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Hand Gesture Recognition System by Converting into Voice

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Abstract

In general, sign language is used by dumb people for communication but they usually find difficulty in communicating with other people who do not know sign language. This project aims to reduce this hurdle in communication. It is based on the need of developing an electronic device that can convert sign language into speech in order to simplify the communication that takes place between the mute communities with the general people. In this, wireless data gloves are used in which normal cloth driving gloves are fitted with flex sensors along the thumb's length and each and every finger. Dumb people can use the gloves to do hand gesture and it will be converted into speech so that normal citizens can understand their expressions. This is a communication skill that will use gestures instead of sound to express meaning simultaneously combining hand shapes, movement of the hands, body or arms and facial expressions and orientations to communicate fluently a speaker's thoughts. Signs are used to communicate sentences and words to people. A gesture used in sign language is a movement of the hands with a specific shape made out of them. A sign language usually gives signs for whole words. It can also provide signs for letters to perform words that do not have corresponding sign in that language. In this project, Flex Sensor plays the main role. Flex sensors are sensors in which resistance changes based on sensor bending. We used glove based on copper plate to implement final design. Small metal strips are used to make the glove. These metal strips will be fixed on five fingers of a hand. It is better to use a ground plate in place of individual metal strips because the contact area for ground will be more facilitating easy identification of fingerposition. The ground contact area is more providing easy identification of position of the finger. So we can use ground plate in place of metal strips. We are in the process of implementing a prototype by using this process to decrease the communication gap between physically disabled and normal people.

Keywords: Flex Sensor, Identification Of Gesture, Sign Language, Sign Language Recognition System.

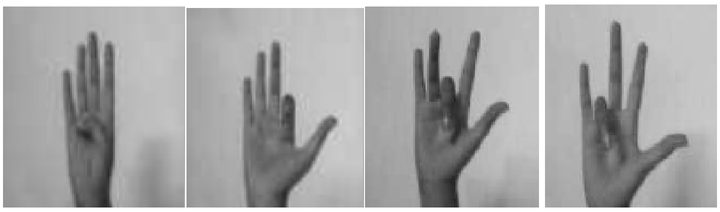
Introduction

Gesture recognition has been a research area which received much attention from many research communities such as image processing and human computer interaction. Physical gestures as discerning expressions will make the interaction process easy and will make humans command computers more naturally.

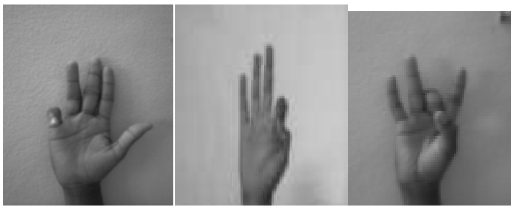
Gesture recognition will be seen as a method of computers to start understanding human body language, thus building a richer bridge between humans and machines than primitive text user interfaces or GUIs. Gesture identification enables human to interface with machine (Human Machine Interface [1]) and interact naturally without the need of any mechanical device. By using the concept of gesture identification, pointing finger at computer screen is possible. Then cursor will move according to the requirement. This can make usual input devices (touch screen, mouse, keyboard) redundant.

A gesture is defined as a movement of face or hand that is used to express an idea, emotion or sentiment [2]. For example, eye brows rising, shrugging of shoulders are some of the gestures we use in our daily life. Sign language [3] is a defined and more organized way of communication in which every alphabet or word is assigned some gesture. In ASL (American Sign Language), each alphabet of English vocabulary, A-Z is assigned a unique gesture. Deaf or dumb people or people with any other disability use sign language. With the fast advancements in technology, the use of computers in our daily life has increased manifolds. Our goal is to design a Human Computer Interface (HCI) system that can understand the sign language [4] perfectly so that the signing people may communicate with the non-signing people without the need of a mediator. It can be used to generate text or speech.

