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MEMS BASED WEARABLE SMART-GLOVE AND ITS APPLICATION OF GESTURE DETECTION AND SIGN LANGUAGE CLASSIFICATION FOR VOCALLY IMPAIRED WITH INTEGRATED HEALTH MONITORING SYSTEM

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Abstract: Conversations between those who have trouble speaking and the normal person have always been a difficult task. Gestures and sign language are considered as the most natural expressive way for communications between dumb and normal people. By adopting tactics that involve glove-based hard of hearing correspondence systems, this smart glove will allow vocally handicapped persons to communicate with normal people using their sign language. Every glove contains a signal within. The gesture module adjusts the flex sensor and accelerometer resistance relative to each unique gesture. This device is controlled by a microcontroller that has been Python-programmed. The structure also incorporates a text-to-talk converter that converts the intended actions, such text-to-voice output through a speaker, and also outputs the same in the phone over Bluetooth. With automatic message notification to the concerned, this prototype also has features for health monitoring and detecting human body temperature and heart rate.

Keywords: Flex sensors, Bluetooth Device, micro-controller, Internet of Things, Health Monitoring, Raspberry Pico, LCD Display, APR 9600, Temperature Sensor, Heart Beat Sensor, Speaker, Analog to Digital Convertor, MEMS acceleration censors

I. INTRODUCTION

This project intends to lessen the communication barrier by facilitating communication between the dumb, deaf communities and their communication with the general public Making communication between the mute populations and the general public as simple as possible requires an electronic device that can translate sign language into audio and recognize handicapped motions. A Wireless data gloves, which look like regular fabric driving gloves but are equipped with accelerometers and flex sensors, are used. Non-mute persons can use the gloves to perform hand gestures that are then translated into speech and text output through a speaker and display in order to comprehend silent people's expression. This device also includes health monitoring sensors that let people with speech impairments alert people who are worried about changes in their health status. Gestures can be produced by any physical action or mental state, but they frequently start with the hand. The development of a system that can recognize particular human gestures and utilize them to communicate or transfer information is one of the main objectives of gesture recognition research.

The prototype goes so far as to use sensors for health monitoring to send a message to those who need to know about the user's health status The main advantages of this prototype are that the deaf and dumb people will have easy access to the glove at a reasonable price. The glove can recognize hand movements and translate gestures into popular formats. Both audio and visual content are created as the output. Integrated circuits are a plus the voice recorder and playback device APR 9600 single chip improves the speaker's audio output. A microphone amplifier, automatic gain control (AGC) circuits, an internal antialiasing filter, an integrated output amplifier, and message management are among the characteristics of the APR 9600. Based on the chosen sampling frequency, an inbuilt automated anti-aliasing filter modifies its reaction. The memory array saves the data using a combination of analogue read/write and sample and hold

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circuitry after signal processing. While incoming voice sounds are recorded using an 8-bit binary encoding technique In non-volatile flash memory cells, instantaneous voltage samples are kept. The recorded signals are replayed while being read from memory and smoothed to generate a steady signal level at the speaker.

The display unit focuses on converting the hand movements made into some sort of text form. On LCD, the text is displayed. The gesture detection module sends a signal to the LCD display module and the voice synthesis module as well. The LCD display module is made up of an LCD and a microcontroller. Each signal is analyzed by the LCD display module, which then compares it to previously saved values. Based on this comparison, the microcontroller determines what should be displayed, and after reaching that determination, it sends an eight-bit address to the LCD telling it what should be displayed. to overcome the limitations of vision-based techniques. Despite difficulties such as unexpected ambient optical noise, slower dynamic response, relatively large data collections/processing, and a balance between the accuracy of collect data and device cost, this project uses a micro inertial measurement unit to detect the accelerations of hand motions in three dimensions.

MEMS acceleration sensors are used to power the suggested recognition system. Because using gyroscopes would significantly increase the amount of computing required, our system now only detects motion using MEMS accelerometers. Displays the MEMS sensor-based design of the proposed gesture recognition system. The sensing gadget detects three acceleration directions. For each of the three axes of acceleration, our sensing system produces an analogue reading. The controller's lookup database was filled with the acceleration values for the motions. Values for all three dimensions of each incoming gesture are compared to their corresponding value in the table. The margin of error between the signal values on each axis and the values that were previously stored. There will be a distinct set of orders for each gesture delivered to each voice chip channel.

