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Electronic Speaking System for Speech-Impaired People UsingRaspberry Pi Pico

Rukhsar Shaik*, Nadakuditi Harshitha*, Gayathri Vasamsetti*, Velagapudi Bala Krishna*,Goru Hema Kumar**
** Department of Electronics and Communication, V.R. Siddhartha Engineering College,
Vijayawada 520007, India

Abstract:- Around 2.78% of people in our nation have trouble speaking clearly. It is challenging for these folks to interact with others. When engaging with others, they feel as though there is a communication gap, which prevents them from openly expressing their emotions and sentiments. The suggested solution is to create a hand-assistive system for physically handicapped people. The goal of this initiative is to address the different issues that physically disabled persons confront. The major goal of this research is to lessen the communication gap between people who are physically disabled and people who aren't. The components of this gadget include gloves, sensors, a Raspberry Pi Pico, a speech module, and a 16x16 LCD screen. Essentially, the voice module will translate the movements into speech in real-time. Gloves, sensors, a Raspberry Pi Pico, a speech module, and a 16x16 LCD make up this gadget. The movements will essentially be translated into real-time speech produced by the voice module, and the display will output text for each corresponding gesture. Therefore, this device offers both deaf and dumb and sighted persons an effective means of communication.

Keywords:- *Raspberry Pi Pico, HC-05 Bluetooth Module, Voice Modulator, Python.*

I. INTRODUCTION

The biggest setback in a person's life is a disability. A total of 26 million people in India are disabled, according to data from the 2011 census. People who are physically unable to communicate can only do so through sign conventions or with the assistance of interpreters. The challenge with sign language is that a normal person might not understand it at all, making it difficult or impossible for physically disabled persons to communicate with one another. Making them independent and allowing them the freedom to speak with regular people without the need for interpreters is thus made feasible by creating a system that enables them to do so without interruption, allowing them to express their sentiments and emotions. This project's primary goal is to create an embedded system that includes a Raspberry Pi Pico, hand gloves, sensors, an accelerometer sensor, a speech module, and a speaker.

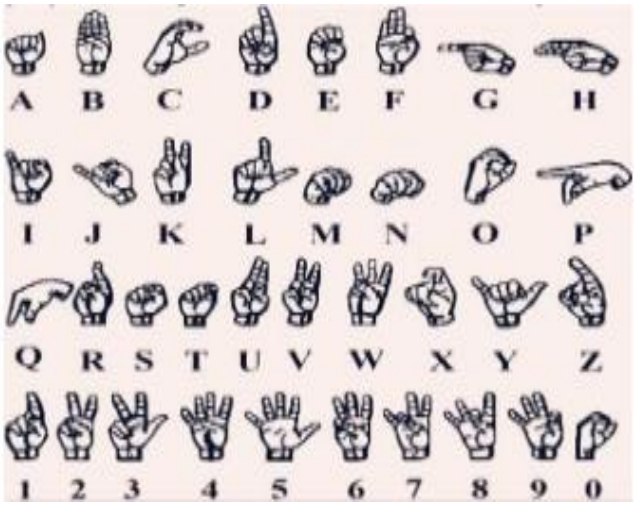

Fig 1 Sign Language or Plains sign Talk

Fig 1 depicts the different hand gestures of the sign language. Few people in the remainder of India's population can use Indian Sign Language because they don't need to learn it. This makes it difficult for the Deaf Dum Band. Normal people communicate with each other. As a result, hearing-impaired people are excluded from society's mainstream. A communication assistant is needed to translate sign language into aural speech to issue. Some systems have been created in the past to accomplish the same goal, but they had drawbacks such as not being portable, almost impossible to implant, or expensive. The only goal of all previous systems was one-way communication.

