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SIGN LANGUAGE TO SPEECH CONVERTER

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Abstract
Digital Vocalizer is a project aimed at bridging the communication gap between mute and hearing-impaired individuals and those without such impairments. Deaf and mute people often use sign language or gestures to communicate, which can be challenging for others to understand. To address this issue, we have developed a system using an Arduino Nano board as the Atmega 328 Controller board to interface all sensors and actuators. The core of our prototype is based on the concept of an Artificial Neural Network. Flex sensors placed on the hands of the deaf individual convert parameters like finger bend and hand position angle into electrical signals, which are then processed by the Atmega 328 controller. The controller interprets these signals according to the sign and converts them into text and speech formats.
Keywords: Flex sensor, HC-05Bluetooth Module, Aurdino Nano, Voltage Divider, LCD

1. INTRODUCTION
Communication is a fundamental human need, yet millions of individuals around the world face significant barriers due to hearing and speech impairments. For deaf and mute people, expressing themselves and understanding others often relies on sign language and gestures. Unfortunately, these methods are not universally understood, leading to communication gaps and social isolation.
The Digital Vocalizer project aims to address this challenge by developing a system that translates hand gestures into speech. By leveraging modern technology, we seek to create a tool that enhances the quality of life for deaf and mute individuals, enabling them to communicate more effectively with the hearing population. At the heart of our system is the Arduino Nano board, equipped with an Atmega 328 controller. This board interfaces with flex sensors placed on the user's hand, which detect finger bends and hand positions. These physical parameters are converted into electrical signals, which are then processed by the controller.

The controller interprets these signals and converts them into corresponding text and speech outputs. The project employs the principles of Artificial Neural Networks to accurately map gestures to their respective meanings. By translating gestures into audible speech, the Digital Vocalizer facilitates real-time communication, breaking down the barriers that mute and deaf individuals face daily.
Our prototype focuses on creating a portable and user-friendly device that supports two-way communication. By converting specific hand gestures into audible speech, we aim to provide a practical solution that bridges the communication gap, promoting inclusivity and understanding.
This document outlines the design, implementation, and testing of the Digital Vocalizer system, detailing the hardware and software components involved. Our goal is to contribute to the development of assistive technologies that empower differently-abled individuals and foster a more inclusive society.

1.1 Methods of Sign Language
Direction of the Sign:- The same sign made in different directions can give opposite meanings. For example, the sign "give" is motioned towards the person signing to mean, "give to me;" however, when it is motioned away from the person signing, it means’ give to you’.

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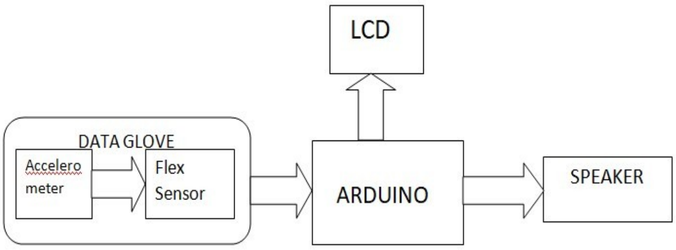
Hand positioning:- The palm of the hand should face the person(s) with whom you are communicating. Hold your arm in a comfortable position. The hand should not block your lips.
Flow and Rhythm:- Each letter should be signed clearly, distinctly, and crisply with a slight pause between words. The pause is indicated by holding the last letter of the word for several seconds.
Vocalization:- The words you finger spell should be spoken at the same time. The individual letters should not be spoken.
Double letters in a word:- The hand is opened slightly in between the first and second letter.
Understanding Signs:- It is not uncommon for new or beginning signers to have difficulty understanding other persons signing to them. People who are deaf or have a speaking impairment and who use sign language will be patient with you when you do not understand them

