The International Journal of Engineering
And Science (IJES)
||Volume|| 1 ||Issue|| 2 ||Pages|| 19-25 ||2012||
ISSN: 2319 – 1813 ISBN: 2319 – 1805

HAND SIGN INTERPRETER

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Abstract

For many deaf people, sign language is the principle means of communication. Normal people around such cases end up facing problems while communicating. This system prototype that is able to automatically recognize sign language to help normal people to communicate more effectively with speech impaired people. This system recognizes the hand signs with the help of specially designed gloves. These recognized gestures are translated into a voice signal in real time. Thus this system reduces the communication gap between normal and the speech impaired people.

Keywords—*speech impaired, hand signs, sensor glove, easy communication.*

Date of Submission: 16, November, 2012 ⟺ Date of Publication: 5,December 2012

1. INTRODUCTION

'Sign Language Interpreter' is a recognition system for the vocally disabled. We have turned to glove-based technique as it is more practical in gesture recognition which involves the use of specially designed sensor glove which produces a signal corresponding to the hand sign. As the performance of the glove is not affected by light, electric or magnetic fields or any other disturbance, the data that is generated is accurate. The processor analyses the signal and fetches the corresponding audio signal from the memory IC which is fed to the amplifier. The speaker generates the relevant sound. As the system uses the low cost and easily available sensors and IC's the system is very much cost effective.

2. LITERATURE SURVEY

In the recent years, there has been tremendous research on the hand sign recognition. The technology of gesture recognition is divided into two categories-

- **Vision-based**

In vision-based methods, computer camera is the input device for observing the information of hands or fingers. The Vision Based methods require only a camera, thus realizing a natural interaction between humans and computers without the use of any extra devices. These systems tend to complement biological vision by describing artificial vision systems that are implemented in software and/or hardware. This poses a challenging problem as these systems need to be background invariant, lighting insensitive, person and camera independent to achieve real time performance. Moreover, such systems must be optimized to meet the requirements, including accuracy and robustness. [5]

- **Glove-based methods**

In glove based systems data gloves are used which can archive the accurate positions of hand gestures as its positions are directly measured. The Data-Glove based methods use sensor devices for digitizing hand and finger motions into multi-parametric data. The extra sensors make it easy to collect hand configuration and movement. However, the devices are quite expensive and bring much cumbersome experience to the users Some of the earlier gesture recognition systems attempted to identify gestures using glove-based devices that would measure the position and joint angles of the hand. However, these devices are very cumbersome and usually have many cables connected to a computer. This has brought forth the motivation of using non-intrusive, vision-based approaches for recognizing gestures Also the sensors used for the detection of the sign language and the gesture recognition in the system that are available in the market are quite costly.

In computer recognition of spoken language, speech data is captured using a microphone connected to an ADC. Similarly a data-capturing device is also required in order to recognize sign language; in this case measuring the position and movement of the signer's hands [1]. Two broad categories of input hardware have been used for recognition of hand gestures – glove-based devices such as those used by Kramer et al (1989) [4] and Fels et al (1993) [2], and camera-based systems as used by Holden (1993). The latter approach has some benefits, particularly as it does not require specialized hardware, but this is offset by the complexity of the computer vision problems faced in extracting the necessary data about the hands from a visual image. Therefore for this research glove-based input was used, as this allowed the research effort to be focused on the area of sign recognition rather than that of data capturing The specific input devices used in developing SLARTI were a Cyber Glove, and a Polhemus Iso Trak. The Cyber Glove measures the degree of flexing of the various joints of the hand and wrist. The version of the Cyber Glove used for this research provides 18 sensors. The Polhemus allows tracking of the spatial position and orientation of the hand with respect to the fixed electro-magnetic source [1].Linguistic analysis of sign language has revealed that signs can be described in terms of four basic manual features, which may be modified in meaning by more subtle factors such as body language and facial expression [3]. The hand shape defines the configuration of the joints of the hand. Orientation specifies the direction in which the hand and fingers are pointing, whilst the place of articulation is the location of the hand relative to the body. The most complex feature is motion, which consists of a change over time of any combination of the other three. The task of transforming a stream of input data directly into a classification of the sign is an extremely difficult task. The approach taken within SLARTI was to initially process the input data so as to produce a description of this sequence in terms of the four features discussed above. The sign is classified on this basis. The SLARTI system consists of four separate feature-extraction neural networks each trained specifically to recognize one of the features of the sign.