When the incoming acceleration value corresponds to the previously recorded value, the instruction is displayed and the corresponding channel is enabled. Since the voice chip's signal is so weak (only 5), it will be amplified before being played through the speaker. When a motion being identified matches one of the gestures already being gathered, one of the eight channels in the speech chip will instantly turn on. Similar information can likewise be broadcast through speakers using the APR9600 speech chip. Voice chips with 8 channels. As a result of the method's foundation on general acceleration values from gesture motion analysis, it cannot be customized for specific users. As a result, there is no need for user training prior to use. The user's mobile phone's Bluetooth module delivers the same outcomes. A notification is delivered to the subject when the value of a sensor, such as a temperature or heart rate sensor, reaches a predetermined threshold.

II. LITERATURE SURVEY

A. Deep learning and computer vision:

Sign language is a means of communication for those who have difficulty hearing or speaking. People in sign language use nonverbal movements to convey their ideas and emotions. However, it is exceedingly challenging for non-signers to comprehend, so skilled sign language interpreters are needed during training sessions as well as meetings for legal, medical, and educational purposes. Over the preceding five years, there has been an increase in demand for translation services. There are now more options, like high-speed video with distant human interpretation. As a result, they will provide a solution that is straightforward to implement but has significant problems with sign language interpretation. To address this, we use an ensemble of two models to recognize sign language gestures.

We make advantage of a unique dataset for American Sign Language for video data motions to train the system to recognize American Sign Language. The dataset contains a variety of motions that were done repeatedly under various video and context situations. For convenience of usage, the movies are being captured at a standard frame rate. We recommend extracting spatial information for Sign Language Recognition from the video stream using the CNN (Convolutional Neural Network) model Inception (SLR). Then, using the outputs from the CNN's Softmax and Pool layers, respectively, we can extract temporal information from the video sequences using an LSTM and an RNN model.

B. Cooperative sequential hand gesture recognition:

Natural language processing, computer vision, and other quickly evolving technologies that are transforming our lives have given rise to artificial intelligence (AI), which has gained prominence recently. Human hands are essential for communication and HCI, hence HGR or hand gesture recognition is a key area of study. HGR is now a very active study field in CV since it largely relies on image processing and vision-based hardware However, conventional vision-based HGR methods have drawbacks and can be influenced by varying conditions and dense backgrounds. A unique wearable

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device that combines a smart glove with a pressure sensor array and the MYO armband with inertial measurement unit (IMU) and electromyography (EMG) sensors been developed to get around these problems. has been described. Each finger's pressure distribution data can be obtained from the pressure sensor array and utilized in a classification algorithm to identify successive hand movements. For the categorization task, the system also applies deep learning techniques, which have been successful in a number of applications. The wearable system was tested using a dataset of 50 test subjects using ten different hand gestures, and the overall accuracy was 92.86%. With the potential to be employed in a range of applications, this system offers a potential replacement for current vision-based HGR methods in areas like sign language recognition and human-computer interaction.

C. An effective glove-based gesture recognition system using wireless multi-channel capacitive sensors and AI:

In this study, a smart glove equipped with sensors was used to grasp and differentiate between 26 different objects. When several sensors were utilized, it was found that the gadget could detect the physical world and do increasingly difficult challenges. The current generation of smart glove prototypes' utility is constrained since they occasionally either do not support wireless communication or do not have the required sensor interface circuits.

This paper proposes a hardware-software technique for 16-channel capacitive pressure sensing and gesture recognition utilising a Raspberry Pi device that is both efficient and effective. The multi-channel inputs are recorded using the code-modulated data approach, enabling effective machine learning algorithms at the edge without the need for additional wireless receivers or the addition of delay-causing server decision-making procedures. This method's usefulness is examined in light of experimental results and machine learning strategies.

D. Soft wrist-worn multi- functional sensor array for real-time hand gesture recognition:

Hand gesture detection is a key technology for a variety of purposes, such as virtual and augmented reality, upper extremity rehabilitation, and user interfaces for machines. One method to achieve long-term hand gesture recognition is to use wearable technology with sensors including pressure, inertial measuring units (IMU), strain, and acceleration sensors, as well as electromyography (EMG). A smart bracelet based on EMG and IMU data and a collaborative computing framework using multi-sensor data fusion in body sensor networks are commercial solutions for hand gesture identification and human-robot interaction (BSNs). However, due to incompatible properties at the interface between the device and the skin, typical sensors might be uncomfortable when worn for a long time.

