E-ISSN 2581 – 7957 CVR Journal of Science and Technology, Volume 21, December 2021
P-ISSN 2277 – 3916 DOI: 10.32377/cvrjst2113

A Novel Approach to Vocalize the Hand Gesture Movement for Speech Disabled

S. Harivardhagini
Professor, CVR College of Engineering / EIE Department, Hyderabad, India
Email: harivardhagini@cvr.ac.in

Abstract: **Mute People use sign language to communicate with each other. They face a problem to communicate with people who can hear and talk. Gesture Vocalizer is a device which reduces the barrier of communication between the mute community and the people not familiar with the concept of sign language, so that the messages that a mute person is trying to relay is understandable to a person with no knowledge of sign language. The aim of this paper is to show how a hand gesture vocalizer can be implemented using Proteus Software. This is a boon to people who suffer from MUTISM. Gesture vocalizer is a prototype made for a social purpose. We know that it is very difficult for deaf people to communicate with normal people. Deaf people communicate with hand gestures, and it is difficult for other people to understand their sign language. Gesture vocalizer is a device which detects the gestures of a deaf and mute person and displays the corresponding output on the virtual terminal. The main objective of this paper is to reduce the communication gap between communicative people and the mute community. It helps the mute community to be independent. A prototype is developed, and simulation is carried out using Flex sensors, an accelerometer, dynamic time warping, an Arduino Uno board, and an output device. The input to be converted is initiated through the Flex. This is given as input to Arduino. Using Dynamic Time Warping technique, a corresponding analog signal is generated and measured. This mapping is done using distance matrix. Later, optimal analog signal is converted into the digital signal. The Arduino module displays on android screen the digital equivalent of the flex and the gesture name associated with the digital value. The Bluetooth module on Arduino board gets connected to the android based mobile phone and converts the text into speech.**

Index Terms: **MUTISM, Gesture Vocalizer, Flex sensors, Dynamic Time Warping, Hand gesture vocalizer**

I. INTRODUCTION

Communication is the most basic and important form of interaction with anyone. Thus, for interfacing with deaf and dumb people, sign language or gestures are used. The mute people use their standard sign language which is not easily comprehensible by communicative people. Also, there is no standardized sign language defined across the world. The people who are having hearing and speaking inabilities are not able to work effectively with other people. Vocalizers convert the sign language into voice which is easily understandable by blind [9] and abled people. Gesture vocalizer is a device which is being designed to enable the communication around the dumb, deaf, and blind societies and their communication with abled people. The gesture Vocalizer project uses Flex sensors, Accelerometer, Arduino, and Bluetooth module to realize hand gestures [8],[10] and convert them to speech. The mute community use Sign Language for communication. A communication Gap exists between Communicative Person and them. Gesture vocalizer tries to reduce communication gap [11] between deaf people and hearing people. Deaf people make use of sign language or gestures to make understand what he/she is trying to say but it is impossible to understand by hearing people. Pablo Bonet paper [13] is considered the first modern treatise on phonetics and speech therapy, setting out a method of oral education for deaf children by means of the use of manual signs, in the form of a manual alphabet to improve communication with the deaf. It is suggested that Pedro Ponce de León developed the first manual alphabet from which Juan Pablo Bonet based his writings. This paper systematically reviews various efforts made in the Gesture Vocalization Design to strengthen its efficacy and exploitability. The review is made on nearly 30 research articles published in the leading journals of technology in the last 15 years. It also puts forth the architectural details of Gesture Vocalizer derived from literature. The articles are accessed by searching for articles with the keywords "Gesture Vocalizer", “American Sign Language”, “Flex Sensor” and “Accelerometer. According to the World Health Organization (WHO), 466 million people across the world have hearing loss (over 5% of the world’s population), of whom 34 million are children [12]. Statistics released by the United Nations also indicate that, in Egypt alone, 7.5 million people suffer from deafness or hearing impairment. Studies expect these numbers to rise to 900 million by 2050. There are about 137 sign languages [14]. American Sign Language (ASL) is a natural language that serves as the predominant sign language of Deaf communities [15] in the United States and most of Anglophone Canada.

