Thrust Stand Hardware Manual

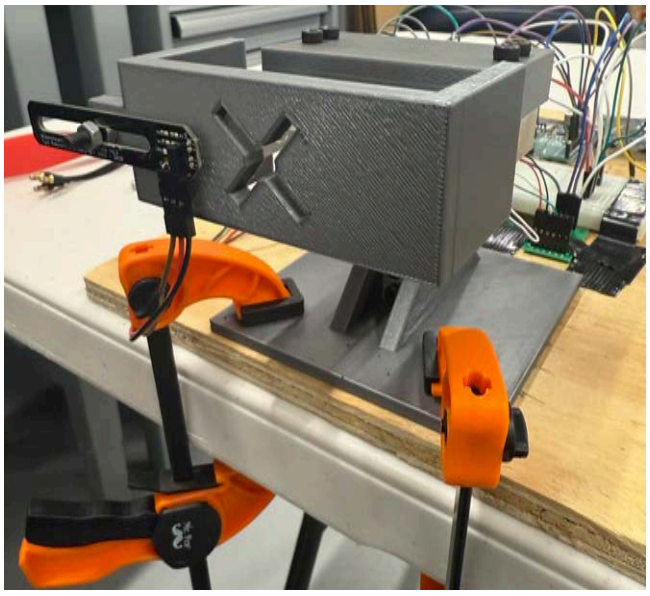
Last Updated: May 6, 2025

This manual guides first-time users through setting up the Arduino-based thrust stand for motor performance testing. It covers unpacking, clamping, motor mounting, wiring, and connections. For software setup, refer to the Software Manual.

1. Unpacking and Initial Setup

1. **Locate the Thrust Stand**:
    - Find the thrust stand in a labeled Amazon box in the ACE Lab.
    - Carefully remove the setup, ensuring no wires are disconnected.
2. **Position the Stand**:

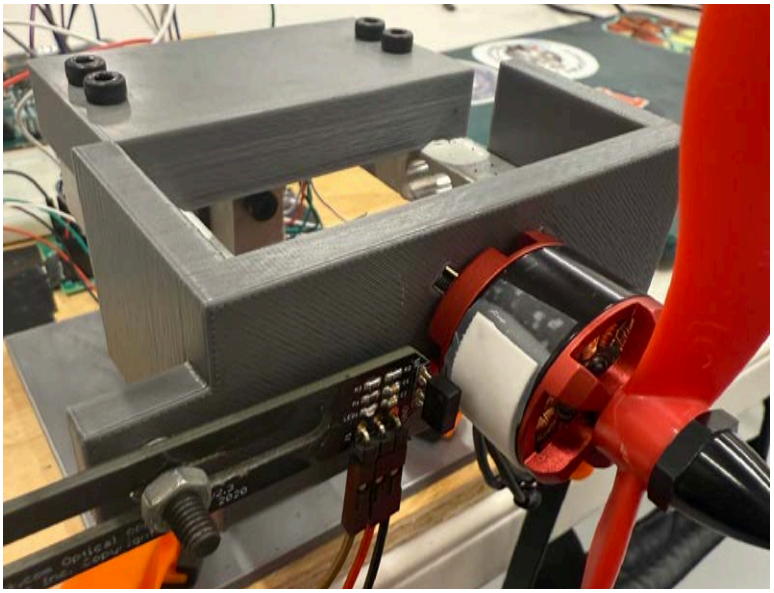
    Place the thrust stand on the edge of a sturdy table.
    - Clamp the grey 3D-printed base plate to the table using the provided wood plate and clamps.
    - Push against the motor mount to confirm the stand is firmly secured.



2. Mounting a Motor

Prerequisite: The thrust stand is clamped to the table.

1. **Detach the Motor Mount**:
    - Unscrew the four black screws connecting the motor mount to the torque load cells.
    - The motor mount will detach from the thrust stand.
2. **Attach the Motor**:
    - Select screws appropriate for your motor (avoid screws long enough to touch internal copper windings).
    - Securely screw the motor to the motor mount.
3. **Optional RPM Testing**:
    - Attach a reflective or white piece of tape to the motor's side for RPM detection.
    - Mount an RPM probe close to the motor (within 1–2 mm) and fasten it to the stand.
4. **Reattach the Mount**:
    - Screw the four black screws back into the motor mount to reconnect it to the torque load cells.

