S2LV – A Sign to Letter and Voice Converter

Christelle Nasrany and Riwa Bou Abdou
Notre Dame University – Louaize
Faculty of Engineering
Department of Electrical, Computer, and Communication Engineering
Zouk Mosbeh - Lebanon
{Ccnasrany; rjbouabdou} @ndu.edu.lb

Abdallah Kassem and Mustapha Hamad
Notre Dame University – Louaize
Faculty of Engineering
Department of Electrical, Computer, and Communication Engineering
Zouk Mosbeh - Lebanon
{akassem; mhamad} @ndu.edu.lb

***Abstract* - This paper describes a sign to letter and voice converter (S2LV). The S2LV aims at eliminating the barriers in communications between people who have disabilities, and those who don't. The S2LV is a smart talking glove which can be used by any deaf and/or mute person regardless of his/her age/gender. It is affordable, portable and light in weight. The S2LV is designed to detect the motions of the hand and translate the signs to letters and voice with a relatively high degree of accuracy (about 96%). It also interfaces with a smartphone application to generate a voice. In this way, the S2LV solution will be able to help blind people as well as those who are not able to read letters (analphabetic person). This system can help people with disabilities find jobs which require voice communications.**

Index Terms – Communication; Accelerometers; Microcontroller; smartphone; Android Application; Hardware; Software; Bluetooth; Analog Multiplexer, Digital processor;

I. Introduction

There are 70 million deaf, mute, or deaf-mute people around the world according to the World Federation of the Deaf (WFD) [1]. These people have the right to transmit their thoughts, have professions and have easy ways to communicate in society; thus, the need for developing a practical solution to these people [2]. An obvious solution may be reading lips which is not an easy way to communicate. Furthermore, a sign language is necessary since reading lips is not efficient because many words in the English language are homophones and many letters are pronounced using the same mouth shape.

The aim of this system is to manipulate a glove in order to translate the 26 letters of the alphabet, generated by the mute person, into a text message and a voice-note that can be clearly heard. The system will be implemented using a microcontroller-based circuit that will read the hand articulations, analyze the signs, and then using an Android application will generate letters and voice. The system has many advantages since it is portable, because of the use of a smartphone rather than a computer, where a smartphone is carried by each person. The glove can be worn all day and cannot function unless it is connected to the phone and used properly.

Sign to Letter and Voice is an electronic device to help deaf people communicate with others who do not have knowledge in sign language [2, 3]. It transforms the hand gestures, using gloves, into letters displayed on the LCD of the smart phone and a voice will be generated by the smartphone corresponding to the displayed words.

The related works of the sign to letter are presented in section II. In section III, overview of the design is discussed in details. The hardware and the software implementations of the proposed system are described in section IV and V respectively, followed by a brief conclusion and future plans in section VI.

II. Related works

It is obvious that not all people can understand the symbols and signs used by the deaf/mute people. Hence, the development of devices for understanding hand movements. The first hand talk glove was designed by Ryan Patterson in 2001. In this design, flex resistors were used to measure the electrical voltage applied with each gesture, and the letters were generated by comparing the values. This system was followed by many others using different technologies, like pressure sensors, contact sensors, gyroscopes and/or accelerometers [3, 4, 5]. Few of these projects used the generation of the voice by connecting a speaker on the glove or by sending the data to a computer via cable or WiFi [6, 7].

III. Overview of the Design

What makes this system different from the others is that only five xyz accelerometers were used, one on each finger, to detect the motions of the hand. The system will also use a smartphone to display the results as arrays of letters. The voice will be generated by the smartphone since it will have an application designed to gather the data from the glove via Bluetooth.

The block diagram of the S2LV system is shown in Figure 1.

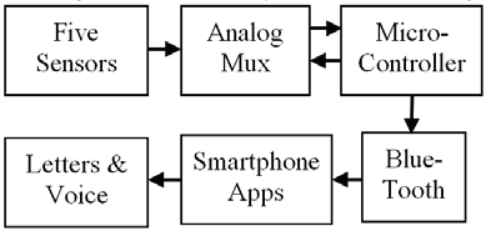

Fig.1. Block Diagram of the S2LV System

As Figure 1 describes, the hand movements will be detected by the five sensors (accelerometers). Then, the signal will have different voltages converted to digital values as inputs to the microcontroller. At this point, the output of the microcontroller will be the signals of the XYZ sensors which will be sent to the Smartphone via Bluetooth. The Smartphone will have an application designed to display the desired letters and to generate a voice.

IV. Hardware Implementation

The system was designed to read hand articulations, as each movement indicates a letter. According to ASL (American Standard Language), the hand positions associated with the letters are shown in Figure 4.

