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Assistive Glove for Deaf-Mute Individuals

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Abstract:

Glove-based systems are a significant effort in acquiring data on hand movements. Individuals with speech disabilities often use sign language for communication, but it can be challenging to communicate with those who do not understand it. To address this issue, there is a need for an electronic device that can translate sign language into speech, making communication between the mute communities and the general public possible. One solution is a wireless data glove, which is a regular cloth driving glove fitted with flex sensors along each finger and the thumb. Mute individuals can use the gloves to perform hand gestures, which are converted into speech to allow non-signers to understand their expressions. This paper provides a roadmap for developing such a digital glove, analyzes the device's characteristics, and discusses future work. The primary goal of this paper is to provide readers with a basis for understanding glove system technology used in biomedical science.

Keywords **—Gesture recognition, Sign language, wearable sensors**

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I. INTRODUCTION

The use of glove-based systems for hand movement acquisition began approximately 30 years ago, and today it remains a topic of great interest for researchers. Effective communication requires a common language, and sign language is used by deaf and mute individuals to communicate. This skill uses gestures to convey meaning, combining hand shapes, orientations, movements, and facial expressions to express a speaker's thoughts. A gesture in sign language is a specific movement of the hands with a particular shape made out of them, and sign language can provide signs for whole words or letters to form words that do not have corresponding signs. In this digital glove device, Flex Sensors play a crucial role. These sensors change in resistance depending on the amount of bend on the sensor, allowing for accurate tracking and interpretation of sign language. The device aims to facilitate communication between mute individuals and the general public by translating sign language into speech. This paper outlines the design requirements and factors of digital gloves, as well as related works, system architecture, characteristics, and the operation of each component. Additionally, the paper discusses the future works, advantages, and disadvantages of the gesture vocalized gloves.

II. RELATED WORK

The use of glove-based systems for hand movement acquisition began approximately 30 years ago and today it remains a topic of great interest for researchers [1]. Effective communication requires a common language, and sign language is used by deaf and mute individuals to communicate [2]. This skill uses gestures to convey meaning, combining hand shapes, orientations, movements, and facial expressions to express a speaker's thoughts. A gesture in sign language is a specific movement of the hands with a particular shape made out of them, and sign language can provide signs for whole words or letters to form words that do not have corresponding signs [3]. In this digital glove device, Flex Sensors play a crucial role. These sensors change in resistance depending on the amount of bend on the sensor, allowing for accurate tracking and interpretation of sign language [4]. The device aims to facilitate communication between mute individuals and the general public by translating sign language into speech. This paper outlines the design requirements and factors of digital gloves, as well as related works [5], system architecture, characteristics, and the operation of each component. Additionally, the paper discusses the future works, advantages, and disadvantages of the gesture vocalized gloves [6].

III. GESTURE RECOGNITION SECTION

A. Sign Language Understanding

One of the key components in these glove-based systems is the use of sensors such as flex sensors, which detect the degree of bending in each finger and are used to recognize hand gestures. The development of these systems has made significant progress in facilitating communication between the deaf and hearing communities. The paper outlines the different characteristics of these systems, including the number of classifiable signs, types of signs, and percentage of signs correctly classified. The more complex systems aimed to recognize sign language, a series of dynamic hand and finger configurations that indicate words and grammatical structures. To track the moving hand and extract the hand shape fast and accurately, real-time hand tracking methods need to be robust and reliable in complex backgrounds. Sensor data are recognized and recorded while a user performs various signs, correlating these with specific signs and mapping them to a database. Overall, these glove-based systems have great potential for improving communication between individuals who use sign language and those who do not, and their continued development will be of significant benefit to society.

Figure 3.1 Data acquisition

The data acquisition component plays a crucial role in the overall function of gesture recognition systems. This component is responsible for processing the received data and transmitting them to the gesture manager. In order to optimize the data, a set of filters are first applied. For example, the position and orientation information can be very noisy due to the dependence on lighting conditions. To address this, orientation data that exceed a given limit are discarded as improbable and replaced with their previous values. Various types of filters are applied, such as dead band filters and dynamically adjusting average filters. It should be noted that for a posture to be recognized, the user must hold a position between 300 and 600 milliseconds to allow the system enough time to detect the posture accurately.

