International Journal of Innovative Research in Engineering
Volume 4, Issue 3 (May-June 2023), PP: 302-306.
www.theijire.com ISSN No: 2582-8746

Smart Speaking Glove for Hospitalized Speech-Impaired People

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How to cite this paper:
Karrepu Sharath Chandra Reddy[1], Karanam Ravindra Nath[2], Chappidi Girithej Naidu[3], Aravindan M[4], "Smart Speaking Glove for Hospitalized Speech-Impaired People", IJIRE-V4I03-302-306.

Abstract: *In this article, we describe the development and deployment of a glove-to-sign language translator and wheelchair system, which utilizes flex sensors. The primary objective of this system is to assist individuals who are both speech-impaired and hospitalized, enabling them to communicate using sign language. The system is composed of a glove embedded with flex sensors, a microcontroller, a wireless communication module, and a wheelchair. The glove is designed to detect hand gestures used in sign language, and the microcontroller translates them into corresponding text or speech. In addition to the sign language translation feature, the system also allows users with mobility impairments to control their wheelchairs using hand gestures detected by the glove. The flex sensors detect the user's hand movements, which are then translated into commands for the wheelchair, such as moving forward, backward, or turning. Overall, the proposed system has the ability to improve the individuality of life for people with mobility impairments and hearing disabilities, providing them with greater independence and improved communication abilities.*

Key Word: *Speech Impaired, Hand Gestures, Flex Sensors, Wheelchair, Bluetooth.*

I.INTRODUCTION

Speech-impaired people with physical disabilities such as spinal cord injuries often face difficulties in everyday life, such as difficulty in moving and communicating on their own. Due to sickness, accident, or a condition requiring a wheelchair, some individuals have trouble walking. Wheelchairs come in a variety of styles and varieties. Manually controlled wheelchairs are propelled by handles, which require another person with us every time, but a few of them are managed by joysticks to control a wheelchair. But if you can't even move your wheelchair with a joystick or voice commands, a gesture-controlled wheelchair can be used. The wheelchair maneuvers in the required directions in response to the user's finger movements. Simply bending their fingers will allow users to maneuver the wheelchair by employing hand gestures to indicate a certain direction, this wheelchair can move without any problems. However, in order to resolve the communication barrier, there is an additional mode "gesture to Voice message" through which they can convey messages to normal people. Normally, people who are hospitalized and cannot speak use hand gestures to communicate. At the same time, we are trying to communicate using sign language to convey messages. Sign language is a visual form of communication used by deaf communities worldwide that does not rely on spoken words. This language is difficult to interpret because it has no common origin. Hand signals used in dumb communication need to be translated into speech by an interpreter. In sign language, gestures are precise hand motions made in a certain pattern. Hand movements convey messages to others. This Gesture recognition can also be done using image processing, but it has some drawbacks like complicated image and video processing and also some problems like background and other conditions should be taken care of. But Sensor-based technology is more simple than image processing. So, when using these two modes of operation of smart speaking gloves he/she doesn't have to wear two different devices for two different purposes, just to change working modes. The purpose of this research is to design a module with flexible sensors that control the direction of the wheelchair and give desired output audio.

II.RELATED WORK

The author describes the design and development process in detail, including the selection and integration of the various components, such as the sensor strip, microcontroller, and power source. They also present several examples of how the system can be used in real-world applications, such as controlling a robotic arm or navigating a wheelchair.[1]; This paper describes the system architecture, which includes the hand glove, a microcontroller, and wheelchair motors. They also describe the algorithms usedto map the hand movements to the wheelchair's motion, and the experimental results obtained from testing the system with a prototype wheelchair.[2]; The paper provides details on the design and development of the smart glove, including information on the hardware and software components used. The authors also describe the testing and evaluation of the device, which involved collecting data on hand gestures from a group of volunteers with varying levels of hearing and speech impairments.[3]; These related works demonstrate the potential of wearable technology in improving communication and mobility for individuals with disabilities and provide insights into the design and implementation of similar systems.

Procedure methodology

This part mostly covers the block diagram and the implementation:

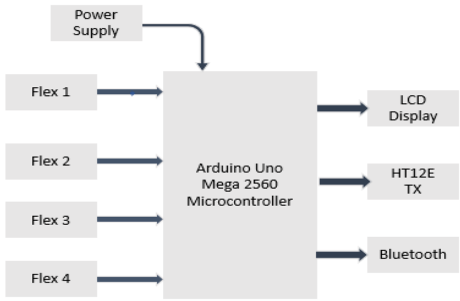

Fig 1.Block Diagram for speech messages

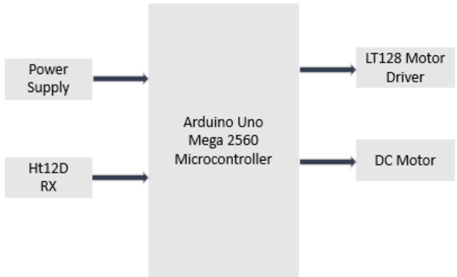

Fig 2. Block Diagram for Wheel chair Control Mode

The schematic diagram of the project is depicted in Figures 1 and 2. The flex sensors are affixed to the gloves, ensuring they can be donned and removed without disrupting sensor calibration. These sensors transmit analog signals to the Arduino, which then converts them into digital signals to facilitate mode recognition. The system boasts two modes of operation: Gesture-to-Voice Messaging and Gesture-to Wheelchair Control. Both modes can be controlled using a single integrated system.

