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Assistive Band for Patients

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Abstract

A small wearable assistive technology for patients with speech or physical disabilities is presented in this paper. Through embedded sensors, the system records wrist motions and converts them into real-time, personalized messages that are shown on a mobile application. The device, which was designed with the Seeed Studio XIAO nRF52840 microcontroller and MPU9250, combines wireless communication, Firebase- based storage, and gesture recognition. The goal of the solution is to facilitate proactive health monitoring and enhance communication between patients and caregivers. Its accuracy, effectiveness, and usability in hospital settings are confirmed by real-world testing.

Introduction

In hospitals and wellness centers around the world, patients deal with difficulties daily. Patients are also physically unwell with the critical illness, and they are not able to convey the information. They usually suffer from emotional instability and feel upset and lost in life.

The band ensures the easy transmission of messages through the IoT-based technology. The quality of life of patients is improved in real time. The time required for the doctors and caretakers is slightly minimized due to the easy patient accommodation. The environment in the hospital is refreshed with easy access and freedom.

The core feature of the device is to convert wrist movements into meaningful messages. These messages are transmitted to our Mobile application. Messages are displayed with a user-friendly interface allowing caretakers, doctors and relatives to monitor the patient's movements in real time. With low power consumption and compact hardware, the device is designed for continuous monitoring without discomfort of users.

The project aims to reduce the communication gap between patients and caregivers, ensuring every voice is heard. It transforms healthcare into a responsive experience. Every patient has different messages to convey, and thus this project helps them to achieve this goal through hand gestures to feel comfortable and stable.

Ease of Use

Patients can wear a comfortable, lightweight, and small assistive band for extended periods, with accurate motion tracking, with little disruption to the patient's daily schedule. It has an easy-to-use, discrete wrist-mounted form factor. Users only need to pair the band with the Flutter- based mobile app and establish gesture-

to-message mappings using an intuitive interface, requiring little technical expertise.
Instant alerts and messages are sent to caregivers, which is crucial in emergencies. In hospital and home care settings, this greatly improves responsiveness.
Future enhancements like AI-based motion classification and more biometric sensors are also made possible by its modular hardware design. The system's adaptability is increased by allowing healthcare providers to customize message sets to meet the needs of specific patients

Literature Review

AI anomaly detection of healthcare monitoring integrated by IOT, Sensors, and blockchain, which improves disease prediction and real-time processing of the body. Blockchain secures data, and it also overcomes the size issues with a lightweight wearable model [1].
Hand gestures with the help of neural networks and different hand gesture representation techniques. This method supports deep learning models like CNN and 3D CNN to bring out and process gesture features, ensuring high accuracy and validity. Their studies have demonstrated that 3D CNN captures the spatiotemporal dependencies, increases active gesture recognition. Additionally, OpenPose-based hand detection has increased gesture representation by identifying different hand features. This study builds on previous advancements by refining C3D-based gesture recognition and integrating both local and global hand configurations for improved accuracy in sign language interpretation [2].
How patients with cirrhosis interact with internet- connected technology and their interest in e-health solutions for managing their condition. Despite potential challenges, cirrhosis patients own and use digital devices and are willing to adopt e-health solutions if they receive guidance. This research supports the integration of digital health tools in cirrhosis care to improve patient outcomes. A majority of participants owned internet-enabled devices, with 68.4% possessing a computer and 84.6% having a mobile phone [3].
Hand gesture recognition methods focus on different data models like vision-based, sensor-based, and hybrid approaches. It studies machine learning and deep learning techniques, their strengths and limitations, real-time processing, and accuracy across different environments. The review provides a structured comparison and offers suggestions for future research in hand gesture recognition [4].
Prior hand gesture recognition systems were constrained by environmental conditions and required hardware, such as gloves. For increased flexibility and accuracy, recent methods combine machine learning, particularly CNNs, with vision-based techniques. Techniques for feature extraction, such as complex moments and hand contours, have been investigated. Although CNNs aid in automating recognition, they have drawbacks such as processing time and lighting fluctuations. This work uses CNN-based classification, max pooling, and grayscale conversion to enhance real-time recognition [5].
The growing need for easily accessible, remote medical services has led to the rise in popularity of mobile healthcare applications. While online consultation is available through existing systems like MDLIVE and Teladoc, many of them lack integrated emergency and medication delivery features. While prior research has demonstrated the potential of mobile health applications, it also highlights the need for increased adoption and standardization. Rapid cross-platform development of all- inclusive healthcare solutions is made possible by utilizing tools such as Flutter [6].