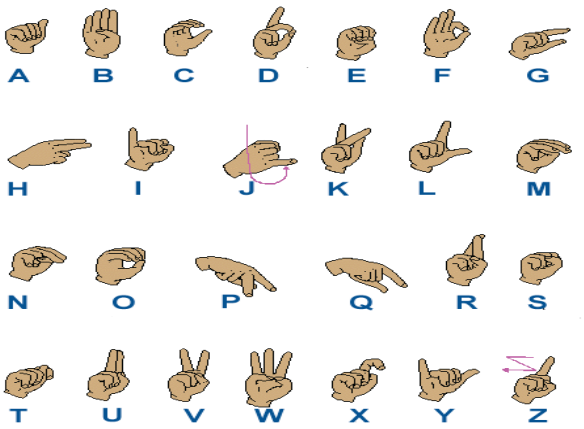

Fig.4. ASL alphabet [8]

Figure 5 shows the circuit schematic which was implemented on a PCB. Five accelerometers are installed on each finger as shown Figure 6. Each accelerometer has X, Y and Z components. In total, the multiplexer receives fifteen inputs, three inputs from each accelerometer (from X1, Y1 and Z1 to X5, Y5 and Z5). When a signal is detected, selection lines select simultaneously each channel, gather the data and send it as an analog input to the microcontroller. The microcontroller then sends the data to the smart phone via Bluetooth. When all fifteen data are received, a smart phone application, designed to analyze data and generate the word and its corresponding, voice will compare the received data with the data saved by the user corresponding to his/her hand articulation. Then, the word or phrase is received and a voice is generated.

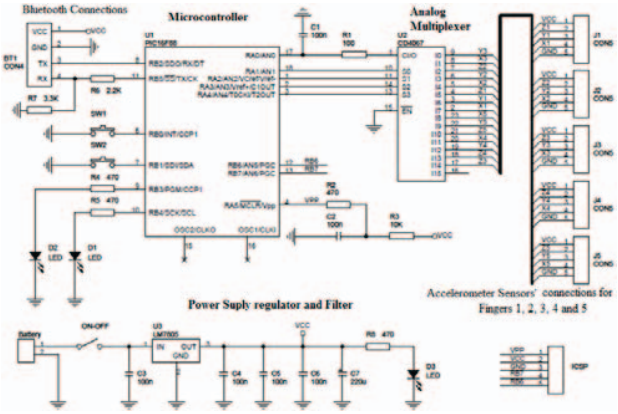

Fig.5. Hardware Circuit Implementation

Fig.6 S2LV Glove

The S2LV design was simple; low pass filters were inserted to eliminate the high-frequency noise signals. Two push buttons are also available for future use, in addition to three LEDs, one green that gets on when the circuit receives a signal, one yellow that flashes at the end of each cycle, and the last one is red and flashes each time a letter is received by the smart phone.

V. System Implementation

A. PICBASIC Program

The program of the microcontroller is written using PIC Basic program. The program operation is illustrated through the flowchart shown in Figure 7.

In brief, the system should learn all characters according to the user's hand glove. And then, the program initializes all needed parameters, and a loop starts. In the loop, the yellow LED is toggled indicating a cycle, and the inputs will be read from the accelerometers. The data received will be compared with the previous one to make sure that the user is making a specified gesture and not an arbitrary movement, for a specified time. If the user is in a fixed position, this position will be compared with the data of all letters, to try to choose the best matching letter, taking into consideration a predefined maximum range of the allowed error.

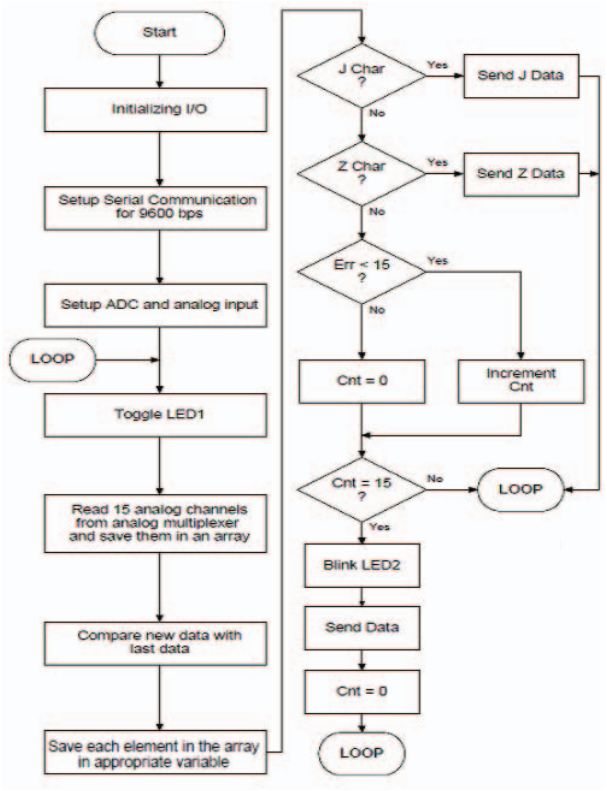

Fig.7. Microcontroller Program Flowchart

If everything's fine, a counter will be incremented. The use of this counter is to ensure that the user has made a fixed gesture for a certain delay. This delay can be modified by the value of the counter according to the user's demand.