This approach of decomposing the problem and applying a modular structure of networks has a number of benefits. First, as demonstrated on the task of speech-recognition by Waibeletal (1989), it allows the use of several smaller networks rather than one massive network and thereby reduces the amount of training time and data required. It may also result in superior classification accuracy. Second, it produces a system which can more easily be extended. The features recognized by the feature-extraction networks are expressive enough to describe an extremely large number of signs, not all of which may be recognized by the final classifier. If the vocabulary of the system is to be extended then only the final classifier will require modification. This greatly reduces the costs involved in performing such expansion of the system, and makes it practical to tailor the vocabulary of the system to a particular user.

Projects available in market:

In the recent era, there has been tremendous development in the work of sign language interpretation. Many systems have been designed for gesture recognition.

Depending upon the two categories many systems are now available in the market.

1. Vision-based
2. Glove-based

Comparison:

In case of vision- based gesture recognition systems, a lot of the digital signal processing has to be done. Also there require large programming. Because of this the response of the system is quite slow. Also the electric, magnetic fields, and any other disturbances may affect the performance of the system. In case of glove-based sign language recognition system that is available in the market lot of the hardware is required. Large numbers of cables have to be connected to the computers for monitoring the data. Hence the systems require lot of space. Also the system is not handy. In case of our project flex sensors that we are using are of low cost. Also the ARM processor that we use in our process is very compact. Hence the space required for our system is very less compared to the other projects that are available in the market.

Thus the system is portable. Performance of the system is not affected by the disturbances. Here we are converting hand signs in to the corresponding speech signal; hence the system is the proper means of effective communication. As the hardware required in designing are low cost, the overall cost of the system is less compared to the other systems available in the market, and it is the system is flexible enough for a user to add, modify or delete a hand sign.

3. RESEARCH ELABORATIONS:

SYSTEM HARDWARE:

System hardware consists of an accelerometer and Flex sensors attached to the glove which are the input devices. The signal so generated by these two sensors is given to the voltage divider and then to the processor i.e. LPC2138 which acts as the heart of the system. Flex sensors made up of resistive carbon element shows the property of change in resistance according to the bending of sensor (fingers). Five Flex sensors are mounted on five fingers of the hand. Accelerometer works on the concept of gravity and serves the purpose of sensing the direction. The output of the Flex sensor is the varying resistance which is converted into a voltage signal using a voltage divider bias circuit. Further, the accelerometer output and the voltage signal are provided to the inbuilt ADC of the processor. The received output from the sensors is continuously monitored.rocessor is interfaced with a memory IC which acts as an input/output device. Various audio files are recorded and then stored in the memory IC for the different hand signs (signals). Thus the processor acts as master and the external memory acts as slave. Depending on the output voltage from the Flex sensors and the accelerometer, processor checks the ADC count in the lookup table and if an audio signal corresponding to the ADC count is found then the audio signal is fetched from the memory IC (external memory). The data so fetched which is in the digital form is converted into an analog signal and provided to the amplifier and thus to the speaker. LCD is used to display the corresponding output, thus serves an important role for cross-verification. The output of the processor is quite weak to drive the loudspeaker. Thus an audio amplifier comes into the picture. The output taken from the processor acting as an input to the audio amplifier is in the form of an analog signal. That is facilitated by DAC which is inbuilt in the processor. Speaker, at the end of the system plays the corresponding audio file.Using only a single glove restricts the system to the recognition of one-handed signs (and hence eliminates the possibility of recognizing the Auslan manual alphabet which is two-handed), but it is envisaged that the techniques used in developing the system could be extended to two-handed signs if appropriate input hardware was available.

