Hand Gesture Recognition And Voice Conversion System Using Sign Language Transcription System

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Abstract
Generally dumb people use sign language for communication but they find difficulty in communicating with others who don't 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. A Wireless data gloves is used which is normal cloth driving gloves fitted with flex sensors along the length of each finger and the thumb. Mute people can use the gloves to perform hand gesture and it will be converted into speech so that normal people can understand their expression. Sign language is the language used by mute people and it is a communication skill that uses gestures instead of sound to convey meaning simultaneously combining hand shapes, orientations and movement of the hands, arms or body and facial expressions to express fluidly a speaker's thoughts. Signs are used to communicate words and sentences to audience. A gesture in a sign language is a particular movement of the hands with a specific shape made out of them. A sign language usually provides sign for whole words. It can also provide sign for letters to perform words that don't have corresponding sign in that sign language. In this project Flex Sensor plays the major role, Flex sensors are sensors that change in resistance depending on the amount of bend on the sensor. The final implemented design is using cupper plate based glove. This glove can be made using small metal strips that are fixed on the five fingers of the glove. It is better to use a ground plate instead of individual metal strips is because the contact area for ground will be more facilitating easy identification of finger position. We are in process of developing a prototype using this process to reduce the communication gap between differentially able and normal people

Keywords
Flex sensor, Gesture recognisation, Sign Language Recognition System

I. Introduction
Gesture recognition has been a research area which received much attention from many research communities such as human computer interaction and image processing. The increase in human-machine interactions in our daily lives has made user interface technology progressively more important. Physical gestures as intuitive expressions will greatly ease the interaction process and enable humans to more naturally command computers or machines.

Gesture recognition can be seen as a way for computers to begin to understand human body language, thus building a richer bridge between machines and humans than primitive text user interfaces or even GUIs (graphical user interfaces),which still limit the majority of input to keyboard and mouse. Gesture recognition enables humans to interface with the machine (HMI) and interact naturally without any mechanical devices. Using the concept of gesture recognition, it is possible to point finger at the computer screen so that the cursor will move accordingly. This could potentially make Conventional input devices such as mouse, key boards and even touch-screens redundant

A gesture may be defined as a movement, usually of hand or face that expresses an idea, sentiment or emotion e.g. rising of eyebrows, shrugging of shoulders are some of the gestures we use in our day to day life. Sign language is a more organized and defined way of communication in which every word or alphabet is assigned some gesture. In American Sign Language (ASL) each alphabet of English vocabulary, A-Z, is assigned a unique gesture. Sign language is mostly used by the deaf, dumb or people with any other kind of disabilities. With the rapid advancements in technology, the use of computers in our daily life has increased manifolds. Our aim is to design a Human Computer Interface (HCI) system that can understand the sign language accurately so that the signing people may communicate with the non signing people without the need of an interpreter. It can be used to generate speech or text. Unfortunately, there has not been any system with these capabilities so far. A huge population in India alone is of the deaf and dumb. It is our social responsibility to make this community more independent in life so that they can also be a part of this growing technology world. In this work a sample sign language [1] has been used for the purpose of testing

No one form of sign language is universal as it varies from region to region and country to country and a single gesture can carry a different meaning in a different part of the world. Various available sign languages are American Sign Language (ASL), British Sign Language (BSL), Turkish Sign Language (TSL), Indian Sign Language (ISL) and many more. There are a total of 26 alphabets in the English vocabulary. Each alphabet may be assigned a unique gesture. In our project, the image of the hand is captured using a simple web camera. The acquired image is then processed and some features are extracted. These features are then used as input to a classification algorithm for recognition. The recognized gesture may then be used to generate speech or text. Few attempts have been made in the past to recognize the gestures made using hands but with limitations of recognition rate and time. This project aims at designing a fully functional system with significant improvement from the past works.

In our project we are using one of the ASL (American Sign Language). In ASL each alphabet of English vocabulary, A-Z, is assigned a unique gesture. A few symbols used are shown below.

