Hand Gesture-Based Vocalizer for the Speech Impaired

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Hand Gesture Based Vocaliser for the Speech Impaired

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Abstract: Communication a basic form of interaction between two individuals. Humans have been using speech to communicate with each other since the ancient times. But for the speech and hearing impaired people it becomes a real challenge to put up their views due to their disability. This project aims at developing a microcontroller based Vocaliser that converts hand gestures to audible sound. The system is easy to calibrate according to the user's need thus removing the complications of different hand sign conventions used around the globe. This system is further developed to work as a home automation system that uses hand gestures to control various appliances like fan or light.

Keywords: Vocaliser, Hand Gesture, Voice Generation, APR33a, Flex Sensor, Data Glove, Home Automation, Speech Synthesis

1 Introduction

Communication is the most basic and important form of interaction with anyone. Thus for interacting with deaf and dumb people, sign language or gestures are used.
The dumb people use their standard sign language which is not easily comprehensible by common people. Also there is no standardised sign language defined across the world. The people who are having hearing and speaking disabilities are not able to work normally with other people. Vocalisers convert the sign language into voice which is easily understandable by blind and normal people.
Gesture Vocalizer is a device which is being designed to enable the communication among the dumb, deaf and blind societies and their communication with the normal people. The system can be dynamically reconfigured to work as a "smart device" that can work for all kinds of sign languages. Gesture vocalizer is basically a data glove and a microcontroller which can detect almost all the movements of a hand and convert some specified movements into human recognizable voice.

2 Literature Review

Kazunori Umeda, et al. propose a method of recognising hand gestures using range images in their paper. Five hand gestures: "come on", "go away", "turn right", "turn left" and "stop" are dealt with. A sequence of velocity vectors and normal vectors of a moving hand are extracted from range images, and gestures are recognized using the features. A recognition system is constructed which utilizes the recognition methods. This system is not that reliable as the images if blur wouldn’t be able to detect the distance properly. Also the estimation of the gesture from the distance and velocity may not be feasible for a large number of gestures [1]. Srinivas Gutta, Jeffrey Huang, et al. showed the advances in the methodology of hybrid classification architectures for face and hand gesture recognition tasks and shows their feasibility through experimental studies using the FERET data base and gesture images. It makes use of radial basis function (RBF) and Inductive decision trees (IDT) for training the network. An impressive accuracy of 96% has been achieved with over 200 different images. This system is highly efficient but fails in circumstances where images are blurred or there isn’t enough light to efficiently identify the gesture [2]. A gesture recognition algorithm was made from Euler angles acquired using multiple orientation sensors. A real-time arm gesture recognition system using the IS-300 Pro Precision Motion Tracker by InterSense was used for the recognition.this is a very good approach and also a very accurate one. The angles achieved by the sensor are precise and the algorithm can properly identify and predict many gestures. This method was implemented and verified by Jean-Christophe Lementec and Peter Bajcsy [3].Automatic Gesture Recognition for Intelligent Human-Robot Interaction method develops a system to automatically recognize a face or gesture. A large database was constructed that stored all the possible gestures. For efficient and natural operation, they used several approaches at each step of gesture recognition; learning and extraction of articulated joint information, representing gesture as a sequence of clusters, spotting and recognizing a gesture with HMM [4].

3 Block Diagram

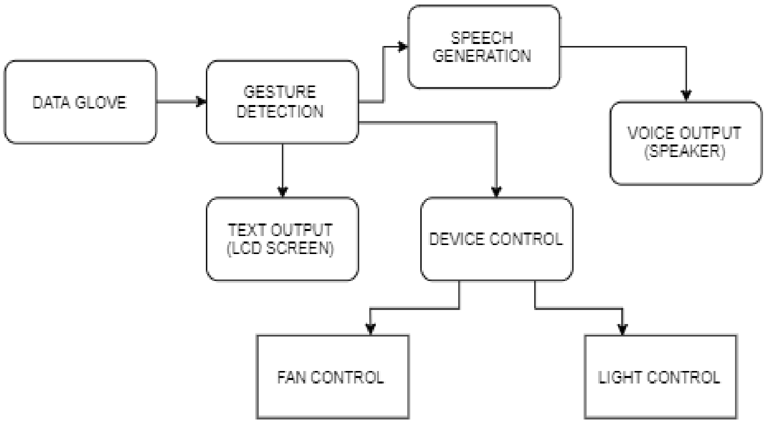


Fig. 1. Block Diagram for the overview of the system

The input is taken from a digital glove that has 5 flex sensor attached to the glove at each finger. A database of multiple gestures is stored within the controller. The predicted gesture output is sent to the LCD display and the speech synthesiser. The speech synthesiser gives the audio output of the gesture. The entire system is divided into two sections-Transmitter and Receiver. The second part of the block diagram is the receiver part which serves other functions of Home Automation. User can change the mode of the system with "change mode" gesture.