Thus, to fulfill this demand in this study, we employ the Raspberry Pi Pico model. First, the code is in Arduino, and after certain simple gestures are made by stupid people, Python technology will be used to play the audio. The system, which is based on Indian Sign Language, has all the vocabulary needed for daily life. Additionally, there is a special, tailored section for personal data. A language processing algorithm is created to organize the words into grammatically correct English sentences due to the differences in sign language grammar.

- *Disability in India-Fast Facts:*

- According to the 2011 Census, 121 million people are living in India; 2.68 billion of them are classified as "disabled" (2.21% of the overall population). Out of 2.68 crores,

- 1.5 crores are males and 1.18 crore are females
- The majority (69%) of people with disabilities lived in rural areas.
- Sikkim has the highest prevalence of disability among the states and UTs(2.98).
- The lowest prevalence of impairment (0.9%) was seen in Daman and Diu.

➢ *Types of Disability;*

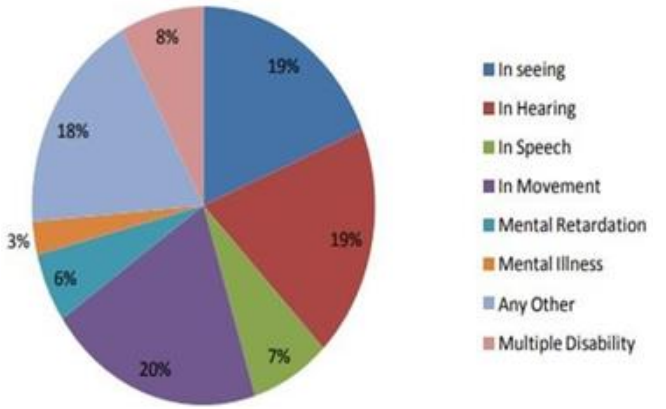

Fig 2 Disabled Population by Type of Disability in India-Census,2011

Fig 2 represents the various types of disability problems such as vision, speech, movement, and mental retardation. According to the census 2011, disability in movement represents the highest among all problems.

II. RELATED WORK

Ryan Patterson invented the first-hand Talk glove in 2001 [1]. With his signing, he started his assignment. The two independent devices that make up a signing interpreter are a glove with flexible sensors sewn into it that track the position of the fingers by measuring the electric resistance created as the fingers bend [1]. The shift in electrical current is converted into digital signals by a tiny microcontroller on the back of the hand, which then wirelessly transmits them to a computer. The computer then interprets the arithmetical values into the letters that display on the screen. The biggest drawback of this type was that it could never function without a computer or laptop, which reduced its portability [1]. Hand Talk Assisting System for the Deaf and Dumb, embedded-based In March 2014, a method was created. This solution makes use of a simple keypad to store and play audio. The disadvantage of this method is that signing is not used. This process was created in May 2014. With the use of MATLAB, this method turns the gesture into audio. The system's biggest flaw, however, is that it is not portable and constantly needs a computer for conversion. Talk Aloud Gloves. This technique was developed in April 2016[2]. This system senses gestures with the flex sensors and audio is produced with the assistance of a computer. The main drawback of this technique is that it requires a computer and there's no way for another person to speak.

➢ *Field Survey:*

Fig 3 Field Survey with the Students

Fig 4 Interaction with the Students

Our team went to Madonna Deaf and Dumb School in Ramavarapadu, Krishna District, Vijayawada, Andhra Pradesh, to survey the speech-impaired students. The school has four classes with a total enrollment of 200 students. Students range in age from 5 to 15 years. The students of X- standard interacted with the team. Students communicated with us through the blackboard and hand gestures. The students interacted with us actively and are eager to share their experiences. During the conversation, it is discovered that some students have issues with their vocal cords. As a result, the idea of hand gestures using hand gloves and a Raspberry Pi Pico is proposed, which is both inexpensive and portable. Figure 3 and 4 depicts the interaction with students.