II. LITREATURE SURVEY

P.Vijaylakshmi, M Aarthi [1] proposed “Sign language to speech conversion”. Flex sensor-based gesture recognition module is developed to recognize English alphabets and few words, and a Text-to Speech synthesizer based on HMM is built to convert the corresponding text. The number of gestures that can be converted to speech here is limited. Amiya Kumar Tripathy, Dipti Jadhav, S. A. Barreto, Daphne Rasquinha, Sonia S. Mathew [2] proposed "Voice for the Mute (VOM)" aims to develop a system that will take real time images and convert them to speech with text as an intermediate taking into considerations all the limitations observed by a 2D system. This paper considers only fingering spelling in our system i.e. Take input in the form of finger spelling of alphabetic signs and providing the resultant voice output. The system will be using a webcam for the input and processing of the signs will be done using Microsoft Visual Studio as an IDE and OpenCv modules. With this proposed system they aim to help the speech

Received on 01-10-2021, Revised on 15-10-2021, Accepted on 26-11-2021.

impaired community. V.Padmanabhan, M.Sornalatha [3] proposed ”Hand gesture recognition and voice conversion system for dumb people”. In this system, all templates are kept in database. For every action the motion sensors get accelerated and give the signal to the microcontroller. The microcontroller matches the motion with the database and produces the speech signal. The output of the system is using the speaker. Lam T Phil, Hung D. Nguyen2, T.T. Quyen Suil, Thang T. Vul [4] proposed:” A development of a glove-based gesture recognition system for Vietnamese sign language has been addressed and illustrated in this paper. Flex sensors and accelerometer have been used to sense curvature of the fingers and detect motion of the hand respectively. For American Sign Language in addition to flex and accelerometer, contact sensors have been used to detect any contact between two fingers.” Ashish Sethi Hemanth S, Kuldeep Kumar, Bhaskara Rao N, Krishnan R [5] proposed” SignPro- An Application Suite for Deaf and Dumb”. They have come up four different approaches based on the methods used for gesture extraction and matching. A Comparative study of these approaches is also carried out to rank them based on time efficiency and accuracy. Other features in the application include the voicing out of text and text to gesture conversion. In [6] Anagha J. Jadhav, Mandar P. Joshi proposed an embedded system module which consists of wearable sensing gloves along with flex sensors which are used to sense the motion of the fingers. The Indian sign language is used for determining the words. Flex sensors and accelerometer are used as sensor, these sensors are mounted on the gloves, the movement include the angle tilt, rotation and direction changes, these signals are processed by the microcontroller and playback voice is generated indicating signs through speaker. Jong-Sung Kim, Won Jang, Zeungnam Bien [7] present a system which recognizes the Korean sign language (KSL) and translates into a normal Korean text. A pair of data-gloves are used as the sensing device for detecting motions of hands and fingers. For efficient recognition of gestures and postures, a technique of efficient classification of motions is proposed and a fuzzy min-max neural network is adopted for on-line pattern recognition.

III. Block Diagram

Figure 1 shows the block diagram of the system. The block diagram consists of 3 layers: Data Access Layer, Business Logic Layer, User Interface Layer

A. The Data Access Layer

It consists of Flex sensors and accelerometers. The gesture is made by the user is sensed by the flex sensors and it is used to measure the amount of deflection. The accelerometer is used to measure acceleration in one to three linear axes (x, y, z).

B. The Business Logic Layer

It comprises of an Arduino. This is connected to the flex sensor and accelerometer which converts the movement based analog signals into digital signals.

C. The User Interface Layer

It consists of a Bluetooth module and an android device. The Bluetooth module is wireless, and it is used to exchange data between microcontroller (Arduino) and Mobile. The Android device is used which is connected via the bluetooth module to the arduino which generates the output in textual and audio format.