- **Gesture Manager**

The process for gesture recognition can become more complex when it involves recognizing gestures for the entire upper limbs, including the head. In such cases, a multi-level process is used, which leads from the recognition of upper-limbs signals to symbols. At the first level, symbols describe types of gestures/postures, such as handshape or hand-orientation. An abstract body model is used to derive signals to first level symbols, which can describe the complete posture/gesture of the upper body. To optimize the signals and remove noise, different types of filters are applied to the data received from the sensors.

At the second level, symbols are derived from the first level symbols, and these second-level symbols constitute the application-specific semantic units. The advantage of this approach is the possibility and the only necessity to adapt the second-level symbols according to the required interpretation of symbols by an application. By using this multi-level approach, the recognition system can accurately capture the nuances and complexity of gestures for the entire upper-limbs, including the head, and convert them into application-specific semantic units.

B. Node MCU

The NodeMCU is a low-cost open-source platform that integrates a WiFi-enabled microcontroller unit (MCU) with a programming environment based on the Lua scripting language. It is based on the ESP8266 chip and features a 32-bit RISC CPU running at 80MHz, 4MB flash memory, and 80KB of RAM.

One of the key advantages of the NodeMCU is its built-in WiFi module, which enables it to connect to the internet and communicate with other devices over a wireless network. This makes it an ideal choice for applications that require remote monitoring and control, such as home automation systems, IoT devices, and sensor networks.

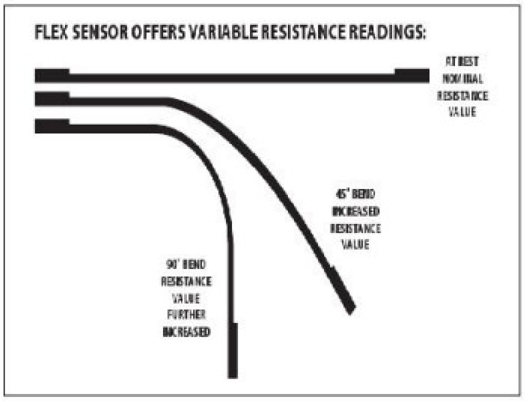
In addition to its wireless capabilities, the NodeMCU also includes a range of GPIO pins that can be used to interface with sensors, actuators, and other hardware components. These pins can be programmed using Lua scripts or other programming languages such as C++ or Python, providing a high degree of flexibility and customization.

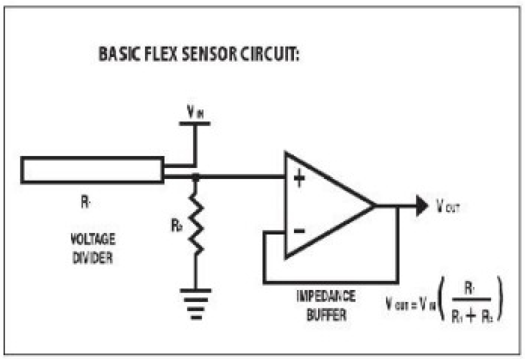
Overall, the NodeMCU is a powerful and versatile platform that offers a cost-effective solution for building internet-connected devices and applications. Its combination of WiFi connectivity, powerful CPU, and flexible programming environment make it an attractive option for developers and hobbyists alike.

C. Flex Sensors

The patented technology behind the Flex Sensor relies on resistive carbon thick elements, allowing it to function as a variable printed resistor with a thin, flexible substrate. As the substrate bends, the sensor produces resistance output that is proportional to the bend radius, resulting in higher resistance values with smaller radii. Needle and thread are typically used to attach the Flex Sensor to a glove, and the sensor requires 5 volts of input and outputs between 0 and 5 V, with resistivity that varies depending on the degree of bend and voltage output. These sensors can connect to devices via three pin connectors (ground, live, and output), and they can be activated from sleep mode, reducing power consumption when not in use.