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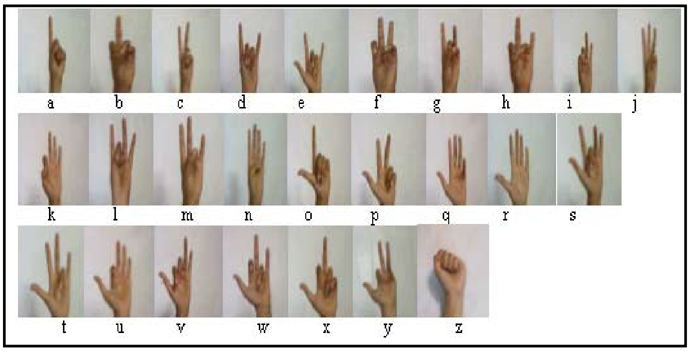


Fig. 1: Sample Sign Language

Table 1: Digital Patterns Formed

S.NO	Digital pattern	Character
1	10111	A
2	01111	B
3	11100	C
4	11010	D
5	10110	E
6	01110	F
7	11001	G
8	10101	H
9	01101	I
10	01011	K
11	00111	L
12	00011	M
13	11000	N
14	10001	O
15	00101	P
16	00001	R
17	10010	T
18	10011	U
19	00110	W
20	11011	SPACE
21	11101	END/STOP

II. Digital Gloves Design

Here we have to design a circuit or any alternative method to generate a digital pattern corresponding hand gesture as shown in methodology. Initially we worked with different methods to design digital gloves which are mentioned below.

- Using CMOS camera
- Flex sensors based glove
- Leaf switches based glove
- Cupper plate based glove

Initially we worked with CMOS camera. It transmits image data via UART serial port. Hand Gestures can detect using CMOS camera by 3 steps

- capturing the image of gesture
- edge detection of that image
- peak detection of that image

Initially hand gesture image is captured by CMOS camera as shown in figure then we get boundary of hand gesture by detected by edge detection principle as shown in fig. 2. Finally open figures of hand gestures are detected by peak detection principle as shown in fig. 2.

There are so many drawbacks on using camera module. They are

- latency, It takes approximately 8 sec to capture image
- highly expensive
- Each image occupies nearly 50Kb memory
- programming complexity with microcontrollers otherwise we have to use MAT-Lab from PC

Fig. 2: CMOS Camera

Flex Sensors Based Glove:

Flex means ‘bend’ or ‘curve’. Sensor refers to a transducer which converts physical energy into electrical energy. Flex sensor is a resistive sensor which changes its resistance as per the change in bend or curvature of it into analog voltage. By increasing the curvature from 0° to 90°, resistance changes from 45K to 75K as shown in the below fig. 3.

Drawbacks:

- Strong logic levels are not obtained so we use pull-up resistors in order to obtained strong logic levels.
- Analog output from flex sensor is in low range.
- Analog output from flex sensor is less accurate.
- Highly unstable analog output from flex sensor.
- More circuits.
- Expensive.

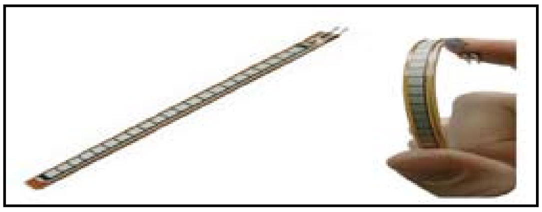


Fig. 3: Flex Sensors

Leaf switches based glove

These are similar to normal switches but these are designed in such a way that when pressure is applied on the switch, the two ends come into contact and the switch will be closed. These leaf switches are placed on the fingers on the glove such that the two terminals of the switch come into contact when the finger is bent.

Under normal condition, when the finger is straight, the supply voltage 5V will pass through the MC input. But when the finger is bent, the switch will be closed and the supply voltage will be drained through the ground and a voltage of 0V reaches the MC input indicating that the finger is closed. Thus appropriate digital patterns are formed similar to the previous case and it is processed for further detail.