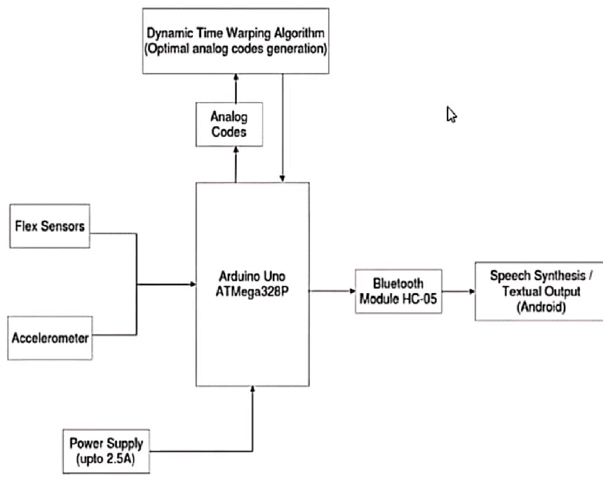

Figure 1. shows the block diagram of the system

III. The description of system

The whole system is targeted to identify the movement indicated by the person to communicate. Hence, once the flex movement is observed, it is given as input to Arduino. Using Dynamic Time Warping, optimal analog signal is measured for mapping the gesture correctly using distance matrix. Optimal analog signal is converted into the digital signal. The Arduino module displays on android screen the digital equivalent of the flex and the gesture name associated with the digital value. The Bluetooth module on Arduino board gets connected to the android based mobile phone and converts the text into speech. Figure 2 shows the schematic diagram of the system. it consists of five logic toggles, five flex sensors, 1 Arduino UNO, 1 HC-05 Bluetooth module and Virtual terminal. The logic toggle is used to give the input to flex sensors depending on the bending in the fingers. If there is a bend in the finger, then the value of the logic toggle is ONE else ZERO. The flex sensor has 3 terminals (GND, VCC AND OUT) which are connected as shown. The organization of the flex sensors are as follows. The right most flex sensor represents the thumb finger, next flex sensor represents the fore finger, the third flex sensor represents the middle finger, the fourth represents the ring finger and the last flex sensor represents the little finger. The connections are made in the Proteus software based on the schematic diagram. The code is written in the Arduino IDE software and dumped into the Arduino UNO after verification and compilation. Now the simulation is run in the Proteus software and the output is checked on the virtual terminal. Figure 3 shows the flowchart of the system.

E-ISSN 2581 – 7957
P-ISSN 2277 – 3916

DOI: 10.32377/cvrjst2113

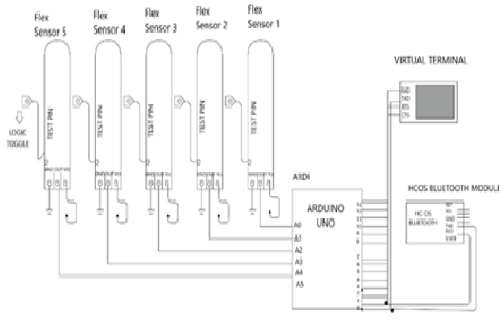

Figure 2. Schematic diagram of the system

The algorithm details are as follows:

1. Start
2. Set the baud rate
3. Input: For a gesture, sensor data inputs (5 flex sensors data and 3 axis accelerometer data) Flex Movement is observed, value=analogRead(flexPin);
4. Add delay of 10 milliseconds
5. Convert raw sensor data to meaningful data Using Dynamic Time warping, averaging value is calculated for mapping the gesture correctly.
6. The android app configured displays the digital equivalent of the flex.
7. The Bluetooth module on Arduino board gets connected to the android based mobile phone and converts the text into speech.
8. Go to step 3.

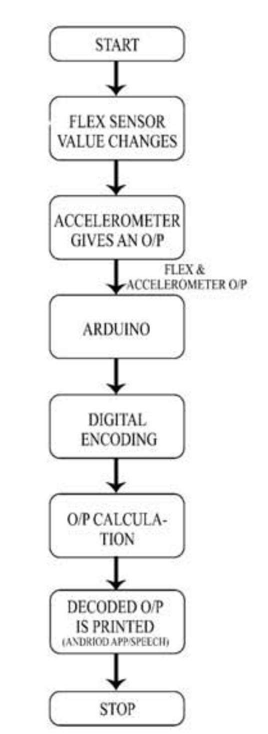

Figure 3. Flow chart of the system

IV. Results

To represent letter 'A' we need to bend all the fingers except the thumb finger. So, all inputs to the flex sensors as logic 1 except the right most flex sensor which represents the thumb finger. Now the output is visible on the virtual terminal as 'A'. Similarly, the outputs for other alphabets are obtained. Table 1 shown below depicts the mapping of respective inputs and the outputs obtained. Figure 4 and 5 show the results of simulations of letters S and C respectively. Figure 6. shows the complete simulation of the whole system.

