Thera-Hand

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Need and Goal Statements

Need Statement: Physical therapy patients need a device that enables them to adhere to a closely monitored therapy routine.

Goal Statement: Create a device that enables routine monitoring of therapy adherence for physical therapy patients

Design Objectives

Design a **cost-effective** solution that is **user-friendly** and **streamlines** the rehabilitation process

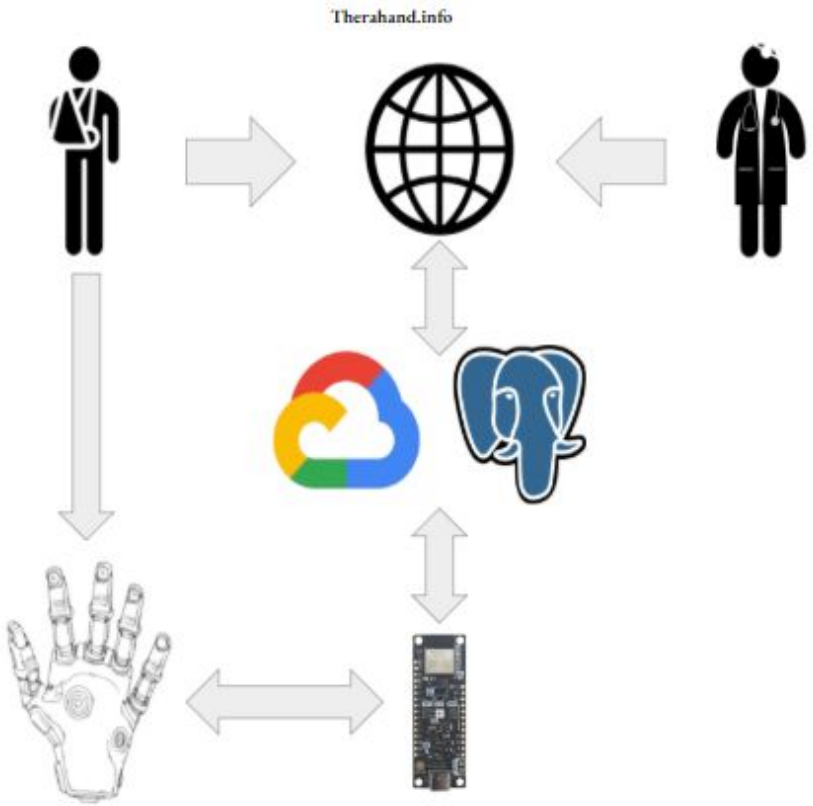
Design Objective	Unit	Target/Range
Visits	Number of visits	10%–50% less
Device Cost	Dollars	$> \$1440$
Accessibility	Minutes	Greater than session time
Weight	lbs	< 2 lbs

Design Overview

Principle Features

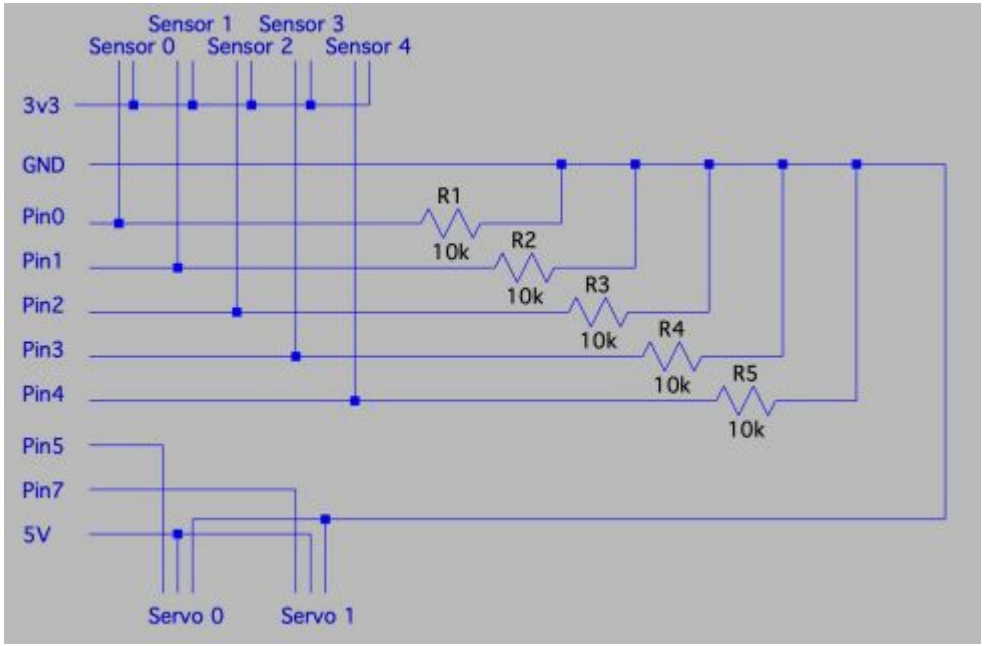
- **Lightweight & Comfortable** - Designed for long-term wear and ease of use
- **Accurate Motion Tracking** - Captures and records finger and hand movement for reliable progress monitoring
- **Remote Accessibility** - Enables therapy from anywhere, reducing the need for in-person visits
- **Interactive Web Portal** - Provides patients & clinicians with exercise assignments, progress visualization, and performance review
- **Customizable Therapy Plans** - Exercises can be tailored to individual patient needs and adjusted over time
- **Scalable and Secure System** - Supports multiple patients and clinicians while protecting sensitive health data

