

1. Key/EN: It is used to bring Bluetooth module in AT commands mode. If Key/EN pin is set to high, then this module will work in command mode. Otherwise by default it is in data mode. The default baud rate of HC-05 in command mode is 38400bps and 9600 in data mode.

HC-05 module has two modes,

1. Data mode: Exchange of data between devices.
2. Command mode: It uses AT commands which are used to change setting of HC-05.

To send these commands to module serial (USART) port is used.

2. VCC: Connect 5 V or 3.3 V to this Pin.
3. GND: Ground Pin of module.
4. TXD: Transmit Serial data (wirelessly received data by Bluetooth module transmitted out serially on TXD pin)
5. RXD: Receive data serially (received data will be transmitted wirelessly by Bluetooth module).
6. State: It tells whether module is connected or not.

HC-05 module Information

- HC-05 has red LED which indicates connection status, whether the Bluetooth is connected or not. Before connecting to HC-05 module this red LED blinks continuously in a periodic manner. When it gets connected to any other Bluetooth device, its blinking slows down to two seconds.
- This module works on 3.3V. We can connect 5V supply voltage as well since the module has on board 5 to 3.3 V regulator.
- As HC-05 Bluetooth module has 3.3V level for RX/TX and microcontroller can detect 3.3 V level, so, no need to shift transmit level of HC-05 module. But we need to shift the transmit voltage level from microcontroller to RX of HC-05 module.
- The data transfer rate of HC-05 module can vary up to 1Mbps is in the range of 10 meters.

Specification of HC-05 Bluetooth Module

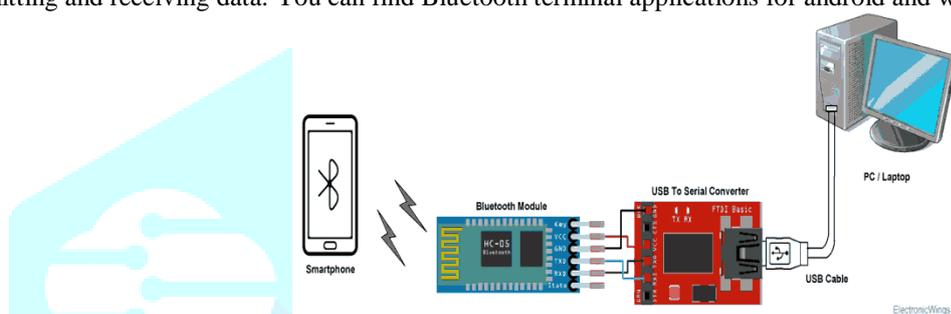
- Bluetooth version: 2.0 + EDR (Enhanced Data Rate)
- Frequency: 2.4 GHz ISM band
- Modulation: GFSK (Gaussian Frequency Shift Keying)
- Transmit power: Class 2 (up to 4 dBm)
- Sensitivity: -80 dBm typical
- Range: approximately 10 meters (or 33 feet) in open air

- Profiles supported: SPP (Serial Port Profile), HID (Human Interface Device) and others
- Operating voltage: 3.3V to 5V DC
- Operating current: less than 50mA
- Standby current: less than 2.5mA
- Sleep current: less than 1mA
- Interface: UART (Universal Asynchronous Receiver/Transmitter)
- Baud rates: 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200, 230400, and 460800
- Operating temperature: -20°C to 75°C (-4°F to 167°F)

Bluetooth communication between Devices

E.g. Send data from Smartphone terminal to HC-05 Bluetooth module and see this data on PC serial terminal and vice versa.

To communicate smartphone with HC-05 Bluetooth module, smartphone requires Bluetooth terminal application for transmitting and receiving data. You can find Bluetooth terminal applications for android and windows in respective app. store.



Bluetooth Module Serial Interface

So, when we want to communicate through smartphone with HC-05 Bluetooth module, connect this HC-05 module to the PC via serial to USB converter.

Before establishing communication between two Bluetooth devices, 1st we need to pair HC-05 module to smartphone for communication.

Pair HC-05 and smartphone:

1. Search for new Bluetooth device from your phone. You will find Bluetooth device with “HC-05” name.
2. Click on connect/pair device option; default pin for HC-05 is 1234 or 0000.

