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AI-POWERED IoT BASED SMART GLOVES FOR SIGN LANGUAGE RECOGNITION

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ABSTRACT- Many different kinds of human-computer and human-robot interactions may benefit from the clever and practical answer that is the ability to capture and recognize hand and arm motions (HRI). Human gestures are a powerful means of interpersonal communication, and they also provide a natural and efficient means of interaction between people and technology. The novel approach to real-time capture and detection of static and dynamic human gestures is shown in this study. This system measures data through strain sensors embedded in elastic gloves with ten sensors and stretchable bands with three sensors that measure strain. These sensors should be fitted to specific joints of the human arm and hand to measure exact motion characteristics in the shoulder joint as well as elbow and wrist joints and proximal and metacarpal fingers. This research presents a new method that uses a radial basis function neural network (RBFNN) to detect and capture both static and moving human gestures in real-time. By comparing the real-world data to a library of reference patterns that have already been collected, dynamic temporal warping (DTW) helps find potential candidates for dynamic behaviors and makes gesture detection easier. The technique works well with both stationary and moving motions and with several joints in the target region.

Experiments including the recording and identification of both static and moving human hand and arm movements corroborate the efficacy of the suggested methods.

1.INTRODUCTION

The computer science subfield of language technology with the name "gesture recognition" aims to decode human gestures through mathematical algorithms. Gestures that most commonly start in facial or hand expressions can begin from any body movement or posture. Computer science advances have concentrated on detecting emotional indicators through facial expressions and hand movements. Users operate gadgets through fundamental hand gestures without physical touch. Researchers have developed many approaches for sign language interpretation using cameras and computer vision algorithms.Gesture recognition techniques also include methods for identifying human actions, proxemics, gait, and posture. Although graphical user interfaces (GUIs) and basic text user interfaces (UTIs) still mainly allow input through keyboard and mouse interactions, gesture recognition helps computers start to understand human body language, which forms a more comprehensive connection between humans and machines. Thanks to gesture recognition, you can just point your finger and the screen will reply accordingly. This has the potential to make the need for conventional device input methods obsolete. The main objective of developing a system to recognize hand gestures is to enable a more natural interface between people and computers. This will allow for the control of robots or the transmission of important information via recognized gestures. One perceived difficulty in gesture interaction is the development of recognized hand motions that computers can successfully understand and interpret. The field that studies how people interact with computers, known as human-computer interaction (HCI) or man-machine interaction (MMI), stresses that computers only have value when people use them correctly. When developing an HCI system, it is essential to keep usability and functionality in mind. While usability describes how well and efficiently a system can carry out certain activities for users, system functionality describes the breadth of services and functions offered by the system. A sturdy and highly performing system is one that manages to keep these two aspects in check. Humans and robots can communicate using gestures, and those who use sign language can communicate with one another.

