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Flex Sensor Based Biofeedback Monitoring for Post-Stroke Fingers Myopathy Patients

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ABSTRACT: In this research, a biofeedback monitoring system based on flex sensors that is specifically designed for patients with post-stroke fingers myopathy is designed and put into use. The data gathering, processing, and display components of the system make use of ThingSpeak, servo motors, flex sensors, NodeMCU, and Arduino microcontrollers. To track flexion levels, five flex sensors are positioned thoughtfully on the fingers of the afflicted hand. Patients are helped to regain finger movement by corresponding servo motors that offer real-time feedback based on the flex sensor readings. Sensor data can be transferred to the ThingSpeak platform for remote monitoring and analysis thanks to the NodeMCU's internet access. The device continuously assesses finger movement through a feedback loop, adjusting servo motor settings to deliver focused assistance. With the use of this technology, patients can receive individualized rehabilitation and receive immediate response to increase the function and dexterity of your fingers.

The project's goal is to improve the rehabilitation outcomes for patients with post-stroke fingers myopathy by offering a technologically advanced, easily accessible remedy. Clinical trials and additional optimization for broad implementation in rehabilitative settings might be part of future revisions.

I. INTRODUCTION

This project implements a flex sensor-based biofeedback system for post-stroke fingers myopathy patients using Arduino, flex sensors, servo motors, NodeMCU, and ThingSpeak. Flex sensors measure finger flexion, while servo motors provide real-time feedback. NodeMCU enables internet connectivity for data transmission to ThingSpeak, facilitating remote monitoring. The system aims to improve finger mobility and rehabilitation outcomes through personalized feedback

The necessity of the flex sensor-based biofeedback monitoring system for post-stroke fingers myopathy patients arises from the need to enhance rehabilitation outcomes and improve finger mobility. Traditional rehabilitation methods often lack real-time feedback, personalized assistance, and remote monitoring capabilities. By utilizing flex sensors, servo motors, and IoT technologies, the system addresses these limitations by:

- 1 Providing Real-Time Feedback: The system offers immediate feedback on finger movement, enabling patients to adjust their rehabilitation efforts accordingly.
- 2 Personalized Assistance: By monitoring individual finger flexion, the system can tailor feedback to each patient's specific needs, promoting targeted rehabilitation.
- 3 Remote Monitoring: Through NodeMCU and ThingSpeak integration, healthcare providers can remotely monitor patients' progress, allowing for timely interventions and adjustments to rehabilitation plans.
- 4 Cost-Effective Solution: The system utilizes affordable components such as Arduino, flex sensors, and servo motors, making it accessible to a wider range of patients and healthcare facilities.
- 5 Empowering Patients: By actively involving patients in their rehabilitation process and providing real-time feedback, the system empowers them to take control of their recovery journey.

II. RELATED WORK

In human activity recognition systems, various low level features are introduced to describe the activity observation that used only single technique to produce the result. Also, they were lacking the feature of modularity which has been compensated in our research work.

Stefan Oniga et. Al., (2014) introduced about developing a system that allows living for as long as possible in familiar environment. He also used IoT technologies to monitor in real time the state of a patient or to get sensitive data in order to be subsequently analyzed for a medical diagnosis. He presented the state of his work related to the development of an assistive assembly consisting of a smart and assistive environment, a human activity and health monitoring system, an assistive and telepresence robot, together with the related components and cloud services. He used ChipKit Max32 microcontroller development board, a 3 axes accelerometer sensor, a heart rate belt sensor and communication modules.

Min-Cheol Kwon et. Al., (2018) proposed a human activity recognition system that collects data from an off-the-shelf smart watch and uses an artificial neural network for classification. The proposed system is further enhanced using location information. He considered 11 activities, including both simple and daily activities. In this study, he proposed an HAR system that collects data from an off-the-shelf smart watch and uses an artificial neural network for classification. Smart watches are effective and readily available wearable devices for use in HAR systems.

Diego Castro et. Al., (2017) He used machine learning algorithms to determine the activity done within four pre-established categories (lie, sit, walk and jog). Meanwhile, it is able to give feedback during and after the activity is performed, using a remote monitoring component with remote visualization and programmable alarms.