The Drawback associated with the Leaf switches is that after prolonged usage, the switch instead of being open when the finger is straight, it will be closed resulting in improper transmission of gesture.

Fig. 4: Leaf Switches

Copper Plate Based Glove

This is final implemented design. This glove can be made using small metal strips that are fixed on the five fingers of the glove as shown below. A copper plate is fixed on the palm as ground. It is better to use a ground plate instead of individual metal strips is because the contact area for ground will be more facilitating easy identification of finger position. The copper strips indicate a voltage level of logic 1 in rest position. But when they come in contact with the ground plate, the voltage associated with them is drained and they indicate a voltage level of logic 0. Thus necessary gestures are formed.

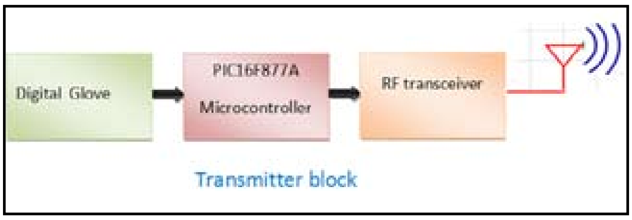
Fig. 5: Copper Plate Based Glove

Advantages

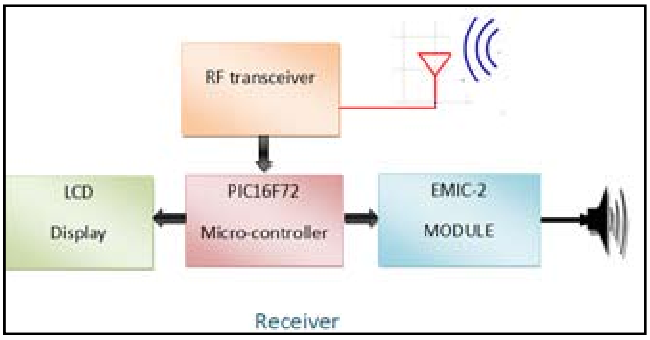
- Very Low cost
- Less circuit complexity
- Smart size
- Fast response

III. Hardware Implementation

Here a digital pattern generated by the glove is directly given to PIC16F877A micro-controller. A firmware is inserted in the micro-controller such that each gesture is assigned a particular character as per the table shown in the methodology chapter. So, as per that code characters corresponding to the gesture are transmitted via RF transceiver.



The transmitted characters are received by RF transceiver at the receiver and it is sent to an LCD display as well as an EMIC module (text to voice IC) simultaneously



PIC indicates Peripheral Interface Controller. Here we use PIC16F877A micro-controller because of its following sufficient and mentioned features below

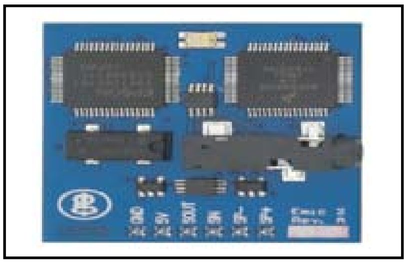
- Ports = 5
- Low power, high speed 40 pin DIP
- RAM = 368 bytes
- ROM = 256 bytes
- Flash = 8K *14-bit words
- 8 bit RISC architecture
- I2C,UART Serial interface

Salient features of in this

- In our project we have to interface Switches and RF transceiver at transmitter side. RF transceiver, LCD display and EMIC module at receiver side.
- Switches (digital glove) at transmitter is connected to port B of microcontroller
- LCD display at receiver is connected to port D and upper pins of port C of microcontroller
- EMIC Module and RF transceiver are the serial peripherals connected to UART port of microcontroller.
- RC6 (25th pin) is transmitter pin and RC7 (26th pin) is receiver pin.

EMIC-2 MODULE:

The EMIC - 2 Text-to-Speech Module is a multi-language voice synthesizer that converts a stream of digital text into speech. It is a simple command-based interface that makes it easy to integrate with any embedded system.