2. PROJECT DESCRIPTION

Generally mute people use sign language for communication but they find difficulty in communicating with others who do not understand sign language. This project aims to lower this barrier in communication. It is based on the need of developing an electronic device that can translate sign language into speech in order to make the communication take place between the mute communities with the general public possible.
Gesture to Speech Conversion is a tool for converting gestures of the differently abled people of the world to speech i.e. converting gestures input to speech output. Proposed system is portable and focuses on two way communication. Main goal of the system is to convert hand gestures to auditory speech for communication between mute and normal people. There are 5 flex sensors and accelerometer's that will be used as a data glove Approach. Each flex sensor will be connected to different pins of Arduino UNO which is the controlling unit. The flex sensors will give the data input to the controlling element and display the output in LCD display and convert the text output into speech output via smartphone
Block Diagram:



Flow Chart:
Flex sensors and Accelerometer are connected to Arduino UNO analog input pins
- The Arduino will accept the input data from the data glove
- Arduino is further connected to the LCD display and smart phone to give an output inthe form of text and Audio.
- The process used to convert the text to audio format will be TTS.

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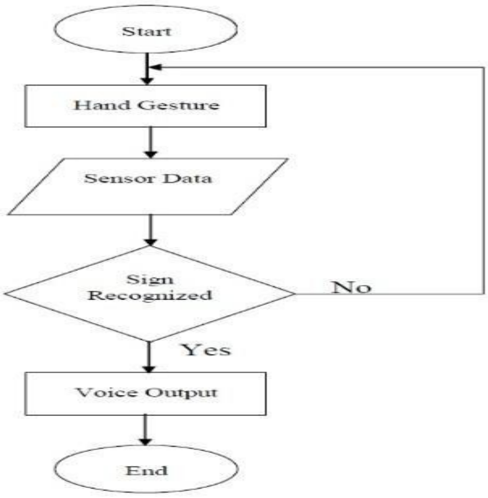

Fig: 2.1: Hand Gesture Recognition System Flow Chart

2.1 Working of Device

The user wears a glove that has flex sensors on it. Now when the user wants to say something, he/she makes gestures by bending the fingers. So, different combinations are made with the bending of the flex sensors creating different resistance combinations for the output pin of the Arduino to exhibit different entity. Arduino is connected to the LCD display. The flex sensor will give input to Arduino with the bending of the fingers of the person resulting in the change of the angles of the flex sensor hence changing the resistance will trigger the Arduino to give the relevant output as per the code we havewritten i.e. which combination of resistances will give which entity as my output. Further, when I will have the output, the smart which is connected through Bluetooth will give the speech signal as my output.

3. VARIOUS COMPONENTS

1. Flex Sensor

Flex sensors are usually available in two sizes. One is 2.2 inch and another is 4.5 inch. Although the sizes are different the basic function remains the same. They are also divided based on resistance. There are LOW resistance, MEDIUM resistance and HIGH resistance types. Choose the appropriate type depending on requirement. Here we are going to discuss 2.2inch Flex sensor that is FS-L-0055.

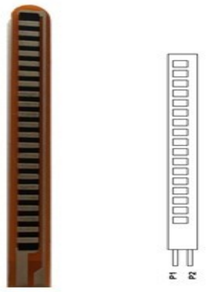

Fig: 3.1 FLEX Sensor

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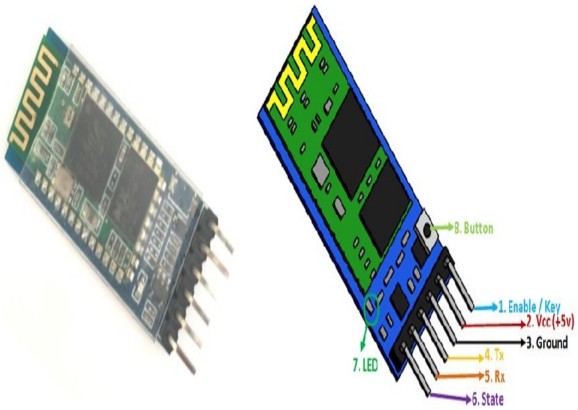
2.HC-05 - Bluetooth Module



The HC-05 is a popular bluetooth module which can add two-way (full-duplex) wireless functionality to your projects.

