Volume: 9 Issue: VI Month of publication: June 2021

DOI: https://doi.org/10.22214/ijraset.2021.35263

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue VI Jun 2021- Available at www.ijraset.com

Audio Visual Reception of American Sign Language for Blind, Deaf and Dumb People

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Abstract: The computer recognition of sign language is an important process for enabling communication with the visually and hearing impaired people. This proposed project introduces an efficient way of computer recognition of sign languageby using a simplified method by the use of an accelerometer sensor which is a three axis sensor and a voice IC. The main objective of our project is to convert the sign language into a voice format and display the corresponding message on the LCD screen. The basic idea of this project is to have accelerometer sensors attached to the gloves worn by the impaired person. When the person flexes his/her hand for the pre-coded commands, the accelerometer sensors senses the change due to the angular movement of fingers and produces a corresponding output voltage. The sensed analog signal is converted to digital signal by ADC and transmits it to the voice IC via a microcontroller. The objective of the microcontroller is to perform the matching of the obtained hex-code with its corresponding pre-coded commands using Keil software. Once the code is matched with its pre-coded commands the output is delivered through a speaker via a voice IC and the command is also displayed in a LCD screen.
Index Terms: Sign Language Recognition, Accelerometer Sensor, Microcontroller, Voice IC, LCD.

I. INTRODUCTION

A Sign Language (also signed language) is a language which, instead of acoustically conveyed sound patterns, uses manual communication and body language to convey meaning. This can involve simultaneously combining hand shapes, orientation and movement of the hands, arms or body, and facial expression to fluidly express a speaker's thoughts.

Wherever communities of deaf people exist, sign languages develop. While they utilize space for grammar in a way that spoken languages do not, sign languages exhibit the same linguistic properties and use the same language faculty as do spoken languages. Hundreds of sign languages are in use around the world and are at the cores of local deaf cultures. Some sign languages have obtained some form of legal recognition, while others have no status at all.

It reveals human language to be more flexible than had been imagined, able to exist in either auditory or visual form. It shows that the human drive for language is so strong that when deafness makes speech inaccessible, it finds another channel, creating language in sign. Sign language has taught us that human language can use either channel speech or sign.

After extensive linguistic analysis of signed languages, it was found that gestures can be described in terms of five basic manual features:

A. The hand shape, which defines the configuration of the joints of the hand
B. The palm orientation, which specifies the direction where the hand and fingers are pointing
C. The place of articulation, which specifies the hand position related to the body
D. The movement that is the most complex feature and consists of the change through time of any combination of the other three features.
E. Facial Expression

As an example, some signs in American Sign Language are illustrated in Fig.1.

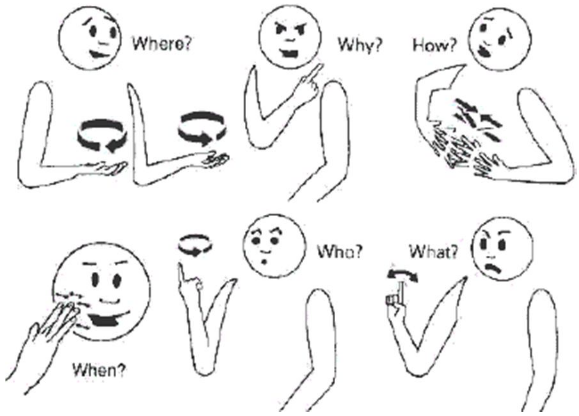

Fig.1. Typical words of American Sign Language

Advantages of studying signs at the component level are due to the fact that, to form a large number of signs, only a limited number of distinguishable classes/patterns in each component are needed. The Sign Language Recognition area, which could mainly be categorized into two groups: the data glove-based approaches and the computer vision (camera)-based approaches.

Unlike the two conventional group mentioned previously, the accelerometer (ACC) sensor provide potential technique for sign sensing ACC is widely used to capture kinematic information associated with the hand and arms. ACC based sign recognition systems are capable distinguishing hand orientation or movements with different trajectories. The goal of the study is to develop a component based American Sign Language Recognition frame work by identifying and modeling sign components interpreted from ACC data. The rest of this paper is organized as follows. Section II describes the proposed method for American Sign Language Recognition (ASLR). Section III provides the results and discussion and conclusion of the paper.

II.PROPOSED METHOD

The block diagram describes the Audio Visual Reception of American Sign Language System which is sequentially depicted in the Fig.2. The glove which has the sensor is attached on both the palm of the hands, is used to acquire the input from the hand in the Audio Visual Reception system.

