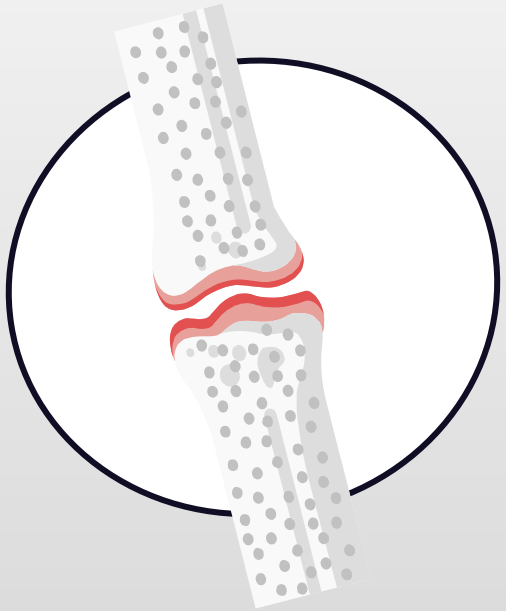
SMART KNEE REHABILITATION ASSISTING DEVICE

POST SURGERY CONDITIONS



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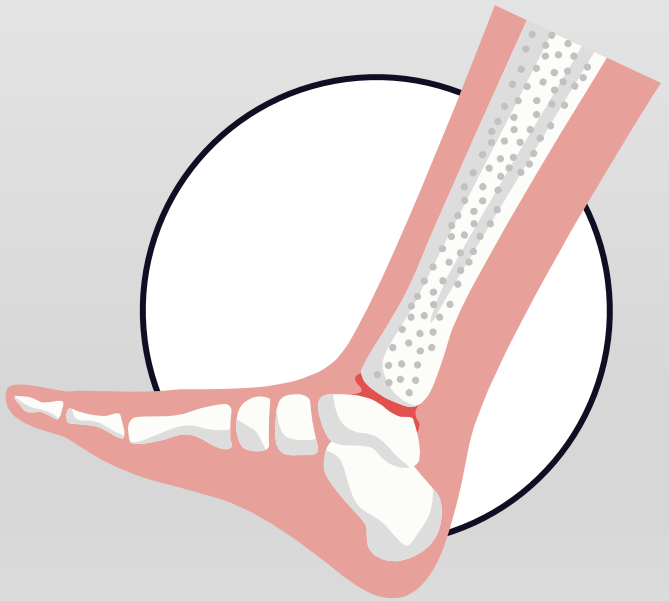

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01 INTRODUCTION.

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 and exercises, paired with a mobile app.

Target Users

Patients recovering from knee surgeries such as:

Anterior Crucial Ligament (ACL)

Total knee replacement (TKR)

Meniscus Repair

02 METHODOLOGY

Hardware Prototype

Sensors

- Angle tracking – Inertial Measurement Units (IMU) 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.

02 METHODOLOGY

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.