Unfortunately, we are not having any system with these capabilities so far. Since many deaf and dumb people are present in India, it is our social responsibility to make this community more independent in life so that they can also be a part of this rising technological world. In this work, a sample sign language [1] has been used for the purpose of testing. Sign language is not universal and it varies from country to country and region to region. Same gesture carries different meanings in different places of the world. Various available sign languages are Indian Sign Language (ISL), American Sign Language (ASL), British Sign Language (BSL), Turkish Sign Language (TSL) [5], and many more. There are 26 alphabets in the English vocabulary. A unique gesture will be assigned to each alphabet. In this project, the hand’s image will be captured by using a web camera. The acquired image is then processed and some features will be extracted. These features are given as input to a classification algorithm for recognition. The identified gesture may then be used to generate text or speech. Some attempts are made in the past to identify the gestures [6] made by using hands. This project aims at making a fully functional system with significant improvement from the past works. In this project, 1 to 7 numbers will be assigned a unique gesture. A few symbols used are shown below.



(1) (2) (3) (4)



(5) (6) (7)

Figure 1.A Sample Sign Language

Table 1.Digital Patterns Formed

S. No.	Digital Pattern	Character
1	1	I NEED WATER
2	10	I WANT TO GO OUTSIDE
3	100	HELLO HOW ARE YOU
4	1000	I NEED SOME FOOD
5	10000	WHAT IS YOUR NAME
6	11	NICE TO MEET YOU
7	101	WHERE ARE YOU GOING

Design of Digital Gloves

Here we are designing a circuit to produce a digital pattern corresponding to hand gesture as explained in methodology. Initially we have worked with different types of methods to design digital gloves.The methods are following:

- By using CMOS camera
- By using Flex sensors based glove
- By using Leaf switches based glove
- By using Copper plate based glove

At first we worked with CMOS camera. It sends image data via UART serial port. Hand gestures are detected by using CMOS [7] camera by 3 steps:

1. Capturing the gesture image
2. Edge detection of that image
3. Detection of peak of image

Initially hand gesture image is captured by CMOS, then we get boundary of hand gesture by edge detection principle. Finally open figures of hand gestures are detected by peak detection principle. At first CMOS captures image of the gesture then we can get hand gesture boundary by the principle of edge detection. Lastly gesture figures will be detected by principle of peak detection.

Drawbacks of using camera module are:

- Latency: It will take approximately 8 sec to capture image.
- Costly
- 50 Kb memory will be occupied by the image.
- Programming complexity with microcontrollers.

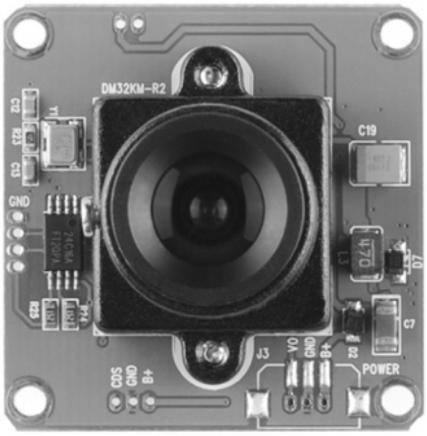


Figure 2.CMOS Camera

Flex Sensors Based Glove

Flex means ‘curve ‘or ‘bend’. Sensor means a transducer which converts physical energy into electrical energy. Flex sensors are resistive sensors which alter their resistance as per the change in curvature or bend of them into analog voltage. By rising the bend from 0° to 90°, the resistance will be changed from 45KΩ to 75KΩ as shown in Fig. 3.

Drawbacks:

- Strong logic levels are not obtained.
- Flex sensor’s analog output is in low range.
- Flex sensor’s analog output is less accurate.
- Highly unstable analog output from flex sensor.
- Costly.