Methodology

Hardware-

1) Seeed Studio XIAO nrf52840.
2) MPU 9250.
3) ESP32 wroom32.

Software-

1) Arduino IDE.
2) Firebase and Firestore.
3) Android Studio.

Implementation

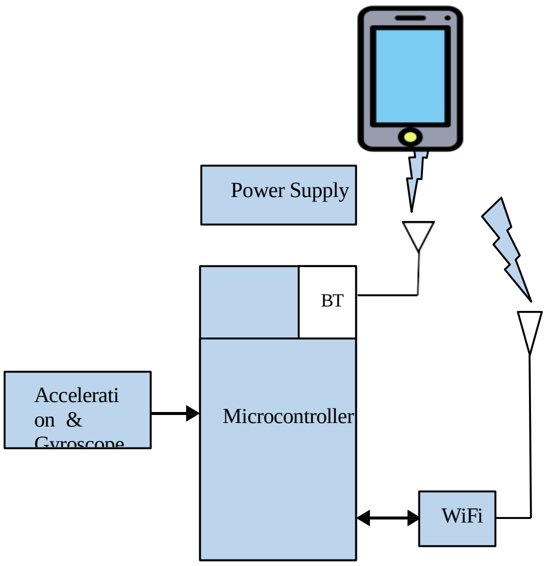

Figure 1. System Diagram

As shown in the Figure 1, the system starts with a comfortable wristband that patients wear, and inside, smart sensors listen to the hand movements. The wristband is equipped with sensors that detect simple hand movements, like a clenched fist for pain or a wrist turn for thirst. These movements are translated into clear messages that caregivers can understand. These signals are sent to a microcontroller, which processes the data and transmits it via WIFI to applications on electronic devices. The patient's silent signals travel securely through the room to a discreet hub on the wall, which passes along alerts to caretakers' phones and tablets through a gentle notification system. The system learns and adapts over time, ensuring no message gets lost. Over time, the system learns and adapts to the patient's behavior, making communication smoother. Family members can also monitor the patient's well-being through a secure online platform, providing peace of mind. As mentioned in Figure 2**,** the workflow describes the Assistive Band for Patients' sequential operation, showing how an integrated hardware-software system converts a wrist gesture into a readable message. The patient makes a predetermined hand gesture to start the Wrist Motion. The wearable band's embedded motion sensors, like the MPU9250, are used to detect this motion.

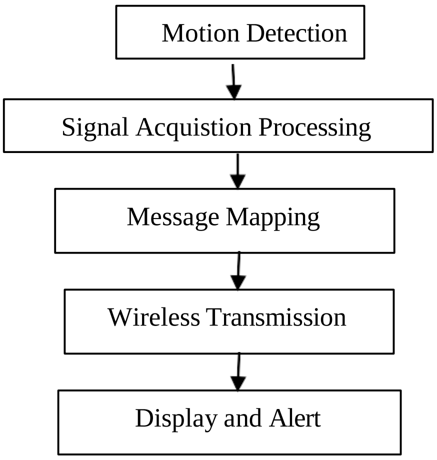

Figure 2. Workflow Diagram

After the movement is detected, the raw sensor data is gathered and filtered to remove noise and guarantee accuracy in the Signal Acquisition and Processing stage. The Gesture Recognition module receives this processed signal and matches particular motion patterns to a library of pre-programmed gestures.
After successful recognition, a gesture moves on to the Message Generation stage, where it is converted into a meaningful message like "Call Nurse" or "Need Water." Lastly, a mobile application receives this message wirelessly through BLE, allowing caregivers to react quickly and receive real-time alerts. Effective, user-friendly, and instantaneous communication between patients and healthcare professionals is guaranteed by this optimized workflow.