03 RESULTS AND FINAL OUTCOME

Hardware Prototype

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

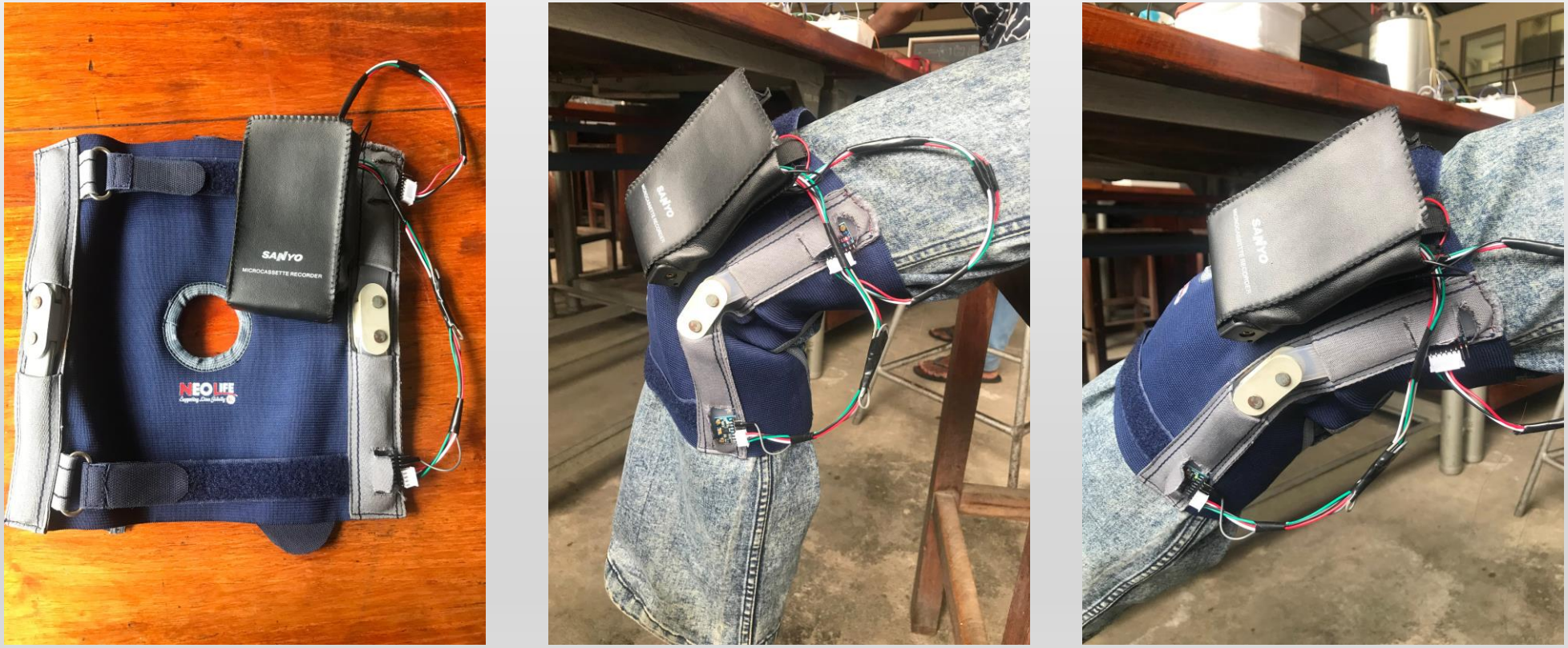


Figure 01: Hardware Prototype of the device

03 RESULTS AND FINAL OUTCOME

App Development

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

1. **Active-assisted Extension**
2. **Passive Flexion**
3. **Straight Leg Raise**
4. **Heel Slides**