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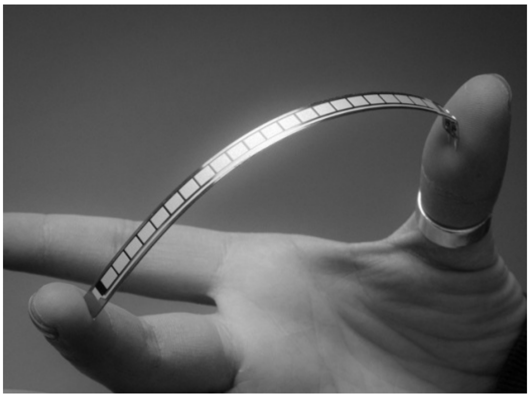

Figure 3.Flex Sensors

Leaf Switches Based Glove

These are like normal switches but these are made in such a manner that if pressure is applied on the switch, then two ends come into contact and the switch will then be closed. These leaf switches will be placed on the fingers of glove in such a manner that the two terminals of switch come into contact when finger is bent. In a normal case, when the finger was straight, the power supply voltage 5V would pass via the MC input. At the time of finger being bent, the switch is closed and the supply voltage is drained via ground and voltage 0V reaches the MC input indicating that the finger is closed. Thus suitable digital patterns are formed similar to the previous case and then it is processed for further detail. The drawback of leaf switches is that after prolonged usage, the switches instead of being opened when the fingers are straight, they will be closed resulting in different indication of gesture.

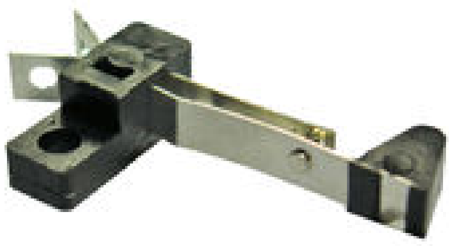

Figure 4.Leaf Switches

Copper Plate Based Glove

This is the last implemented design. This type of glove is made by using small metal strips that are fixed on the five fingers of the glove as shown below. A copper plate has been fixed on the palm as ground. It is better to use a ground plate in place of metal strips because the contact area to ground will easily recognize finger position. The copper strips will indicate a voltage level of logic 1 in rest position. When coming to contact with the ground plate, the voltage with them is drained and the copper strips indicates a voltage level of logic 0. In this manner, necessary gestures are formed.

Figure 5.Copper Plate based Glove

Advantages

- Low cost
- Low circuit complexity
- Smart size
- Speedy response

Hardware Implementation

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

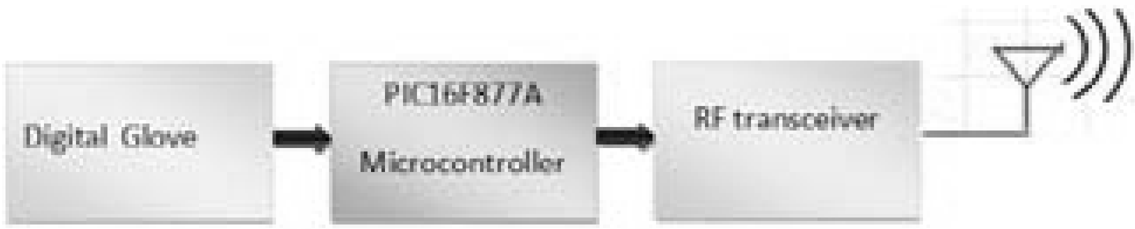

Figure 6.Transmitter Block

RF transceiver will receive transmitted characters at the receiver block and it will be sent to an LCD display and to an EMIC module (text to voice IC) simultaneously.

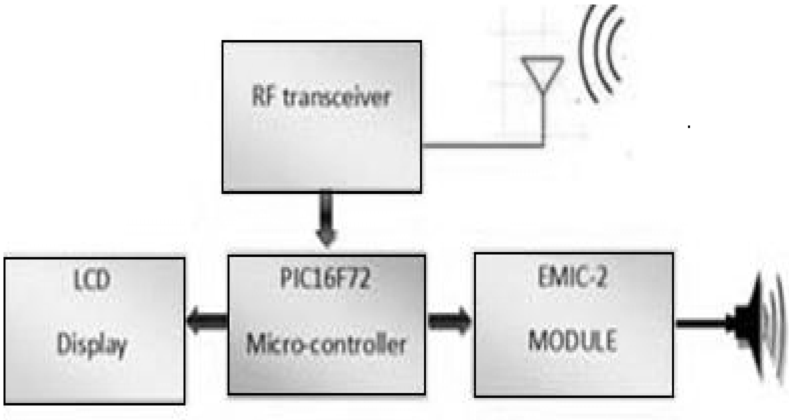

Figure 7.Receiver Block

PIC stands for Peripheral Interface Controller. Here we are using PIC16F877A microcontroller because it has the following features:

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

Salient Features

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

EMIC-2 Module

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

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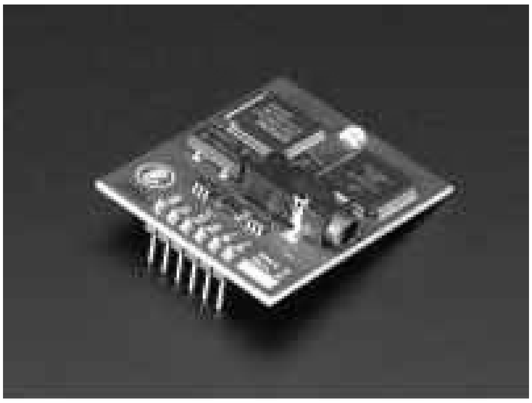

Figure 8.EMIC-2 Module

Important Features

- High-quality speech synthesis for Spanish and English languages.
- Nine pre-defined styles of voice comprising both female, male.

Voice and speech characteristics like speaking rate, pitch and word emphasis are controlled dynamically.

- We can interface directly to micro-controller serially.

Pic16f877a Basic Circuit

Basic circuit includes 4 sub circuits. They are:

1. Bridge rectifier circuit
2. Voltage regulator circuit
3. Crystal oscillator circuit
4. Reset circuitary

Circuit of Bridge Rectifier

This FWR circuit will be used for protection from fluctuations of voltage. Even though 12 volts is applied, instead of 12 volts, it converts it into positive voltage and provides to a voltage regulator circuit.

7805 – Circuit of Voltage Regulator

The 78xx (sometimes L78xx, MC78xx, LM78xx,...) 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 (the 7812 produces 12 volts, while 7805 has a 5 volt output). The 78xx refers to positive voltage regulators: they will produce a positive voltage relative to a common ground. There is related line of 79xx devices; they are Complementary Negative Voltage Regulators. For providing a constant output of 5 volts voltage and 1mA current, there must be a minimum input of 7 volts. Here we are using 100 uF bypass capacitor to by-pass the voltage ripples of more than 5 volts.

Circuit Of Crystal Oscillator

- The Crystal oscillator output frequency is precise and stable.
- PIC microcontroller consists of an on-chip crystal oscillator.
- Crystal oscillator coordinates microcontroller operation. Microcontroller executes every instruction with a particular period called machine cycle.
- One machine cycle will be equal to 12 clock pulses. So this crystal will generate 11,059000/12 =921,583 machine cycles/second.
- (1/11.0592M)*12= 1.08506 usec. This is the amount of time taken to complete one machine cycle.