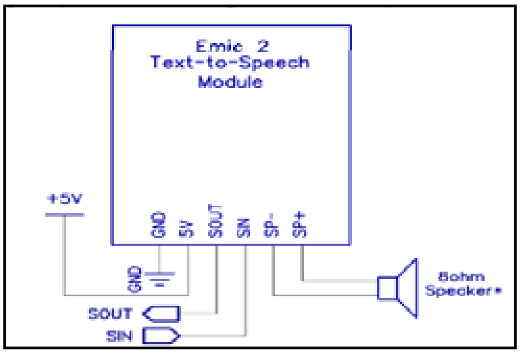


Fig. 6: EMIC-2 Interfacing

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Key Features

- High-quality speech synthesis for English and Spanish languages
- Nine pre-defined voice styles comprising male, female, and child
- Dynamic control of speech and voice characteristics, including pitch, speaking rate, and word emphasis
- We can directly interface to micro-controller serially

PIC16F877A BASIC CIRCUIT:

Basic circuit includes four sub circuits they are:

- Bridge rectifier circuit
- Voltage regulator circuit
- Crystal oscillator circuit
- Reset circuit

Bridge Rectifier Circuit

This full wave rectifier circuit is used for protection from voltage fluctuations. Even though -12 volts is applied, Instead of 12 volts it converts it into positive voltage and provided to a voltage regulator circuit.

7805 - Voltage regulator circuit

The 78xx (sometimes L78xx, LM78xx, MC78xx...) is a family of linear voltage regulator integrated circuits. For ICs within the family, the xx is replaced with two digits, indicating the output voltage (for 7805 has a 5 volt output, while the 7812 produces 12 volts). The 78xx refers positive voltage regulators: they produce a voltage that is positive relative to a common ground. There is a related line of 79xx devices which are complementary negative voltage regulators. To provide constant output voltage 5 volts and current 1mA there must be a minimum of 7 volts input. Here 100 uF bypass capacitor is used to by-pass the voltage ripples above 5 volts.

Crystal oscillator circuit

- Crystal oscillator is a radio frequency oscillator. The output frequency of the crystal oscillator is very precise and stable.
- PIC microcontroller has an on-chip crystal oscillator where the piezoelectric quartz crystal in feedback network is connected externally.
- Purpose of crystal oscillator in any microcontroller is to synchronize its operation. Each instruction of program can executed by microcontroller with particular period called machine cycle.
- One machine cycle is equal to 12 clock pulses. So this crystal produces
  11, 059000/12 =921,583 machine cycles per second.
- (1/11.0592M)*12 = 1.08506 usec , It is the time taken to complete one machine cycle

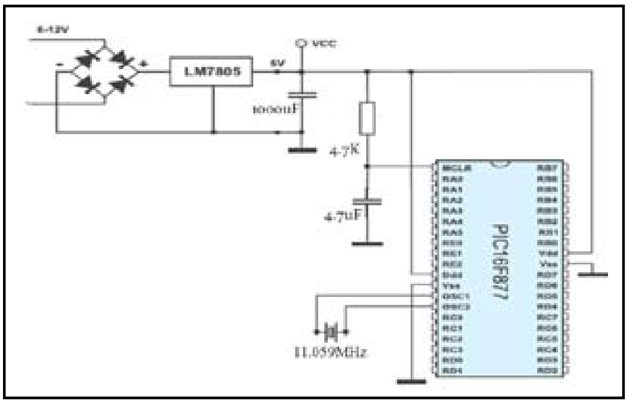


Fig. 7: Pic16f877a Basic Circuit

The communication between RF transceiver and PIC16F877A micro-controller is a UART communication as shown in below figure.

Before direct hardware interfacing we have to adjust transmission parameters of module in command mode. (By making contact between 'prog' Pin and 'ground', The module enters into command mode

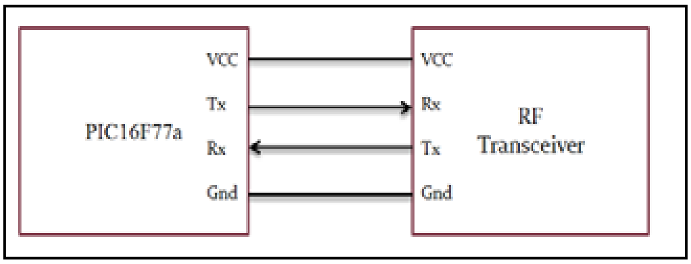


Fig. 8: RF Interface at Transmitter

EMIC Interfacing

The communication between RF transceiver and PIC16F877A micro-controller is also a UART communication as shown in below figure.

