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TheraHand

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INTRODUCTION

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

Design Objectives: Design a cost-effective solution that is user-friendly and streamlines the rehabilitation process.

Objective	Unit	Target / Range
Visits	Number	10% – 50% fewer than standard care
Device Cost	Dollars	Less than $1440
Accessibility	Minutes	Greater than average session time
Weight	Pounds	Less than 2 lbs

Personas:

Mark, 36 – End User

Context: IT job for 12 years, has a kid & two cats, loves family time
Issue: Carpal tunnel from constant typing
Goal: Wants to stretch and reduce pain to stay active
Challenge: Forgets to do hand exercises; needs help staying consistent
Need: A device to build daily routine & relieve pain

Tom, 42 – Physical Therapist

Context: Dedicated to helping clients
Goal: Support clients remotely & retain those skipping appointments
Challenge: Many can’t attend therapy often
Need: Remote tracking & prescription tools to keep clients engaged

Insurance Company – Client

Context: Mid-size, for-profit provider
Goal: Offer affordable, accessible therapy solutions
Challenge: Reduce physical visits, retain users
Need: Scalable, low-cost tools to increase user access & service value

Functional Prototype

Working prototype for middle finger exercises

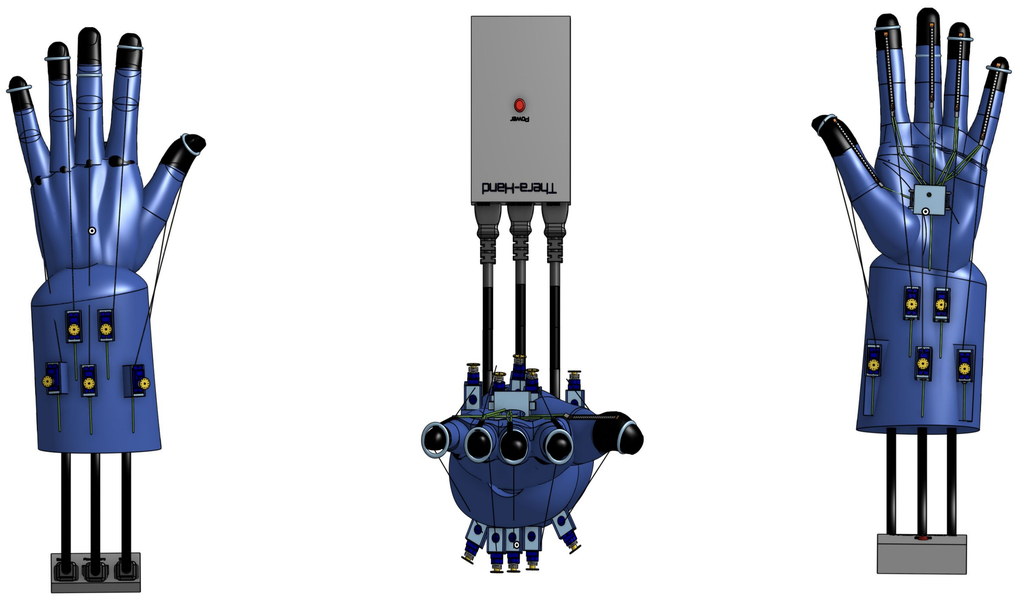
- Flex sensor on each finger
- Two rotation servos on each side of the wrist
- 3D printed components on each side for fishing wire to feed through
- Rotors pull the strings attached to the palm side of the hand to clench
- Rotors on the other side pull to unclench the hand (return to resting position)

Design for Manufacture and Maintenance

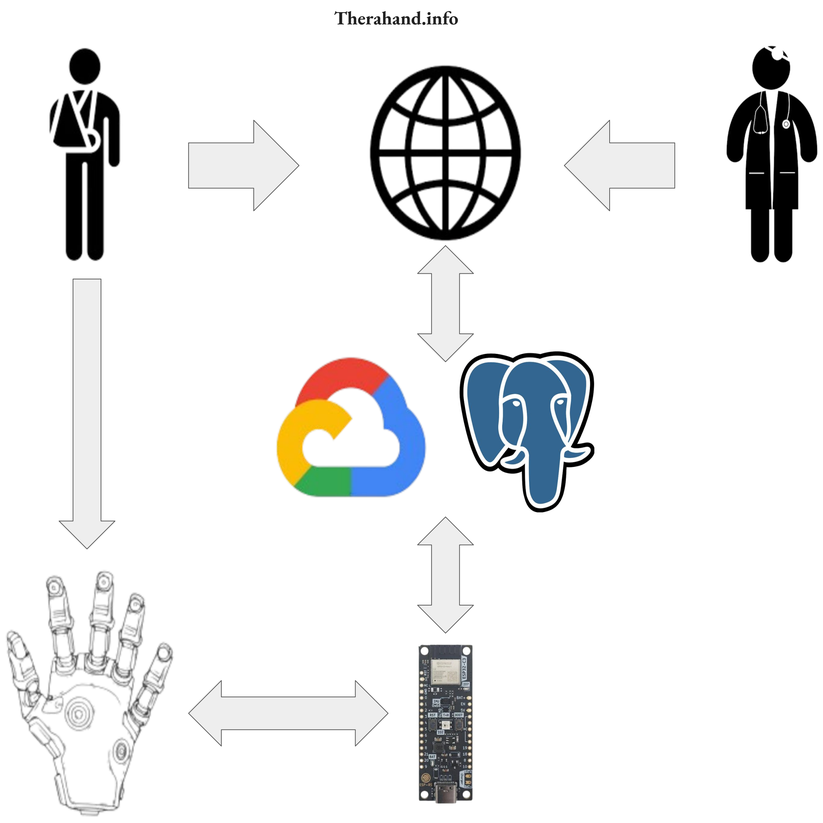
Imagined prototype design for proposed device. Inside the box is the breadboard with battery, led, resistors, etc.

- **Tool-free battery access** – Rechargeable battery in snap-fit compartment; no tools needed for swapping or replacement
- **Modular electronics** – Two plug-and-play PCBs (power management + sensors/radio) for quick part replacement without disturbing other components
- **Standard fasteners** – Phillips screws and captive fasteners; no proprietary tools required
- **Washable glove liner** – Removable and machine-washable for hygiene.
- **OTA updates & diagnostics** – Firmware updates and alerts for low battery, sensor drift, or connectivity loss via web portal and LED indicator
- **Simple operation** – Easy to put on/take off, instant Bluetooth connection, and one-click exercise start
- **Replaceable wear parts** – Inexpensive flex sensor strips; other repairs (e.g., string replacement) possible with company assistance
- **Emergency stop** – Dedicated button (labeled “Stop” in final design) for ending exercises immediately

CAD Drawings



Block Diagram



Flow chart of prototype connections and design

- 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