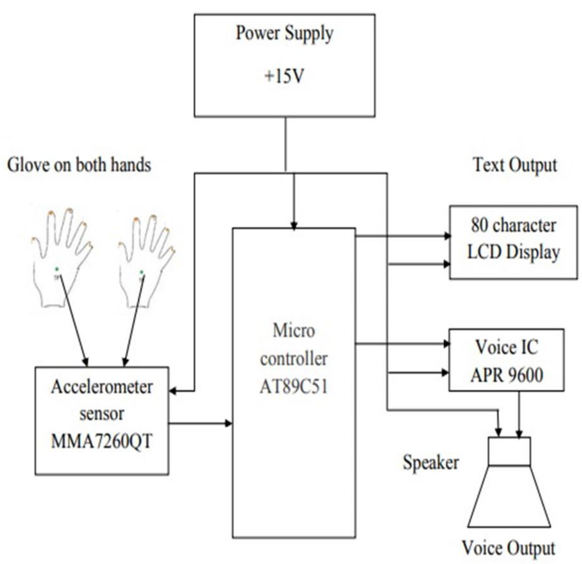

Fig.2. Block diagram of the ASLR approach

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The Audio Visual Reception System of American Sign Language focuses on the conversion of the American Sign Language into a voice output as well as a visual output. The desired output is obtained in the LCD and the speaker. In order to obtain the audio visual result, the accelerometer sensor is placed on the 14 palm of the right and left hand of the user. When the user communicates with the sign language, for every sign shown, based on the angle of the sensor the output values vary in x, y and z axes.