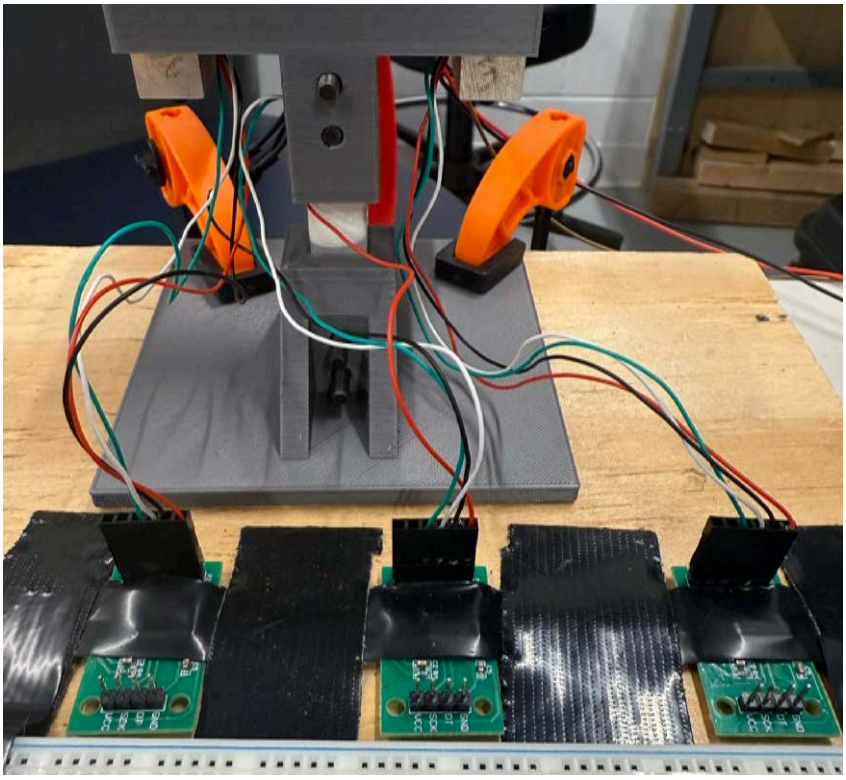


3. Wiring the Thrust Stand

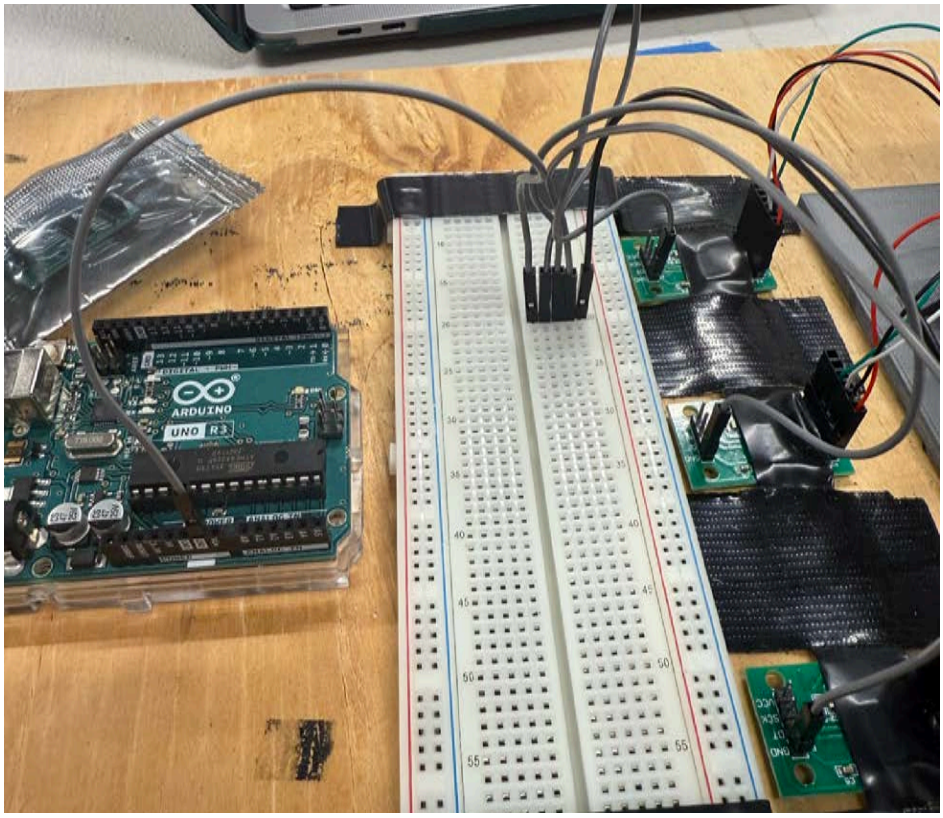
3.1 Load Cell Amplifier Wiring

The thrust stand uses three HX711 load cell amplifiers (left torque, right torque, and thrust), taped to the baseplate. Each load cell has four wires (red, black, white, green) pre-crimped and connected.

