Mini Project: Embedded Systems

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Problem Statement: Smart Rehabilitation Glove for Hand Therapy

1. Basic Introduction of Problem Statement

Hand disabilities due to neurological disorders such as strokes, traumatic brain injuries, spinal cord injuries, and conditions like arthritis are increasingly prevalent, affecting millions of individuals worldwide. Rehabilitation is critical for these patients to regain motor functions, improve hand dexterity, and enhance their quality of life. Traditional rehabilitation methods, however, often require frequent visits to healthcare facilities, making the process time-consuming, costly, and inaccessible to many.

The integration of wearable technology in healthcare presents a promising solution to these challenges. A smart rehabilitation glove designed to assist in hand therapy can provide a cost-effective, personalized, and engaging method for patients to perform their rehabilitation exercises at home. Such a device can monitor hand movements, provide real-time feedback, and adapt exercises to the user's progress, thereby increasing the effectiveness and efficiency of the rehabilitation process.

2. Objective of the Work

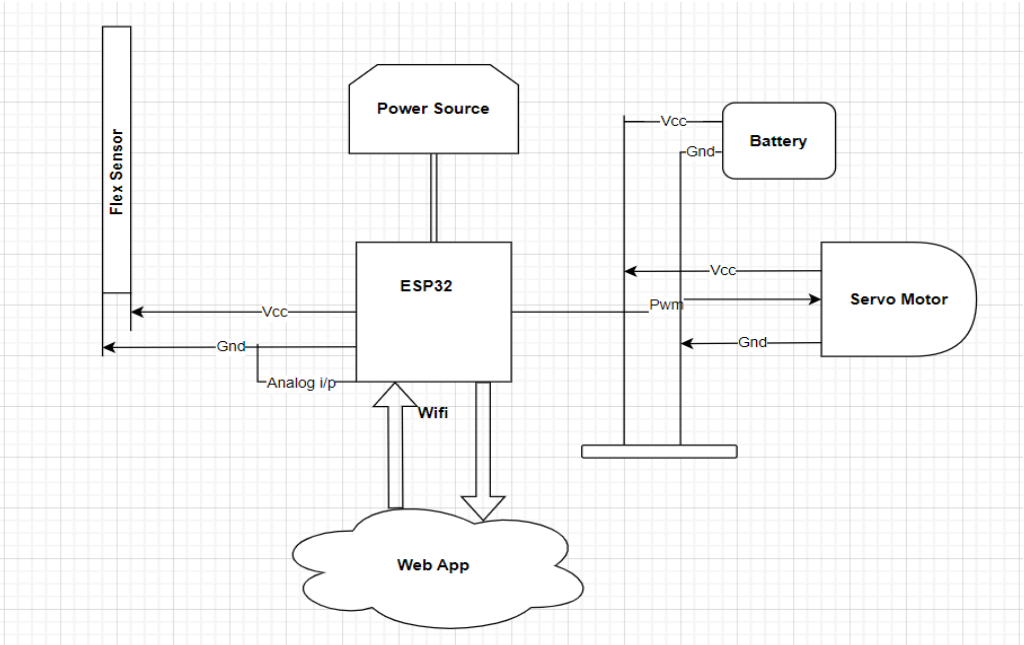
To develop a smart rehabilitation glove that assists in hand therapy by providing real-time feedback and personalized exercise programs, thereby enhancing the rehabilitation process for individuals with hand disabilities.

3. Proposed Model

Explanation with Block Diagram

The proposed model consists of a wearable glove equipped with flex sensors and actuators controlled by a ESP32. The glove monitors hand movements and provides assistance to the fingers through a tendon-based mechanism. Data collected by the flex sensors are processed by the ESP32, which then controls the servos to assist or resist finger movements as required. This system is connected to a mobile app for real-time monitoring and feedback.

Block Diagram:



System Workflow:

1. Flex Sensors: Measure the degree of bending for each finger.
2. ESP32: Processes sensor data and determines the required actuator response.
3. Servo Motors: Adjust finger positions by pulling or releasing tendons based on the ESP32's instructions.
4. Web App: Displays real-time data, allows users to set parameters, and provides feedback.

4. Components or Items Required

1. Microcontroller: Arduino or ESP32
2. Flex Sensors: 5 (one for each finger)
3. Servo Motors: 10 (two for each finger for more precise control)
4. Tendons/Cables: To connect servos to finger joints
5. Power Supply: Battery pack (Li-ion or Li-Po)
6. Wires and Connectors: For electrical connections
7. Glove: Comfortable fabric glove to mount sensors and actuators
8. Laptop: Laptop for the app
9. Software: Arduino IDE for programming, web app development platform

5. Plan of Work

Week 1-2: Research and Component Selection

- ❖ Study existing rehabilitation gloves and their functionalities.
- ❖ Select appropriate sensors, actuators, and microcontroller.

Week 3-4: System Design

- ❖ Design the glove layout, ensuring comfortable placement of sensors and actuators.
- ❖ Develop the system architecture and create a detailed block diagram.

Week 5-6: Hardware Assembly

- ❖ Mount flex sensors on the glove along each finger.
- ❖ Attach servo motors to the back and front of the hand or forearm.
- ❖ Connect tendons from servos to finger joints.
- ❖ Set up the microcontroller and establish all necessary electrical connections.

Week 7-8: Software Development

- ❖ Write code for the microcontroller to read sensor data and control servos.
- ❖ Develop the web app to display real-time data and provide feedback.

Week 9-10: Integration and Testing

- ❖ Integrate hardware and software components.
- ❖ Test the glove on different hand sizes and movements.
- ❖ Calibrate sensors and adjust control algorithms for smooth operation.

Week 11-12: User Testing and Iteration

- ❖ Conduct user tests to gather feedback on the glove's functionality and comfort.
- ❖ Make necessary improvements based on feedback.
- ❖ Finalize the design and prepare documentation for the project.

Deliverables:

1) Fully functional smart rehabilitation glove.
2) Web app for monitoring and feedback.

3) Detailed project documentation including design, implementation, and testing results.

Conclusion:

The smart rehabilitation glove aims to revolutionize hand therapy by providing an effective, user-friendly, and accessible solution for individuals with hand disabilities. Through continuous monitoring, real-time feedback, and personalized exercise programs, this project seeks to significantly enhance the rehabilitation process and improve patient outcomes.