The system's operation and data processing are done on an Arduino board. The device helps silent persons transmit fundamental signals by using roughly 16 recorded messages like "Help," "Danger," "Hungry," and so on. The system interprets user finger gestures for various hand movement variations. Sensor input values are continuously received by the Arduino, which then processes them. Now it looks for messages that match a specified pattern for the set of sensor data. When the message is located in memory, it is retrieved and spoken out using a smartphone app. So, utilizing a straightforward wearable device, we now have a fully functional smart-speaking system toassist mute people in communicating with non-mute people.

ISSN No:-2456-2165

III. PROPOSED MODEL

The Raspberry Pi receives the power supply as an input. The system receives the hand motion as input. The IR sensor picks up and registers the hand gesture. The Raspberry Pi can store several commands. The Raspberry Pi's memory is compared to the input command that was delivered. Given the input, the output of the HC-05 Bluetooth module will be adequate. The PCB works as a voice module. TheRaspberry Pi's command is transferred to the PCB, which functions as a voice module, where it is executed. A mobile Bluetooth text-to-speech converter program transforms this voice into text.

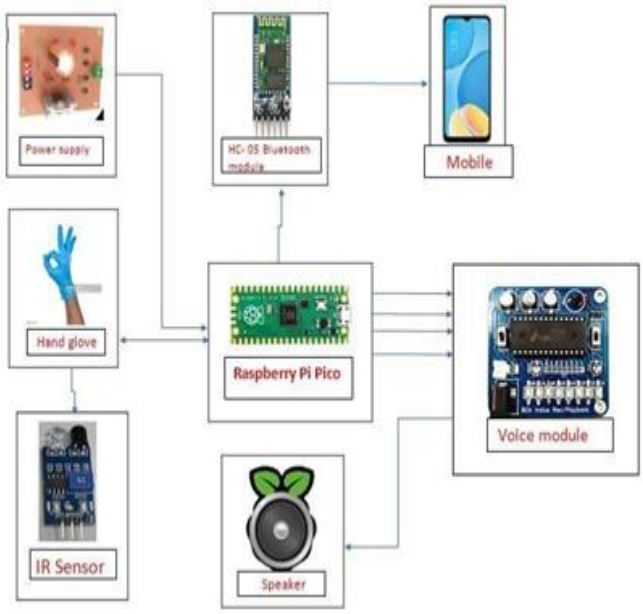

Fig 5 Proposed Block Diagram

Specifically, the Raspberry Pi Pico is provided with a power source, a speech modulator, and an 8-ohm speaker. These components are connected via the Raspberry Pi Pico's GPIO pins, an ABCD pin-based IR sensor, and a Bluetooth HC-05 module. The proposed model for hand gestures using the Raspberry Pi Pico RP2040 microcontroller and APR33A3 voice recorder and playback IC with an 8-ohm speaker that is coupled with GPIO [8,9,10,11,12,13] Pins is illustrated in Figure 3. It's known as a voice module. The Raspberry Pi Pico is also connected to three IR sensors, which are connected to ABCD [26, 27], and there are three ABCD pins on the Raspberry Pi Pico. In place of the LCD, we are using a Bluetooth HC-05 module, which is connected to a mobile device via one Bluetooth DTS; the GPIO [4,5,6,7] pins we are usingfor this project, which are GPIO [14, 15, 16, 17] pins, were also used. The Raspberry Pi is connected to the power source via a bridge rectifier, a filter capacitor, and 7805 transistors. Using a voltage divider rule, signal conditioning is accomplished. Flex sensors are coupled to IOK resistors. Flex sensors' resistance alters with each bend, and for each gesture, a certain voltage output result.

➢ *Voltage Divider Formula.*

$$V_{out} = V_{in} \cdot \frac{R_2}{R_1 + R_2}$$

IV. HARDWARE SPECIFICATIONS

A. *Raspberry Pi Pico*

A new microcontroller from the Raspberry Pi foundation is called the Raspberry Pi Pico, or just Pico. It offers a dual-core ARM processor, 2 MB of flash memory, and 26 GPIO pins on the hardware side. Software-wise, it provides a port of Micro Python as well as a comprehensive C/C++ SDK. Figure 6 depicts the Raspberry Pi Pico's pin diagram.