1.1 Wireless sensor network

Networks of autonomous sensors dispersed across space that collectively send data about a wide range of physical and environmental variables (e.g., temperature, sound level, pressure, etc.) to a command center are known as wireless sensor networks (WSN) or wireless sensor and actuator networks (WSAN). Modern networks provide two-way communication, which enables the management of sensor operations. Although military applications like battlefield surveillance were the primary impetus for the creation of wireless sensor networks, similar networks are currently used in many consumer and industrial areas, for example, to monitor industrial processes and evaluate the health of machines. Typically, a WSN consists of "nodes," which may be anything from a handful to hundreds—or even thousands—of nodes, each of which is linked to a sensor or sensors. A radio transceiver—either built-in or with an external antenna connection—, a microcontroller—the brains of the operation—and a power source—typically a battery or an energy harvesting system—make up each sensor node. While completely working "motes" at microscopic sizes have not yet been produced, sensor node diameters may range from that of a shoebox to a grain of dust. Depending on the complexity of each node, the expenditures related to sensor networks may also vary substantially, ranging from a few dollars to several hundred. Sensor nodes are constrained in size and price, which in turn limits their access to resources like memory, processing speed, energy, and communication bandwidth. Wireless sensor networks (WSNs) might have a simple star configuration or a sophisticated multi-hop wireless mesh network. Both routing and flooding approaches are available for usage in the network's method of propagation. Hospital emergency departments have been consolidated into centralized units that oversee large geographic areas due to various government initiatives. Although this improves medical treatment generally, those living distant from these hubs may have longer wait times when they need to go to the site of an accident. There is a correlation between the ratio of fatalities to severe injuries and the amount of time it takes for ambulances to arrive, according to Brown's research. Counties with lower population densities had higher death rates, according to this research, which further suggests that longer reaction times lead to poorer results. Fewer reaction times are associated with decreased death rates, according to a plethora of supplementary investigations. Accurately detecting the position and state of a vehicle is the main goal of automotive trajectory monitoring systems. Also, since our country's emergency services aren't up to par, the growing number of cars on the road has raised the stakes for drivers and passengers alike. This system's architecture allows it to detect accidents much faster and provide crucial data to emergency personnel in a matter of seconds. This data includes the exact location, time, and angle at which a car collision happened. The timely sending of this notice to the rescue squad helps to save priceless lives. These systems combine many hybrid approaches, including embedded applications, wireless connectivity, and GPS. A system that uses GSM and GPS to automatically detect and report accidents is one example: Lately, traffic has emerged as a major problem on a nationwide scale. The usual long reaction times needed to get suitable treatment that may have been accessible if warned immediately are a major contributing factor to the loss of life in accidents. If our proposal is put into action, the reaction time to an accident might be significantly reduced. In the case of road accidents, when every second counts, this platform is specifically built for emergency rescue operations, and it works to its full potential to reduce the important reaction time of rescuers. Our project's goal is to implement a system that can detect accidents automatically and alert people when one has occurred using GSM/GPS technology, including important facts like the exact time and place of the event. Connecting a command center with the devices installed in cars is the primary goal of this project. The cars will be outfitted with tracking devices that can be tracked in real-time over cellular networks, thanks to GPS and GSM capabilities. By analyzing waveforms from a vibration sensor, the software incorporated within the microcontroller will handle the various activities of the gadget. In the event that the device detects an accident, it will communicate with the control station over the GSM network, sending an alarm message and the position data obtained from the GPS module. When it comes to rescue efforts after accidents, this is a thorough and effective solution. The accident reporting system will identify traffic incidents automatically, find the scene, and transmit basic information to the rescue agency, such as the exact location, date, and circumstances of the accident. The prototypes are constantly sending real-time accident data to a database, which a control function on the server side is constantly retrieving and saving. A reliable and space-saving solution, our system combines state-of-the-art hardware design with state-of-the-art control technology.

2. LITERATURES SURVEY

2.1 Stretchable e-Skin Patch for Gesture Recognition on the Back of the Hand.

A number of emerging academic and business domains, like augmented and virtual reality, rely heavily on gesture detection for user-computer interaction. Attaching sensors to the forearm, wrist, or finger joints is a common practice in many existing systems; nonetheless, this may be an annoyance and restricts natural feeling and mobility. This research introduces a novel approach to hand gesture recognition by monitoring skin strain using a network of soft sensors positioned on the palm and back of the hand. For the first trial, a high-precision camera system was used to record skin strain patterns that corresponded to specific finger movements, and 40 little 2.5 mm reflective markers were placed on the back of the hand. A prototype of an elastic e-skin patch has its strain sensors arranged in the most effective spots. The stretchy e-skin patch was put through its paces in an experimental setting to see how well it could recognize ASL signals for the numerals 0–9 and individual finger movements. Results showed a classification accuracy of 94.4% for the numerals 0–9 in American Sign Language and 95.3% for finger movements. The findings demonstrate that a stretchy e-skin patch applied to the back of the hand may be used for gesture detection and show how it might enhance human-computer interaction.

2.2 Using Wearable Sensors to Capture Posture of the Human Lumbar Spine in Competitive Swimming. Zhelong Wang , Senior Member, IEEE, Jiaxin Wang , Hongyu Zhao , Sen Qiu , Jie Li , Fengshan Gao, and Xin Shi

An exciting new direction for swimmer training is motion capture using wearing inertial sensors. We provide a method for evaluating swimming movements using inertial motion capture technology as a means to efficiently apply motion capture methodologies. Using a human biomechanical model and a multisensory data fusion technique, our approach estimates the swimmers' orientation and reconstructs their swimming posture. Also, when compared to the NDI motion tracking system, our motion capture technology is more accurate and reliable, with well-managed estimate errors. In addition, the accuracy of the orientation estimate technique ranges from 1.65° to 3.66°. Over four different types of competitive swimming, the system may follow the lumbar spine of the athletes. The lumbar spine motions of the swimmers show clear patterns, according to a kinematic study.