At receiver we have two peripherals which are to be connected to a UART port.

This problem can be avoided by following below connections. Here there is only reception of data from RF transceiver to microcontroller. Similarly there is only transmission of data from microcontroller to EMIC module. So RF transceiver is connected to Rx pin and EMIC module is connected to Tx pin.

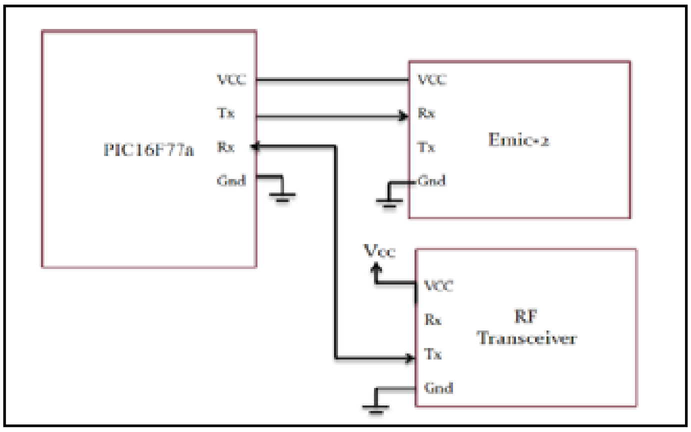


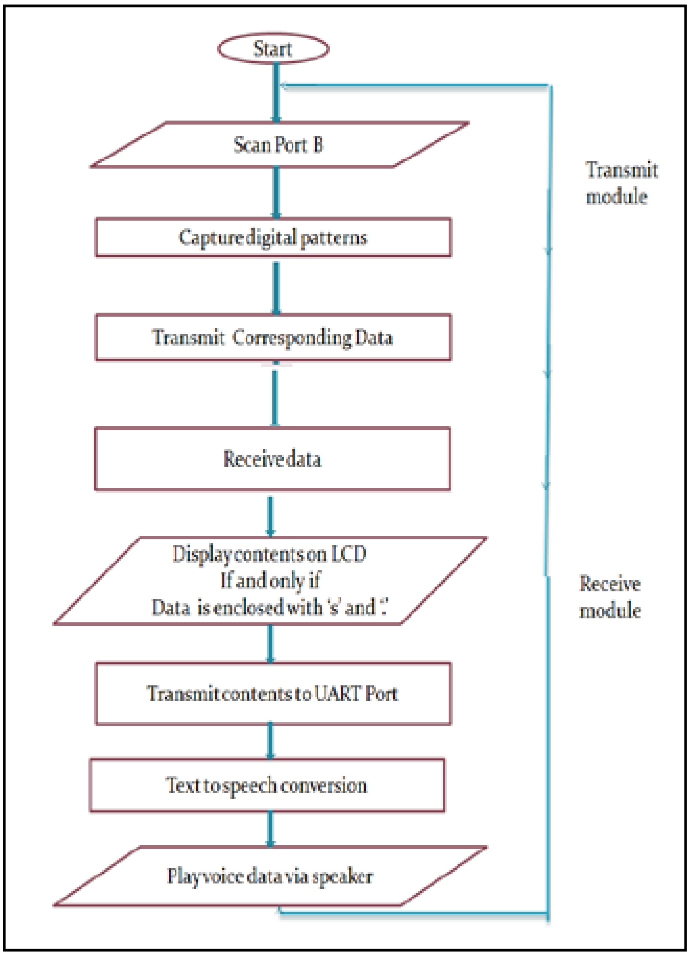
Fig. 9: Serial Interfaces at Receiver Module