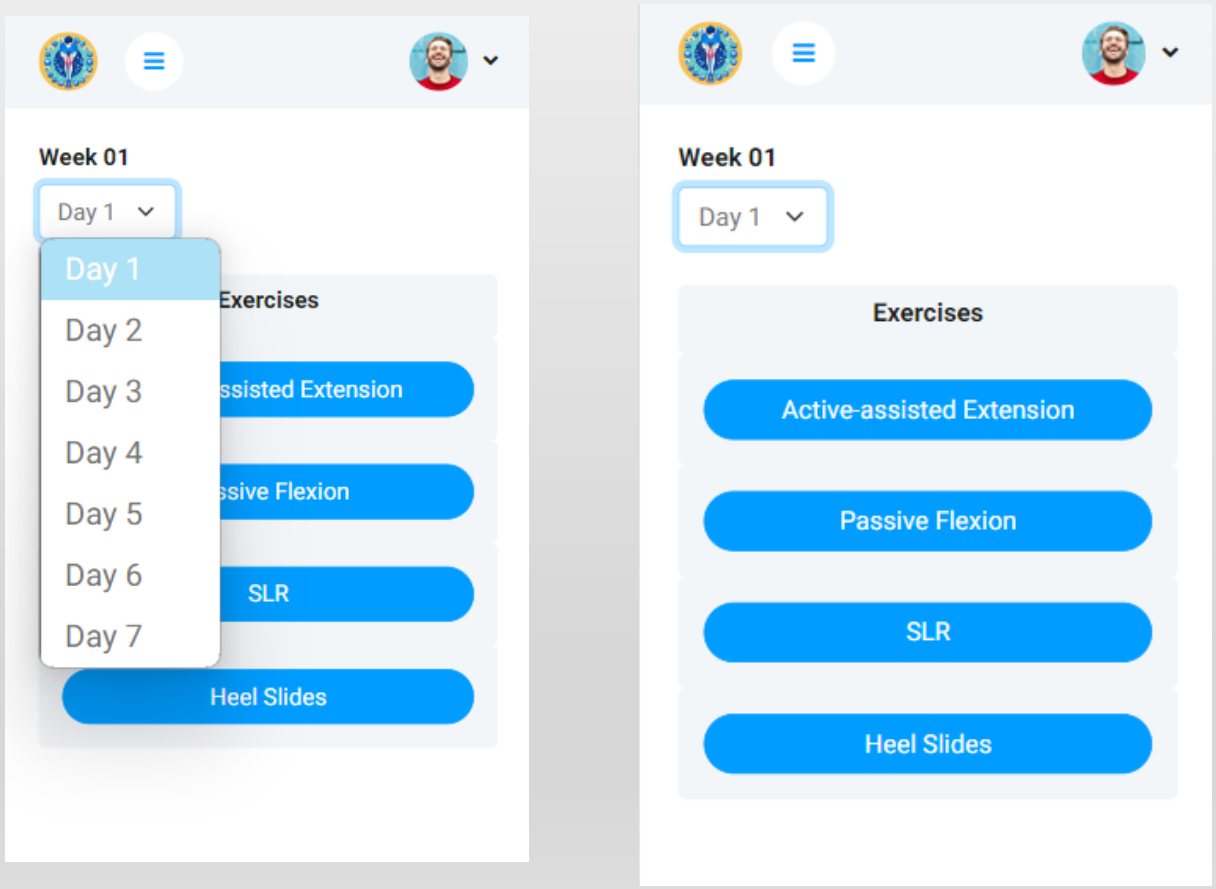


Figure 02: User interface for first week

03 RESULTS AND FINAL OUTCOME

App Development

- The app offers clear, step-by-step instructions for each exercise, accompanied by video tutorials which demonstrate the correct techniques, helping users to understand and perform exercises accurately.