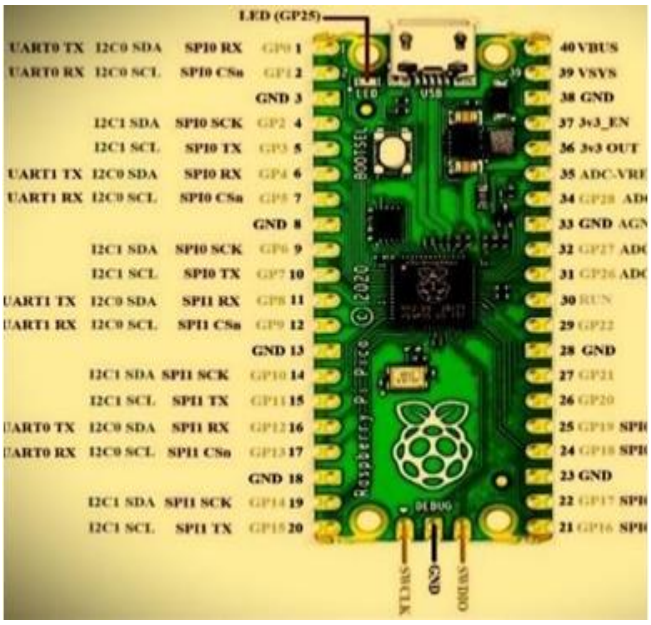

Fig 6 Raspberry Pi Pico

➢ *The Pico has the following features:*

The Raspberry Pi microcontroller chip was created in theUK as the RP2040.

- ARM Cortex-M0+ dual-core processor with a variable clock speed of up to 133 MHz
- SRAM memory of 264 kB and on-board flash memory of 2 MB
- Soldering modules directly to carrier boards is possible with casted modules.
- Support for USB 1.1 Host and Device
- Dormant and low-power sleep modes
- Programming with drag-and-drop and large storage through USB
- 26 GPIO multipurpose pins
- SPI, I2C, UART, three 12-bit ADCs, and 16programmable PWM channels are all included.
- On-chip accurate clock and timing [3].

B. HC-05 Bluetooth Module

The HC-05 module as shown in Fig 7 is a Bluetooth Serial Port Protocol (SPP) module that provides a wireless and transparent serial data link between two devices. It operates in the 2.4 GHz ISM frequency band and supports Bluetooth Version 2.0 with Enhanced Data Rate (EDR) for faster data transfer rates up to 3 Mbps.

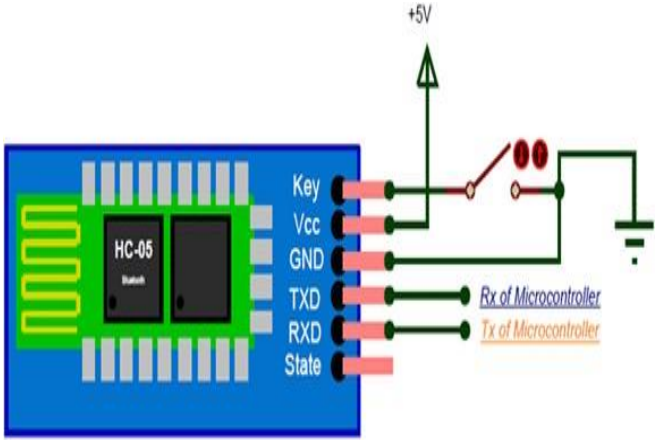

Fig 7 HC 05 Bluetooth Module

This module includes a complete radio transceiver and baseband, making Bluetooth connectivity simple to implement in a wide range of embedded systems and devices. The module is powered by a 3.3- to 5-volt power supply and works with a variety of microcontrollers and other embedded systems. A popular Bluetooth module known as the HC-05 can provide two-way (full-duplex) wireless connectivity to your projects.