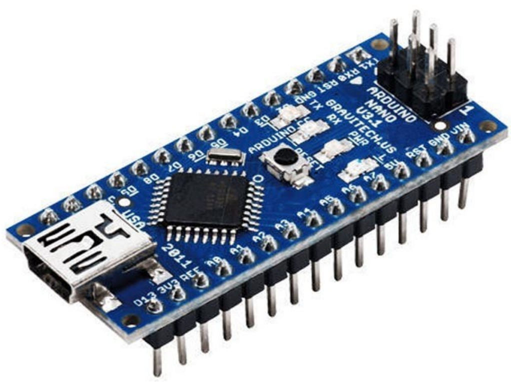
HC-05 Default Settings

- Default Bluetooth Name: “HC-05”
- Default Password: 1234 or 0000
- Default Communication: Slave
- Default Mode: Data Mode
- Data Mode Baud Rate: 9600, 8, N, 1
- Command Mode Baud Rate: 38400, 8, N, 1
- Default firmware: LINVOR

HC-05 Technical Specifications

- Serial Bluetooth module for Arduino andother microcontrollers
- Operating Voltage: 4V to 6V (Typically +5V)
- Operating Current: 30mA
- Range: <100m
- Works with Serial communication (USART)and TTL compatible
- Follows IEEE 802.15.1 standardized protocol
- Uses Frequency-Hopping Spread spectrum(FHSS)
- Can operate in Master, Slave or Master/Slavemode
- Can be easily interfaced with Laptop orMobile phones with Bluetooth
- Supported baud rate: 9600,19200,38400,57600, 115200,230400,460 800.

3.Arduino Nano



The Arduino Nano is another popular Arduino development board very much similar to the

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Arduino UNO. They use the same Processor(Atmega328p) and hence they both can share the same program.

Powering you Arduino Nano:

There are total three ways by which you can power your Nano.

USB Jack: Connect the mini USB jack to a phone charger or computer through a cable and it will draw power required for the board to function

Vin Pin: The Vin pin can be supplied with an unregulated 6-12V to power the board. The on-board voltage regulator regulates it to +5V.

+5V Pin: If you have a regulated +5V supply then you can directly provide this o the +5V pin of the Arduino.

Input/output:

There are total 14 digital Pins and 8 Analog pins on your Nano board. The digital pins can be used to interface sensors by using them as input pins or drive loads by using them as output pins. A simple function like pin Mode() and digital Write() can be used to control their operation. The operating voltage is 0V and 5V for digital pins. The analog pins can measure analog voltage from 0V to 5V using any of the 8 Analog pins using a simple function like analog Read().

These pins apart from serving their purpose, can also be used for special purposes, which are discussed below:

- **Serial Pins 0 (Rx) and 1 (Tx):** Rx and Tx pins are used to receive and transmit TTL serial data. They are connected with the corresponding ATmega328P USB to TTL serial chip.
- **External Interrupt 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.
- **PWM Pins 3, 5, 6, 9 and 11:** These pins provide an 8-bit PWM output by using analog Write() function.
- **SPI Pins 10 (SS), 11 (MOSI), 12 (MISO) and 13 (SCK):** These pins are used for SPI communication.
- **In-built LED Pin 13:** This pin is connectedwith a built-in LED. When pin 13 is HIGH – LED is on and when pin 13 is LOW, it is off.
- **I2C A4 (SDA) and A5 (SCA):** Used for IIC communication using Wire library.
- **AREF:** Used to provide reference voltage for analog inputs with analogReference() function.
- Reset Pin: Making this pin LOW, resets the microcontroller.

Applications

- Prototyping of Electronics Products andSystems
- Multiple DIY Arduino Projects.
- Easy to use for beginner-level DIYers andmakers.
- Projects requiring Multiple I/O interfaces andcommunications.