Researchers have created soft electronics that are highly stretchable and flexible to solve this issue and provide continuous hand motion detection. Examples of these soft electronics include soft wrist worn sensor systems (SWSS) for the recognition of hand gestures and for epidermal electronics capable of controlling the motion of a four-rotor aircraft. The SWSS is worn on the back of the wrist for increased comfort and makes use of soft conductive polymer-based EMG, strain, and pressure sensors. Support vector machine (SVM) and linear discriminant analysis (LDA) approaches can be used to construct a recognition framework based on the SWSS and evaluate the performance of the system.

E. Wearable Bio sensing Gloves:

A vital technology for a variety of applications, such as augmented and virtual reality, upper extremity rehabilitation, and human-machine interfaces, is hand gesture detection. Wearable technology using sensors such as electromyography (EMG), pressure, inertial measurement units (IMU), strain, and acceleration sensors can be used for long-term hand gesture recognition. A smart bracelet based on EMG and IMU data and a collaborative computing framework utilizing multisensory data fusion in body sensor networks are two commercially available approaches for hand gesture detection and human-robot interaction (BSNs).

However, traditional sensors can cause discomfort when worn for extended periods due to mismatched qualities between the hard device and the soft skin. To solve this problem, scientists have created soft electronics that are incredibly elastic and pliable, much like skin, and can continuously detect hand gestures. Epidermal electronics, which can be used to control a four-rotor helicopter's movements, and a SWSS for hand gesture recognition are two examples of these soft electronics. The SWSS uses soft conductive polymer-based EMG, strain, and pressure sensors and is worn on the wrist's rear for increased comfort. The performance of the system can be evaluated after developing a recognition framework based on the SWSS.

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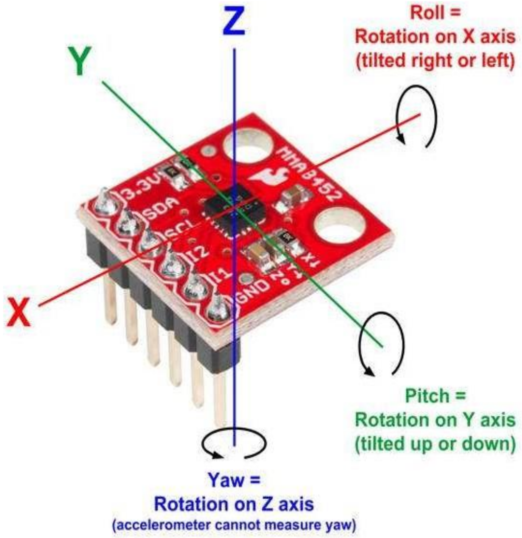
III. EXISITING SYSTEM

The most usual way of communicating with the vocally impaired is by using basic hand gestures. The existing system for smart gloves for the vocally impaired typically consists of a pair of gloves equipped with sensors and electronics that can detect hand gestures and finger movements. These gestures and movements are then translated into speech or text through a connected device, such as a smartphone or computer. The user can select from a variety of pre-Programmed phrases or create their own custom phrases to be used in communication. The smart gloves may also Include haptic feedback, allowing the user to feel when a gesture has been recognized and translated. The goal of this system is to provide a more intuitive and efficient method of communication for individuals who are unable to speak or have difficulty speaking.

IV. PROPOSED SYSTEM

The proposed system includes a Raspberry Pico as the central processing unit, which is a small and powerful microcontroller that can handle the data processing and communication tasks required by the system. The Raspberry Pico can communicate with the system's different sensors and electronics thanks to a variety of inputs and outputs, including GPIO (general-purpose input/output) pins. The suggested system contains an APR (Automatic Packet Reporting) module for wireless connection in addition to the Raspberry Pico. The gloves may communicate with a smartphone or computer using the APR module and transfer the data gathered by the sensors in real-time. This enables the user to communicate with others using the smart gloves, as well as access any additional features or functions that may be provided by the connected device.

The proposed system also includes an LED (light-emitting diode) to provide visual feedback to the user. The LED can be utilized to signal when a gesture or movement has been identified and understood, giving the user confidence in the effectiveness of their communication. The suggested system comprises a variety of sensors in addition to these essential parts to increase its functionality and adaptability. These sensors include accelerometers, flex sensors, an analog to digital converter module, a temperature sensor, and a heartbeat sensor. The accelerometers are devices that measure acceleration and orientation, and can be used to detect more precise hand gestures and movements. This allows the user to communicate more effectively and accurately, as well as potentially have other applications such as gaming or virtual reality.