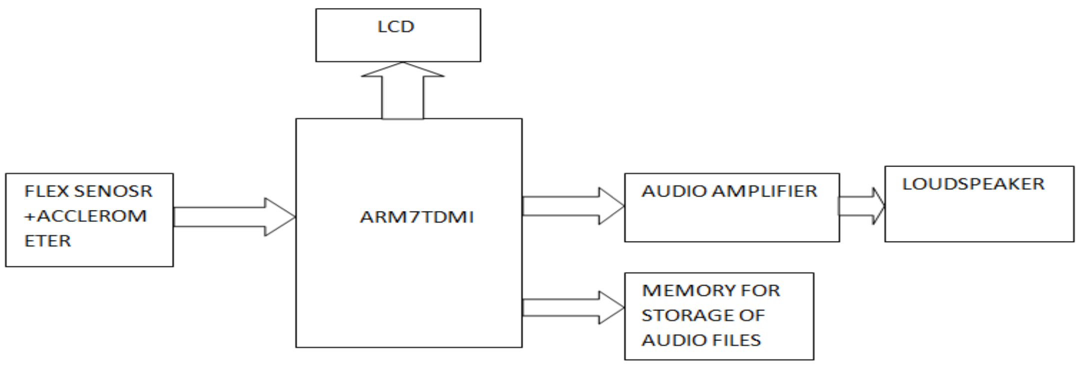

Fig. 1 Block diagram of system

Flex Sensors:

The output the Flex sensor is in the form of the variable resistance. As the fingers are bend the resistance of the Flex sensor changes. This property is shown below

Working of Flex sensor

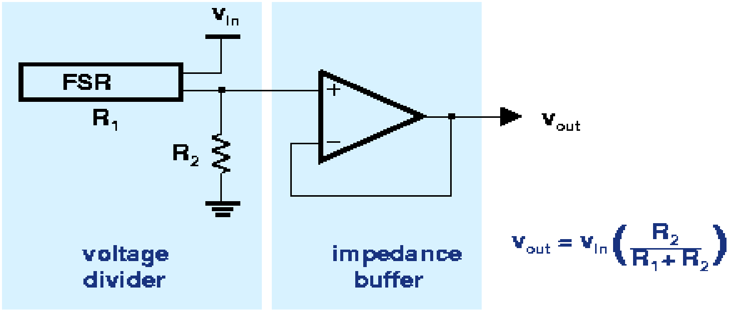

Fig. 2 Voltage divider for flex sensors

Electrical Specifications:
1. Flat resistance : 25 k ohms
2. Tolerance : 30%
3. Bend Resistance Range : 45k to 125k ohms

Accelerometer:

In the system a 3 axis accelerometer is used. Accelerometer works on the principle of the gravitational force. Accelerometer Output changes according to the inclination, in response to the movement of the mass inside. To maintain the simplicity in the prototype we are considering only the 2 dimensional models. Accelerometer provides temperature compensation and g-select option which allow selection among 4 different type of sensitivity. It can be directly interfaced to the ADC.

***Table I:* Gravity Selection Table**

g-select 2	g -select 1	g –range	Sensitivity
0	0	1.5g	800mV/g
0	1	2g	600mV/g
1	0	4g	300mV/g
1	1	6g	200mV/g

LPC2138:

It belongs to ARM7TDMI family. LPC stands for low power consumption.

Features:
- 32 bit RISC processor.
- Hardware Debug Technology.
- Load store architecture.
- 512 KB flash memory.
- 32 KB RAM.

ADC (Analog to Digital Convertor):

It uses 10 bit successive approximation technique. Input multiplexing among the 6 channels of ADC0 and 8 channels of ADC1 can be done. The 10 bit conversion time is approximately 2.44 us.

DAC (Digital to Analog Convertor):

The 10 bit DAC uses resistor string architecture. It produces buffered output.

