Smart Glove Based Gesture Vocalizer for Deaf and Dumb

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ABSTRACT

Sign language is a natural way for communication between normal and dumb person, but often they find difficulty in communicating with normal people, as we don't understand their sign language. Therefore, there always exists a language barrier. To minimize this barrier, we propose a device which can convert their hand gestures into voice, which a normal person can understand. This device consists of a Wireless Glove, consisting of flex sensors and accelerometer. These sensors sense the movement of hands and fingers. This system consists of a speech synthesizer circuit, which convert these movements of hand gesture into real time speech output and the display will give the text for the corresponding gesture. The text and voice output being in any language, this device provides efficient way of communication for both deaf-dumb and normal people.

Keywords

Hand Gesture; Deaf-Dumb; Smart Glove; LPC 2148 ARM Controller;

1. INTRODUCTION

In the recent years, there has been a rapid increase in the number of hearing impaired and speech disabled victims due to birth defects, oral diseases and accidents. When a speech impaired person speaks to a normal person, the normal person finds it difficult to understand and asks the deaf-dumb person to show gestures for his/her needs. Dumb persons have their own language to communicate with us; the only thing is that, we need to understand their language. Sign language is used by deaf and 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. But most of the time normal people find it difficult to understand this sign language. The people who cannot speak or have lost their ability to speak in some accident, it becomes difficult for them to convey their message within the society. To overcome this, we have come up with an idea called 'SMART GLOVE'.

K A Baskaran et al. points on the technology used to find the hand gesture using flex sensor and accelerometer. Here, different gesture movements are obtained as the input and are processed to produce voice assistance using data estimation method. A few more applications where the gloves could be used are in gaming industry, controlling a robotic arm using the gloves and helping hand for people with Cerebral Palsy [1].

The technology used to find the hand gesture using flex sensor, gyroscope and Intel gelileo gen2 IoT Kit. Here, different gesture movements are obtained as input and processed to produce voice assistance using real time IoT based gesture recognition system. The device also has applications in home automation with different gestures control various functions such as, switching on/off basic electronic appliances [2]. Santiago Aguiar et al. presented an analysis of the current situation of individuals in Ecuador who suffer hearing impairment leading to speech disorders, who are unable to communicate using common language structures [3].

According to Tushar Choushan et al., the primary goal was to design and implement a low cost wired interactive glove, interfaced with a computer running MATLAB or Octave, with a high degree of accuracy for gesture recognition. Using Hall Effect sensors and accelerometer hand gestures are obtained. Using MATlab the input data was processed and the message was decoded [4]. Novel approach of interpreting the sign language using the portable smart glove was proposed by Nikhita Praveen et al. Using LED-LDR pair, zigbee and microcontroller, the gesture was recognized. The data are then processed through analog to digital converters and ASCII equivalent values. Then the outputs for corresponding gesture are displayed [5].

Mina I et al. proposed a technique using Flex sensor, Gyroscopes and Accelerometer to obtain the hand gestures. Using Arduino and Bluetooth the signals were transmitted from transmitter and receiver section [6]. Akshay D.R et al. presented the implementation of a simple hand glove, to help the physically challenged or bed-ridden patients to be semi-independent. The complete gadget would cost around Rs.600 ($10-12), and is easy to fabricate. The range of operation now is limited, due to the RF transmission used. The range can be increased using Zigbee for transmission [7]. S Yarisha Heera et al. proposed gesture recognition system that converts Indian Sign Language to speech with the help of variety of sensors like flex sensor, gyroscope and accelerometer, in order to successfully determine the position and orientation of the hand gesture [8]. The microcontroller implements an in-house developed program to recognize the sign and corresponding Arabic alphabet vocally and textually [9]. Tangible interface using a customized glove are equipped with flex sensors. These sensors are placed across the length of fingers and the thumb. Hand gestures can be captured by the digital glove, which are then converted to speech/text so that it could easily be understood by the common people [10].

