



PERADENIYA  
ENGINEERING

# SMART KNEE REHABILITATION ASSISTING DEVICE FOR POST SURGERY CONDITIONS

P.S. Abeyweera (E/18/009) | Supervised By : Dr. P.B. Boyagoda  
Department of Mechanical Engineering, Faculty of Engineering, University of Peradeniya

## INTRODUCTION

### Objective

Enhance post-surgery knee rehabilitation through smart technology.

### Background

Addresses the gap in current rehab methods by providing real-time feedback and personalized guidance

### Innovation

A device equipped with sensors to monitor range of motion(ROM) and exercises, paired with a mobile app.

### Target Users

Patients recovering from knee surgeries such as: **Anterior Crucial Ligament (ACL)**, **Total knee replacement (TKR)**

## METHODOLOGY

### Hardware Development

#### • Initiating the Sensors

Angle tracking – Inertial Measurement Units Sensors (MPU6050)  
Microcontroller – ESP32  
Sensor Calibration  
Signal Filtering – Complementary Filter

#### • Attachment to the Patient

Used Existing Motion control Knee guard for the sensor attachment.

#### • Data Transmission

Sensor data is transmitted to the mobile app through Wi-Fi.

### Software Development

#### • Front End

HTML – Used for developing web based UI/UX design.  
Flutter – Utilized for creating the mobile app in Android platform.

#### • Back End

PHP – Powers the backend of the application, handling the data processing, logic and integration with sensors.

#### • Data Base

MySQL – Used for managing and storing user data, exercise records and progress tracking.

## FUTURE DEVELOPMENT

### Expand App Functionality

- **Additional Weeks for ACL Surgery:** Plan to extend the app's capabilities to include rehabilitation exercises for subsequent weeks.
- **Support for Other Surgeries:** The app will be expanded to cater to other knee surgeries such as TKR and Meniscus Repair, with specific exercise protocols and feedback mechanisms tailored to each type.
- **Add user Authenticate Function:** Need to add the Sign-in and Sign-Up functionality to the App.

### Modify the Hardware Prototype

- **Flexible and Ergonomic Design:** Develop a more ergonomic design that conforms better to the knee's natural movement.
- **Wireless Connectivity Improvements:** Upgrade to more reliable wireless communication technologies like Bluetooth Low Energy (BLE) 5.0 to enhance data transmission speed.

## RESULTS & FINAL OUTCOMES

### • Hardware Prototype:

- Successfully developed a working prototype, capable of measuring the knee's angle in real-time.



Figure 01: Hardware Prototype

### • Mobile App:

- The mobile app's current version supports one week of exercises for ACL surgery, focusing on the early stage of rehabilitation.

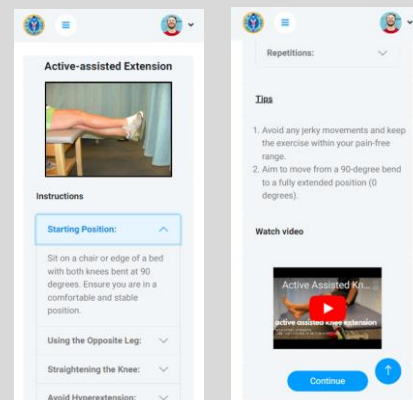


Figure 02: Exercise Instructions Screen

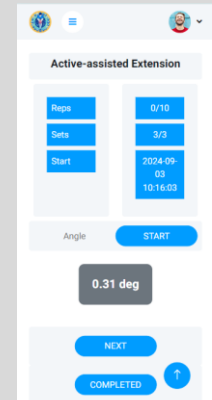


Figure 03: Current Exercise Dashboard

- The device provides users with real-time feedback on the knee angle during exercises and tracks the number of exercise repetitions, sets completed and time duration.
- Users and therapists can view daily and weekly reports that include key metrics like the average maximum knee angle achieved and completion percentage of prescribed exercises.



Figure 04: Daily Analysis Screen



Figure 05: Weekly Analysis Screen