IV. Algorithm and Flow Chart

1. ALGORITHM

Step 1 :- start
Step 2 :- read digital pattern from gloves
Step 3 :- send characters for coressponding patterns to RF transmitter
Step 4 :- recevie text from transmitter via UART receiver pin
Step 5 :- display text on LCD which was enclosed with gestures 'S' and '.'
Step 6 :- Send that data to emic module via UART transmitter pin
Step 7 :- text to voice conversion
Step 8 :- play voice output

2. Flow Chart



V. Firmware Tools and Programmer

Micro C IDE

Micro C is powerful rich development tool for PIC microcontrollers to develop firmware for itWe have to Write our C code in built-in code editor(Code and Parameter assistant, Auto correct, Syntax highlighting and more) It contains wide number of inbuilt library functions with syntax , example, sample code and with circuit diagram. This data provides flexible for programming It monitors your program structure, variables, functions in code explorer It contains in-circuit debugger to monitor program execution on hardware level Before creating a new project we have to choose device name ,oscillator frequency and we have to include all library functions

Proteus 7 professional

The Proteus 7 Professional differs from Proteus Lite in that it does not allow you to save, print or design your own microcontroller based designs but you can however write your own software programs to run on the existing sample design suite for evaluation. The Proteus Design Suite combines schematic capture, SPICE circuit simulation, and PCB design to make a complete electronics design system. Add to that the ability to simulate popular micro-controllers running your actual firmware, and you have a package that can dramatically reduce your development time when compared with a traditional embedded design process.

Lab Tool

The LABTOOL-48UXP is a high performance intelligent PC-based universal programmer that works through PC′s parallel port. It features 48-pin ZIF sockets, supports all kind of programmer chip in the market which include CPLD, EPROM, EEPOM, Serial EEPROM, Flash memory and MCU, extremely high throughput, 5V and 3V chip support in both Vcc and I/O, lower voltage chip (for example 1.8V Vcc and I/O support) also possible through special adapter, device insertion and continuity checks, all within a PC-based design. Device updates are disseminated through software, giving our customers quicker and more flexible access to new chip support.
In the Lab Tool, the HEX file of the project's code is transferred into the Programmer through a USB port

VI. Results & Discussions

Fig. 10: Transmitter Module

In the above transmitter is giving command this command is send it to receiver by using the RFID communication

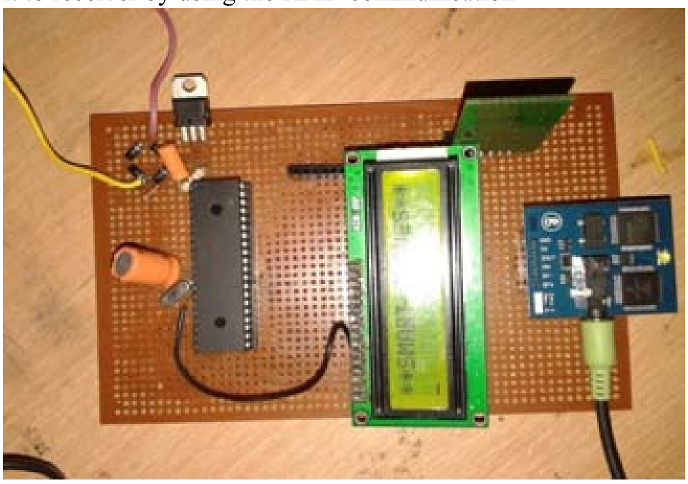


Fig. 11: Receiver Module

In the receiver is giving voice output by using EMIC text too voice conversation is done in the receiver section

VII. Conclusion

Sign language is one of the useful tools to ease the communication between the deaf and mute communities and normal society. Though sign language can be implemented to communicate, the target person must have an idea of the sign language which is not possible always. Hence our project lowers such barriers
This project was meant to be a prototype to check the feasibility of recognizing sign language. With this project, deaf or dumb communities can use the gloves to form gestures according to sign language and the gestures will be converted to speech.

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