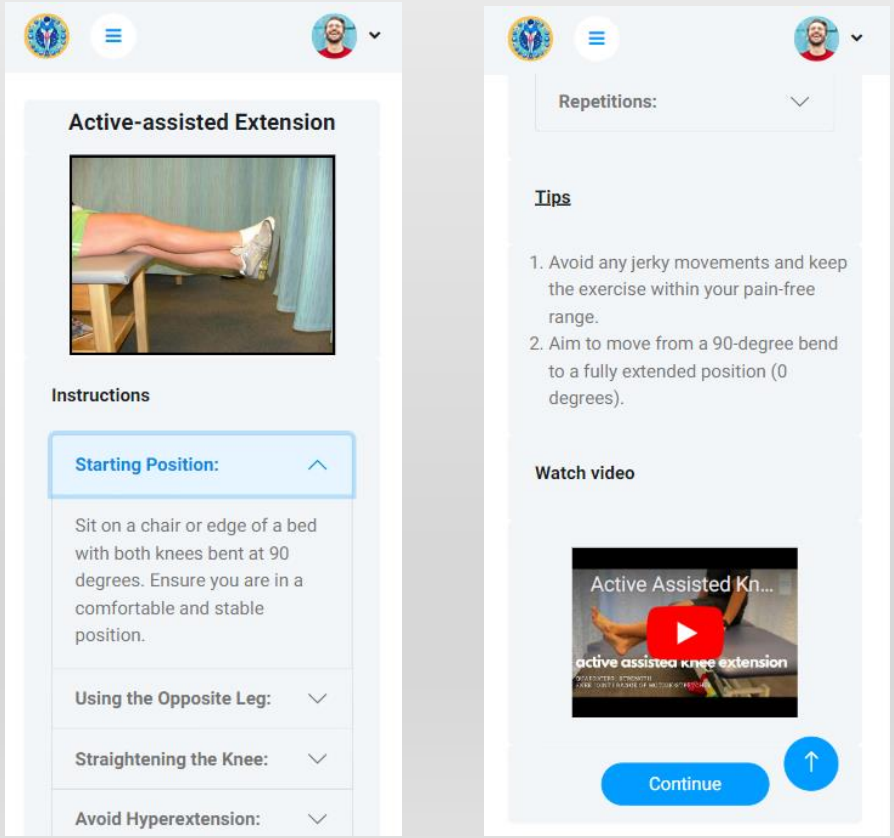


Figure 03: User interface for instruction of active assisted extension

- 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.

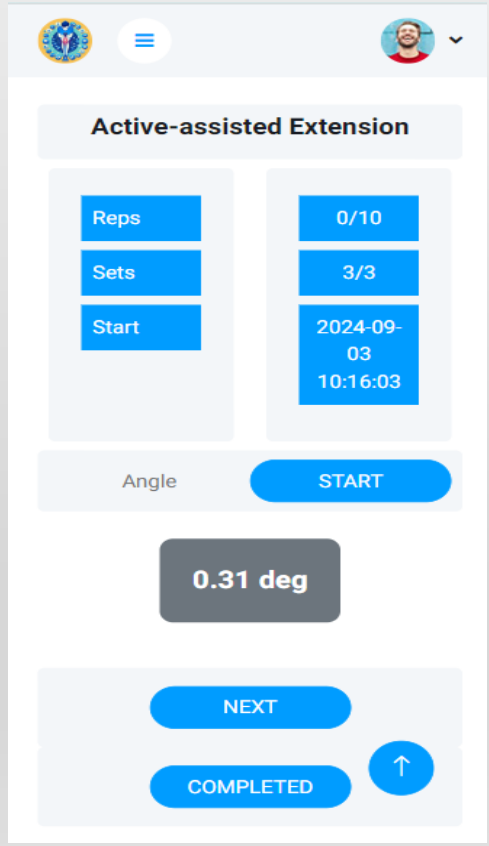
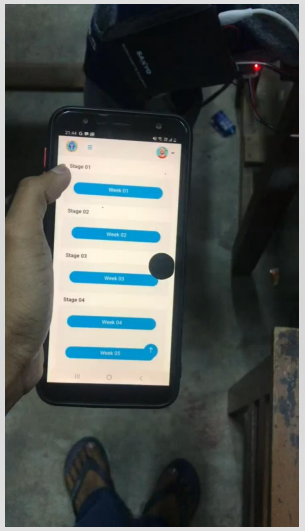


Figure 04: User interface for current exercise dashboard

03 RESULTS AND FINAL OUTCOME

App Development

- 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.