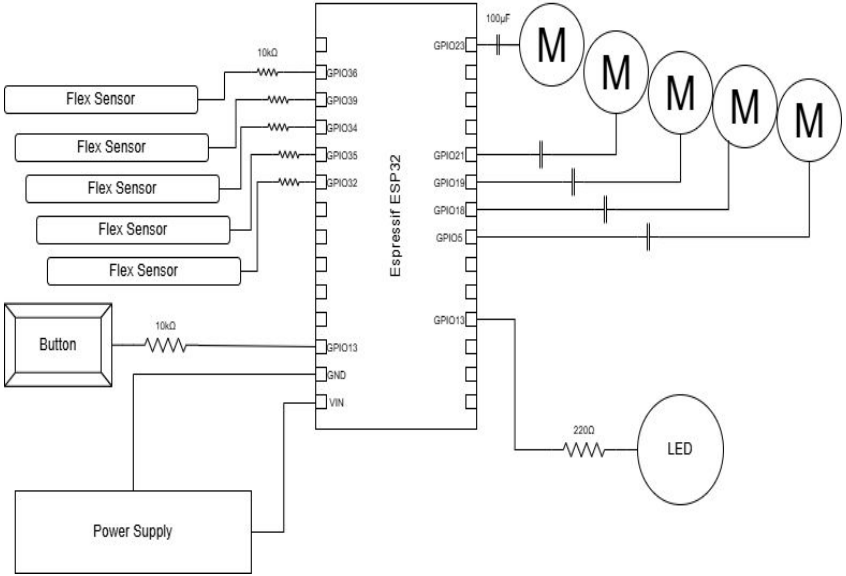
Block Diagram



- Patients/clinicians select exercises via TheraHand web portal
- Google Cloud backend stores profiles, logs, and exercise data
- ESP32-C3 connects to Wi-Fi, downloads routines
- Reads flex/IMU data, drives actuators, gives haptic feedback
- Streams data securely (HTTPS) for clinician monitoring and updates
- Unified hardware–firmware–cloud rehab system

Wiring Diagrams





Design for Manufacture & Maintenance

- **Snap-fit battery** – Tool-free replacement
- **Modular PCBs** – Quick swap of parts
- **Standard fasteners** – No special tools
- **Washable liner** – Removable for hygiene
- **OTA updates** – Alerts & diagnostics
- **Easy use** – Wearable, Bluetooth, 1-click start
- **Replaceable parts** – Cheap sensors, repairable strings
- **Emergency stop** – Clearly labeled button