After pairing two Bluetooth devices, open terminal software (e.g. Teraterm, Realterm etc.) in PC, and select the port where we have connected USB to serial module. Also select default baud rate of 9600 bps.

In smart phone, open Bluetooth terminal application and connect to paired device HC-05.

It is simple to communicate, we just have to type in the Bluetooth terminal application of smartphone. Characters will get sent wirelessly to Bluetooth module HC-05. HC-05 will automatically transmit it serially to the PC, which will appear on terminal. Same way we can send data from PC to smartphone.

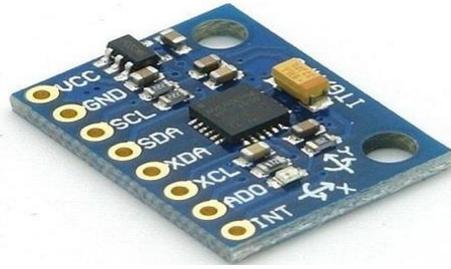
Command Mode

- When we want to change settings of HC-05 Bluetooth module like change password for connection, baud rate, Bluetooth device’s name etc.
- To do this, HC-05 has AT commands.
- To use HC-05 Bluetooth module in AT command mode, connect “Key” pin to High (VCC).
- Default Baud rate of HC-05 in command mode is 38400bps.
- Following are some AT command generally used to change setting of Bluetooth module.
- To send these commands, we have to connect HC-05 Bluetooth module to the PC via serial to USB converter and transmit these command through serial terminal of PC.

GYROSCOPE SENSOR:

Gyroscope sensor is a device that can measure and maintain the orientation and angular velocity of an object. These are more advanced than accelerometers. These can measure the tilt and lateral orientation of the object whereas accelerometer can only measure the linear motion.

Gyroscope sensors are also called as Angular Rate Sensor or Angular Velocity Sensors. These sensors are installed in the applications where the orientation of the object is difficult to sense by humans. Measured in degrees per second, angular velocity is the change in the rotational angle of the object per unit of time.

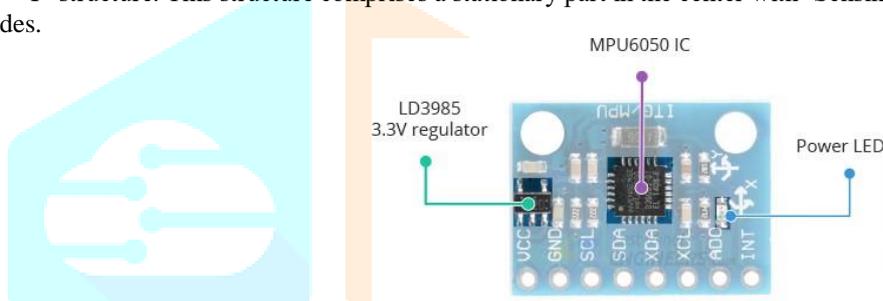


Gyroscope Sensor Working Principle

Besides sensing the angular velocity, Gyroscope sensors can also measure the motion of the object. For more robust and accurate motion sensing, in consumer electronics Gyroscope sensors are combined with Accelerometer sensors.

Depending on the direction there are three types of angular rate measurements. Yaw- the horizontal rotation on a flat surface when seen the object from above, Pitch- Vertical rotation as seen the object from front, Roll- the horizontal rotation when seen the object from front.

The concept of Coriolis force is used in Gyroscope sensors. In this sensor to measure the angular rate, the rotation rate of the sensor is converted into an electrical signal. Working principle of Gyroscope sensor can be understood by observing the working of Vibration Gyroscope sensor. This sensor consists of an internal vibrating element made up of crystal material in the shape of a double – T- structure. This structure comprises a stationary part in the center with ‘Sensing Arm’ attached to it and ‘Drive Arm’ on both sides.