In this paper, Flex Sensor plays the major role. The glove is fitted with flex sensors along the length of each finger and the thumb. The flex sensors give output in the form of voltage variation that varies with degree of bend. This flex sensor output is given to the ADC channels of microcontroller. It processes the signals and perform analog to digital signal conversion. Further the processed data is sent in a wireless manner to the receiver section. In this section, the gesture is recognized and the corresponding output is displayed on LCD and simultaneously a speech output is play backed through speaker, controls the working of devices like T.V, Fan, light and also sends message to registered mobile number in emergency condition. The portability of this paper is a major advantage. Thus with the help of this device, the barrier faced by these people in communicating with the society can be reduced to a great extent.

2. HARDWARE DESIGN

The proposed system consists of primarily two sections namely transmitter section and receiver section. In the proposed system as in Fig 1, at the transmitter side we use a glove, which has to be worn by the user. This glove is mounted with four flex sensors, each on the four fingers of the glove namely, thumb, index, middle, and ring. The flex sensors give their output in the form of change in resistance according to the bend angle. The output from the flex sensors is given to the ADC channels of the microcontroller. The processed ADC values from the microcontroller are compared with the threshold values for the recognition of a particular gesture. The particular gesture is recognized and the microcontroller gives corresponding commands to the LCD and the Voice Module. If the emergency switch in the gloves is pressed, the microcontroller send a message to the mobile number using the GSM modem connected to it.

Whenever the person wants to control the devices such as light, TV, fan, then the microcontroller identifies the gesture signals and using the RF transmitter module, the control signals are transmitted to the RF receiver module which as shown in Fig 2. For each value received at RF receiver, the microcontroller gives corresponding commands to the LCD and the device control module controls the action of the devices connected to it. Thus, we get the output for each gesture and display of each gesture in the form of text on the LCD display.

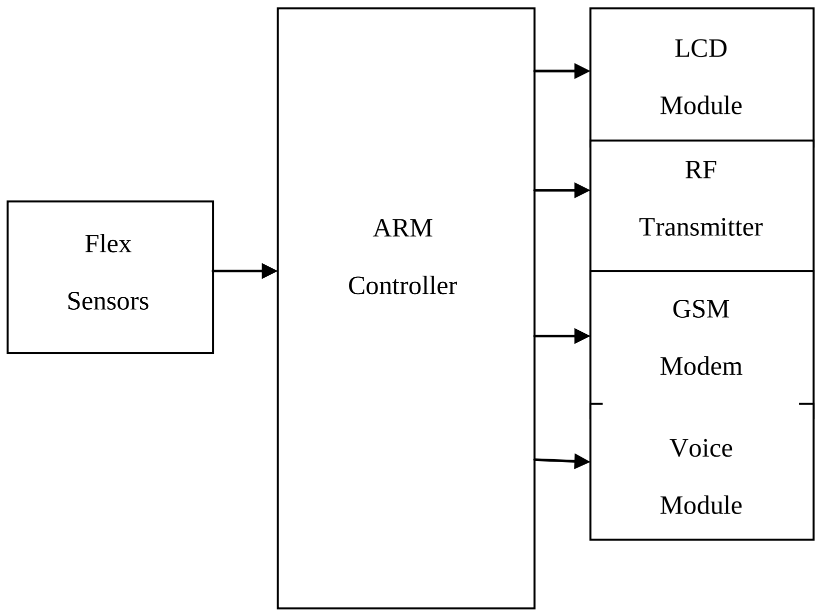

Fig 1: Block Diagram of Transmitter Section

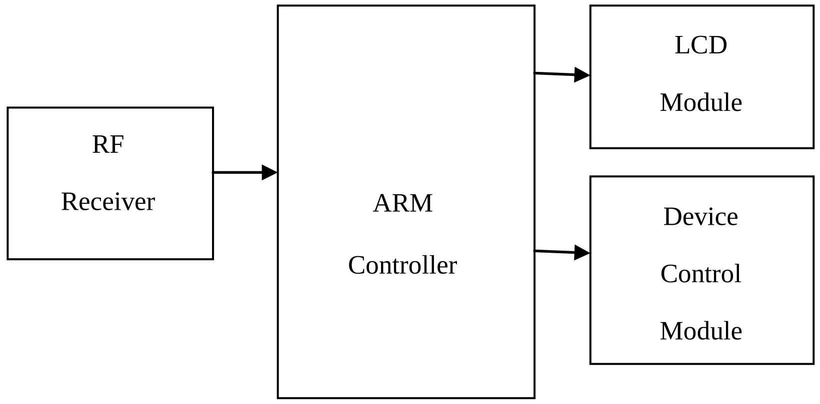

Fig 2: Block Diagram of Receiver Section

The following devices are interfaced to the ARM controller and explained as below:

2.1 LPC-2148 Microcontroller

The LPC2148 microcontrollers are based on a 32 bit ARM7TDMI-S CPU in a tiny LQFP64 package with real-time emulation and embedded trace support, which combines the microcontroller with embedded high speed flash memory ranging from 32kB to 512kB.