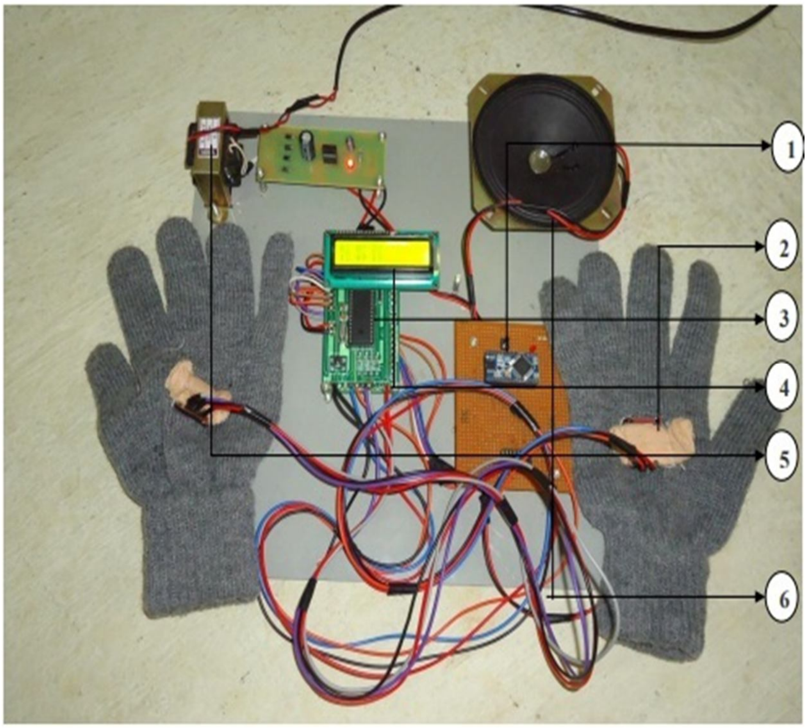


Fig.3. Experimental Setup of Audio Visual Reception System

The overall setup of the Audio Visual Reception System of American Sign Language is shown in Fig.3. which is built from the block diagram which is shown in Fig.2. The output from each of the sensor is given to the microcontroller where the processing of the acquired input from the sensor takes place. The microcontroller used here is AT89C51, which uses the Keil software to set the commands. The output from the sensor is matched with the preset commands in the microcontroller to obtain the desired output.
Once the output of the sensor matches with the preset commands in the microcontroller, the output is displayed in the LCD which is interfaced with the microcontroller and is also sent to the voice IC APR9600. The voice IC uses it play mode to produce the voice output of the given input in the speaker.
In this project the making of a sentence "Welcome to the Department of Biomedical Engineering' is done. This sentence involves the American signs and their respective x, y and z axes values which are elaborated in the section III.
The Accelerometer Sensor MMA7260QT is placed on the palm of the right and left hand. The output pins are connected to the microcontroller input ports. The output from the accelerometer sensor, when every action is made, it is given to the microcontroller where the process of display in voice format is made. The sensor detects the slightest changes during an action and based on its angle [Honggang Wang *et al.*, 2006] it gives the analog output values of the action's corresponding x, y and z axes. The values of the axes from both the sensors are used to set ranges for the setting of words in the microcontroller. The accelerometer sensor used here works with an appropriate power supply of 5V.
The programming for producing a voice output of the American Sign Language is done using the Keil software. Keil Micro Vision is software which solves many of the problems for an embedded developer. This is an Integrated Development Environment (IDE), which integrated a text write programs, a 29 compilers and convert source code to hex files. In Keil, first the target device i.e. the microcontroller AT89C51 is selected after which the source file for the device is automatically created. Once the source file is created, a new project window is opened which is saved in the name ASLR with an extension of .C. The program coding to obtain the desired output is entered in this window.

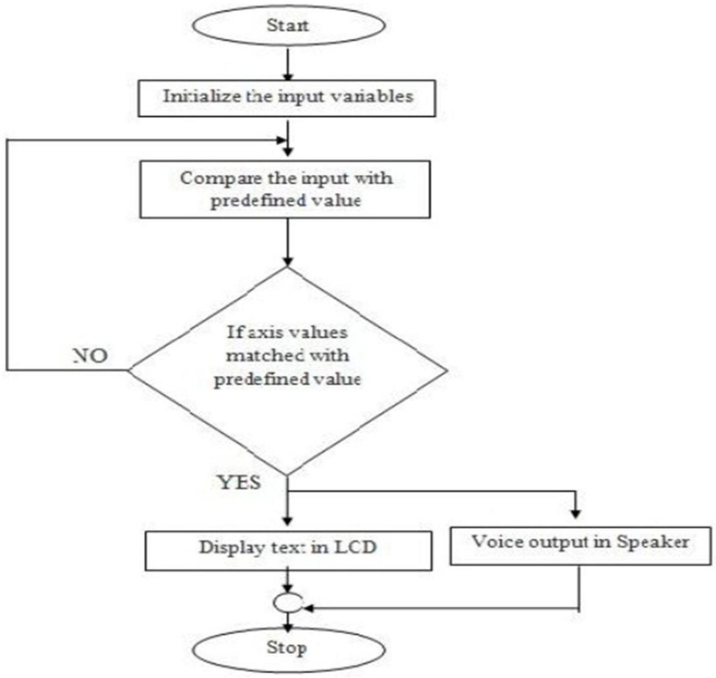


Fig. 4. Process Flow of Audio Visual Reception System

The process of programming flow in the microcontroller as shown in the Fig.4 begins with input acquisition from the accelerometer sensor which is given to the port 3 of the AT89C51. After the values from the sensor are taken 30 the process of matching [Sunita Nayak *et al.*, 2009] with the preset commands is done to obtain the output. In case the values do not match the preset commands the microcontroller checks for the values from the beginning. Once the values match the preset commands the desired output word is displayed in the LCD which is interfaced with the AT89C51 microcontroller.

The module interfaced to the system is treated as RAM input/output, expanded or parallel I/O. Since there is no conventional chip select signal, a strobe signal is developed for the enable signal (E) and appropriate signals to the register select (RS) and read/write (R/W) signals are applied. The module is selected by gating a decoded module and specifying address of the host and processor's read/write strobe. The resultant signal, applied to the LCDs enable (E) input, clocks in the data. The 'E' signal must be a positive going digital strobe, which is active while data and control information are stable and true.

All module timings are referenced to specific edges of the 'E' signal. The 'E' signal is applied only when a specific module transaction is desired. The read and write strobes of the host, which provides the 'E' signals, should not be linked to the module's R/W line. An address bit which sets up earlier in the host's machine cycle can be used as R/W. When the controller is performing an internal operation the busy flag (BF) will be set and will not accept any instruction and hence a delay of approximately 2ms after each instruction is provided. The liquid crystal display module is interfaced to an 8-bit microcontroller for which the bus lines D4 to D7 which is shown in table5.3 are used for data transfer, while D0 to D3 lines are disabled. Here for 8-bit data interface, all eight-bus lines (D0 to D7) are used for data transfer.