➢ *HC-05 Technical Specifications:*

The following specifications describe the Serial Bluetooth module for Arduino and other microcontrollers:

- Operating Voltage: 4V to 6V (typically +5V)
- Operating Current: 30 mA
- Range: approximately 100 m
- Compatible with Serial communication (USART)and TTL
- Follows IEEE 802.15.1 standard protocol
- Uses frequency-hopping spread spectrum(FHSS)
- Can operate in master, slave, or master/slavemode

➢ *HC-05 Pinout Configuration:*

- *VCC Pin*

HC05 Modules, like any other device, require power to function, and the VCC pin interfaces with the external power source.

- *GND Pin*

Every device requires a common ground to interface with the microcontroller.

- *TX Pin*

The HC-05 Bluetooth module communicates with the microcontroller via UART. In UART, the TX will be the module's data transfer pin.

- *RX Pin*

In UART communication, this pin will be the data-receiving.

- *State Pin*

The state will display Bluetooth's current state. It informs the controller about Bluetooth connectivity with another device.

- *Enable/Key Pin*

The only pin that distinguishes the HC-05 from the others is the enable/key pin. It is useful to use an external signal to switch the device between data and command mode.

- *Button Pin*

The command and data mode states can be changed using a button on the module.

- *LED Pin*

The LED will aid in visualizing the various states of the HC-05 module [4].

C. IR Sensors:

A sensor that produces infrared light to sense certain features of its environment is an electrical gadget. Both the heat and motion of an item can be measured by an IRsensor. These kinds of sensors, also known as passive IR sensors, don't emit infrared radiation; instead, they merelymeasure it. Typically, all objects in the infrared range emit some kind of thermal radiation.

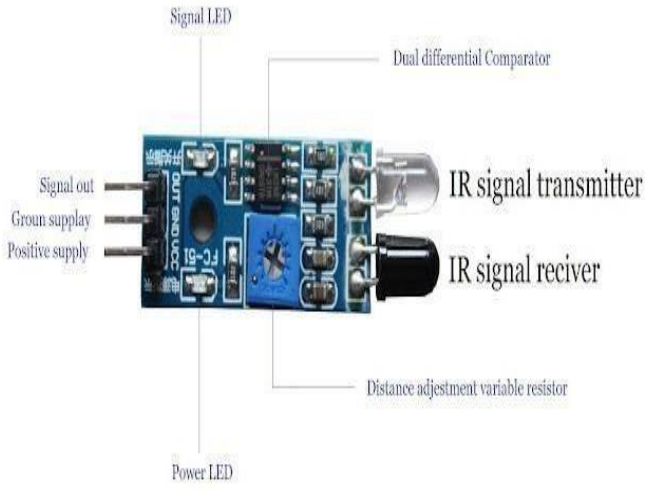

Fig 8 IR Sensor Pin Diagram

Fig 8 is an IR Sensor pin diagram in general, an IR sensor will have two important pins signal and power. Infrared sensors can be further classified into IR transmitters and receivers. IR transmitters emit infrared radiation, while IR receivers detect it. IR transmitters are commonly used in remote controls and other applications where a signal needs to be sent wirelessly. IR receivers, on the other hand, are used to receive signals from IR transmitters and are often found in devices like TVs and set-top boxes.

➢ *Active IR Sensor*

This sort of sensor consists of a transmitter and a receiver, sometimes known as an emitter and a receiver. A laser diode or LED is typically employed as a source. While laser diodes are used for imaging infrared sensors, LEDs are used for non-imaging infrared sensors.

An infrared sensor can function by radiating radiation that is then detected and received by the detector. To obtain the necessary data, it is further processed using a signal processor. Reflectance and break-beamsensors are the top examples of active infrared sensors.