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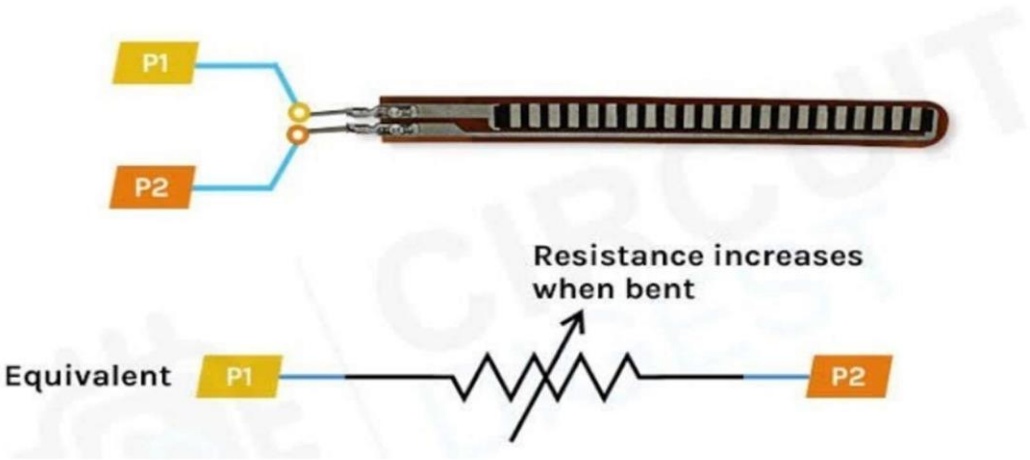

The flex sensors are devices that can detect the bending of the fingers and can be used to trigger different phrases or commands. This allows the user to communicate a wider range of phrases and messages, as well as potentially have other applications such as controlling devices or interacting with virtual objects. The analog to digital converter module allows for the integration of analog sensors into the digital system. This enables the use of a wider range of sensors, including those that measure temperature or pulse rate, and allows for the collection of more diverse and detailed data. The temperature sensor can detect the temperature of the user's skin, which may be useful in detecting fever or other changes in body temperature. This information could be used for monitoring the user's health or for alerting the user to potential medical issues. Finally, the heartbeat sensor can detect the user's pulse rate, which can be used for monitoring the user's health or detecting changes in stress levels or other emotional states. Overall, the proposed system for smart gloves for the vocally impaired is a highly advanced and comprehensive system that provides a wide range of features and capabilities. With its various sensors and electronics, it is designed to enable users to communicate more effectively and efficiently, as well as potentially have other applications beyond just communication for the vocally impaired

V. CONCLUSION

For people who cannot talk or have trouble communicating, such as those who are deaf or mute, the suggested smart glove system is intended to provide a more intuitive and effective form of communication. The gloves are equipped with sensors and electronics that can detect hand gestures and finger movements and translate them into speech or text through a connected device, such as a smartphone or computer. With the use of this technology, the communication gap between the deaf or mute population and the general public might be greatly minimized, allowing members of these communities to engage with others more successfully and easily. The proposed technology may offer additional advantages to the deaf and mute people in addition to serving as a tool for communication. For example, the system may be able to monitor unusual health issues and provide emergency care person indications, helping to ensure that individuals in these communities receive timely and appropriate medical care. To ensure that the smart gloves are accessible to as many people as possible, they are designed to be easy to use and are constructed in such a way that anyone can wear and use them. The Raspberry Pico, which acts as the system's central processing unit, is also user- friendly and easily configurable without requiring a complete rewrite of the software code. The suggested system's ability to be used as an independent system in daily life is one of its main selling factors. It is not reliant on any specific hardware or software, making it very versatile and able to meet a variety of requirements. Overall, the proposed system for smart gloves for the vocally impaired has the potential to greatly benefit the deaf and mute community, as well as anyone else who may have difficulty speaking or communicating. By providing a more intuitive and efficient method of communication, it has the potential to significantly lower the communication gap between these communities and the general public, and may also have other benefits such as providing emergency carrier indications and monitoring unusual health issues.

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The blind and illiterate will benefit from this endeavor. to improve communication between the general public and the deaf or silent, this hand gesture detection and speech converter technology is being developed. This prototype can assist in tracking unusual health issues and emergency situations. A benefit to the community of the deaf and the dumb is carrier notification. The glove will be thoughtfully designed to be user-friendly for everyone, and Raspberry Pico will be created to allow for simple configuration setting changes without rewriting the complete programed code. The project's main selling point is its independent gesture recognizer, which may be used in everyday situations.

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