TABLE I.
Outputs for Respective Inputs

FLEX SENSOR 5 *(Little finger)*	FLEX SENSOR 4 *(Ring finger)*	FLEX SENSOR 3 *(Middle finger)*	FLEX SENSOR 2 *(Fore finger)*	FLEX SENSOR 1 *(Thumb finger)*	OUTPUT ON VIRTUAL TERMINAL
1	1	1	1	0	a
0	0	0	0	1	b
1	1	1	1	0	c
1	1	1	0	1	d
0	0	0	1	1	f
1	1	1	0	1	g
0	1	1	1	1	i
1	1	1	0	0	l
1	0	0	0	1	u

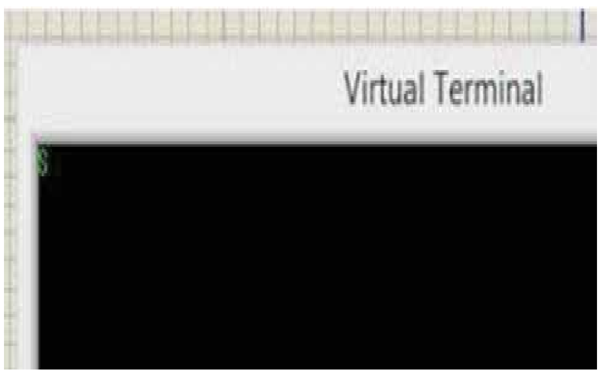

Figure 4. Letter 'S' at Simulation Virtual Terminal

CVR Journal of Science and Technology, Volume 21, December 2021
DOI: 10.32377/cvrjst2113

Figure 5. Letter 'C' at Simulation Virtual Terminal

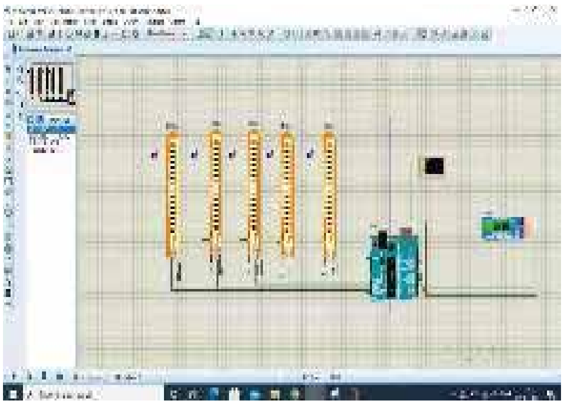

Figure 6. The simulation diagram of the whole system

Sign language is a useful way to ease communication between the deaf-mute community and abled people. However, there is a barrier between these communities with ordinary people where they must rely on human translators. In this paper, this technique is used to ease communication between deaf and dumb people. So, it is concluded that flex sensor based gesture recognition module is developed to recognize the English alphabets. Therefore, this system accurately converts the gestures to speech. The communication between mute people and other abled persons who are unfamiliar with the concept of sign language is possible only using gesture vocalizer device. Gesture vocalizer is a hand gesture based interface for facilitating communication among normal people and people with speech and hearing disabilities. The Gesture Vocalizer is a social initiative paper that helps bridge the communication gap between normal people and disabled people. The system can be easily implemented. The compact, portable design is its main advantage. It eliminates the need for having interpreter. Thus, this paper contributes to the upliftment of the deaf community and ensures that they also lead a life that is no different from the rest, thus breaking down the social stigmas which prevail in our society.