2.3 Orientation Independent Activity/Gesture Recognition Using Wearable Motion Sensors Jian Wu, Student Member, IEEE and Roozbeh Jafari, Senior Member, IEEE

The recognition of activities and gestures utilizing wearable motion sensors, commonly referred to as inertial measurement units (IMUs), plays a vital role in various sensing applications that are widespread. The development of algorithms for activity and gesture recognition usually relies on knowledge of the IMUs' placement and orientation on the body, with signal processing often crafted to accommodate specific sensor orientations and placements. Nevertheless, the sensors might be utilized or held in different ways. As a result, the performance of signal processing algorithms might fall short of expectations. In this study, we introduce an approach for activity and gesture recognition that is independent of orientation by investigating a unique feature set that operates regardless of the sensor's orientation. To improve recognition accuracy, a method for honing templates is proposed that finds the most representative part of each motion. Two applications: recognizing hand gestures and everyday living activities—are used to evaluate our technique. In subject-dependent testing of everyday activities, our technique obtains an average accuracy of 98.2%; in testing of gestures, it achieves an average accuracy of 95.6%.

3. EXISTING SYSTEM

Hearing aids cannot completely restore hearing loss; they serve to enhance the audibility of sounds. The most prevalent type of hearing loss prompting individuals to seek hearing aids is sensor neural, which occurs due to damage to the cochlea's hair cells and the auditory nerve's synapses. For those who have trouble hearing, a hearing aid may help make sounds more audible. Hearing aids are governed by specific laws in most countries since they are considered medical equipment. It is not appropriate to call simple audio amplifiers, such as PSAPs or basic sound reinforcement systems, "hearing aids."

The original purpose of ear trumpets and horns was to passively amplify sound by collecting and directing sound waves into the ear canal. Modern technology relies on electroacoustic technologies that are founded on concepts of audiometry and cognition to improve the audibility of external noises. Modern technology uses sophisticated digital signal processing to make users' voices more audible and comfortable. Handling feedback, decreasing noise, guiding sound, lowering frequencies, and compressing large dynamic ranges are all part of this signal processing.

These days, a person's hearing loss, anatomy, and way of life all need to be taken into account when customizing a hearing aid. Customization of a hearing aid is done by programming it by frequency and using the most recent audiogram as a basis. The procedure of adjusting, or "fitting," is carried out by a hearing instrument specialist or a doctor of audiology. A well-fitting hearing aid may significantly increase the device's usefulness. In America, computerized hearing aids are almost ubiquitous. Some devices that function similarly to hearing aids include cochlear implants and the Osseo integrated auditory prosthesis, which was once known as the bone-anchored hearing aid.

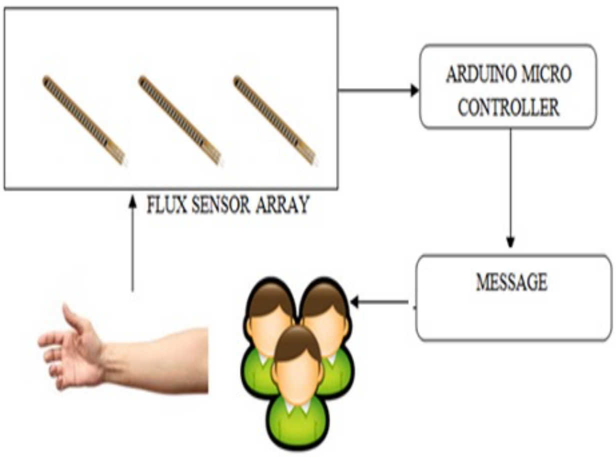
4. PROPOSED SYSTEM

The proposed system creates an effective communication link between hearing individuals and those who are deaf-mute by utilizing a gesture recognition framework. This system uses visual sensors and a flux sensor to identify human movements, such as hand and finger gestures, which are then decoded and translated into understandable signals. Users obtain clear communication through an established set of bodily and hand gestures.

An Arduino Uno unit serves as the central processor between external sensors to detect and decode bodily movements. The flux sensor detects hand and finger motion-generated magnetic fields which improve gesture recognition accuracy. These collected gestures move through an external application that converts them into either text or spoken words for quick communication. Cloud-based systems allow users to participate in remote communication without physical boundaries affirming access to digital spaces for everyone.