Note that the process of detecting the letters 'J' and 'Z' is different because of the tilts or movements present when doing the gestures of these letters. For this purpose, a study was performed to get the conditions to be followed in those cases. Many trials were done on the 'J' letter, and each time the received data based on an array of fifteen numbers is saved. From these saved data, XYZ of the third and fourth fingers are then plotted. The third and fourth fingers are the ones used to perform the 'J' and the 'Z' letters respectively, and they are referred to as shown in Figure 8. As examples, Figure 9 and 10 show the record of data got for a single finger when making the trials of the 'J' and 'Z' letters.

Fig.8. Fingers Distribution

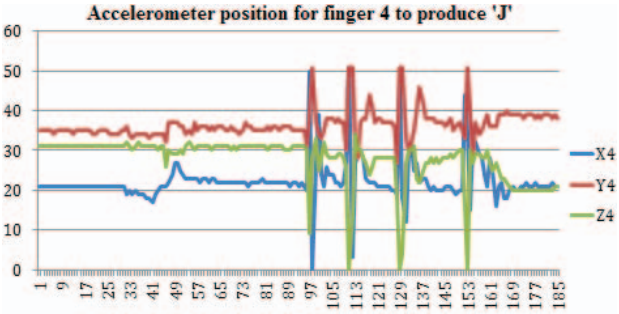

Fig.9. Data of Finger 4 with 'J'

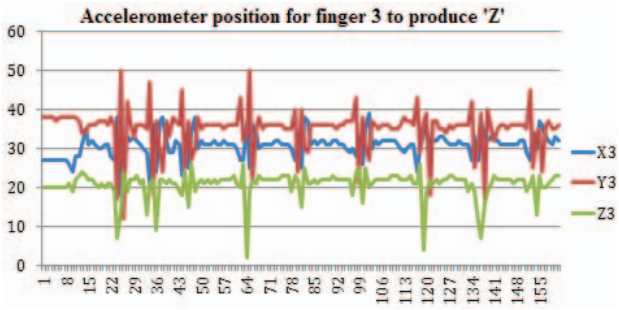

Fig.10. Data of Finger 3 with 'Z'

Similarly, *the same process was performed on other fingers for 'Z' and 'J' letters, to remark a certain pattern to be used in the microcontroller code.*

B. Android Application

The last step in the software design is the implementation of a smartphone application to receive the data via Bluetooth, display the letters and generate a voice. The flowchart describing this application is shown in Figures 11 and 12.

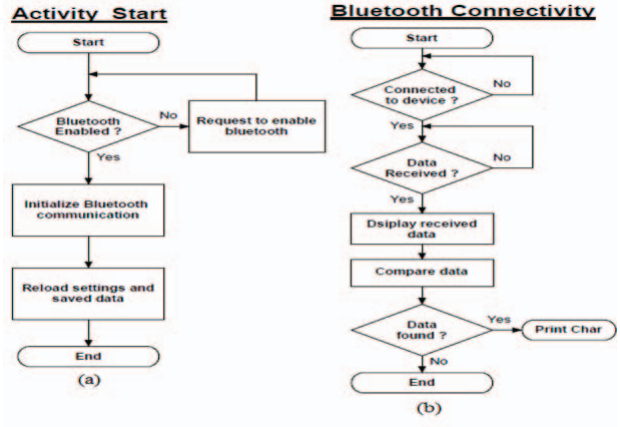

Fig.11. Android Application Flowchart (part 1)

This application takes care of many functions. The first one is the activity start and the Bluetooth connectivity responsible of initializing the Bluetooth connection between the glove and the smartphone. Then, two options of printing are present: the word mode displaying one word at a time, and the phrase mode making the display of a whole sentence possible. The user must

choose one of the two modes, as each mode will have its specifications and font.

