HMR INSTITUTE OF TECHNOLOGY AND MANAGEMENT

TECHEXPO 2K25 PROJECT EXHIBITION

Team- Thunderbolts

PROJECT TITLE - Hand Exoskeleton Using ESP32

CATEGORY - Hardware

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COLLEGE NAME - HMRITM

DEPARTMENT - MECHANICAL

PROBLEM STATEMENT AND SOLUTION OVERVIEW

Problem Statement:

•Millions of individuals suffer from **hand mobility impairments** due to stroke, nerve damage, or physical trauma.

•**Traditional rehabilitation devices** are often **expensive**, **non-portable**, and lack real-time adaptive control.

•Patients in **rural or resource-limited settings** have minimal access to continuous or guided therapy

Proposed Solution:

•A **cost-effective, lightweight hand exoskeleton** built using **3D printed PLA** and **ESP32 microcontroller**.

•Enables **wireless real-time control** through the **Blynk app**, eliminating the need for tethered or complex interfaces.

•Provides a platform for **home-based rehabilitation**, allowing patients to perform guided finger exercises with adjustable motion.

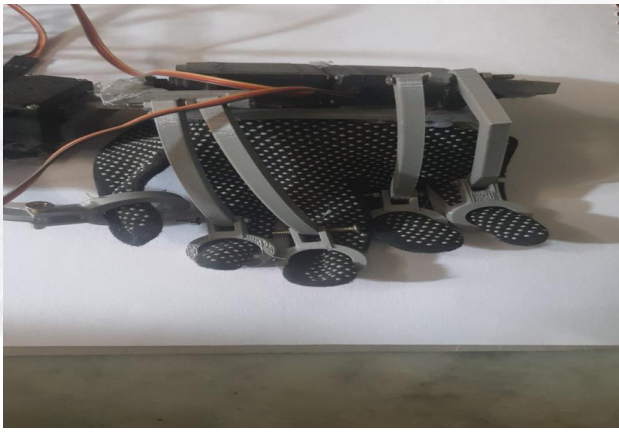
•Modular and scalable—future integration of **sensors** and **AI algorithms** can enable **adaptive rehabilitation protocols** tailored to individual recovery progress

Components:-

- **ESP32 Microcontroller**
- **Servo Driver**
- **Servo Motors**
- **Power Supply (Li-ion battery or USB)**
- **3D Printed Frame**

IMPLEMENTATION AND PROTOTYPE

- •CAD model created in Fusion 360 / SolidWorks
- •PLA used for low weight and flexibility
- •Modular finger linkages designed for comfort and adjustability
- •Servo holders and mechanical finger guides 3D printed separately



- •Develop a 3D printed wearable hand exoskeleton
- •Enable wireless manual control using the Blynk IoT platform
- •Integrate servo motors for finger articulation

IMPACT AND UNIQUENESS

• **Affordable & Accessible**
Utilizes low-cost components like ESP32, SG90 servos, and 3D-printed PLA, making exoskeleton technology accessible to students, hobbyists, and developing regions.
• **Custom-fit design via 3D Printing**
PLA-based modular construction allows easy customization for different hand sizes and applications, improving ergonomics and wearability.
• **Wireless Real-Time Control**
Integration with the Blynk IoT platform enables remote control via smartphone, showcasing a seamless Human-Machine Interface (HMI) with zero tethering.
• **Open-Source and Scalable**
The project's architecture is based on open-source hardware and code, enabling easy upgrades—such as adding flex sensors, force feedback, or ML-based gesture recognition.
• **Bridging Robotics & Rehabilitation**
It acts as a low-cost platform to explore applications in **assistive tech**, **rehab training**, and **robotic teleoperation**, making it both socially impactful and academically valuable.

FUTURE SCOPE AND REFERENCES

Sensor Integration

Add **force sensors** or **flex sensors** to enable automatic response based on user intent or resistance level.

Adaptive Rehabilitation

Implement **AI/ML algorithms** for tracking recovery and customizing motion patterns based on patient progress.

Cloud-Based Data Logging

Store and analyze usage data via Blynk Cloud for doctors and therapists to monitor progress remotely.

Gesture Recognition

Expand the system to recognize hand gestures for applications in **robotic teleoperation** or **AR/VR interfaces**.

Full-Hand or Dual-Hand Systems

Scale the design

References:

•Blynk IoT Documentation: https://docs.blynk.io
•Adafruit PCA9685 Library: https://github.com/adafruit/Adafruit-PWM-Servo-Driver-Library
•ESP32 Docs: https://docs.espressif.com
•Arduino Forum & Tutorials
•Research Articles on Soft Robotics & Rehab Device