V.Padmanabhan et. Al., (2014) He proposed a new technique called artificial speaking mouth for dumb people. It will be very helpful to them for conveying their thoughts to others. Some peoples are easily able to get the information from their motions. The remaining is not able to understand their way of conveying the message. In order to overcome the complexity the artificial mouth is introduced for the dumb peoples. This system is based on the motion sensor. According to dumb people, for every motion they have a meaning. That message is kept in a database. Likewise all templates are kept in the database. In the real time the template database is fed into a microcontroller and the motion sensor is fixed in their hand. For every action the motion sensors get accelerated and give the signal to the microcontroller. The microcontroller matches the motion with the database and produces the speech signal. The output of the system is using the speaker.

Li Wei and Shishir K. Shah (2017) In his paper, he proposed context features along with a deep model to recognize the individual subject activity in the videos of real-world scenes. He has proposed a deep neural network model for human activity recognition from video. The input features of the deep network include motion feature and context feature. He designed the scene prior feature and scene context feature to capture the environment around the subject of interest global and local levels.

Theo Jourdan et. Al., (2018) In his paper, he proposed a privacy-preserving framework for activity recognition. This framework relies on a machine learning technique to efficiently recognize the user activity pattern, useful for personal healthcare monitoring, while limiting the risk of re-identification of users from biometric patterns that characterizes each individual. To achieve that, he first deeply analyzed different features extraction schemes in both temporal and frequency domain.

III. METHODOLOGY

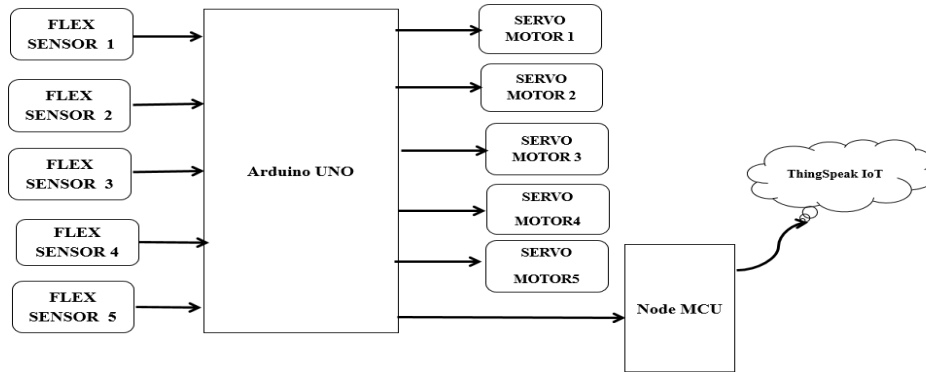


Fig 1: Block Diagram of Proposed System

The block diagram illustrates a system designed to control servo motors using data from flex sensors, interfaced with an Arduino UNO and a NodeMCU for IoT connectivity via ThingSpeak. The setup includes five flex sensors (FLEX SENSOR 1 to FLEX SENSOR 5) that measure bending or flexing motions. Each sensor is connected to the Arduino UNO, which processes the analog signals received from the sensors. The Arduino UNO, acting as the central processing unit, converts these signals into corresponding digital outputs to control five servo motors (SERVO MOTOR 1 to SERVO MOTOR 5). Each servo motor's movement is thus directly influenced by the flexing motion detected by its respective flex sensor, enabling precise control of the motors based on sensor input. Additionally, the Arduino UNO is connected to a NodeMCU module, which provides wireless communication capabilities. The NodeMCU uploads sensor data and motor statuses to the ThingSpeak IoT platform. This integration allows for remote monitoring and analysis of the system's performance in real-time, facilitating applications such as remote diagnostics, data logging, and enhanced control algorithms via cloud computing.

Overall, this system demonstrates a practical application of sensor integration with microcontrollers and IoT platforms to achieve responsive and remotely accessible motor control.