1. **Connect Load Cell Wires to Amplifiers**:
    - **Thrust Load Cell**: Middle amplifier.
    - **Left Torque Load Cell**: Left amplifier.
    - **Right Torque Load Cell**: Right amplifier.
    - For each load cell, connect:
        - Red wire to **E+** port
        - Black wire to **E-** port
        - White wire to **A-** port
        - Green wire to **A+** port

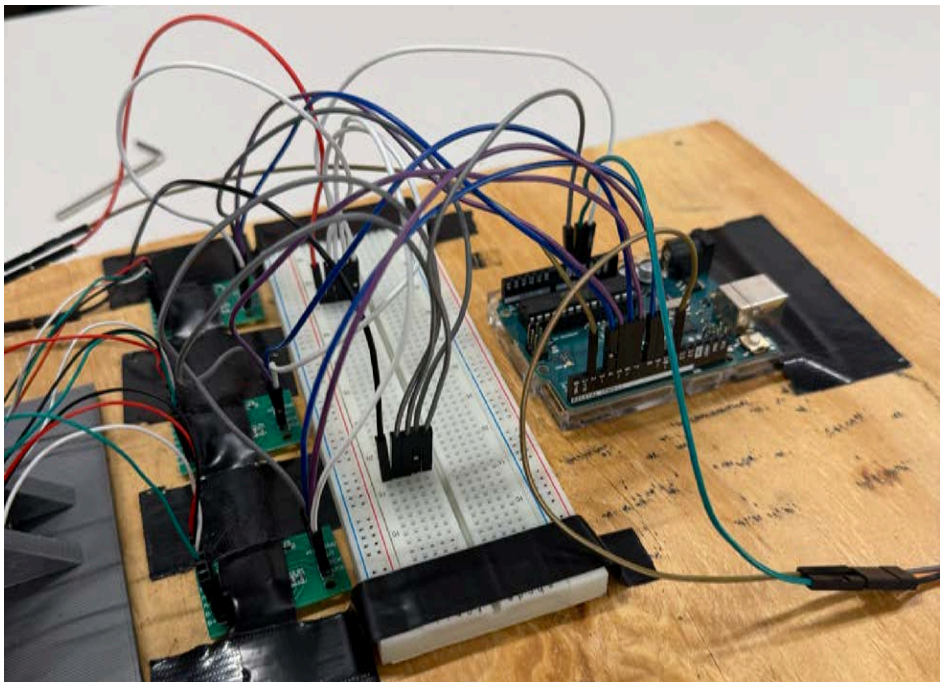


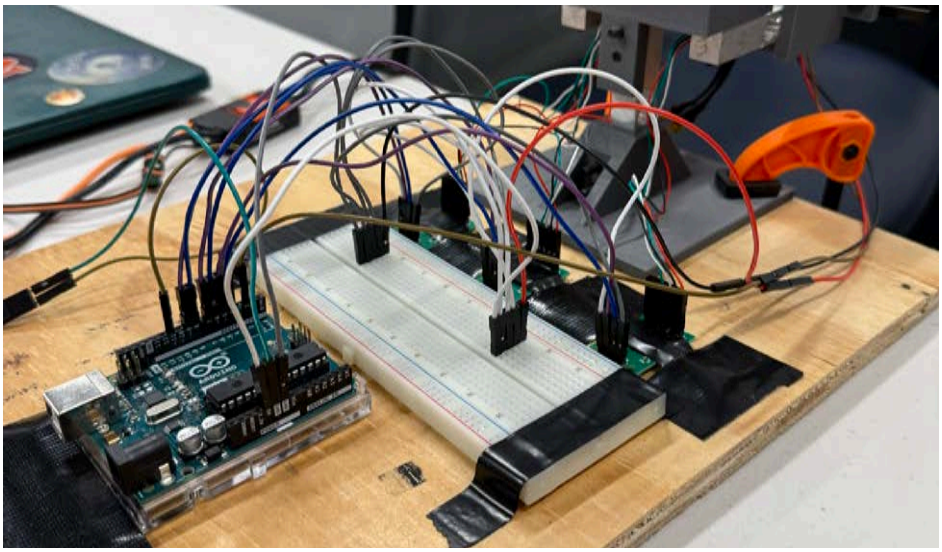
2. **Power and Ground Connections**:
    - **Ground (GND)**: Grey wires from each amplifier's GND port. Connect all in parallel to a breadboard row, then run one wire from the breadboard to an Arduino GND pin (Arduino has two GND pins).
        - Important to note the RPM Sensor is included in the breadboard row (black wire in picture below)