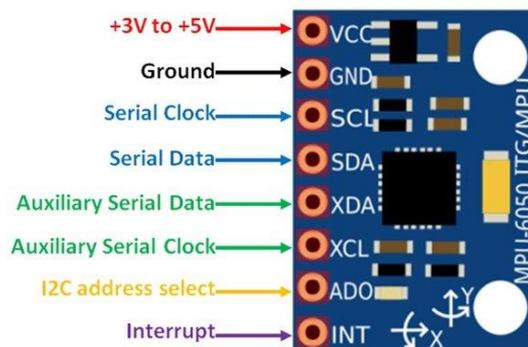


This double-T-structure is symmetrical. When an alternating vibration electrical field is applied to the drive arms, continuous lateral vibrations are produced. As Drive arms are symmetrical, when one arm moves to left the other moves to the right, thus canceling out the leaking vibrations. This keeps the stationary part at the center and sensing arm remains static. When the external rotational force is applied to the sensor vertical vibrations are caused on Drive arms. This leads to the vibration of the Drive arms in the upward and downward directions due to which a rotational force acts on the stationary part in the center. Rotation of the stationary part leads to the vertical vibrations in sensing arms. These vibrations caused in the sensing arm are measured as a change in electrical charge. This change is used to measure the external rotational force applied to the sensor as Angular rotation.

The Coriolis Effect states that when a mass (m) moves in a specific direction with a velocity (v) and an external angular rate (Ω) is applied (Red arrow), the Coriolis Effect generates a force (Yellow arrow) that causes the mass to move perpendicularly. The value of this displacement is directly related to the angular rate applied.

Pinout:

- VCC supplies power to the module.
- GND is the ground pin.
- SCL is a serial clock pin for the I2C interface.



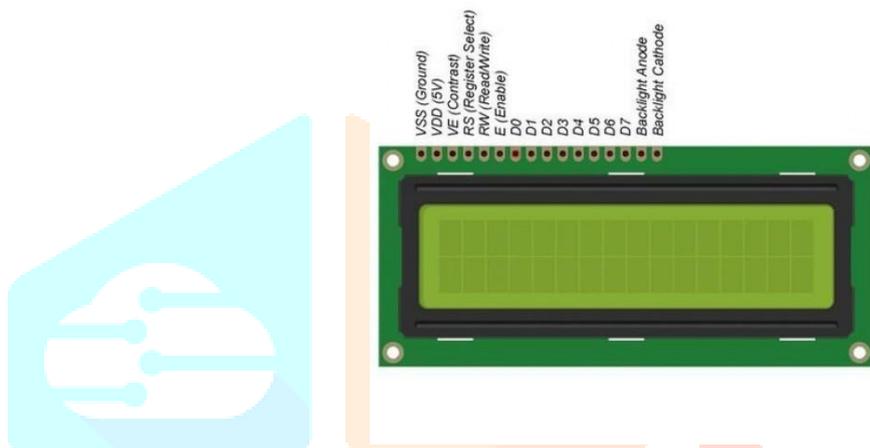
MPU6050 Pinout

- SDA is a serial data pin for the I2C interface.
- XDA is the external I2C data line. The external I2C bus is for connecting external sensors, such as a magnetometer.
- XCL is the external I2C clock line.

- ADO allows you to change the I2C address of the MPU6050 module. It can be used to avoid conflicts between the module and other I2C devices or to connect two MPU6050s to the same I2C bus. When you leave the ADO pin unconnected, the default I2C address is 0x68HEX; when you connect it to 3.3V, the I2C address changes to 0x69HEX.
- INT is the Interrupt Output pin. The MPU6050 can be programmed to generate an interrupt upon detection of gestures, panning, zooming, scrolling, tap detection, and shake detection.

LCD MODULE 16X2:

The LCD 16x2 is a display module that can show up to 16 characters per row with a total of 32 characters across the entire display. It uses liquid crystal display (LCD) technology for low power consumption and high contrast. The display is typically controlled by an integrated circuit (IC) driver, such as the HD44780, which communicates with a microcontroller or other digital device. The LCD 16x2 module typically requires 16 pins to be connected to a microcontroller or other digital device, which are used for power, ground, and data communication. The data communication is typically done using a parallel interface, where eight data pins are used to transmit the character data, along with other control pins for selecting the display row and column. The LCD 16x2 display can be programmed to display text, symbols, and even simple graphics, and the backlight can be turned on or off to improve visibility in different lighting conditions.



I2C MODULE:

I2C, or Inter-Integrated Circuit, is a communication protocol commonly used in microcontroller-based systems. The I2C protocol uses a two-wire serial interface consisting of a data line (SDA) and a clock line (SCL). This allows multiple devices to be connected to the same bus, with each device having a unique address. An I2C module is a hardware module that provides support for the I2C protocol.