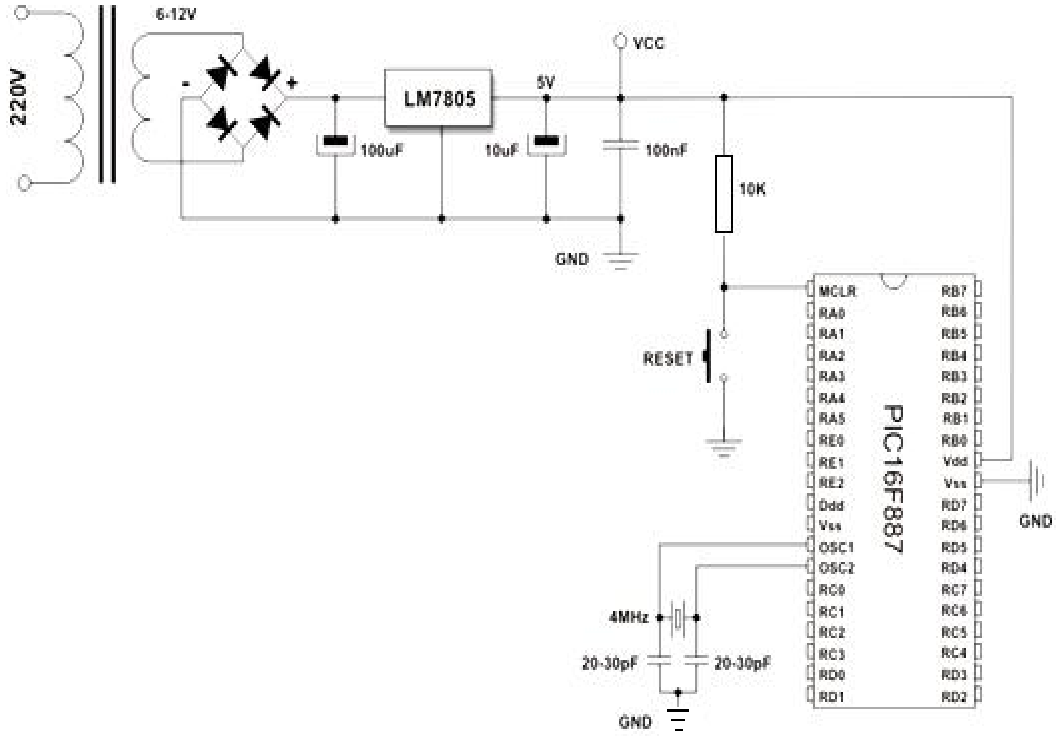

Figure 9.Basic Circuit of PIC16f877A

UART communication is used between PIC16F877A microcontroller and RF transceiver as shown in Fig. 10. Before hardware interfacing, we will adjust module's transmission parameters in command mode (by providing contact between 'ground' and 'prog' pin, the module enters into command mode).

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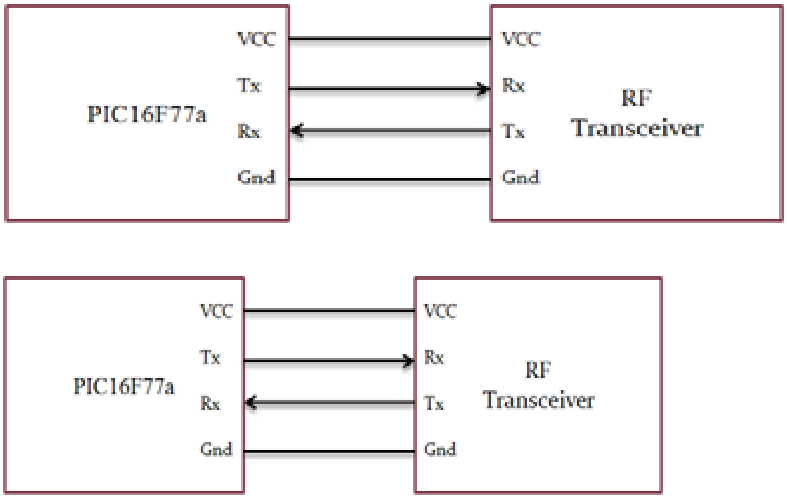


Figure 10. RF Interface at Transmitter

Emic Interfacing

RF transceiver and PIC16F877A micro-controller communicates via UART communcation as shown below. We have two peripherals at receiver which will be connected to a UART port. This problem will be avoided by following connections. Here only reception of data is done from RF transceiver to MC. Similarly there is only transmission of data from MC to EMIC module. So RF transceiver is connected to Rx pin and EMIC module is connected to Tx pin.