    - **Power (VCC)**: White wires from each amplifier's VCC port. Connect all in parallel to another breadboard row, then run one wire to the Arduino's **5V** pin.
        - The wiring setup is the same as the ground pins. Red wire from RPM Sensor is power. Connect it to the breadboard like the ground connection was
    - **Signal Pins**: Ensure signal pins (e.g., CLK, DOUT) from each HX711 are connected to the Arduino (SEE Appendix A).

- **Final Wiring Setup:**





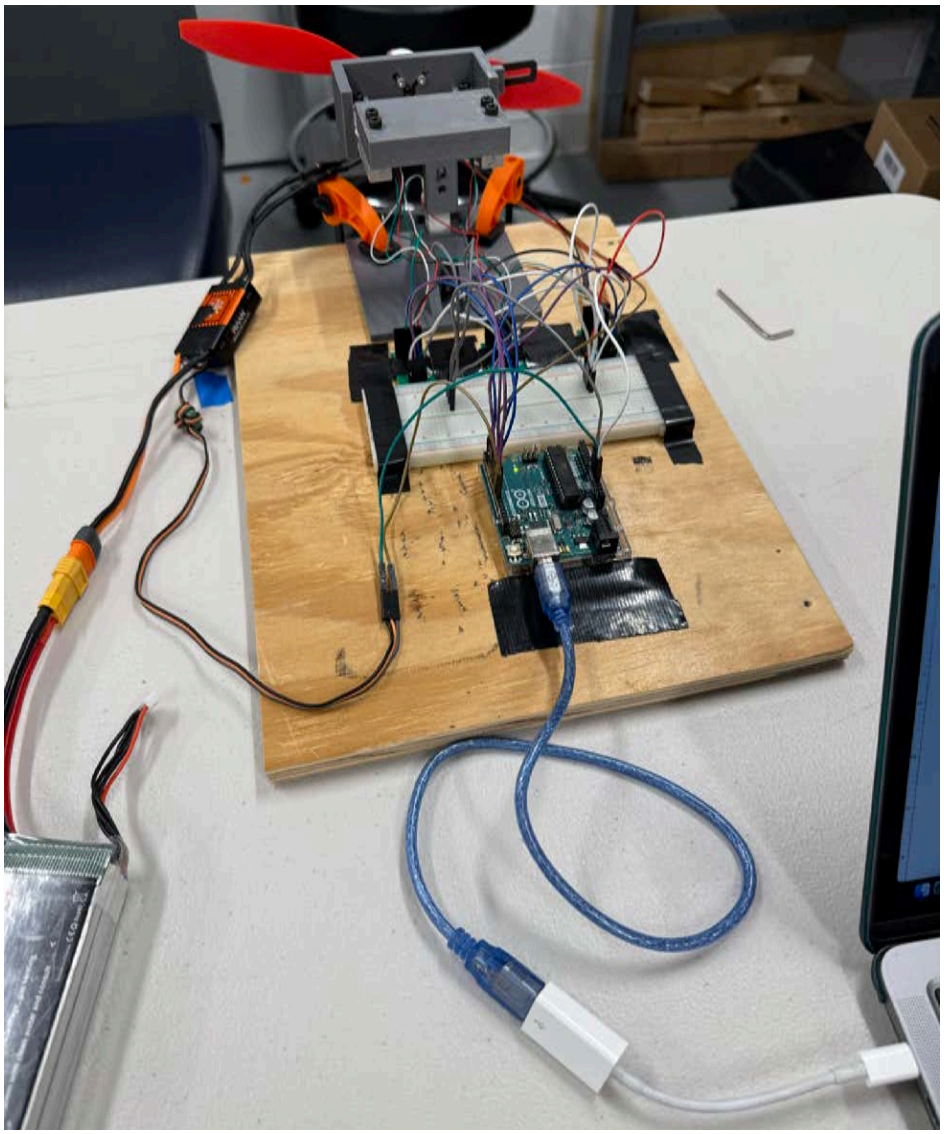
3.2 ESC and Motor Connections

1. **Connect ESC to Arduino**:

   Plug the ESC signal wire (grey wire) into **digital pin 11** on the Arduino.
   - Connect the ESC ground wire to an Arduino GND pin.
2. **Connect ESC to Motor**:
   - Attach the ESC's three wires to the motor in any order.
   - Test the motor spin direction. The propeller should blow air toward you (into the stand). If it spins backward, swap any two of the three ESC wires.
3. **Connect Power**:
   - Plug a LiPo battery (or compatible power supply) into the ESC.
   - The motor will jingle and start beeping. This is fine.