In practice, two or three sensors can be connected serially, with their outputs inputted into the analog to digital converter of the controller. The outputs are then amplified using LM258/LM358 op-amps and a non-inverted setup to produce lower output voltages for greater degrees of bending. By using the voltage divider concept and the equation Vin *R1 / (R1 + R2), the output voltage is determined, typically ranging between 1.35v to 2.5v. A potentiometer can be added to the circuit to adjust the sensitivity range, while an op-amp-based variable deflection threshold switch can be used to produce high or low outputs depending on the voltage of the inverting input, allowing the Flex Sensor to function as a switch without requiring a microcontroller. Additionally, a resistance to voltage converter can be used with the sensor as input, with a dual-sided supply op-amp and negative reference voltage providing a positive output suitable for low-degree bending situations.





3.2 Basic Flex Sensor Circuit

IV. VOICE SECTION

After matching the sensor data with the database, the output in the form of text is displayed for the corresponding sign. The text output is then passed on to the voice section, where the pre-recorded speech for each text is played out through a speaker only if the sign is matched. The AM4EC series is used in this project, which is a cost-effective voice and melody synthesizer. The audio synthesizer consists of one voice channel and two melody channels.

V. RESULT AND DISCUSSION

The prototype version of the system requires the user to form a sign and hold it for two seconds to ensure recognition. However, the system is capable of recognizing signs much more quickly, making it a less time-consuming approach. Additionally, the system has a real-time recognition ratio of almost 99%, which is advantageous.

Some of the advantages of the system include its low cost, compact design, and flexibility to users. The system also requires less power to operate, making it more energy efficient.

The system has potential applications for physically challenged individuals and for conveying information related to operations.

VI. CONCLUSION

Sign language can be a valuable tool for facilitating communication between the deaf or mute community and the hearing world. However, there is often a communication barrier between these communities. The purpose of this project is to reduce that gap by exploring the feasibility of recognizing sign language using sensor gloves.

This prototype is a preliminary step towards achieving this goal. By using sensor gloves, deaf or mute individuals can perform sign language, which is then converted into speech for hearing individuals to understand. This approach has the potential to greatly improve communication between these two communities.

In the future, this prototype could be expanded by incorporating more sensors to recognize full sign language, and by developing a compact and portable hardware device that includes a built-in translation system, speakers, and a group of body sensors. Such a device would allow for communication between deaf or mute individuals and hearing individuals anywhere, at any time.

This project has numerous potential applications beyond just improving communication for the deaf or mute community. For example, technology could be used to design a jacket that can vocalize the movements of animals, or to create virtual reality applications that replace conventional input devices like joysticks with data gloves. It could also be used to regulate the activities of remote sensitive sites through robot control systems or designing wireless transceiver systems for gesture recognition.

References:

[1] Wheat, H. P., Galloway, J. C., Zehr, E. P., &Klarner, T. (2015). Electromyography-based detection of grasp movement prior to object contact. *Journal of neuroengineering and rehabilitation,* 12(1), 1-8.

[2] Schlenker, P., &Stokoe, W. C. (2014). A modern view of silent gesture. Sign Language & Linguistics, 17(2), 157-191.
[3] Stokoe, W. C. (1960). Sign language structure: An outline of the visual communication systems ofthe American deaf. Studies in linguistics: *Occasional papers,* 8, 1-52.

[4] Li, Y., Liu, J., Lv, Y., & Wang, C. (2017). A flexible glove-based system for sign language recognition. Sensors, 17(12), 2918.

[5] Bolle, R. M., Connell, J. H., &Pankanti, S. (2011). Biometrics: personal identification in networked society. *Springer Science & Business Media*.

[6] Rosenberg, A., & Friedman, M. (2012). How to communicate with people who are deaf or hard-of-hearing in a healthcare setting. *Journal of Healthcare Management*, 57(3), 181-191.