Results

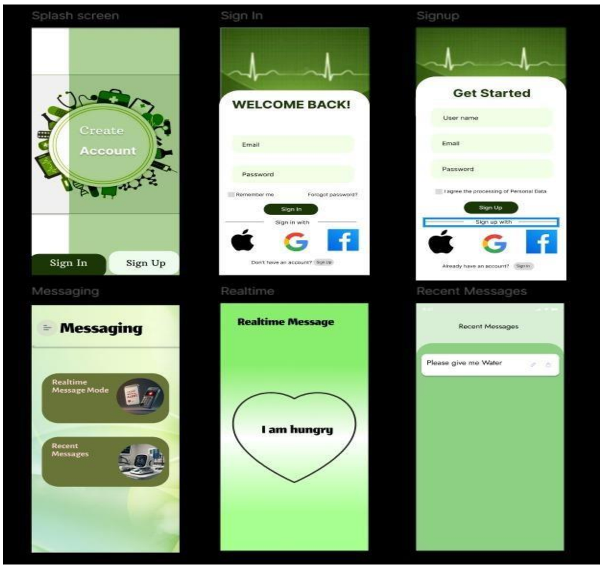

Figure 3. Application software

Figure 3 shows that presently, 80% finished, the mobile application's user interface offers a clear and simple interface intended to improve patient accessibility and support for those who struggle with communication. Splash, sign-in, sign-up, messaging, real-time communication, and recent messages are among its essential screens. Multiple platforms (Apple, Google, and Facebook) allow users to log in, providing convenient and safe access. To facilitate immediate communication and access to earlier messages, the messaging section is separated into real-time and historical views. By enabling users to send urgent needs like "I am hungry" instantly, the "Realtime Message" feature helps caregivers respond more quickly. The interface's medical aesthetic design promotes trust and makes navigation easier.
The functionality and usability of the application will be further improved by planned enhancements. Timestamped messages for improved monitoring, emergency alerts, in-app notifications, and a sidebar for simpler menu access are some of the upcoming features. The app will also include a recommendation engine that, depending on the user's needs, suggests relevant or nearby medical professionals. The system will dynamically update the availability and profiles of doctors, empowering users to make well-informed healthcare decisions. The

application will become a comprehensive assistive healthcare platform as a result of these upcoming developments, which will be in line with the larger goal of intelligent and easily accessible telehealth support.

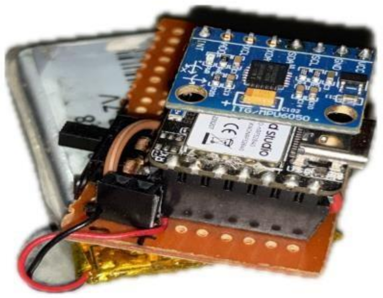

Figure 4. Hardware representation

The main system components have been successfully integrated and tested as per Figure 4, and the hardware implementation of the Assistive Band for Patients is about 80% complete. The Seeed Studio XIAO nRF52840 microcontroller, which was selected for the wearable device due to its small size, BLE compatibility, and low power consumption, is used in its construction.

It is interfaced with the MPU9250 sensor module, which precisely records wrist motion data by combining a 3- axis accelerometer, gyroscope, and magnetometer. Real- time motion tracking is made possible by the custom code that is uploaded through the Arduino IDE to process the sensor data on board. To safely house the components and guarantee patient comfort, a prototype enclosure has been created. Reliable transmission of gesture data has been confirmed through testing and verification of BLE communication between the band and the Flutter-based mobile application. Charging and power supply.

Conclusion

By continuously tracking patient movements and converting them into actionable alerts, the assistive band functions as an efficient health monitoring tool. Its emergency alert system improves response to urgent needs by guaranteeing prompt medical assistance. The device provides a useful solution for healthcare settings without requiring complicated infrastructure because it is portable and reasonably priced. In the end, it improves patient safety by offering dependable communication for people who can't verbally communicate their needs, showcasing wearable technology's potential in contemporary healthcare.

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