4. AURDINO CODING

Programming:-

```
//sign to speech(NSIC) #include <SoftwareSerial.h>int RX_pin = 11;
int TX_pin = 12;

SoftwareSerial BTserial(RX_pin,TX_pin);String Arduinodata ;
const int flexPin = A1; // Pin connected tovoltage divider output
const int flexpinthumb = A0;
const int flexpinmiddlefinger = A2;const int flexringfinger = A3;
const int flexlittlefinger = A4;
const int switchPin = 9; // Pin connected tothe switch
int switch_data =0;
```

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```
// Change these constants according to yourproject's design
const float VCC = 5;  // voltage at Ardunio5V line
const float R_DIV = 10000.0;  // resistor usedto create a voltage divider
const float flatResistance = 25000.0; //resistance when flat
const float bendResistance = 100000.0;  //resistance at 90 deg

void setup() { Serial.begin(9600); BTserial.begin(9600); pinMode(flexPin,
INPUT);
pinMode(flexpinthumb, INPUT); pinMode(flexpinmiddlefinger, INPUT);
pinMode(flexringfinger, INPUT); pinMode(flexlittlefinger, INPUT);
pinMode(switchPin, INPUT_PULLUP);
}

void loop() {
switch_data =digitalRead(switchPin);if(Serial.available()>0){
Arduinodata = Serial.readString();
BTserial.println(Arduinodata);
}
// Read the ADC, and calculate voltage andresistance from it
int ADCflex = analogRead(flexPin);int ADCflexthumb =
analogRead(flexpinthumb);
int ADCflexmiddlefinger = analogRead(flexpinmiddlefinger);
int ADCflexringfinger = analogRead(flexringfinger);
int ADCflexlittlefinger =analogRead(flexlittlefinger);
float Vflex = ADCflex * VCC / 1023.0;
float Vflexthumb = ADCflexthumb * VCC /1023.0;
float Vflexmiddlefinger = ADCflexmiddlefinger * VCC / 1023.0;
float Vflexringfinger = ADCflexringfinger * VCC / 1023.0;
float Vflexlittlefinger = ADCflexlittlefinger * VCC / 1023.0;
float Rflex = R_DIV * (VCC / Vflex - 1.0);float Rflexthumb = R_DIV * (VCC /
Vflexthumb - 1.0);
float Rflexmiddlefinger = R_DIV * (VCC /Vflexmiddlefinger - 1.0);
float Rflexringfinger = R_DIV * (VCC /Vflexringfinger - 1.0);
float Rflexlittlefinger = R_DIV * (VCC /Vflexlittlefinger - 1.0);
Serial.println("Resistance: " + String(Rflex)
+ " ohms"); Serial.println("Resistancethumb: " +
String(Rflexthumb) + " ohms"); Serial.println("Resistancemiddlefinger: " +
String(Rflexmiddlefinger) + " ohms"); Serial.println("Resistanceringfinger: " +
String(Rflexringfinger) + " ohms"); Serial.println("Resistancelittlefinger: " +
String(Rflexlittlefinger) + " ohms");
// Use the calculated resistance to estimatethe sensor's bend angle:
float angle = map(Rflex, flatResistance,bendResistance, 0, 90.0);
float anglethumb = map(Rflexthumb, flatResistance, bendResistance, 0, 90.0);
float anglemiddlefinger = map(Rflexmiddlefinger, flatResistance,bendResistance,
0, 90.0);
float angleringfinger = map(Rflexringfinger,flatResistance, bendResistance, 0,
90.0);
float anglelittlefingerr = map(Rflexlittlefinger, flatResistance,bendResistance, 0,
90.0);
Serial.println("Bend: " + String(angle) + "degrees");
Serial.println("Bendthumb: " +String(anglethumb) + " degrees");
```

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```
Serial.println("Bendmiddlefinger: " +String(anglemiddlefinger) + " degrees");
Serial.println("Bendringfinger: " +String(angleringfinger) + " degrees");

Serial.println("Bendringfingerlittlefingerr:   "   +   String(anglelittlefingerr)+   "
degrees");

if(switch_data==0)
{

if(angle>10&&anglethumb<5&&anglemiddle
finger>10&&angleringfinger>10&&anglelittl efingerr>0){
Serial.print("GOOD JOB"); BTserial.println("GOOD JOB");
}


if(angle>5&&anglethumb>4&&anglemiddlef
inger<5&&angleringfinger<5&&anglelittlefingerr<5){
Serial.print("OK"); BTserial.println("OK");
}



if(angle<5&&anglethumb<4&&anglemiddlef
inger<5&&angleringfinger<5&&anglelittlefingerr<5){
Serial.print("STOP"); BTserial.println("STOP");
}


if(angle<5&&anglethumb<4&&anglemiddlef
inger<5&&angleringfinger>5&&anglelittlefingerr<5){
Serial.print("I WANT TO TALK");BTserial.println("I WANT TO
TALK");
}


if(angle>5&&anglethumb>4&&anglemiddlef
inger>5&&angleringfinger>5&&anglelittlefingerr>3){
Serial.print("PAIN"); BTserial.println("PAIN");
}


if(angle<5&&anglethumb<4&&anglemiddlef
inger>5&&angleringfinger>5&&anglelittlefingerr<3){
Serial.print("I LOVE YOU"); BTserial.println("I LOVE YOU");
if(angle<5&&anglethumb<50&&anglemiddle
finger<60&&angleringfinger<20&&anglelittl efingerr<22){
// Serial.print("bye");
//  BTserial.println("data sent");
// } delay(1500);
```