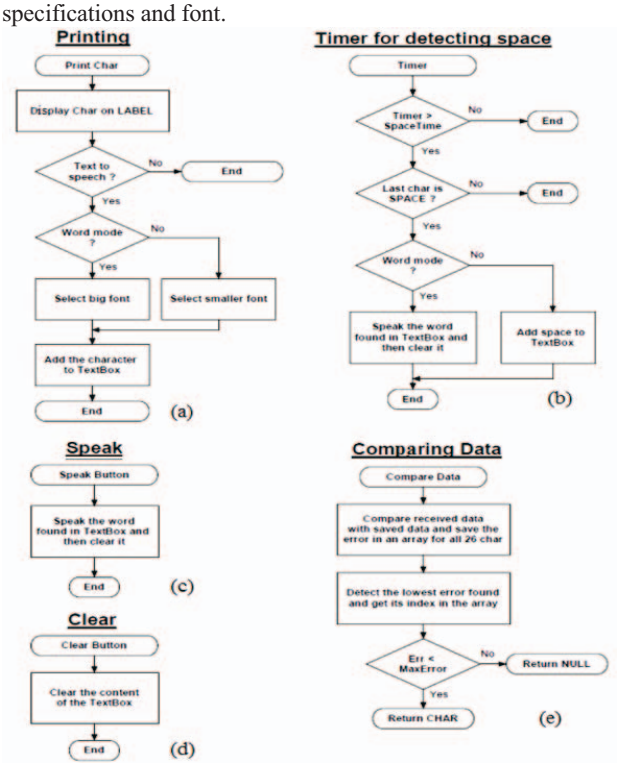

Fig.12. Android Application Flowchart (part 2)

The time for detecting a space is the time required for the user to do arbitrary movements, indicating a space and the end of a word. The application compares data with the letters already saved by the user on his/her smartphone application. Finally, the application has “speak and clear” buttons for manual operation as shown in Figure 13.

Fig.13. S2LV Android Application

This system achieved an average accuracy of about 96% when trying to display all letters and generate voice. Figure 14 shows the average accuracy values for each letter after many trials.

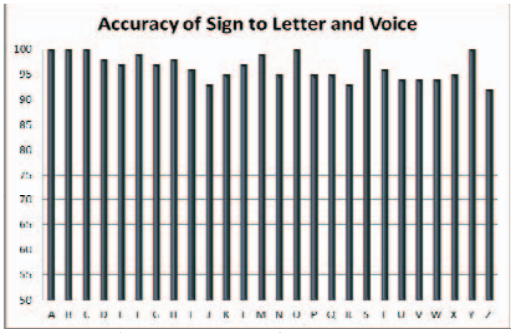

Fig.14. Accuracy of S2LV System

VI. Conclusion

In conclusion, the main purpose behind the previously described design is to come up with an innovative idea that can ease the communication of people having disabilities. The system succeeded to translate signs to letters, and then to generate a voice using a Smartphone.

Enhancing the proposed system is a future plan, and it can be done by first solving the problems encountered, and then by adding some extra features. For example, auto-correction can be achieved by adding a new gesture which will be designed to erase a wrong letter. Other gestures can be added to design commonly used phrases, or a point. The same system could be also implemented using other Alphabet (e.g. Arabic Alphabet) to accommodate different cultures.

References

[1] The World Federation of the Deaf (WFD), http://wfdeaf.org

[2] Kam David, "The Importance of Communication", Marketing Deviant - Marketing Business Strategies. N.p., 11 Jun 2009. Web. 5 Jan 2013. <http://marketingdeviant.com/the-importance-of-communication/>.

[3] Su-Jing Wang, De-Cai Zhang, Cheng-Cheng Jia, Na Zhang, Chun-Guang Zhou, Li-Biao Zhang, "A Sign Language Recognition Based on Tensor," Second International Conference on Multimedia and Information Technology (MMIT), vol.2, pp.192-195, 2010

[4] H. El Hayek, J. Nacouzi, A. Kassem, M. Hamad, S. El-Murr, "Sign to letter translator system using a hand glove," 2014 Third International Conference on e-Technologies and Networks for Development (ICeND), pp.146-150, 2014

[5] C. Rishikanth, H. Sekar, G. Rajagopal, R. Rajesh, V. Vijayaraghavan, "Low-cost intelligent gesture recognition engine for audio-vocally impaired individuals," 2014 IEEE Global Humanitarian Technology Conference (GHTC), pp.628,634, 10-13 Oct. 2014

[6] Y. Khambaty, R. Quintana, M. Shadaram, S. Nehal, M.A. Virk, W. Ahmed, G. Ahmedani, "Cost effective portable system for sign language gesture recognition," 2008 IEEE International Conference on System of Systems Engineering, SoSE '08, pp.1-6, 2008

[7] N. Praveen, N. Karanth, M.S. Megha, "Sign language interpreter using a smart glove," 2014 International Conference on Advances in Electronics, Computers and Communications (ICAECC), vol.1 , no.5, pp. 10-11, 2014

[8] The American Sign Language (ASL) Alphabet. And a description of (ASL) in Text, http://www.deafblind.com/asl.html