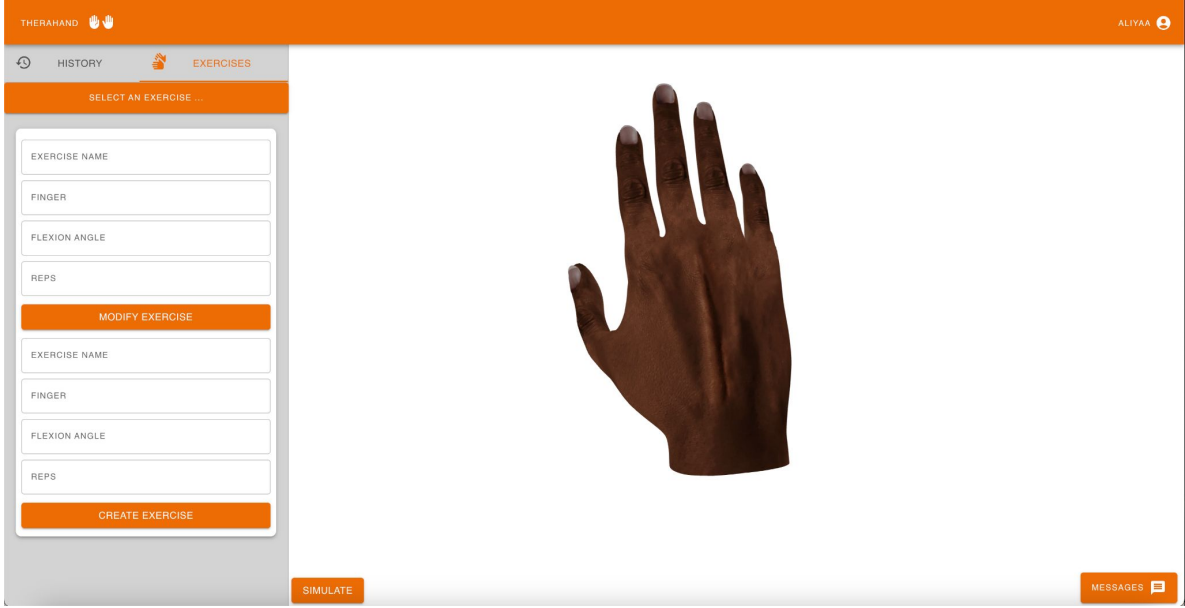
Functional Prototype

Functional Prototype

- Device runs exercises from the website
- Prototype only moves the middle finger, but flex sensors read data on all the fingers
- Number of reps and clench angle can be modified and created, some we tested are:
  - 30 degrees, 2 reps
  - 45 degrees, 2 reps
  - 60 degrees, 2 reps
  - Etc

Website Overview

- Doctor View
- History
- Exercises
- Modify Exercise
- Stimulate Exercise
- Replay Exercise
- Messaging
- Create / Delete / Select Patients



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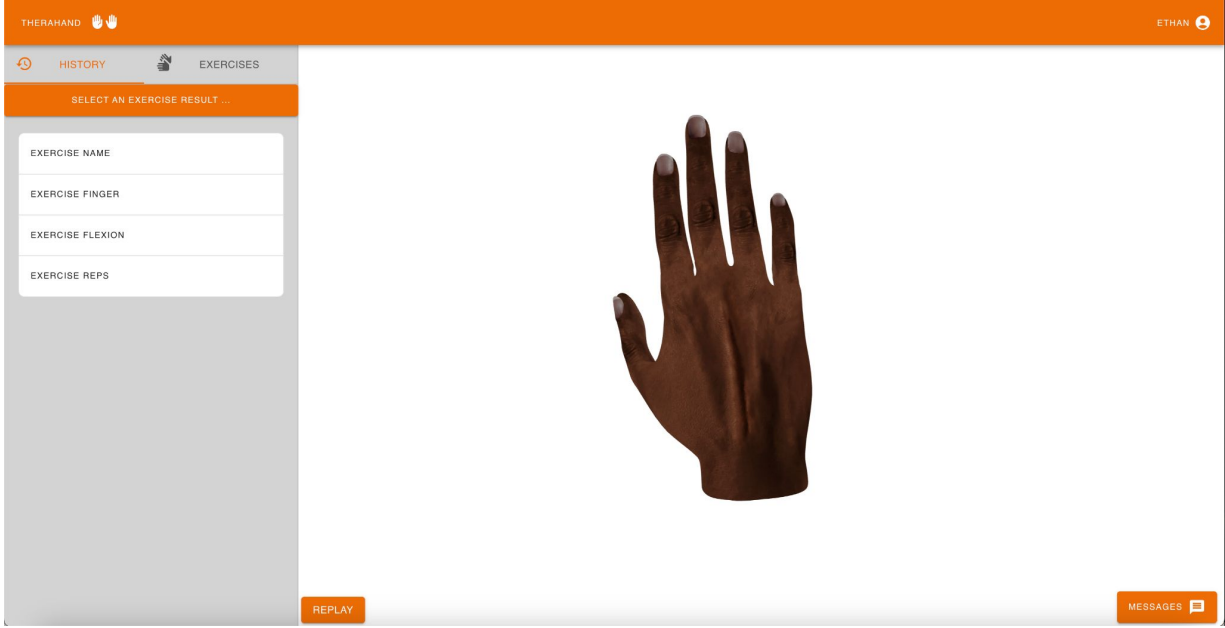

Test Results

Name(s)	Date/Location	Tests
Andy, Aliyaa, Ethan	Lab room	**Test 1:** Did the power turn off? Yes
Jhovanny, Caden, Andy	Lab room	**Test 2:** Was data remotely sent? Yes
Aliyaa, Andy	Lab room	**Test 3:** Weight: 2.5 lbs
Andy, Ethan, Aliyaa	Lab room	**Test 4:** What accuracy were the repetitions counted to? 90%
Andy, Ethan, Aliyaa	Lab room	**Test 5:** How many fingers were individually controllable? 1
Andy, Ethan, Aliyaa	Lab room	**Test 6:** Did the device return to a resting state? Yes
Andy, Ethan, Aliyaa	Lab room	**Test 7:** Full Range of Motion on each finger? Yes
Andy, Ethan, Aliyaa	Lab room	**Test 8:** Ability to fit on common hand? Yes