UART (Universal Asynchronous Receiver Transmitter):

The Universal Asynchronous Receiver/Transmitter (UART) takes bytes of data from the LPC1238 and transmits the individual bits in a sequential fashion which is received at the other side i.e. AT45db161. It has got FIFOs capable of receiving and transmitting 16 bytes of data. It has got built-in fractional baud rate generator with autobauding capabilities. It uses the mechanism that enables software and hardware flow control implementation.

SPI (Serial Peripheral Interface):

SPI is a full duplex serial interfaces. It can handle multiple masters and slaves being connected to a given bus. Only a single master and a single slave can communicate on the interface during a given data transfer. During a data transfer, the master always sends 8 to 16 bits of data to the slave, and the slave always sends a byte of data to the master. The maximum bit rate of data is one eighth of the input clock rate.

AT45db161:

Memory IC is Electronically Erasable Programmable Read Only Memory (EEPROM), which is used in portable devices. It provides a rapid serial peripheral interface, where 66 MHz is the max clock frequency. It also provides a page program operation and user configurable page size. With presence of various erase options the process become convenient.

LM386:

The LM386 is a power amplifier designed for use in low voltage consumer applications. It's a versatile amplifier which can be used for different gains. The gain is set as 20 by default but it can be changed by changing the components between
Pin no.1 and Pin no.8.

Software Design:

Getting the analog input from the sensors and converting it into digital form is one of the crucial parts, for this purpose different registers are used. ADCR, ADGDR, ADDR0, DACR... are used to control and monitor the process.

1. **ADCR (A/D Control Register)**: The ADCR register must be written to select the operating mode before A/D conversion can occur.

2. **ADGDR (A/D Global Data Register)**: This register contains the ADC's DONE bit and the result of the most recent A/D conversion. The count is stored

3. **ADDR0 (A/D Channel 0 Data Register)**: This register contains the result of the most recent conversion completed on channel 0.

   After fetching the audio signal and sending to the speaker DACR comes into picture.

4. **DACR (D/A Control Register)**: This read/write register includes the digital value to be converted to analog, and a bit that trades off performance vs. power. Bits 5:0 are reserved for future, higher-resolution D/A converters.

Writing a file in the memory IC:

For the output to be an audio data the audio file should be stored in the memory IC. For this purpose SPI (serial peripheral interface) and UART (universal asynchronous receiver/transmitter) are used. The data is transferred in form of pages. Using the code set, the local buffers and SPI are initialized. There are two local buffers 1 and 2 of size 528 Kbytes each, are used for sending and receiving of the data serially. The data file is first taken into the local buffer 1 as soon as it is full the data is now taken into the local buffer 2 and data from the local buffer 1 is send to the memory IC to a specific location. As soon as buffer 2 is full its switched back to buffer 1 and the process continues the same way until whole data is written into the memory IC.

Reading a file from a memory IC:

On the other hand while reading a file from the memory; we use an address to fetch a file from its location. The same process is repeated only in a reverse manner, where the data is transferred from memory IC to the processor.

Result And Discussion:

Application:

Being an application based project it only serves as nullifying the communication medium between dumb and normal people.

Future Modification

1. With a little modification these hand signs can be used for operating vehicles. The various operations like taking turns, starting or stopping vehicles can be implemented efficiently.
2. The system can be modified to be a wireless one in such a way that it will minimize the complexity while using. Without the wirings around it will be a further step towards commercialization of the product.

4. Result

The output signal is an audio signal which is dependent on ADC count, all the hand signs that are to be fetched depends on the counts. The hand signs taken in the prototype do not belong to a specific language, rather these are taken in a way such that user can modify it as per their requirement.Every bending of the sensor (finger) produces a unique ADC count so that when different hand sign is made different ADC count is produced. Processor uses these ADC counts to decide which audio signal should be fetched and played accordingly. With different hand signs different signals can be produced. Using this concept of ADC count, more and more no. of hand signs can be used as per user and accuracy can be increased with a little change in the ADC count. System accuracy, user configurability, portability, its immunity to noise and environmental disturbances make it to be a better choice over the other products available in the market.