➢ *Passive Infrared Sensor*

Only detectors are used in passive infrared sensors (PIR), which use targets like infrared transmitters or sources. Here, the object will emit energy, and infrared receivers will pick it up. The signal is then decoded by a signal processor to produce the needed data [5].

D. Power Supply

An electrical circuit known as a power supply is created to deliver different ac and dc voltages for device functioning. A variety of source voltages isnecessary for the proper operation of electronic equipment. Transistors and ICs must work at low dc voltages. To run CRTs and other devices, high voltagesare required. All of these voltages can be generated bybatteries. However, the neighborhood power company typically provides electricity for electrical and electronic equipment. This electricity is delivered by an outlet at 115 volts AC and 60 hertz. Some equipment requires a different voltage to operate. A bridge rectifier, filter capacitor, 7805 regulators, and lead are used in this.

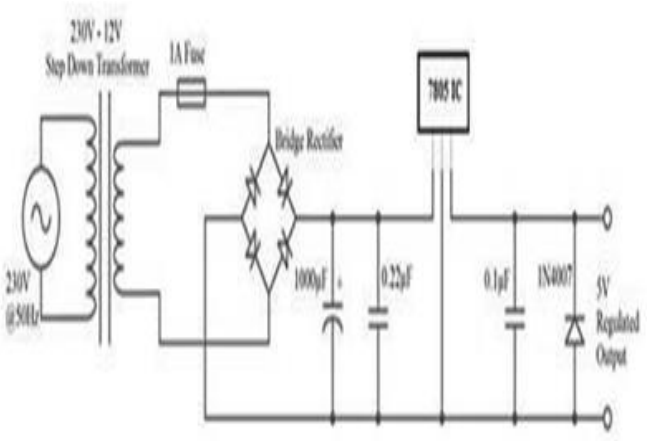

Fig 9 Power supply circuit diagram

➢ *Fig 9 Shows the Power Supply Circuit Diagram and the Components as Follows:*

- *Transformer*

This component converts high-voltage alternating current (115 VACS, 60 Hz) to a lower-voltage alternating current level (typically 12-24 VAC). The transformer is made up of a primary coil that is connected to the input voltage and a secondary coil that delivers the lower voltage alternating current output.

- *Bridge Rectifier*

This component converts the transformer's lower-voltage AC output into pulsing DC voltage. The bridge rectifier is made up of four diodes connected in series to ensure that the output voltage is always positive.

- *Capacitor*

By storing and releasing electrical charge, this component smoothes out the pulsing DC voltage from the bridge rectifier. The capacitor is connected in parallel to the bridge rectifier's output.

- *Regulators*

These components maintain the output voltage at a constant level, ensuring that it remains stable even when the input voltage and load conditions change. The 7805 voltage regulators, which provide a fixed 5-volt output, are common voltage regulators used in power supply circuits.

- *Output Voltage*

This is the power supply circuit's final output, which provides the necessary DC voltage levels for electronic devices.

➢ *Power Supply Functions:*

The entire power supply circuit can carry out the following tasks:

- By using a transformer, step voltages are raised or lowered to the desired ac line voltage.
- To fulfill the needs of the equipment, offer a voltage division technique. Either half-wave or full-wave rectification can be used to convert ac voltage to pulsing dc voltage.
- Filter pulsing dc voltage to obtain a pure, constant dc voltage for equipment use.
- Adjust the output of the power supply by theapplied load [6].

E. Voice Module

The Voice Recognition Module is a small, easy-to-use speaking recognition board. This speaker-dependent module supports up to 80 voice commands. Any sound can be trained to function as a command. Before the module can recognize any voice command, users must first train it. Voice commands are grouped in a large group, much like books in a library.