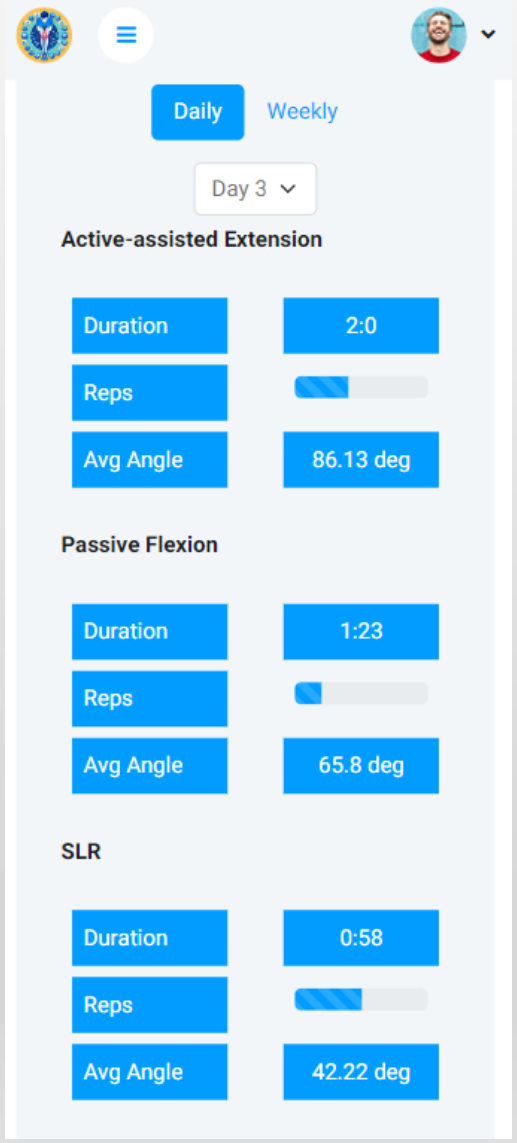


Figure 05: User interface for daily analysis

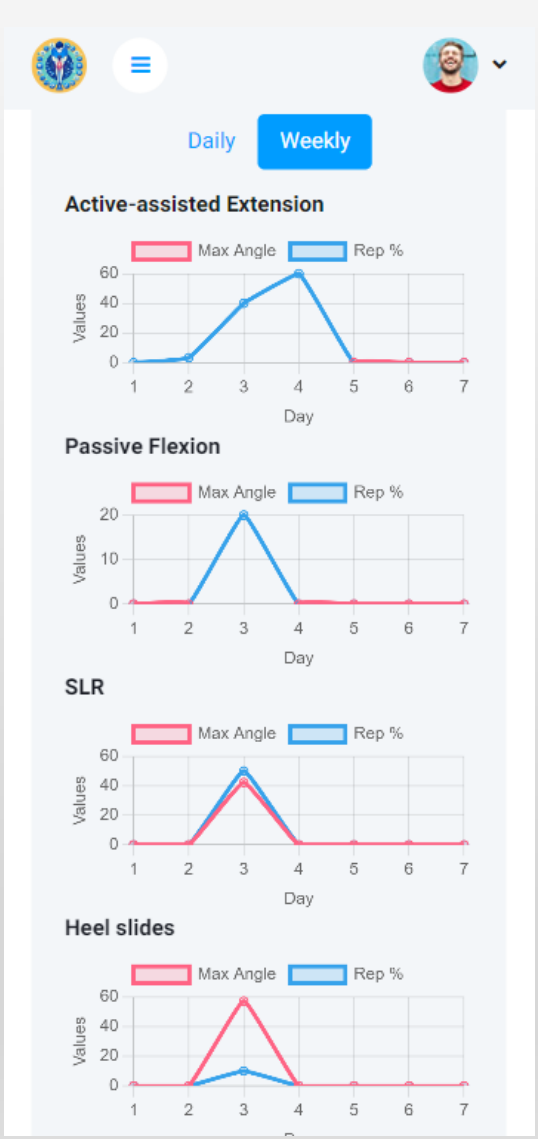
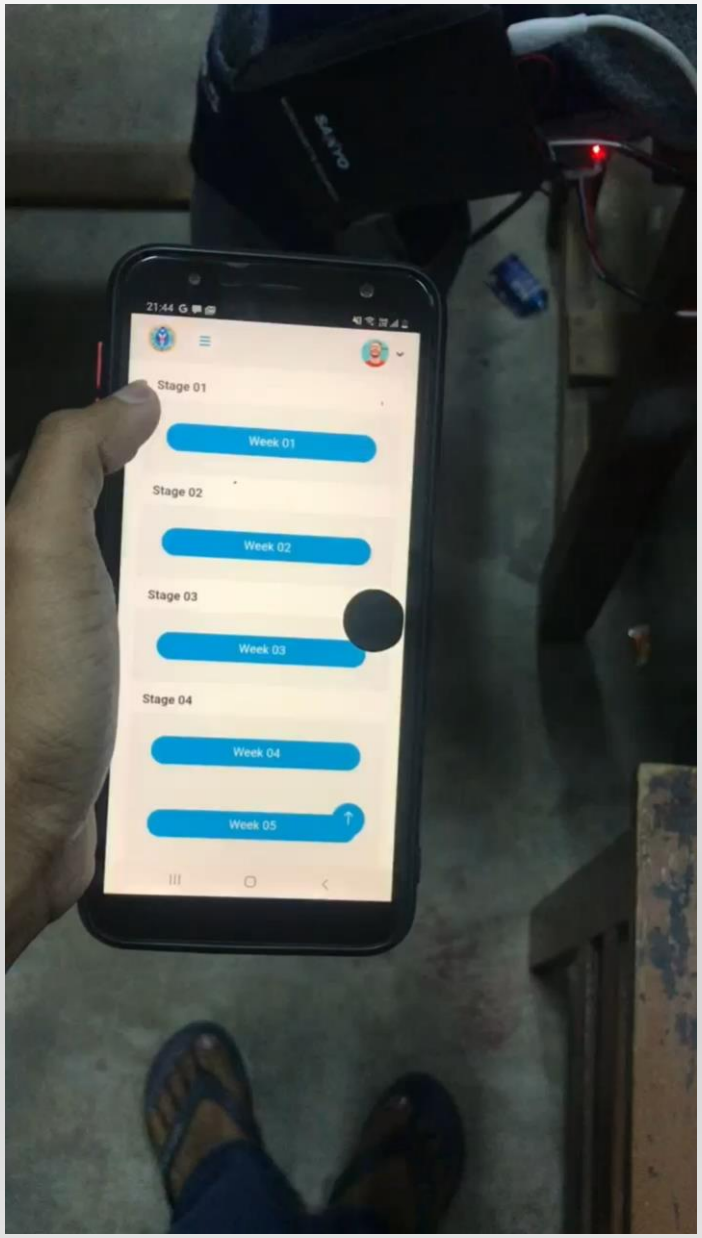