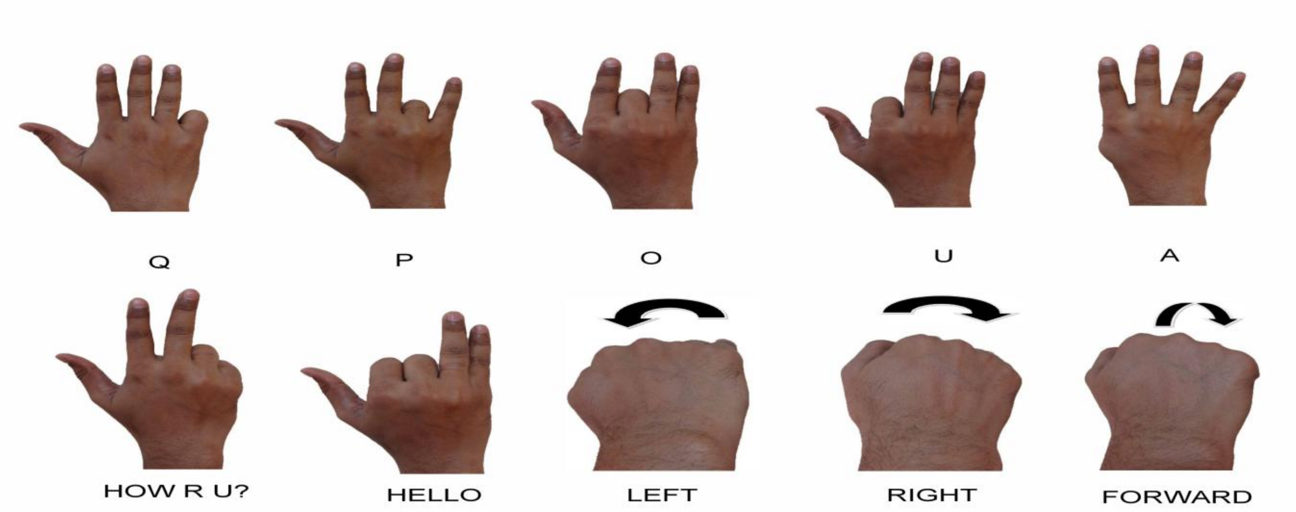

Fig 1 Hand signs used in the system

***Table II:* Count and Selection Table**

	A	U	O	P	Q	HWR	HELLO	LEFT	RIGHT	FORWARD
ADC1(2)	<560	<560	<560	<560	>800	<560	>800			
ADC1(3)	>900	<650	<650	<650	<650	<650	<650			
ADC1(4)	<600	>850	<600	<600	<600	>850	<600			
ADC1(5)	<450	<450	>700	<450	<450	>700	<450			
ADC1(6)	<560	<560	<560	>800	<560	<560	>800			
ADC(1)								<350	>650	
ADC(2)										<350

5. Conclusion

In today's digitized world, processing speeds have increased dramatically, with computers being advanced to the levels where they can assist humans in complex tasks. Yet, input technologies seem to cause a major bottleneck in performing some of the tasks, under-utilizing the available resources and restricting the expressiveness of application use. Hand Gesture recognition comes to the rescue here The system is designed in such a way that it helps in communication between speech impaired & normal people with the help of flex sensors & accelerometer. We made a prototype in which we have stored 10 different signals of as per the user's hand sign. Three of them are totally based on the output of the accelerometer and seven of them are based on the output of flex sensors. The accuracy of the system is efficient enough to produce different outputs with different hand signs of the user. With different bending, angle different ADC count & hence different hand signs can be made & could be stored accordingly. The created system is made in such a way that with small changes the system can become more & more versatile. To continue this momentum it is clear that further research in the areas of feature extraction, classification methods, and gesture representation are required to realize the ultimate goal of humans interfacing with machines on their own natural terms.

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