In this case, the APR33A3 speech module is used. The APR33A series IC, a powerful audio processor,is coupled with high-performance analog-to-digital converters (ADCs) and digital-to-analog converters (DACs) on the 8-Channel Voice Record and Audio Playback Board8.5

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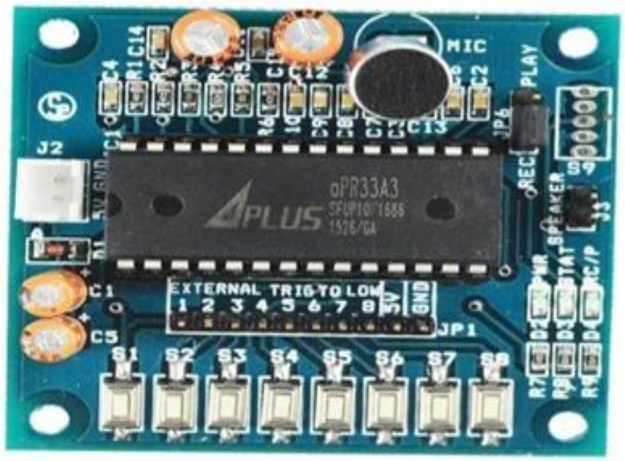

Fig 10 APR33A3 Voice Module APR33A3 Voice Module Function

➢ Fig 10 is the diagram of the APR33A3 Voice module APR33A3 voice module Function and the pin diagram as follows:

- *VCC*

This pin is responsible for powering the module. It should be powered by a 5V supply.

- *GND*

This pin is used to connect the module to the ground. It should be connected to the circuit's ground.

- *REC*

This pin is used to activate the module's recording function. The module will begin recording the voice message when this pin is pulled low.

- *PLAYE*

This pin is used to activate the module's playback function. When this pin is pulled low, the module begins playing back the previously recorded voice message.

- *ERASE*

This pin is used to delete the previously recorded voice message. The module will erase the previously recorded message if this pin is pulled low.

- *RXD and TXD*

These pins are used to communicate serially with the module. They can be used to program and control the module's functions via a microcontroller or other serial device.

✓ *Features of APR33A3 Voice moduleAPR33A3 voice-module Function:*

- Exceptionally low dropout voltage: 180 mV at 200 mA (typical);
- High precision over line and load: 0.8% at
- +25 °C, 1.4% over temperature
- For stability, only 0.47 °F of CO is required.
- All capacitor types are stable with any cap (including MLCC).
- A power supply voltage range of 3.2 V to 12
- Excellent line and load regulation performance
- Current and thermal limiting
- Low noise; dropout detector
- low shutdown current of 1 A
- Thermally improved SOIC N package.

F. Raspberry Pi OS

All Raspberry Pi models can run the official operating system, Raspbian. The OS was copied to the SD card using Win32DiskImager, and the installation was checked using VNC viewer Operating the Raspberry Pi OS in Windows OS required the use of the VNC viewer editor.

Fig 11 VNC Viewer

The user was able to access and operate the Raspberry Pi's desktop environment from their Windows OS computer using VNC viewer, as seen in Figure 4. This highlights the versatility and flexibility of the Raspberry Pi, which can be used in various applications and environments.

V. RESULT ANALYSIS

The project hardware is illustrated in Fig 12 This project consists of 16 inputs and respective outputs. The IR sensors are connected to the hand glove.IR sensors detect the movement of our hands. As the movement of our hand changes, there is a change in resistance which gives respective voltage. Raspberry Pi Pico contains the memory of different commands. The input command given is compared with memory in Raspberry Pi Pico. Based on the input HC-05 Bluetooth module will give appropriate output. PCB is worked as a voice module. The command retrieved from Raspberry Pi Pico is sent to PCB which acts as a voice module. This voice is converted into text by a Bluetooth text-to-speech converter app on mobile. There are 5 IR sensors each sensor connected to each finger. When a gesture is given the appropriate output will be produced. In table 5.1, the outputs for the specific inputs are shown. Gesture 0000 gives the output "Good Morning", gesture 0001 gives the output "Good Day" and gesture 0010 gives the output "Good Afternoon".