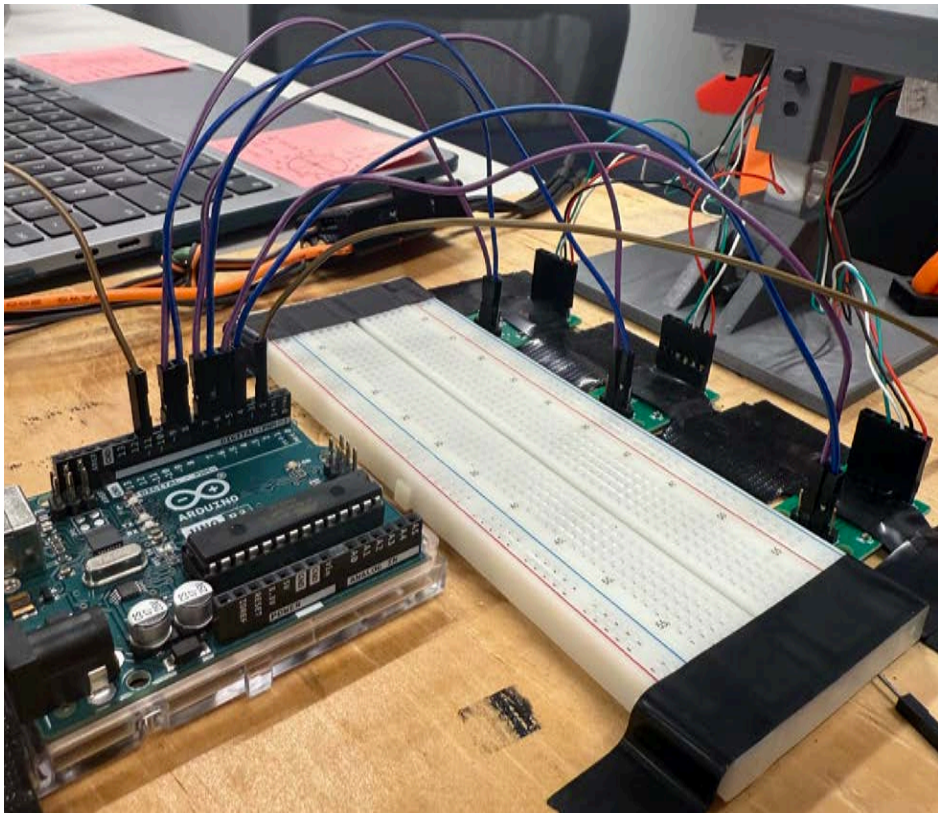
4. Final Steps

- Verify all connections (see Appendix A for schematic).
- Connect the Arduino to your computer via USB cable (blue cable).
- Proceed to the Software Manual for code setup and testing.



Appendix A: Pin Assignments

- **Pin Assignments** : Amplifier —> Arduino DIGITAL Pins
    - HX711 Left Torquet: DT to 4, SCK to ~5
    - HX711 Left Thrust: DT to ~6, SCK to 7
    - HX711 Right Torque: DT to 8, SCK to ~9
    - RPM Sensor: Signal (Brown wire) to pin 2
    - ESC: Signal (ESC's grey wire) to pin ~11
- This is established in the Arduino code: Arduino_ThrustStand.ino



Appendix B: Safety Notes

- Secure the motor and propeller to prevent vibration or detachment.
- The amplifiers are very sensitive. This is why they are taped & secure. Touching or moving during operation can heavily skew results.
- Be sure wires coming out of the RPM sensor are not in the way of the propeller.
    - This applied to the 3 wires connecting the ESC to the motor as well
    - Simply spin propellor to ensure it does not hit any wires before operation
- When using the thrust stand, be sure to have it facing a wall, or at least AWAY from doors & people
- Keep battery close withing arm's reach during operation. Quickly disconnect LiPo from ESC if anything begins to go wrong
    - The Arduino is powered by your computer, but the motor & ESC is solely powered by the battery. Disconnecting it shuts the motor down.
- Be careful with the wires connecting the load cells and amplifiers. While they are attached to the load cell with some white adhesive, this can easily come off
    - Had two load cells become unusable due to a single one of the 4 wires being removed without realizing
- The battery will keeps its charge for a long time, but it doesn't hurt to check its charge once a week