4 Implementation

The entire circuit was developed in 2 parts- Voice Synthesis and RF Section

i. **Data Glove**

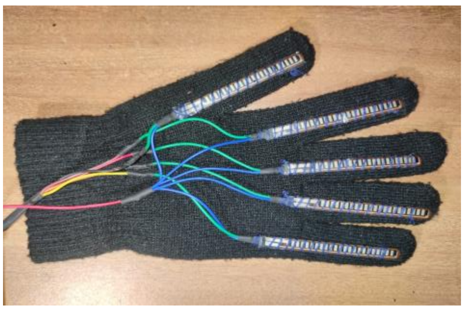


Fig. 2. Data Glove

The flex sensors are stitched onto a glove, one onto each fingers. The flex sensors detect and record the finger movements. The bending on fingers changes the resistance of the flex sensor thereby detecting the gestures made based on predefined values.

ii. Voice Synthesis

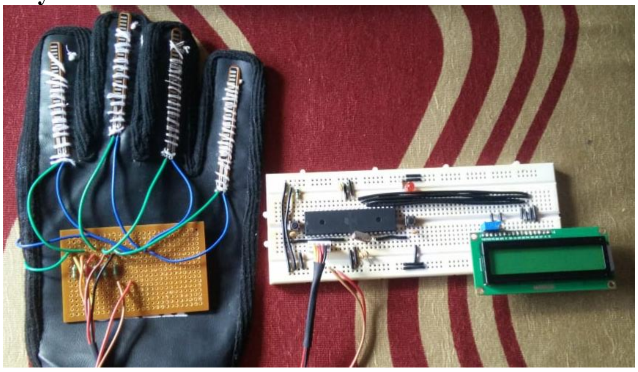


Fig. 3. Voice generation circuit

The entire circuit was developed on the breadboard. Power was supplied using the 220V AC input that was down converted to 5V DC. The wire sizes were kept minimum so as to reduce any losses and disturbances caused due to it and also to keep the circuit tidy and clutter free. The speaker was given external output so that the voice was audible.

iii. RF Section

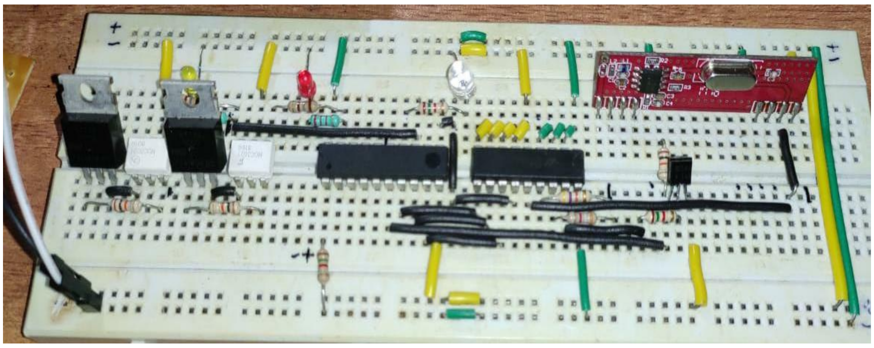


Fig. 4. RF Transmitter and Receiver circuit

A RF transmitter and receiver was used for wireless transmission of data for home automation applications. The transmitter side has an encoder for encoding the multiple signals for different functionalities in one single stream and sends it to the transmitter. The receiver section has a decoder to decode the stream and take the corresponding action. RF transmission takes place at 433 MHz

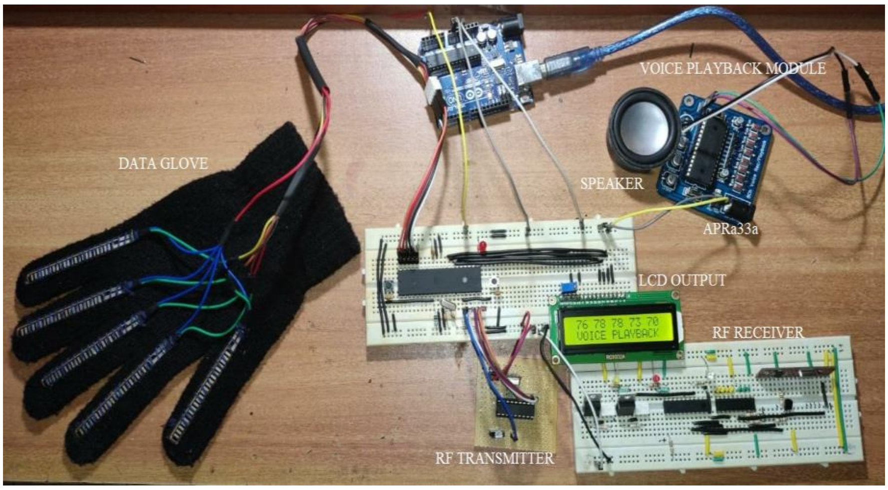


Fig. 5. Complete implementation of the system

5 Results

Table 1: Gesture and their respective outputs

Gesture	Gesture To Voice Synthesis Mode	Device Control Mode
	Output	
Gesture 1	"It's time to take my pills"	Light Switched ON
Gesture 2	"Can you get me today's newspaper?"	Light Switched OFF
Gesture 3	"I'm starving! Can I have my meal"	Fan Switched ON
Gesture 4	"Get me some water to drink!"	Fan Switched OFF
Gesture 5	"I need a pertinent attire"	Turn ON TV
Gesture 6	"I feel sickish, call the doctor!"	Turn OFF TV
Gesture 7	"Critical, need expeditious help!"	Open the Window Curtains
Gesture 8	"I need to go to the restroom!"	Shut the Window curtains
Gesture 9	Mode change	-

Mode change: there are two modes of operation in the system- Voice synthesis and Device Control. Mode change gesture is used to switch between the two modes.