Gesture Voice Messages– This mode of operation primarily focuses on facilitating gesture-based vocalization for individuals with speech impairments who face difficulty communicating with others. The glove functions based on hand gestures, which are detected by sensors attached to it that provide varying voltage levels corresponding to different finger movements. These sensor values are then read and transmitted to an Arduino, where the analog-to-digital conversion process takes place using the ADC ports. The resulting digital values are utilized in the decision-making process, with voice playback taking place via a mobile device connected to a Bluetooth module. Additionally, the message is displayed as a text message on an LCD screen. To switch modes of operation, predefined gestures must be used, enabling seamless transitions between modes.

Gesture to Wheelchair control – This method of operation pertains to the gesture-controlled mobility device for individuals with speech disabilities who are admitted to a hospital and have difficulty relocating. The mode of operation functions using a dual-component transmitter and receiver. Four flex sensors are implemented at the transmitter end, which transmit signals to the device, allowing the Automatic wheelchair to be steered in various directions based on the user's movements.

Algorithm:

1. Start the program: This initializes the program and sets up any necessary components. Initialize the microcontroller and the Bluetooth module: This initializes the microcontroller and sets up the Bluetooth module for communication with the wheelchair control unit.

2. Loop forever: This is the main loop of the program that runs continuously until the program is stopped.
   a. Read the input from the user to determine the mode to switch to: This reads the input from the user to determine whether to switch to sign language mode or wheelchair control mode.
   b. If the mode is Sign Language mode, go to step 3: If the user selects sign language mode, the program goes to the sign language mode section.
   c. If the mode is Wheelchair Control mode, go to step 4: If the user selects wheelchair control mode, the program goes to the wheelchair control mode section.

3. Sign Language mode: This section of the program is executed when the user selects sign language mode.
   a. Read the flex sensor values from the glove: This reads the values from the flex sensors in the glove.

b. Determine the finger positions based on the flex sensor values: This determines the position of each finger based on the values from the flex sensors.
c. Translate the finger positions into sign language gestures: This translates the finger positions into sign language gestures based on a predefined mapping.
d. Display the sign language messages on the Bluetooth-connected mobile: This displays the sign language messages on the smartphone screen through Bluetooth and gives voice output through mobile.
e. Go back to step 2: This returns the program to the main loop to wait for the user to select another mode.

4. Wheelchair Control mode: This section of the program is executed when the user selects wheelchair control mode.

5. a. Read the flex sensor values from the glove: This reads the values from the flex sensors in the glove.
   b. Determine the finger positions based on the flex sensor values.
   c. Translate the finger positions into commands for controlling the wheelchair.

6. Go back to step 2.

7. Stop the Program.

Components Used:

1. Flex Sensor (2.2 inch):

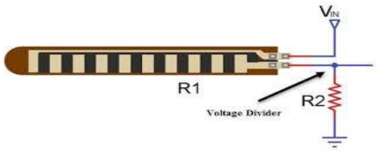

Fig 3. Flex Sensor

Flex sensors work by converting changes in deflection into electrical resistance, meaning that the resistance value increases as the deflection increases. These sensors are typically composed of thin, 1 to 5-inch strips that have varying resistance levels and can function as variable analog voltage dividers. Inside the sensor, there is a flexible carbonresistive element that is sensitive to changes in carbon concentration. As demonstrated in Figure 3, the resistance of the sensor decreases as the amount of carbon increases. When the sensor is bent, it produces an output of resistance that corresponds to the bend radius.

2. Arduino Uno mega 2560 Microcontroller:

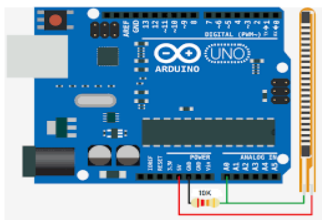

Fig 4. Circuit Board of an Arduino

The Arduino Uno is an accessible microcontroller board that operates using the ATmega328P chip and is open-source. It can be utilized for a variety of electronic projects, catering to both novices and experts. We have used two Arduino microcontrollers in the project.