It typically consists of an integrated circuit (IC) that interfaces with a microcontroller and handles the low-level details of I2C communication, such as generating clock pulses, transmitting and receiving data, and addressing devices on the bus. The I2C module allows for simple and efficient communication between multiple devices, making it useful in many applications such as sensor networks, displays, and memory devices. Its simplicity and low pin count make it a popular choice for embedded systems, especially for communication between sensors and microcontrollers.



FLEX SENSOR:

A flex sensor is a kind of sensor which is used to measure the amount of deflection 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.



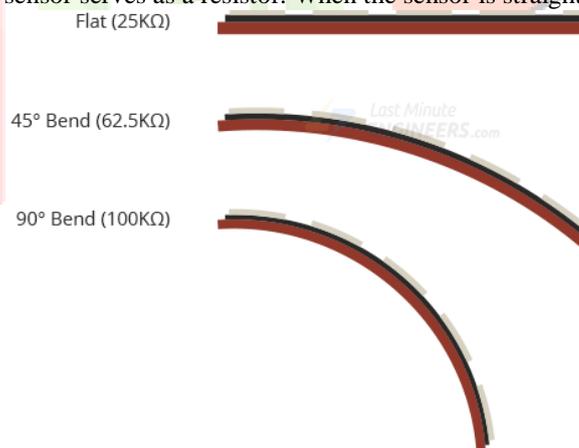
- Pin P1: This pin is generally connected to the +ve terminal of the power source.
- Pin P2: This pin is generally connected to GND pin of the power source.

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 45° then the resistance would be dissimilar. Similarly, when this sensor is twisted to 90° 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.

The conductive ink on the sensor serves as a resistor. When the sensor is straight, this resistance is around 25k.



When the sensor is bent, the conductive layer is stretched, resulting in a reduced cross section (imagine stretching a rubber band) and increased resistance. At a 90° angle, this resistance is approximately 100K.

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 -45°C to +80°C
- Flat resistance is 25K Ω

- The tolerance of resistance will be $\pm 30\%$
- The range of bend resistance will range from 45K - 125K Ohms

SOFTWARE DESCRIPTION

ARDUINO IDE:

Arduino IDE (Integrated Development Environment) is a software tool used for programming and development of Arduino boards. It is an open-source platform, available for free, and is compatible with multiple operating systems including Windows, Mac OS, and Linux.

The main features of the Arduino IDE include:

- **Code Editor:** The code editor is the main interface of the Arduino IDE where you can write, edit and upload code to the Arduino board. It includes features such as syntax highlighting, auto-completion, and code snippets to make programming easier.
- **Sketches:** Arduino programs are referred to as "sketches" and can be easily created and saved within the IDE. The sketch contains two main functions: the `setup()` function, which is called once at the start of the program, and the `loop()` function, which is called repeatedly as long as the program is running.
- **Library Manager:** The Library Manager allows users to easily install and manage libraries for their Arduino projects. It includes a collection of pre-built libraries that can be used to add functionality to your projects. Users can also create their own libraries and add them to the IDE.
- **Serial Monitor:** The Serial Monitor allows users to communicate with the Arduino board and monitor the data being sent and received through the serial port. This is particularly useful for debugging and troubleshooting.
- **Board Manager:** The Board Manager allows users to select the type of Arduino board they are using, configure settings, and install the necessary drivers. This is important because different Arduino boards may have different specifications and require different drivers.
- **Upload:** The Upload feature allows users to upload their sketches to the Arduino board and begin executing the program. Users can select the correct board and serial port before uploading the sketch.
- **Tools:** The Tools menu includes a range of options for configuring and customizing the IDE. This includes options for setting the board type, serial port, programmer, and other settings.