2.2 Voice Recorder

The APLUS RECORDER (APR) module is used and it records the conversation that happened before the accident.

2.3 Liquid Crystal Display (LCD)

The LCD display Module is built in a LSI controller, which has two 8-bit registers, an instruction register (IR) and a data register (DR).

2.4 Driver ULN2003A

Drivers are used to amplify the current coming from the microcontroller and to run the DC motor via relays. The ULN2003A series are high voltage, high current Darlington drivers comprised of seven NPN Darlington pairs. All units feature integral clamp diode for switching inductive loads.

2.5 Relay

A relay is essentially a switch activated by a small electromagnet. We can use a 12V supply to power the relay.

2.6 GSM Module

The SIM800L GSM module is used in this system. It is a GSM/GPRS module with EDGE of downlink. It features with voice, SMS, and data services.

2.7 Encoder HT12E

These encoders are a series of CMOS LSIs for remote control system applications. They are capable of encoding information which consists of N address bits and 12-N data bits. For example, it can encode 8 bit address and 4 bit data.

2.8 Decoder HT12D

The HT12D decoder is a series of CMOS LSIs for remote control system applications. They are paired with HOLTEK's H12E series of encoders.

2.9 RF Transmitter

High Performance SAW Based Architecture with a Maximum Range of 100 feet at 4800 bps data rate.

2.10 RF Receiver

This is the Radio Frequency Receiver Module, which can facilitate the designers to design their remote control applications in the quickest way. This Receiver Module is Super-Regenerative Version without decoder using Amplitude Modulation or in other words ON-OFF Keyed Modulation (OOK).

2.11 Flex Sensor

These types of bend sensors are passive resistive devices, typically fabricated by laying a strip of resistive ink on a flexible plastic substrate, shaped as a thin, flexible stripe in lengths between 1" and 5".

3. PROPOSED SYSTEM IMPLEMENTATION

In order to implement the proposed system Keil Microvision 4 IDE and Fash Utility 2000 were used.

3.1 KeilMicrovision 4 IDE

The vision IDE is a window-based software development platform combining a robust editor, Project Manager, and Make Utility tool. Vision supports all the Keil tools including C/C++ Compiler, Macro Assembler, Linker, Library Manager, and Object-HEX Converter.

3.2 Flash Utility 2000

The Philips LPC2000 Flash utility utilizes two, otherwise unused, signals (RTS and DTR) of the PC serial port to control the microcontroller reset and P0.14 pins. Without the Boot loader, updating the main firmware in the product is more difficult, because the enclosure must be opened to access the configure button, and a special software program from Phillips must be used to send new firmware to the product to avoid an opening of the product and using the Phillips program.