Figure 06: User interface for weekly analysis

03 RESULTS AND FINAL OUTCOME



04 FUTURE IMPROVEMENTS

Expand App Functionality

1.Additional Weeks for ACL Surgery: Extend the app's capabilities to include exercises for subsequent weeks.

2.Support for Other Surgeries: Expand to cater to other knee surgeries such as Total Knee Replacement (TKR) and Meniscus Repair.

3.User Authentication: Add Sign-in and Sign-up functionality to the app. This will allow users to create personal accounts, track their progress.

Modify Hardware Prototype

1.Flexible and Ergonomic Design: Develop a more ergonomic design that conforms better to the knee's natural movement.

2.Wireless Connectivity Improvements: Upgrade to more reliable wireless communication technologies like Bluetooth Low Energy (BLE) 5.0. to enhance data transmission speed.

05 DISCUSSION & CONCLUSION

Discussion

Strengths:

- Provides real-time feedback on knee angle and exercise performance, enhancing adherence and technique.
- Includes clear instructions and video tutorials for effective rehabilitation guidance.
- Tracks exercise repetitions and sets, offering valuable progress data for users.

Challenges:

- Currently limited to the first week of ACL rehabilitation with no support for other surgeries or later stages.
- Needs further development to expand capabilities for other knee surgeries like TKR and Meniscus Repair.

Conclusion

- The device effectively addresses gaps in knee rehabilitation by combining real-time feedback with personalized guidance, improving patient engagement and outcomes.
- Future enhancements will make the device a more comprehensive tool, extending its benefits to a wider range of surgeries and recovery stages.

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THANK YOU