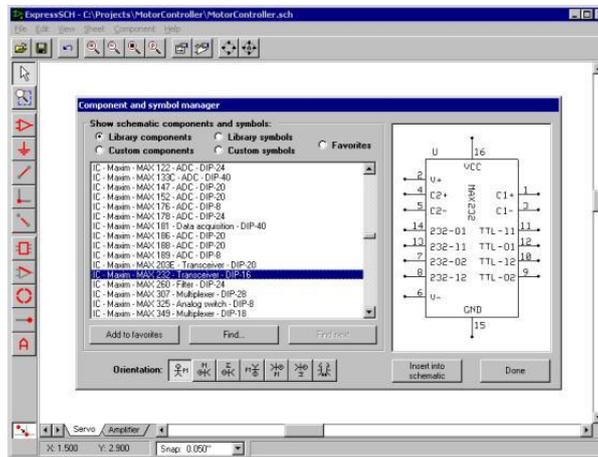
Overall, the Arduino IDE is a user-friendly software tool that simplifies the programming process for beginners and experienced users alike. It is compatible with a wide range of Arduino boards and shields, making it a versatile tool for a variety of applications. With its many features and community support, the Arduino IDE is an essential tool for anyone interested in electronics and programming.



In addition to the basic features listed above, the Arduino IDE also supports advanced features such as debugging and profiling tools, version control integration, and multiple file editing. The IDE can also be extended through plugins and add-ons, allowing users to customize the tool to their specific needs. Additionally, the Arduino community provides a wealth of resources and tutorials to help users get started and troubleshoot any issues they may encounter.

EXPRESS PCB:

Express PCB is a free-to-use software program for designing printed circuit boards (PCBs). It is a simple and user-friendly tool that is ideal for beginners and hobbyists who want to design and create their own PCBs.



Some of the key features of Express PCB include:

- **Schematic Capture:** Express PCB allows users to create schematic diagrams of their circuits using a library of pre-built symbols. The software also provides a range of editing tools to help users create and modify their schematic diagrams.
- **Board Layout:** Express PCB includes a powerful board layout editor that allows users to place components on the board, route traces between components, and add text and graphics. The software also includes a range of design rules to ensure that the PCB meets the required specifications.
- **Gerber Export:** Once the board design is complete, Express PCB allows users to export the design as Gerber files, which can be used to manufacture the PCB.
- **Parts Library:** Express PCB comes with a large library of pre-built parts and components that users can use to create their designs. Users can also create their own custom parts library.
- **Auto-Router:** The software includes an auto-router feature that can automatically route traces between components on the board. This can save users a lot of time and effort, especially for complex designs.
- **3D Viewer:** Express PCB includes a 3D viewer that allows users to view their board designs in 3D, providing a realistic view of how the final product will look.

Overall, Express PCB is a powerful and user-friendly software tool that can help users design and create their own PCBs quickly and easily. The software is free to download and use, making it accessible to hobbyists and beginners who may not have a large budget for PCB design software. Additionally, Express PCB provides a range of tutorials and resources to help users get started and troubleshoot any issues they may encounter during the design process.

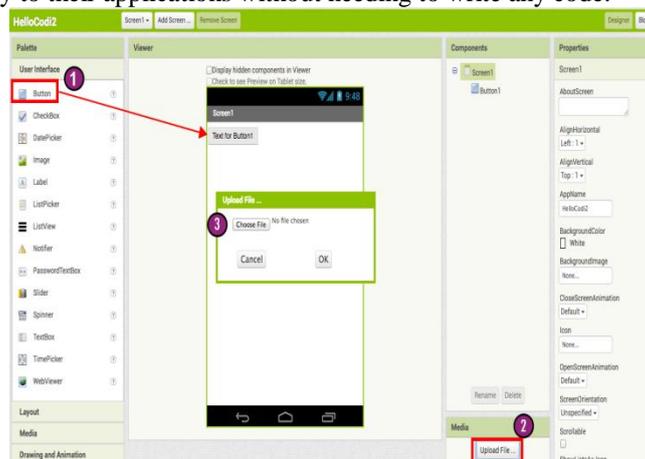
MIT APP INVENTOR:

MIT App Inventor is a web-based integrated development environment (IDE) that allows users to create mobile applications for Android devices without needing any programming knowledge. It is developed and maintained by the Massachusetts Institute of Technology (MIT) and is an open-source platform. The platform is designed to be easy to use and intuitive, making it accessible to users of all ages and backgrounds.