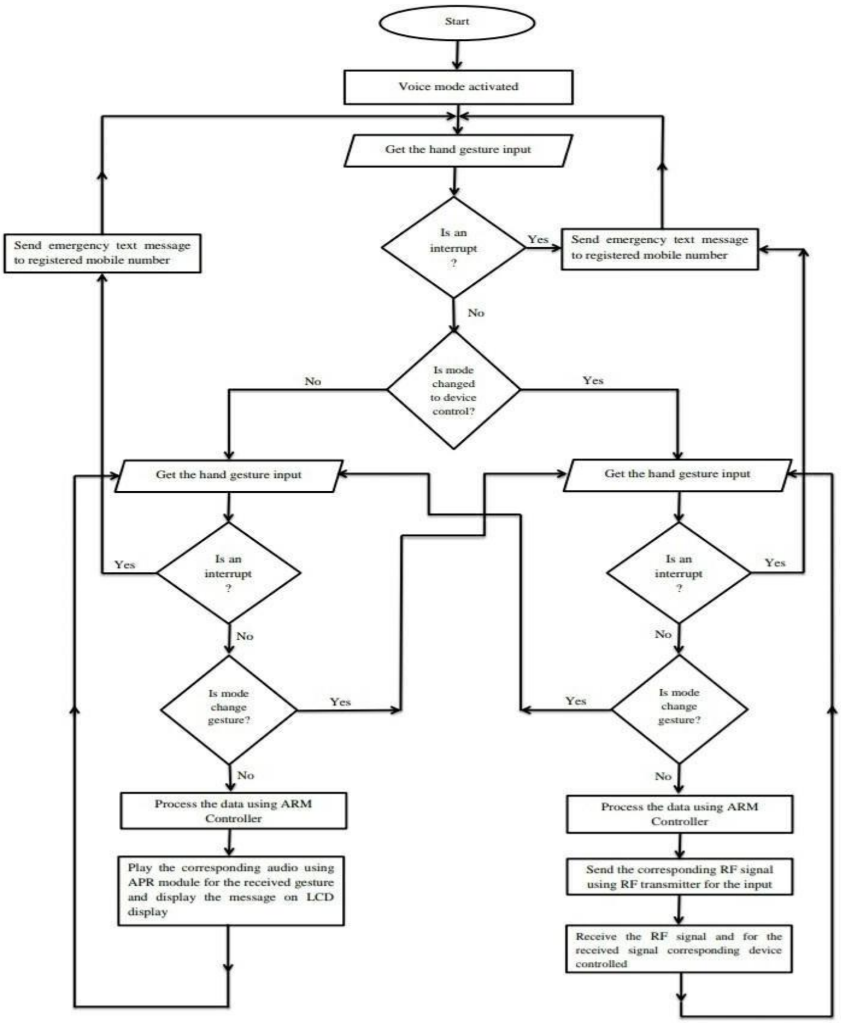

Fig 3: Working Diagram for Gesture Vocalizer for Deaf-Dumb

When system gets activated as in the flow chart Fig 3, initially it goes to voice control mode. The two types of gestures are used here, namely, the mode change gesture and the control gesture. Whenever the mode change gesture is recorded from the gloves, the system changes the mode from voice control to device control. Next, the control gestures are given to the system using the gloves. While operating in the device control mode, the device continuously checks the input gesture mode is changed or the control gesture and also checks for interrupt. If the interrupt occurs, the system immediately activates the GSM modem and sends emergency text message.

If the gesture is mode change, then the system changes the mode. If it is not a mode change gesture, it either controls the devices when the system is in device control mode or plays audio message if the device is in the voice control mode. The mode change can be done at any point of the execution. The interrupt enables the GSM model and transfers the message. The system continuously monitors for the interrupt. Mode switching action will be performed, to change the mode in between any point of the execution flow.

4. EXPERIMENTAL RESULTS

In this work, LPC 2148 ARM controller acts as heart of the system. The voltage variation due to the bending of the fingers is collected using the four flex sensors attached to the glove. These obtained values are analog in nature. Hence, the built in 10 bit ADC of ARM controller is used to convert these input signals into digital signals. The system is programmed using embedded C, which uses the input data's on the I/O pins to identify the message to be played using APR module, the device to be controlled or the emergency message to be sent. Initially when the device is turned on, the system is in the voice playback mode. The input gesture is recognized and checked for identify whether the gesture is mode change gesture or voice playback gesture. If the gesture is for mode change, then the system goes to device control mode or else it performs the audio playback using the pre-recorded audio in the APR33A3 module.

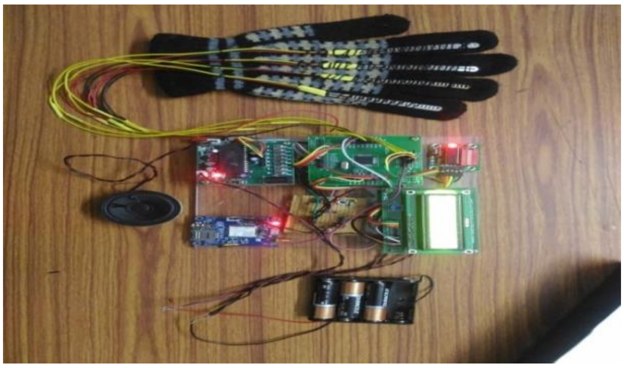

Fig 4: Sensor part of the system with processing unit, Audio playback module and GSM module

Fig 5: Device Control Circuit

Experiments are carried out for four gestures in both voice playback and device control mode and also the emergency mode using a toggle switch. The results obtained for 20 trails are shown in the Table I. The threshold value for ADC is set for 800, whenever the flexing of flex sensor results in ADC output more than threshold i.e. 800, then the gesture is recognized by the ARM controller.