The Voice IC APR 9600 is widely used to record the voice signal. The microphone is used to pick up the voice signal. Then the signal is given to APR9600 multi section sound record and replay IC. APR 9600 is a low cost high performance sound record/reply IC incorporating flash analogue storage technique. Record sound is retained even after power supply is removed from the module. The replayed sound exhibits high quality with low noise level. Total sound recording time can be varied from 32 seconds to 60 seconds by changing the value of a single resistor. The IC can operate in two mode such as serial mode and parallel mode. In serial access mode, sound can be recorded in 256 sections. In parallel access mode, sound can be recorded in 2, 4 and 8 section. The IC is controlled using push button keys and also the microcontroller. During sound recording, sound is picked up by the microphone. A microphone pre- amplifier amplifies the voltage signal from the microphone. An AGC circuit is included in the pre-amplifier which is controlled by an external capacitor and resistor. If the voltage level of a sound signal is around 100mv peak to peak, the signal can be fed directly into the IC through ANA IN pin (pin 20) shown in table.6.2. The sound signal passes through a filter and a sampling and hold circuit. The analogue voltage is then written into non volatile flash analogue RAMs.

There are two kinds of modes available. They are Record mode and Play mode. Record Enable pin (27) is pulled low to enable recording and pulled high for playback which is shown in table.6.2. During record mode, the processed voice signal is written into the memory and read the same from memory during the play mode. If the circuit is busy in Reading or Writing, the LED glows indicating that the circuit is busy. This LED is driven by transistor Q1. For recording into memory, MS1 and MS2 are pulled high. To enable recording of message from the microphone, the RE pin goes low. The maximum length of eight sounds track is 7.5 seconds each. When LED2 blinks the voice is recorded in the microphone. The recording will be terminated if the recording time exceeds 7.5 sec. Similarly for playbacks, RE pin goes high.

Message1-Message 8 pin have eight memories; each pin is connected to a push button. The buttons are set initially in a high state. MS1 and MS2 Pins are used to indicate the part of the memory and number of the memory to be chosen. The Audio amplifier is used to amplify the signal that is to be played and an amplified output is obtained from the loud speaker. If the circuit is busy in Reading or Writing, the LED glows to indicating that the Circuit is Busy. A loudspeaker or ("speaker") is an electroacoustic transducer that produces sound in response to an electrical audio signal input. Non-electrical loudspeakers were developed as accessories to telephone systems, but electronic amplification by vacuum tube made loudspeakers more generally useful. The most common form of loudspeaker uses a voice coil electromagnet acting on a permanent magnet, but many other types exist. Where accurate reproduction of sound is required, multiple loudspeakers may be used, each reproducing a part of the audible frequency range. Miniature loudspeakers are found in devices such as radio and TV receivers, and many forms of music players. Speaker is connected with voice IC to play the recorded words. The Pin 14 and 15 of Voice IC is connected with speaker.

The output unit consists of LCD, Speaker, and Voice IC. The output of the processing unit is given to text and voice outputs i.e. displays it in LCD and hear it through speaker via Voice IC (APR9600). The APR9600 device offers true single-chip voice recording, non-volatile storage, and playback capability for 40 to 60 seconds. The device supports both random and sequential access of multiple messages. Sample rates are user-selectable, allowing designers to customize their design for unique quality and storage time needs. The device is ideal for use in portable voice recorders i.e. speakers. The APR9600 is text to voice convertor that will convert the processing unit output i.e. text into voice output. Finally the voice output is delivered by the speaker.

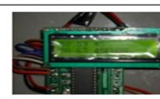
III. RESULTS AND DISCUSSION

The Audio Visual Reception System of American Sign language is done for the sentence “Welcome to the Department of Biomedical Engineering”. This result obtained possesses a set of American hand signs and a set of axes values obtained from the accelerometer sensors MMA7260QT which are placed on each palm. The obtained results are elaborate in Table 3.

TABLE 3. Results of Axes value from Accelerometer sensors MMA7260QT

S.NO	HAND USED	X-AXIS VALUE	Y-AXIS VALUE	Z-AXIS VALUE	WORDS
1	RIGHT	<=15	<=10	<=25	Welcome to
2	RIGHT	<=5||>=60	>=12||<=23	>=54||<=66	The Department of
	LEFT	>=60	>=38||<=48	>=50	The Department of
3	RIGHT	>=48||>=58	>=10||<=20	>=55	Biomedical
4	RIGHT	>=50	>=50	>=42||<=50	Engineering
	LEFT	>=50	<=65	>=40	Engineering

Table 4. American Signs and axes values

AMERICAN SIGNS	WORD	LCD DISPLAY
	Welcome to	
	The Department of	
	Biomedical	
	Engineering	

IV. CONCLUSION

This paper was mainly focused on designing and developing of an audio visual reception system for American Sign Language which could be utilized for the ease of communication by the blind, deaf and dumb people. The system when made as a standalone unit can be utilized as a hearing signs too in the rehabilitation sector. The future work of the system is the testing of the speed of the sensor and memory storage of the voice IC which should increase to construct complex sentences and synchronizing and timing the entire unit.