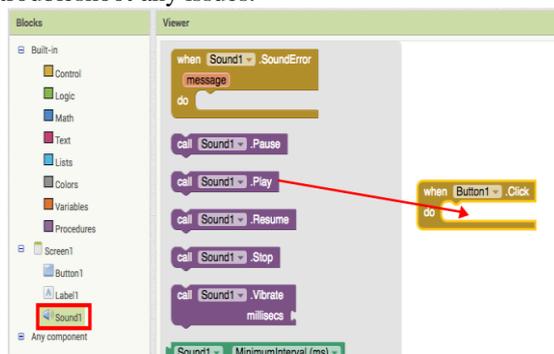
The platform uses a visual drag-and-drop interface, which makes it easy for users to design the user interface and add functionality to their application. The user interface is designed using a set of pre-defined components, such as buttons, text boxes, images, and labels. These components can be dragged and dropped onto the design canvas to create the application's user interface.

Once the user interface is designed, users can add functionality to their application using a block-based programming language. The programming language is designed to be easy to use and intuitive, allowing users to create complex applications without needing to write any code. The blocks are arranged in a logical sequence, and users can connect them together to create the desired functionality.

MIT App Inventor also provides a set of pre-defined blocks for common tasks, such as reading and writing to a database, accessing the device's sensors, and communicating with other devices over Bluetooth. These pre-defined blocks make it easy for users to add advanced functionality to their applications without needing to write any code.



One of the key features of MIT App Inventor is its live testing capabilities. Users can connect their Android device to their computer, and the application will be installed and run on the device in real-time. This allows users to test their application as they build it, making it easier to debug and troubleshoot any issues.



Overall, MIT App Inventor is an easy-to-use, intuitive platform that allows users to create mobile applications for Android devices without needing any programming knowledge. Its visual drag-and-drop interface and block-based programming language make it accessible to users of all ages and backgrounds, while its live testing capabilities make it easy to test and debug applications in real-time.

CONCLUSION:

In conclusion, the proposed system for sign language detection for deaf and dumb using flex sensor, gyroscope sensor, Bluetooth module, and LCD module Arduino Uno is an innovative and effective solution for bridging the communication gap between the deaf and the hearing community. The system is designed to detect the hand movements and finger flexion of the user and translate them into sign language letters, which can then be transmitted to a mobile application on a smartphone or tablet and spoken out loud. The system is easy to use and does not require any prior knowledge of sign language, making it accessible to anyone who wants to communicate with the deaf community. Moreover, the system is cost-effective and can be easily replicated, making it suitable for widespread use in schools, hospitals, and other public places. Overall, the proposed system has the potential to make a significant impact on the lives of the deaf and dumb community and help them communicate more effectively with the hearing community.

DISCUSSION:

This system is a comprehensive solution that utilizes a combination of hardware and software components to recognize and interpret sign language gestures in real-time. This system offers several advantages and disadvantages.

Advantages:

- **Improved communication:** The proposed system for sign language detection enables people with hearing disabilities to communicate more easily and effectively with the hearing community. This can help to reduce communication barriers and promote better social interaction and inclusion.
- **Low cost:** The system is designed using low-cost components, which makes it affordable and accessible to a wide range of users. This can be particularly useful in developing countries, where the cost of traditional assistive technologies is often prohibitive.
- **Easy to use:** The system is easy to use and does not require any prior knowledge of sign language, making it accessible to anyone who wants to communicate with the deaf community.
- **Portable:** The system is portable and can be used in a variety of settings, including schools, hospitals, and public places.
- **Customizable:** The system is highly customizable and can be adapted to suit the specific needs and preferences of individual users.

Disadvantages:

- **Limited accuracy:** While the proposed system is effective in detecting hand movements and finger flexion, it may not be able to capture the nuances of sign language gestures accurately. This could result in misinterpretations or miscommunications.
- **Limited vocabulary:** The system is designed to recognize a limited vocabulary of sign language letters, which may not be sufficient for more complex communication needs.
- **Bluetooth connectivity:** The system relies on Bluetooth connectivity to transmit data to a mobile application. This could pose connectivity issues, especially in areas with poor network coverage.
- **Sensor calibration:** The system requires careful sensor calibration to ensure accurate detection of hand movements and finger flexion. This could be time-consuming and may require technical expertise.
- **Limited compatibility:** The system is designed to work with specific hardware and software components, which may limit its compatibility with other devices or applications.

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