The failures are attributed to the sensor error, especially when changing the hand gesture. The garbage values provided by the sensors during this phase are undesirable. However, to overcome this issue time filter is introduced to obtain a static value from the sensor.

Table I. Test Result for Gesture Recognition

Test No	Test Finger Gesture	Success Event	Success Rate	Device Mode	
				Playback	Control
1	Index	17	85%	Yes	No
2	Middle	18	90%	Yes	No
3	Ring	19	95%	Yes	No
4	Pinky	19	95%	Yes	No
5	Index	18	90%	No	Yes
6	Middle	19	95%	No	Yes
7	Ring	19	95%	No	Yes
8	Pinky	18	85%	No	Yes
9	Toggle	19	95%	Emergency Mode	

5. CONCLUSION

This system is useful for dumb, deaf and blind people to communicate with one another and with the normal people. This system converts the sign language into voice, which is easily understandable by blind and normal people. The sign language is translated into some text form, to facilitate the deaf people as well. This text is displayed on LCD in order to improve and facilitate more gesture recognition. The GSM modem incorporated with this project help in emergency conditions. The home automation system also helps to the physically disabled person, to control the home appliances easily.

With the implementation of more kinds of sensors, we can achieve a system comprising of all the alphabets. This glove can also be used to control various other appliances like a TV, Computer, etc. Just like the microcontroller is programmed to convert the finger movements into recognizable alphabets, it can also be programmed to do various other things upon certain movements of the hand.

ACKNOWLEDGMENT

Acknowledgments due towards beloved students Anitha T R, USN: 4GL14EC400, Madhu Kumar M, USN: 4GL14EC025, Silvestar D Souza, USN: 4GL15EC408 and Sowmya K S, USN: 4GL15EC409. Special thanks to teaching and non-teaching faculty of GEC, Kushalnagar.

REFERENCES

[1] K Abhijith Baskaran, Anoop G Nair, K Deepak Ram, Kristnan Ananthanarayanan and H R Nandhi Vardhan, 2016. “Smart Gloves for Hand Gesture Recognition”, IEEE conference.

[2] Abhinandan Das, Lavish Yadav and MayankSighal, 2016. “Smart Glove for Sign Language Communication”, IEEE conference.

[3] Santiago Aguiar, Andres Erazo and Sebastian Romero, 2016. “Development of a Smart Glove as a Communication Tool for People with Hearing Impairment and Speech Disorders”, IEEE Ecuador Technical Chapters Meeting (ETCM).

[4] Tushar Choushan, Ankith Panse and Anvesh Kumar Voona, 2014. “Smart Glove with Gesture Recognition Ability for the Hearing and Speech Impaired”, IEEE conference.

[5] Nikhita Praveen, Naveen Karanth and M S Megha, 2014. "Sign Language Interpreter using a Smart Gloves", IEEE conference.

[6] Mina I, Michale N and Hala A, 2017. "A New Approach for Design a Smart Gloves", National Radio Science Conference.

[7] Akshay D. R. Schneider K. Uma Rao, 2013. "Low Cost Smart Glove for Remote Control by the Physically Challenged", IEEE.

[8] S Yarisha Heera, Madhuri K Murthy, Sravanti V and Sanket Salvi, 2017. "Talking Hands – An Indian Sign Language to Speech Translating Gloves", IEEE.

[9] Dalal Abdulla, Shahrazad Abdulla, Rameesa Manaf and Anwar H. Jarndal, 2017. "Design and Implementation of A Sign-to Speech/Text System for Deaf and Dumb People", IEEE.

[10] Suraksha Devi and Suman Deb, 2017. "Low Cost Tangible Glove for Translating Sign Gestures to Speech and Text in Hindi Language", 3rd IEEE International Conference on Computational Intelligence and Communication Technology, IEEE-CICT.