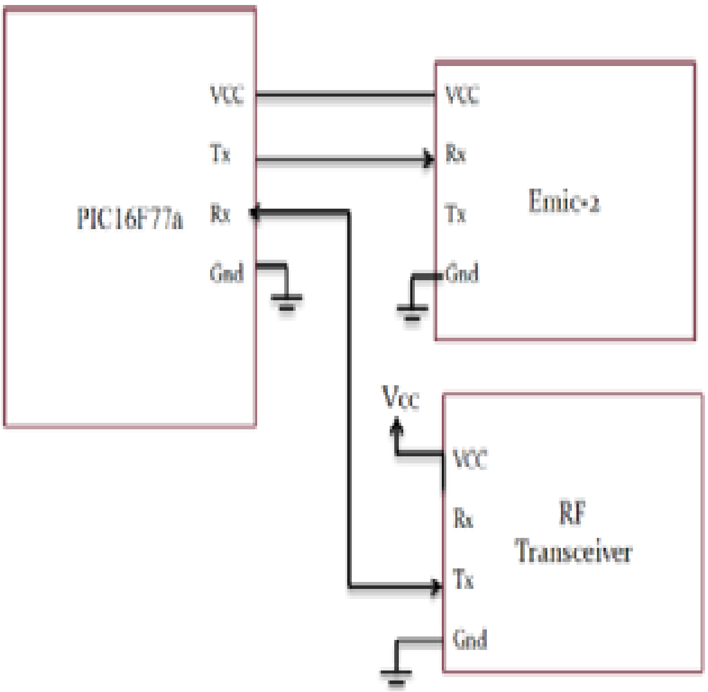


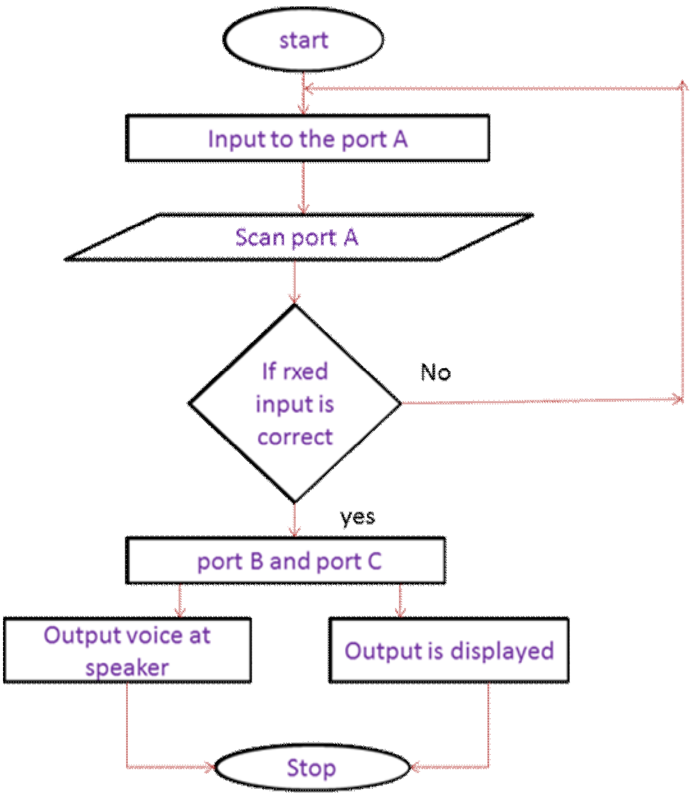
Figure 11.Serial Interface at Receiver Module

Algorithnm And Flow Chart

Algorithm

Step 1:- Start.
Step 2:- Read digital pattern by using gloves.
Step 3 :- Send message to PIC microcontroller.
Step 4:- Display text on LCD which was enclosed with gestures.
Step 5 :- Text to voice conversion.
Step 6 :- Play voice output.

Flow Chart



Firmware Tools and Programmer

Micro C IDE

Micro C is powerful development tool for PIC microcontrollers to develop firmware for it. We have to write our C code in built-in code editor (Syntax highlighting, Code and Parameter assistant, Auto correct, and more). It contains wide number of inbuilt library functions with syntax, for example, sample code and with circuit diagram. This data provides flexibility for programming. It monitors our program structure, functions, and variables in code explorers. It has in-circuit debugger to monitor execution of the program on hardware level. We need to select oscillator frequency, device name and include all library functions before creating a new project.