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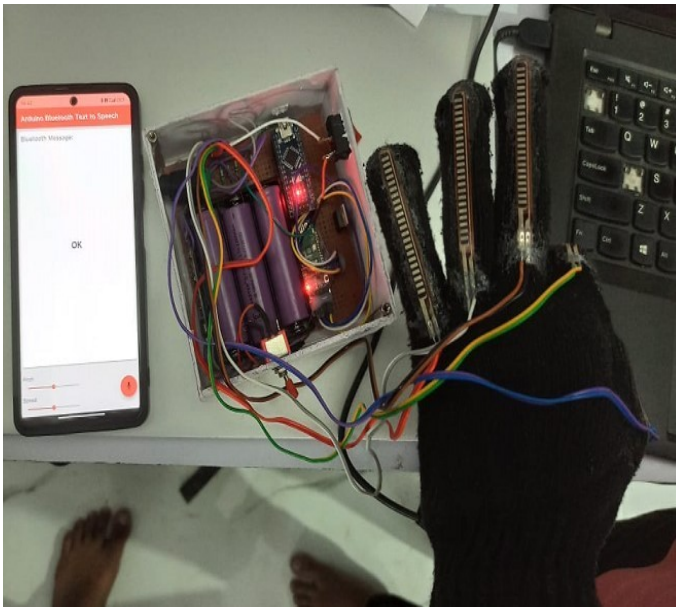

5. CONCLUSION

As for now, we have successfully interfaced the flex sensor with ARDUINO nano using the software Arduino IDE with the suitable Embedded code Language. Hence, We could further proceed for the hardware interfacing.

The main goal of this project is to develop sign language translation system that can translate the sign language into text. Since not every typical people being educate with communication through signing, this system will help them to comprehend the language of deaf and dumb people so that will give points of interest to them in conducting their daily tasks ahead.

This system explains the design and working of a system which is helpful for dumb deaf people to commune with themselves as well as with the normal people. The dumb people use their standard sign communication which is not easily intelligible by generic people and mute people cannot see and comprehend their gestures.

This device converts the sign language into speech which is easily apprehend by dumb and generic people. The sign language is translated into some text for the deaf people as well which will get displayed on LCD.

FUTURE SCOPE

There can be a lot of future enhancements related to this research work, which includes:

- In homes offices and more, gesture remembrance can be greatly used to increase usability and reduce the resources necessary to create primary or secondary input systems like remote controls or car entertainment systems with buttons.
- Designing of a whole jacket which will be capable enough to read and vocalize the movements of animals and displaying the same on LCD for deaf people
- Virtual reality application e.g., replacing the conventional input devices like joy sticks in videogames with the data glove.
- Gesture remembrance along with facial remembrance, lip movement remembrance, and eye tracking can be combined to create something called perpetual user interface to interact with computer systems which will improve creativity by leaps and bound.

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