[1]. Calibration:

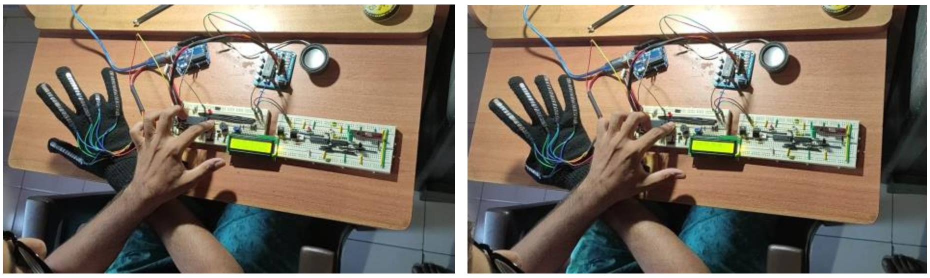
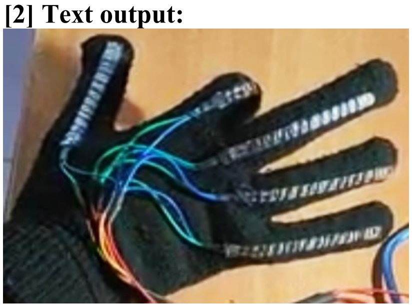


Fig. 6. Calibration of Data Glove

[2] Text output:



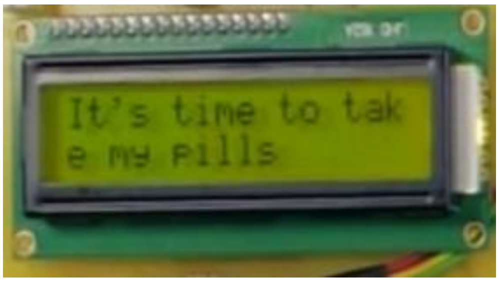


Fig. 7. Hand Gesture for gesture 1

Fig. 8. Text output for gesture 1

[3] Voice output:

Fig. 9. Voice Playback mode displayed on LCD

[4] Mode Change:

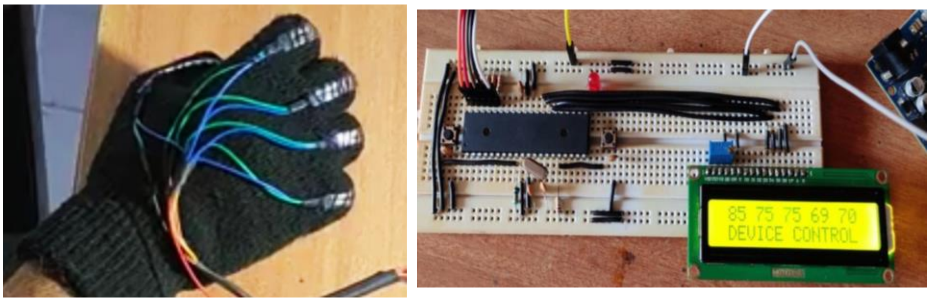


Fig. 10. System in Device Control Mode

6 Conclusion:

This project was aimed at developing a portable speech synthesiser and vocaliser for the speech impaired people. The system developed is capable of detecting 8 different hand gestures and convert them into voice outputs. The hand gestures can be calibrated depending on the preference of the user. The outputs can also be assigned according to the needs of the user. The project is also extended towards home automation using hand gestures. Various home appliances like light and fans can be controlled using hand gesture. The data from the system is transmitted to the home appliances controller using 433 MHz radio signals.

7 Future Scope:

- Addition of an accelerometer in collaboration with the flex sensors to measure the wrist movement as well. Also the system can be updated for sensing both hand gestures as well. This would help us increase the number of gestures by incorporating the wrist and finger movements of two hands thereby increasing the number of outputs.
- Developing a custom vocaliser module that can provide more number of voice outputs than the standard one available in the market while at the same time cost less if considered for mass production.
- Generate gestures for as many words as possible and develop a machine learning system that can interpret the various words generated and develop a sentence on its own. This would reduce the load on the system due to storage of large sentences and make the system more robust and adaptive.
- Interface with voice assistants like Siri or Alexa to generate voice outputs rather than the vocaliser module. This would make the system more compact and be used on various platforms like mobile phones that would make it portable.
- Use hand gestures to control vehicles. This would be particularly useful for wheelchair bound people who find it difficult to manoeuvre it and require assistance of someone.

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