IV. EXPERIMENTAL RESULTS

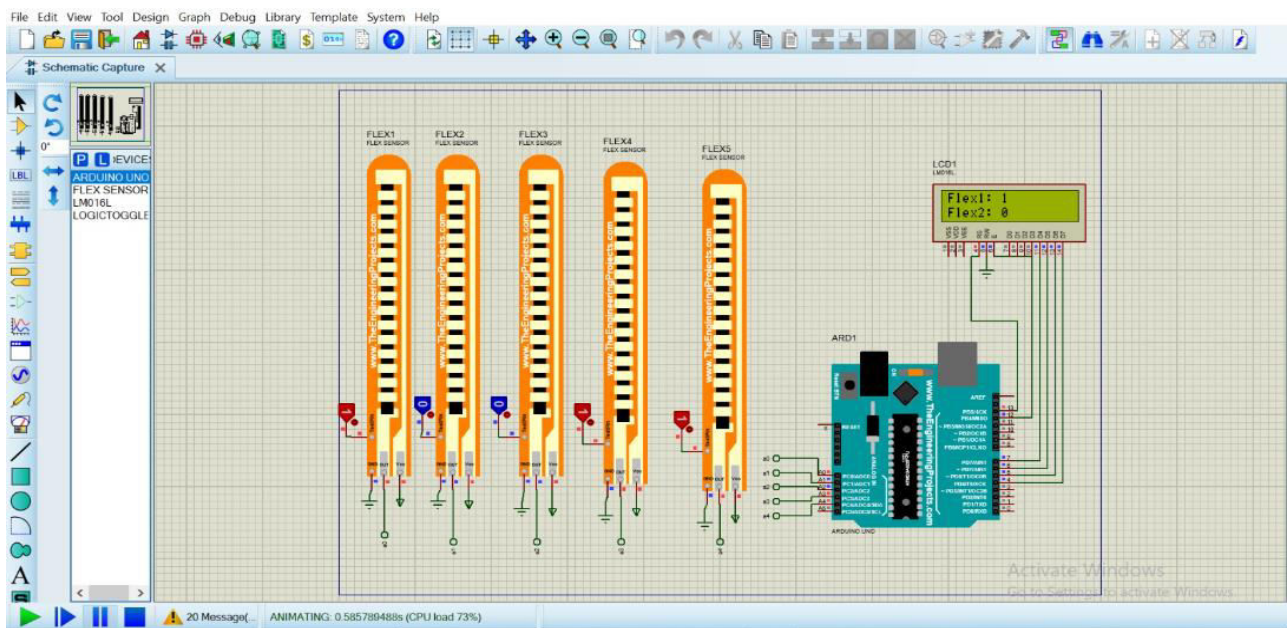


Fig 2: Circuit Diagram

The circuit diagram presented showcases a system designed to monitor and display the readings from five flex sensors using an Arduino UNO and an LCD display. Each of the five flex sensors (labeled FLEX1 to FLEX5) is connected in series with a resistor, forming a voltage divider. This setup allows the Arduino UNO to read the variable resistance changes of each flex sensor as they bend. The output of each voltage divider is connected to an analog input pin on the Arduino UNO. Specifically, FLEX1 is connected to A0, FLEX2 to A1, FLEX3 to A2, FLEX4 to A3, and FLEX5 to A4. These connections enable the Arduino to measure the analog voltage, which corresponds to the bending degree of each flex sensor. An LCD display (LCD1) is also integrated into the circuit to provide real-time feedback of the flex sensor readings. The LCD is connected to the Arduino using digital pins for data transmission (D2 to D7) and control pins for enabling and registering the display data. The data pins (D4 to D7) handle the 4-bit data transmission to the LCD, while the control pins (RS and E) manage the instruction and enabling operations of the display.

In this configuration, the Arduino UNO reads the analog voltages from the flex sensors, processes the data, and sends the corresponding values to the LCD display. This enables the real-time visualization of the flex sensor states, facilitating monitoring and further analysis. The setup provides a practical example of integrating sensor data acquisition with microcontroller processing and display technology, useful in various applications requiring responsive and visual feedback of sensor data.

V. CONCLUSION

In conclusion, the development of a flex sensor-based biofeedback monitoring system for post-stroke fingers myopathy patients holds significant promise in revolutionizing rehabilitation approaches. By leveraging the capabilities of Arduino, flex sensors, servo motors, NodeMCU, and ThingSpeak, this system offers real-time feedback, personalized assistance, and remote monitoring capabilities that address key challenges faced by patients during their recovery journey. Through a structured approach involving research, engineering, clinical validation, and user testing, the system has the potential to improve rehabilitation outcomes, enhance patient engagement, and ultimately, enhance the quality of life for post-stroke fingers myopathy patients.

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