ISSN No:-2456-2165

Fig 12 Electronic speaking device

Table 1 shows the gesture recounted output in the sentences corresponding to the given input handgesture in the form of binary code.

Table 1 Result Table

Sl. No.	Gesture (BinaryCode)	ure RecountedOutput
0	0000	Good morning
1	0001	Good day
2	0010	Good afternoon
3	0011	Good evening
4	0100	Good night
5	0101	May I Come In
6	0110	y I Drink someWater
7	0111	I want water
8	1000	I will come later
9	1001	I will do it later
10	1010	Well done
11	1011	Let's go
12	1100	Goodbye
13	1101	What is that?
14	1110	Come fast

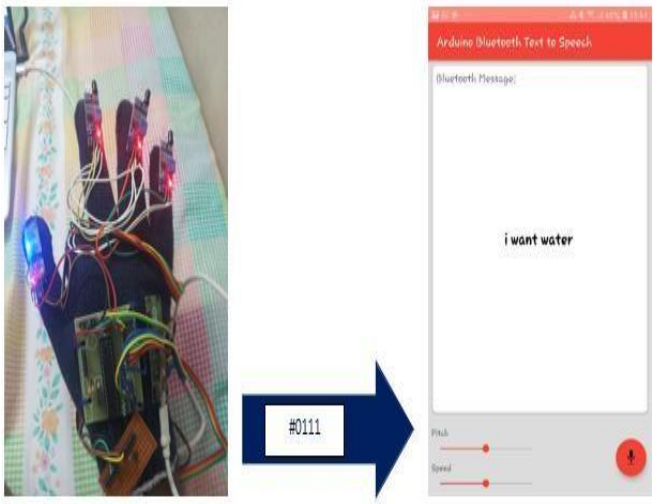

Fig 13 Result For Input Command '0111'

The message "I want water" is represented by the bendingindex finger in Fig 13.

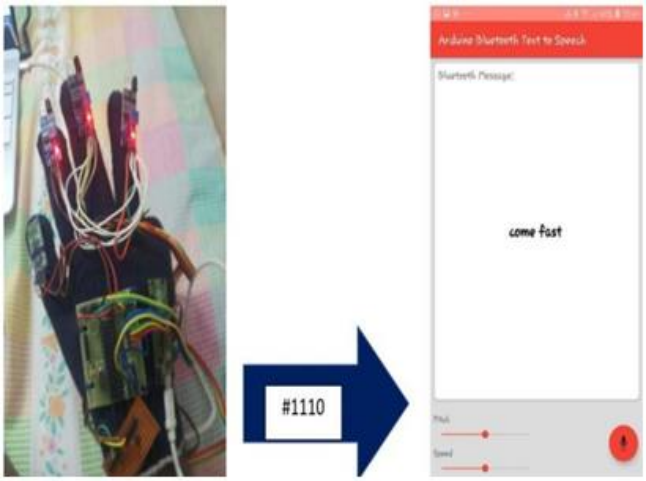

Fig 14 Result for input command '1110'

In Fig 14 bending the thumb is shown as a hand gesture, and "come fast" is the output message.

VI. ADVANTAGES

- The communication between a normal person and a speech-impaired person becomes easier.
- As we are using the display to show the user command so one speech-impaired person can also communicate with a deaf person.
- There is an option for user input.
- This device is portable and compact; the user can bring it anywhere he/she wants

VII. CONCLUSION AND FUTURE WORK

The hardware protocol for speech-impaired individuals utilizing hand gestures will be a useful tool and aid in communication in workplaces and the public sector. By making it simple for people to communicate with them, the system will be able to successfully convert hand signals. This project seeks to close the communication gap between the quiet society and the rest of society. The gesture symbol's potential to be an associated autonomous system that applies to shared living areas is this project's most noteworthy characteristic. Only a few commands can be used with this system. The following is expandable in the future to include more commands. The use of two gloves in place of one is also possible with 16 modules.

ISSN No:-2456-2165

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