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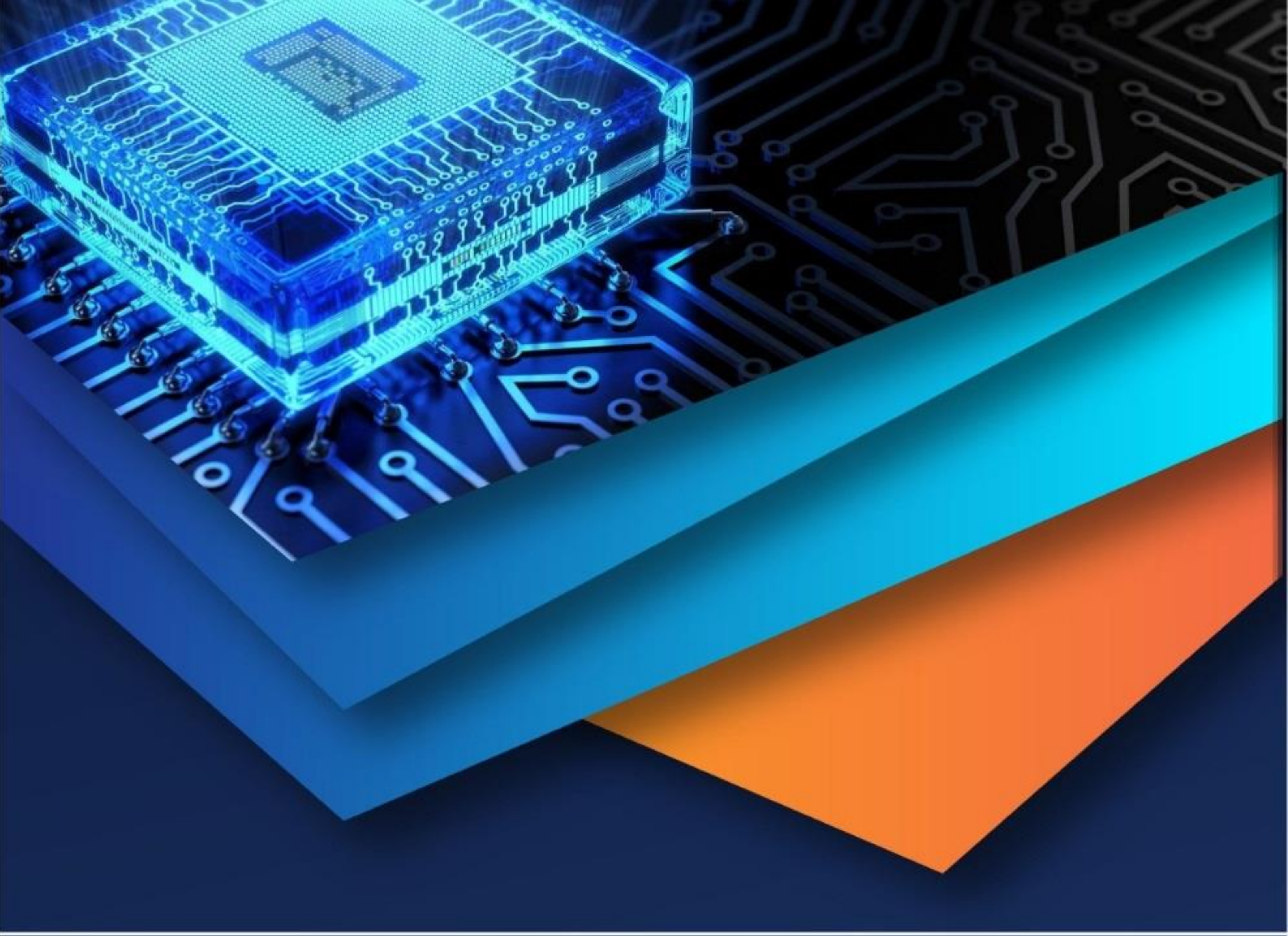

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