Yechen Zheng

Team 2

Teammates： Bi Zhengyang, Daniel Gonzalez-Lazaro, Liu hongru, Liu Hongfei, Yechen Zheng

Objective

The objective of this work was to demonstrate the use of multiple sensor inputs on a microcontroller to control different types of motors, implement a debounced state transition using a physical switch, and make tangible progress toward the mechanical subsystem of the team's assistive hexapod-style mobility platform. The work also serves as an early integration step toward future locomotion and expressive motion control in the final system.

Individual Progress

For this lab, my primary contribution focused on RC servo motor testing and validation, followed by system-level integration of the servo into the team's final multi-sensor, multi-motor control program.

I began by developing a standalone Arduino test program to verify correct servo wiring, PWM control, and angular limits. This program swept the servo through its operating range to visually confirm motion, identify safe minimum and maximum angles, and ensure stable behavior before integration. This step was necessary to isolate hardware and timing issues prior to combining the servo with other motors and sensors.

After verifying standalone operation, the servo control was integrated into the team's unified microcontroller program. In the final system, the servo is controlled using a potentiometer sensor, with the analog input mapped to a command range of 10° to 180°. This mapping allows the servo to be positioned at any intermediate angle in physical units (degrees), satisfying the lab requirement for continuous position control.

Beyond servo testing, I also contributed to mechanism development by conducting a preliminary leg linkage study for the team's future hexapod platform. Using the PMKS planar mechanism simulator, I explored Klann-style linkages through trial-and-error synthesis to identify configurations that produce smooth foot trajectories suitable for non-wheeled locomotion. This work provides an initial candidate linkage for later integration into the full robot platform.

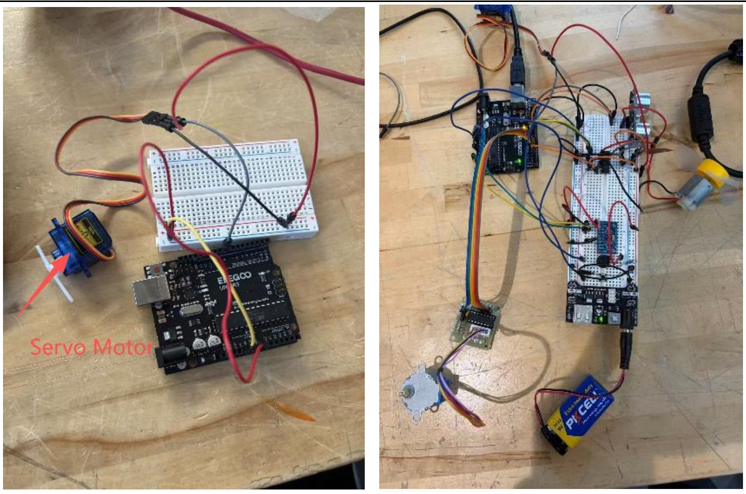

Figure 1&2: Servo Motor Setup & Entire System Setup

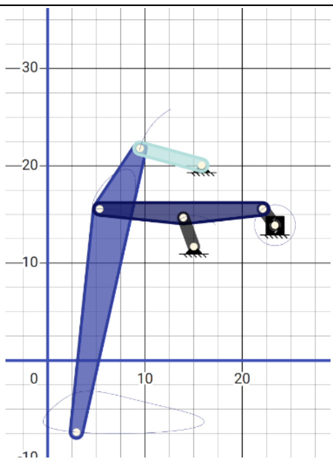

Figure 2: First Version of Linkage

System Integration Context

After individual testing was complete, my servo code and findings were incorporated into the team's final integrated program. The completed system runs as a **single Arduino sketch** and includes:

- Potentiometer → RC servo position control
- Ultrasonic sensor → DC motor speed control via L293D
- IMU (MPU-9250) pitch angle → stepper motor position control
- Debounced pushbutton → RUN/PAUSE state machine

All sensors, motors, and state logic execute concurrently within one program, with serial output structured to support a GUI running on an external computer.

Challenges

The primary challenge encountered during this lab was related to power consumption of the DC motor during integrated operation. When the DC motor was enabled in the full system, the motor drew a sufficiently large current that the overall system could not remain operational for extended periods.

This issue did not appear when testing the servo motor and stepper motor independently, as both were able to operate reliably when isolated from the DC motor subsystem. The problem is therefore attributed to the DC motor's current draw and its interaction with the shared power infrastructure rather than to software logic or control timing.

For the linkage study, the main challenge was identifying link length ratios that produced a smooth and usable foot trajectory without excessive vertical motion. This required iterative tuning and visual inspection in the simulator rather than an analytic solution.

Teamwork

While I focused on servo validation and linkage exploration, other teammates implemented ultrasonic sensing, IMU processing, DC motor control, stepper motor control, and the overall state machine architecture. Once individual components were verified, they were combined into a single integrated codebase.

Plans

The next step is to transition from isolated motor demonstrations to mechanism-level integration. Specifically, I plan to:

- Further refine the selected Klann-style linkage and analyze how it interacts with a rigid platform
- Import the linkage into Gazebo to study body motion, stability, and ground interaction
- Evaluate how servo, DC motor, and stepper motor actuation strategies can support expressive, non-wheeled locomotion for the final assistive mobility platform

This work will directly inform actuator selection and leg architecture for the hexapod system.