

LEGARD Project Completion Plan

Ricardo Garcia

September 4, 2025

Project Timeline

This document outlines the key milestones and deliverables required for project completion of LEGARD by the target date of December 19, 2025. Goals are organized into two-week periods that align with standard UNM 2R timesheet submissions.

- **Aug 25 – Sep 5:** *Complete 100% core software improvements*
 - Implement high-frequency angle measurement and calculate instantaneous angular velocity.
 - Migrate all data handling to the new CSV format.
- **Sep 8 – Sep 19:** *Complete 100% final hardware implementation*
 - Complete hardware build, including assembly of the power system and perform the UI screen integration mounting and configuration.
 - Finalize permanent micro controller wiring for the COP system.
- **Sep 22 – Oct 3:** *Complete 50% UI enhancements, Complete 50% routine re-implementation*
 - Finalize UI improvements including integrated data visualization (COP + Angle) and ensuring smooth graphics during routine.
 - Begin re-implement the routine logic to run on the final hardware configuration with the new data collection.
- **Oct 6 – Oct 17:** *Complete 100% UI enhancements, Complete 100% routine re-implementation*
 - Finalize re-implement the routine logic to run on the final hardware configuration with the new data collection.
 - Finalize improvements to past session management in the History tab.
- **Oct 20 – Oct 31:** *Complete 50% testing and troubleshooting*
 - Conduct initial system-wide testing, mainly for data accuracy and UI bugs.
- **Nov 3 – Nov 14:** *Complete 100% testing and troubleshooting*
 - Address feedback from testing, such as bug fixes and other improvements.
- **Nov 17 – Nov 28:** *Complete 100% documentation*
 - Finalize documentation
- **Dec 1 – Dec 19:** *As needed*
 - Buffer time

Core Software Enhancements

Data Storage Migration to CSV

The application's data storage is being upgraded from plain text (`.txt`) files to a structured Comma-Separated Values (`.csv`) format. The previous method required custom parsing and was error-prone. The new CSV format enforces a standardized structure with headers, making data compatible with analysis tools like Pandas and improving overall robustness.

Live Data Processing Improvements

Data collection is being updated to enhance real-time performance and accuracy.

- **High-Frequency Angle Measurement:** The angle reading is moving from a 1-second interval to a continuous stream. This eliminates on-screen lag and judder, providing the smooth, real-time feedback essential for a rehabilitation device.
- **Instantaneous Angular Velocity:** The velocity calculation is transitioning from an average ($\text{Angle} / \text{Time}$) to instantaneous angular velocity. By using the gyroscope's raw output (v_x, v_y, v_z), the true velocity is calculated in real-time with the formula:

$$v_{ang} = \sqrt{v_x^2 + v_y^2 + v_z^2}$$

This provides superior fidelity and enables advanced metrics like peak velocity.

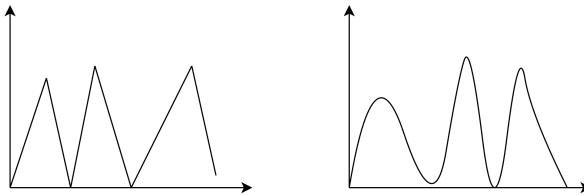


Figure 1: Average vs instantaneous visual

Final Hardware Implementation

The hardware is moving from a temporary testing setup to a final, unified implementation.

- **Unified Power System:** A permanent, single-source power delivery system will be wired and mounted, consolidating power distribution to improve safety and reliability.
- **UI Screen Integration:** The dedicated touchscreen will be mounted to the chassis, connected to the Raspberry Pi, and configured as the primary user interface.
- **Permanent Microcontroller Wiring:** The center of pressure (COP) microcontroller will be soldered onto a perfboard and securely fastened to the device chassis to ensure stable, long-term electrical connections.

Re-implementation of Routine Logic

With the new architecture in place, the final software task is to re-implement the core application logic. This includes:

- **Setup and Calibration:** Re-creating the user workflow for setting session goals.
- **State Management:** Programming the logic to handle active, resting, and failure states during a routine and to correctly save session data to the new CSV format.

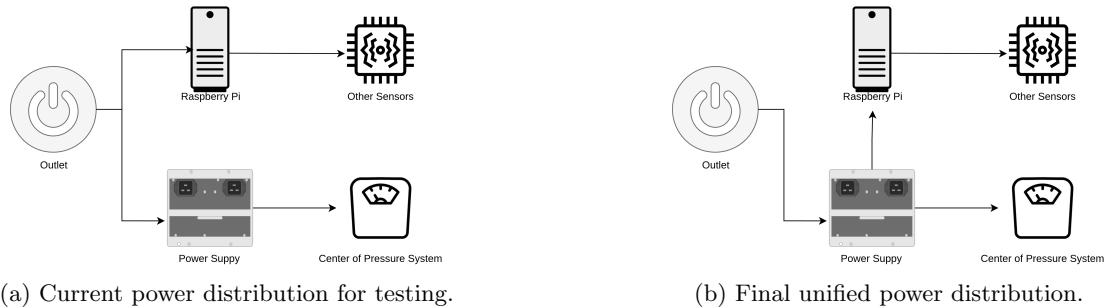


Figure 2: Comparison of power distribution systems.

User Interface and Experience Enhancements

The user interface will be updated to fully leverage the new high-frequency data and improve overall usability.

- **Integrated Data Visualization:** Implement on-screen plots to display both center of Pressure (COP) and angle data simultaneously during the routine, providing comprehensive real-time feedback.
- **Smooth Graphics:** Ensure the new high-frequency angle and velocity data is rendered efficiently to maintain a smooth, non-lagging animation on the live graphs, crucial for an intuitive user experience.
- **Past Session Management:** Enhance the 'History' tab to allow users to directly browse, visualize, and delete past session files within the application, simplifying data management.