3. L298 Motor Driver:

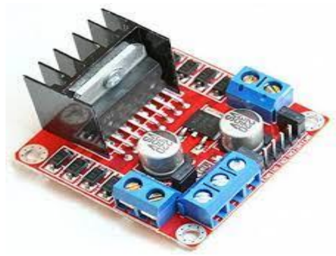

Fig 5. Circuit Board of Motor Driver

A microchip known as a motor driver, depicted in Figure 5, is utilized to control the movements of motors in independent robotic systems. The motor driver acts as an intermediary between the motors and the Arduino, enabling efficient control. These integrated circuits have been engineered to simultaneously regulate the operation of two DC motors.

4. DC Motor:

DC motors are a category of rotary electrical machines that convert electrical power from direct current into mechanical power. To regulate the movement of the wheelchair, a DC motor is employed. For the left and right directional movements, we utilized two DC motors.

III.RESULT

The Flex Sensors give values after bending them which are kept above the glove. By bending the index and middle finger the system enables the sign mode and after bending each finger it gives desired output through LCD and Bluetooth-connected device. And by bending another two fingers the mode will be converted to wheelchair mode and the person can control the wheelchair on their own.

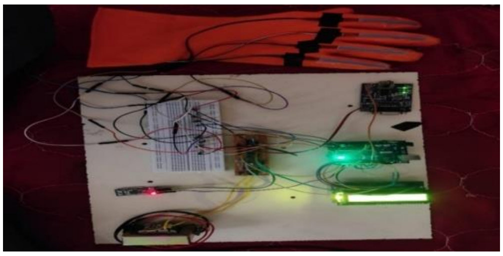

Fig 6. Main Board with a glove attached with flex sensors

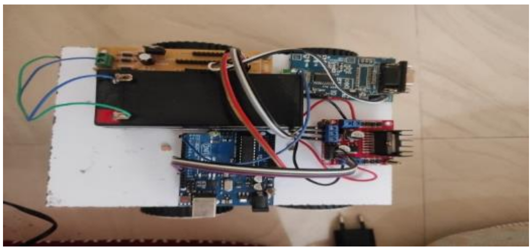

Fig 7. Wheelchair Robot model

By bending the Index finger and bending the middle finger it will be converted into sign Mode. By Bending the Ring finger and little finger it will be in wheelchair mode.

SL. No	GESTURE INPUT	OUTPUT
1		
2		
3		
4		

Fig 8.Results of a sign with a corresponding output message

1. Bending Index Finger: By bending the index finger in the sign mode the output will be "NEED WATER". And can move the wheelchair forward in Wheelchair mode.
2. Bending Middle Finger: By bending the Middle finger in the sign mode the output will be "NEED FOOD". And it can move the wheelchair backward in Wheelchair mode.
3. Bending Ring Finger: By bending the Ring finger in the sign mode the output will be "NEED MEDICINE". And you can move the wheelchair to the left side in Wheelchair mode.
4. Bending Little Finger: By bending the little finger in the sign mode the output will be "NEED HELP". And it can move the wheelchair on the Right side in Wheelchair mode.

IV.DISCUSSION

The use of flex sensor-based gloves for sign language recognition and wheelchair control can have a significant impact on the lives of individuals with communication and mobility impairments. By enabling more efficient communication and greater independence, these gloves have the potential to greatly improve the quality of life for users. One of the main advantages of using flex sensor-based gloves for sign language recognition is the ability to detect a wide range of hand gestures accurately and reliably. Additionally, the gloves can be customized to meet the specific needs and preferences of individual users, making the technology more accessible to a wider range of individuals.

Similarly, the use of flex sensor-based gloves for wheelchair control can greatly improve the mobility and independence of users. By detecting the movement of the user's hand, the gloves can be used to send signals to the wheelchair's control system, allowing the user to move the wheelchair in different directions and at varying speeds. This technology can be particularly useful for individuals who have limited mobility or who are unable to use traditional wheelchair controls. Despite the potential benefits of using flex sensor-based gloves for sign language recognition and wheelchair control, there are also some limitations and challenges to consider. These include ensuring that the gloves are accurate and reliable in detecting hand movements, providing adequate training and support for users, and addressing issues related to affordability and accessibility.

Overall, the results of using flex sensor-based gloves for sign language recognition and wheelchair control are promising, and the technology has the potential to greatly improve the lives of individuals with communication and mobility impairments. Continued research and development in this area is needed to further refine the technology and address any remaining challenges or limitations.

V.CONCLUSION

In Conclusion, the smart speaking glove project has the potential to revolutionize the lives of hospitalized speech-impaired people using hand gestures and wheelchair controls. By improving communication, increasing independence, improving healthcare, expanding our user base, and facilitating technological advancement, this project will have a far-reaching impact on people with disabilities and the healthcare industry at large. It is possible. Although many challenges remain, the potential benefits of this technology make it an exciting area for future research and development.

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