V. Conclusions

By introducing different languages, the flexibility is increased. Total 5 flex sensors are used so it increases the precision of the system. Upon addition of an accelerometer in collaboration with the flex sensors the wrist movement can be measured 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. By interfacing with voice assistants like Siri or Alexa voice outputs can be generated rather than the vocalizer 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. Developing a custom vocalizer module that can provide more number of voice outputs than the standard one available in the market while at the same time reduce the cost 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.

References

[1] P. Vijayalakshmi and M. Aarthi, "Sign language to speech conversion," 2016 International Conference on Recent Trends in Information Technology (ICRTIT), Chennai,2016,pp.1-6.doi: 0.1109/ICRTIT.2016.7569545

[2] A. K. Tripathy, D. Jadhav, S. A. Barreto, D. Rasquinha and S. S. Mathew, "Voice for the mute," 2015 International Conference on Technologies for Sustainable Development (ICTSD), Mumbai, 2015, pp. 1-6.doi: 10.1109/ICTSD.2015.7095846

[3] Padmanabhan, M.Sornalatha."Hand gesture recognition and voice conversion system for dumb people", International Journal of Scientific & Engineering Research, Volume 5, Issue 5, May-2014

[4] Lam T. Phil, Hung D. Nguyen2, T.T. Quyen Suil, Thang T. Vul. "A Glove-Based Gesture Recognition System for Vietnamese Sign Language", 2015 15th International Conference on Control, Automation and Systems (ICCAS), Busan, South Korea,2015

[5] Ashish Sethi, Hemanth S, Kuldeep Kumar, Bhaskara Rao N, Krishnan R IJCSET "SignPro-An Application Suite for Deaf and Dumb" , May 2012 Vol 2, Issue 5,1203-1206

[6] Anagha J. Jadhav, Mandar P. Joshi "AVR based embedded system for speech impaired people" , 2016 International Conference on Automatic Control and Dynamic Optimization Techniques (ICACDOT), Pune, India ,2017

[7] Jong-Sung Kim, Won Jang and Zeungnam Bien, "A dynamic gesture recognition system for the Korean sign language (KSL)," in IEEE Transactions on Systems, Man, and Cybernetics, Part B (Cybernetics),vol. 26, no. 2, pp. 354-359, April 1996.doi: 10.1109/3477.485888

[8] Abhinandan Das, Lavish Yadav, Mayank Singhal, Raman Sachan, Hemang Goyal, Keshav Taparia, Raghav Gulati, Ankit Singh, Gaurav Trivedi, "Smart glove for Sign Language communications", Accessibility to Digital World (ICADW) 2016 International Conference on, pp. 27-31, 2016.

[9] A. Cazan, R. Varbanescu, D. Popescu, "Algorithms and Techniques for Image to Sound Conversion for Helping the Visually Impaired People - Application Proposal", Systems Signals and Image Processing 2007 and 6th EURASIP Conference focused on Speech and Image Processing 14th International Workshop on Multimedia Communications and Services., pp. 471-474, 27–30 June 2007.

[10] S. Ahmed, "MAGIC GLOVES (Hand Gesture Recognition and Voice Conversion System for Differentially Able Dumb People)", Tech ExpoThe Global Summit. London, 2012.

[11] Paris, Damara Goff and Katrina R. Miller. "Wearables and People with Disabilities: Socio-Cultural and Vocational Implications." In Wearable Technology and Mobile Innovations for Next-Generation Education, ed. Janet Holland, 167-183 (2016) doi:10.4018/978-1-5225-0069-8.ch009.

[12] https://www.almentor.net/en/course/Raising_A_Competent_Deaf_Mute_Child1

[13] Pablo Bonet, J. de , "Reduction de las letras y Arte para enseñar á ablar los Mudos." Ed. Abarca de Angulo, Madrid, ejemplar facsímil accesible en la [1], online (Spanish) scan of book, held at University of Sevilla, Spain, (1620).

[14] Lewis, M. Paul; Simons, Gary F.; Fennig, Charles D., eds. (2013), "Deaf sign language", Ethnologue: Languages of the World (17th ed.), SIL International, archived from the original on 2013-11-26, retrieved 2013- 12-03

[15] Karen Nakamura, "About American Sign Language", Deaf Research Library, accesses since 1995, http://www.deaflibrary.org/asl.html