Aesthetic Prototype

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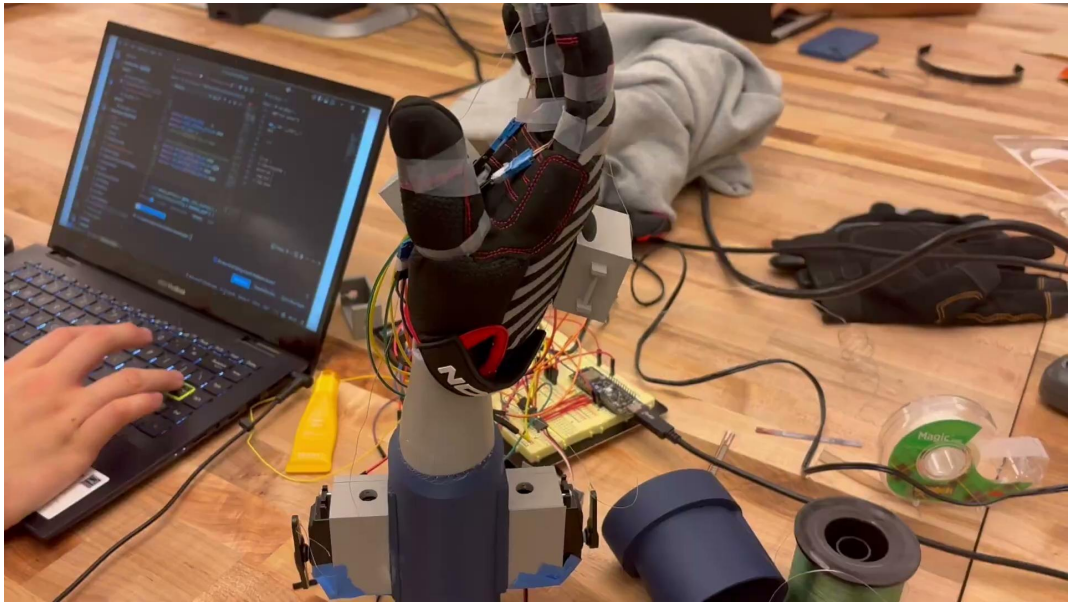
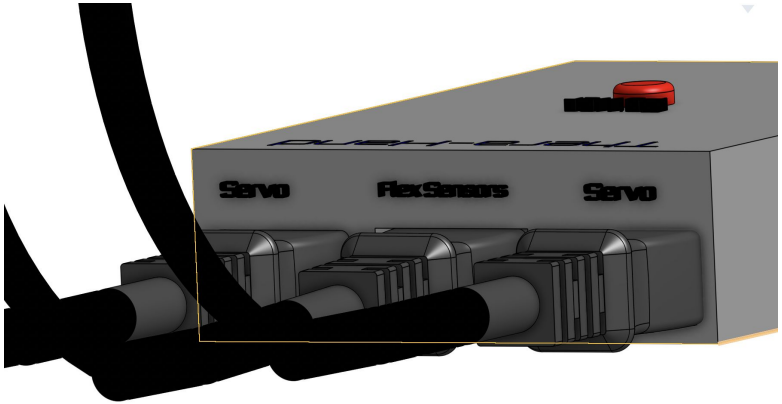
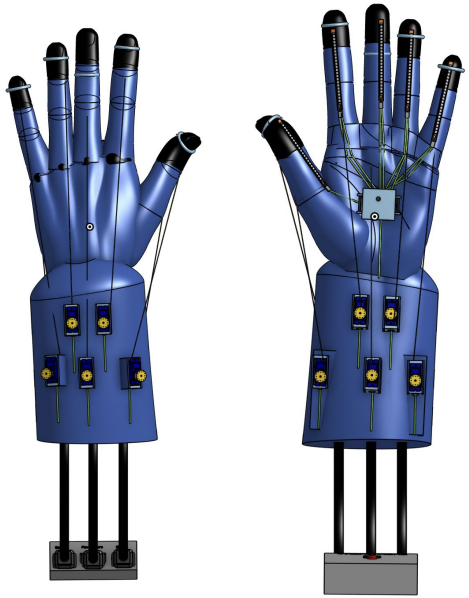


Video of exercise being run, 1 rep

Aesthetic Prototype- CAD



Power Box Plug Configurations



Back and Front of TheraHand glove, respectively

Power Box

Thank You