Proteus 7 Professional

The Proteus 7 Professional and Proteus Lite are different in the sense that it will not allow you to print, design or save your microcontroller based designs but you can write your software programs for running on the existing sample design suite for evaluation.

The Proteus Design Suite adds PCB design, schematic capture, and SPICE circuit simulation to create a complete electronics design system. In addition to the simulation ability of popular microcontrollers running our actual firmware, we have a package that can decrease 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. It works through parallel port of the PC. Its features include and support every kind of programmer chip which consists of EPROM, EEPROM,CPLD, Serial EEPROM, MCU and flash memory, 48-pin ZIF sockets, extremely high throughput, 3V and 5V chip support in both I/O and Vcc, lower voltage chip (1.8V Vcc and I/O support) also possible by using special adapter, device insertion and continuity checks, all within a PC-based design. The software distributes device updates [7], gives our customers a flexible and quicker access to new chip support. In Lab Tool, the HEX file of code of the project is sent into the programmer through a USB port.

Results & Discussion

Figure 12.Input Section

In the above figure, transmitter gives command. This command will be sent to the receiver using RFID.

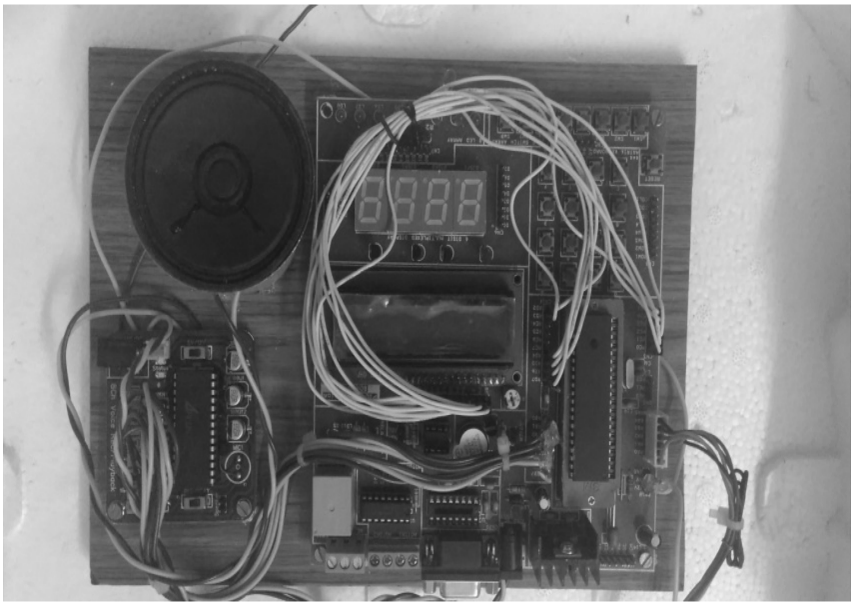


Figure 13.Output Section

The receiver gives voice output by using EMIC. Text to voice conversion is done in the receiver section.

Conclusion and Future Scope

Sign language is one of the most useful tools to simplify the communication between the deaf and mute communities and the normal society. Though sign language can be implemented to communicate, the target person must have an idea of the sign language which will not be possible always. Hence our project reduces such barriers. This project was meant to be a prototype to check the feasibility of identifying language using signs. By using this project, deaf or dumb people use the gloves to form different gestures according to sign language and those gestures will be converted to voice. This is our electronic gadget (Smart Gloves) which provides sound for gestures made by mute people. Sign language may be helpful to ease the communication between the deaf and mute community and the normal people. The project that we have done is not limited only to this particular sign language but can also be implemented with any sign language that is easy for the particular user. Industrially using VLSI technology, the total project can be fabricated on a single silicon layer, thereby reducing the size and cost.

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