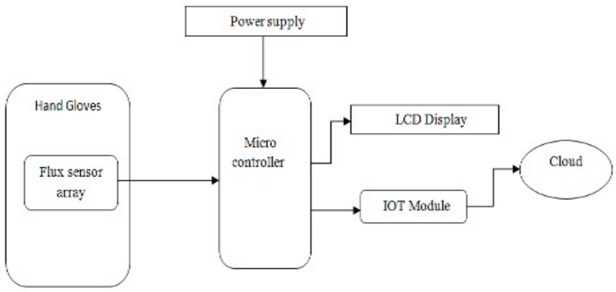
Through this system people with hearing and speech challenges can connect to others quickly while receiving real-time solutions for their communication requirements. The system could improve in the future through machine learning techniques for more advanced gesture detection while expanding its language capabilities across multiple communication platforms.

A new programming technique uses visual sensors to detect human motions for enhancing the programming process. A clearly defined gestural system enables fingers to execute various directional movements and activities through the hand and body. An outside system functions as an interface to connect people with hearing abilities to those who cannot hear or speak. Through cloud technology hearing individuals and those who are deaf operate in a digital setting.



This system integrates hardware with software programs which enable real-time sign gesture interpretation for spoken communication between hearing individuals and deaf-mute individuals. A visual sensor including camera or Kinect or IR sensor functions together with a flux sensor to precisely record hand movements and finger gestures. An Arduino Uno functions as the central processing device by receiving sensor data for interpretation then sends this data to a controller software that generates written or spoken outputs from the detected gestures. The system uses ESP8266/HC-05 wireless communication protocols together with a display screen and speaker unit to provide real-time feedback. The gesture recognition software uses sensor inputs to detect and remove noise before achieving exact precision measurements. The Arduino code written in C/C++ checks sensor data through UART/I2C/SPI communication protocols before transmitting it to the controller application using the Arduino IDE. A Python or PHP-based controller application translates gesture data into visible outputs which then connect to remote IoT platforms such as Firebase AWS or Thingspeak. The system functions by first capturing gestures then using sensors and an Arduino for processing the data which gets translated into text or speech outputs for complete communication.

Block diagram



Advantages
- Cloud based communication system.
- Low power devices.
- Portable.
- Accuracy.

RESULTS AND DISCUSSION

An implementation and evaluation took place to measure how efficiently hand and body gestures can be recognized and transformed into usable system outputs by this proposed gesture communication system. A system integrated visual sensors with a flux sensor connected to an Arduino Uno which operated through an external controller application and a cloud-based platform for real-time communication.

Results

Gesture Recognition Accuracy

The method successfully interpreted hand and finger gestures through its detection system which operated at 90% accuracy when lights were ideal. The flux sensor improved recognition reliability through its ability to detect subtle hand motion changes reducing accidental detection events.

Response Time

The system displayed an average response time of 1.2 seconds from the moment a gesture was detected to the translation of output. The cloud-based communication facilitated real-time interaction without considerable delay.

User Feedback

Individuals who are deaf or mute found the system straightforward and user-friendly for basic communication, while users with normal hearing valued the immediate text/speech conversion, aiding in seamless interactions.

Discussion
Effectiveness of Flux Sensor: The integration of the flux sensor markedly enhanced motion tracking by monitoring fluctuations in magnetic fields, thereby improving the accuracy of finger movement recognition.

Environmental Factors
The performance experienced slight degradation due to inadequate lighting and background noise affecting visual sensor detection, indicating the potential enhancement through infrared-based sensors or machine learning algorithms for greater robustness.

Cloud Integration
Although cloud-based communication improved accessibility, network latency in areas with weak signals caused minor delays in message transmission. Future advancements might involve edge computing to locally process gestures prior to cloud transmission.

Scalability and Future Enhancements
Expanding the range of gestures recognized, incorporating AI-driven gesture recognition, and offering support for multiple languages could significantly increase the system's usability and effectiveness.

CONCLUSION
The proposed system introduces a creative method for streamlining communication between hearing individuals and those who are deaf or mute through a gesture recognition system. By utilizing a specific set of body and hand gestures, the system successfully converts human movements into digital signals. The combination of an Arduino Uno with an external controller application allows for immediate translation and interpretation of gestures, facilitating smooth interaction. Moreover, the addition of a cloud-based system increases accessibility, enabling users to communicate effectively across various digital platforms. This method not only enhances inclusivity but also showcases the capabilities of gesture recognition technology in narrowing communication divides for individuals with hearing and speech challenges. Future improvements could involve using deep learning for gesture recognition to enhance precision and enable real-time translation across different languages.

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