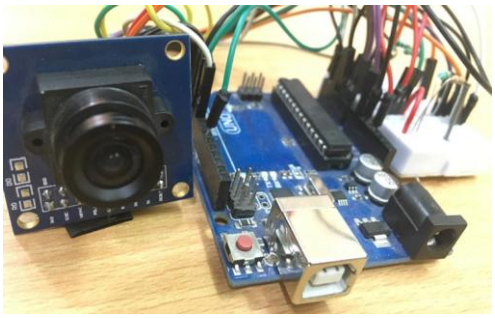
In Week 7, we transitioned from core integration to system optimization and refinement. Our focus shifted toward enhancing responsiveness, ensuring real-time reliability, and establishing modularity across subsystems. The fusion of artistic expression and embedded electronics continued, but now with an emphasis on polish and performance tuning.

SENSOR NETWORK STABILIZATION

We conducted stability testing across the microwave Doppler, PIR, and camera modules, targeting false-positive suppression and improved environmental resilience. Fine-tuning of sensitivity thresholds, coupled with noise-filtering circuitry (capacitor-resistor networks), yielded noticeable gains in motion detection precision. The Doppler sensor's positioning was also revised to minimize echo distortion and enhance directional accuracy.

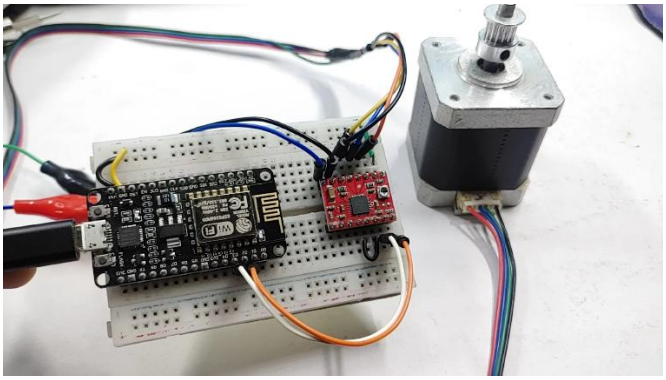
ENHANCED COMPUTER VISION PIPELINE

The ESP32-CAM module was optimized for frame stability and memory management. We introduced a double-buffering strategy to minimize latency during frame acquisition and transmission. Additionally, lightweight motion-detection logic using frame differencing was implemented directly on the device, reducing reliance on cloud-side computation.



MOTOR CONTROL SYNCHRONIZATION

Servo and stepper motor configurations were modularized for reuse across interaction nodes. Using object-oriented code structures within the Arduino IDE, motor routines were abstracted into reusable classes. We integrated end-stop switch logic for the stepper motors, preventing overrun and enabling automatic homing—critical for reset functions in interactive mechanical elements.



CNC SHIELD ADVANCEMENTS

The CNC shield setup was refined to support coordinated multi-axis movement. We successfully tested simultaneous control of X and Y stepper motors with minimal jitter using the DRV8825 driver. Heat dissipation improvements, such as aluminium heatsinks and active cooling, were added to ensure thermal stability under prolonged operation. The integration of limit switches and emergency stop functionality was prototyped, aligning with safety best practices.

INTEGRATED SYSTEMS TESTING

A full-stack dry run was conducted: from sensor trigger to mechanical actuation to visual feedback. System latency averaged below 250 ms, demonstrating near real-time responsiveness. Failover tests, including simulated power loss and network disconnection, confirmed robust fallback routines and recovery without data loss.

UPCOMING OBJECTIVES

- Implement OTA (Over-the-Air) firmware updates for ESP32 modules.
- Add visual debugging dashboards using a WebSocket server for real-time sensor/motor status.
- Begin user-centric testing to gather interaction feedback and fine-tune aesthetic-motion coupling.

Contribution

Shreshth Shukla: Improved the image processing quality of OV7670 camera module connected to ESP32 for better object detection.

Harsh Alok Shah: Synchronize the stepper and servo motor and added end switches.

Ayush Kumar Saw: PIR and doppler modules were fine tuned and noise were reduced.

Aditya Sharma: Improved the CNC shield setup with better heat management.