

# LEGARD Project Completion Plan

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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 (Angle / 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.

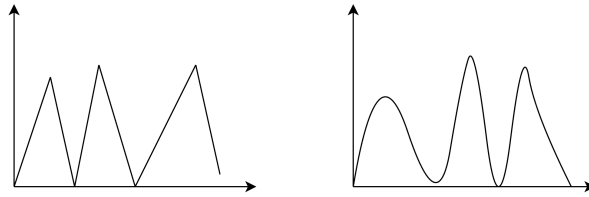


Figure 1: Average vs instantaneous visual

## 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.

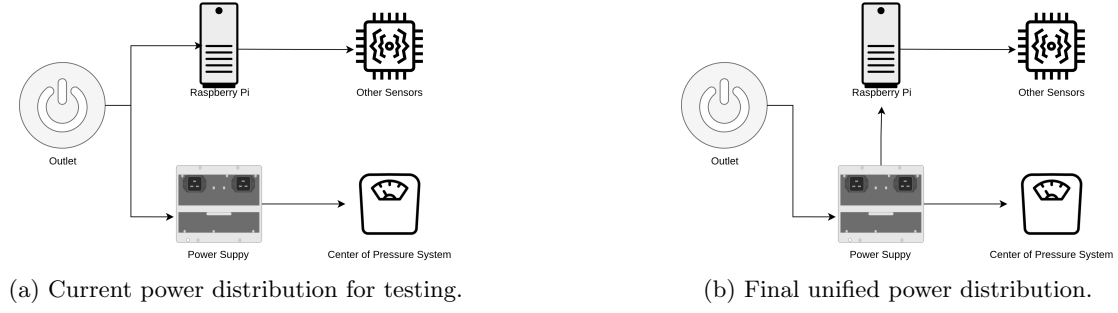


Figure 2: Comparison of power distribution systems.

## 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.