ISIM FINAL PROJECT

Strain Gauge-Based Grip Strength Measurement System

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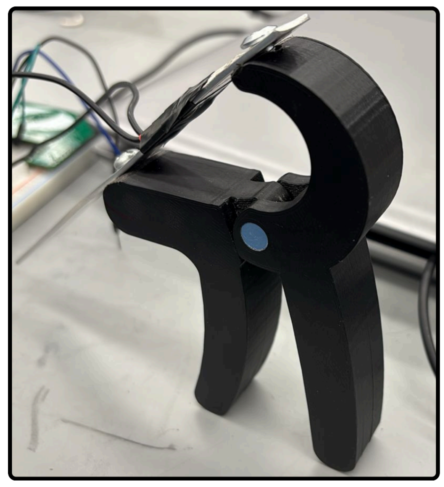
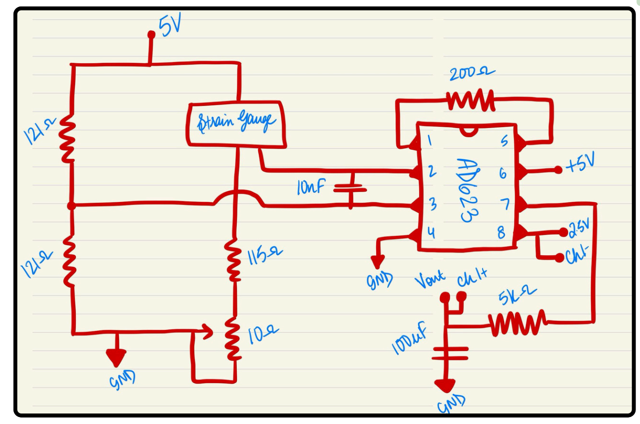
THE MECHANISM:

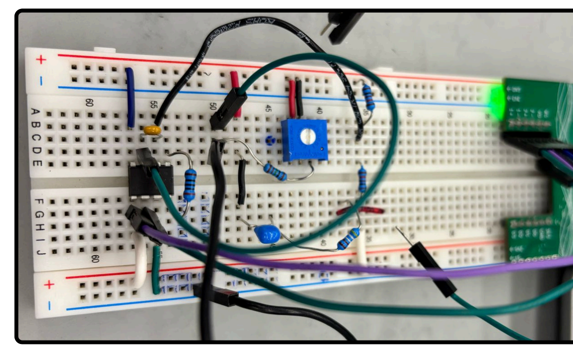
- A strain gauge in a Wheatstone bridge changes resistance under grip force.
- This creates a small voltage imbalance, amplified by an AD623 (gain ≈ 248–501, centered at 2.5V).
- Input filter (10 nF, ~270 kHz) removes high-frequency noise.
- Output filter (5 kΩ + 100 µF, ~0.318 Hz) smooths the signal.
- The resulting voltage is converted to force using a calibrated transfer function.



Grip Strength Hand Exerciser



Circuit Diagram



Built Circuit

KEY EQUATIONS:

Strain Gauge Equation

$$\frac{\Delta R}{R} = GF \cdot \frac{\Delta L}{L} \quad \Rightarrow \quad \Delta R = 252 \cdot \frac{\Delta L}{L}$$

Relates the change in the strain gauge's resistance to the strain caused by deformation; detection of applied force.

Theoretical Voltage Equation

$$V_{\text{out}} = 1251\,V - \frac{300600\,V}{225 + 252 \cdot \frac{\Delta L}{L}}$$

Predicts the output voltage based on the strain experienced by the gauge, providing a theoretical link between mechanical deformation and electrical response.

TRANSFER EQUATION:

The strain gauge and circuit only give us voltage, but our goal is to quantify the physical force applied, making the data meaningful and comparable across users or test conditions.

Calibration Equation

$$F = aV + b$$

This linear equation is derived from calibration data, mapping measured voltage to force based on applied known weights.

Final Transfer Equation

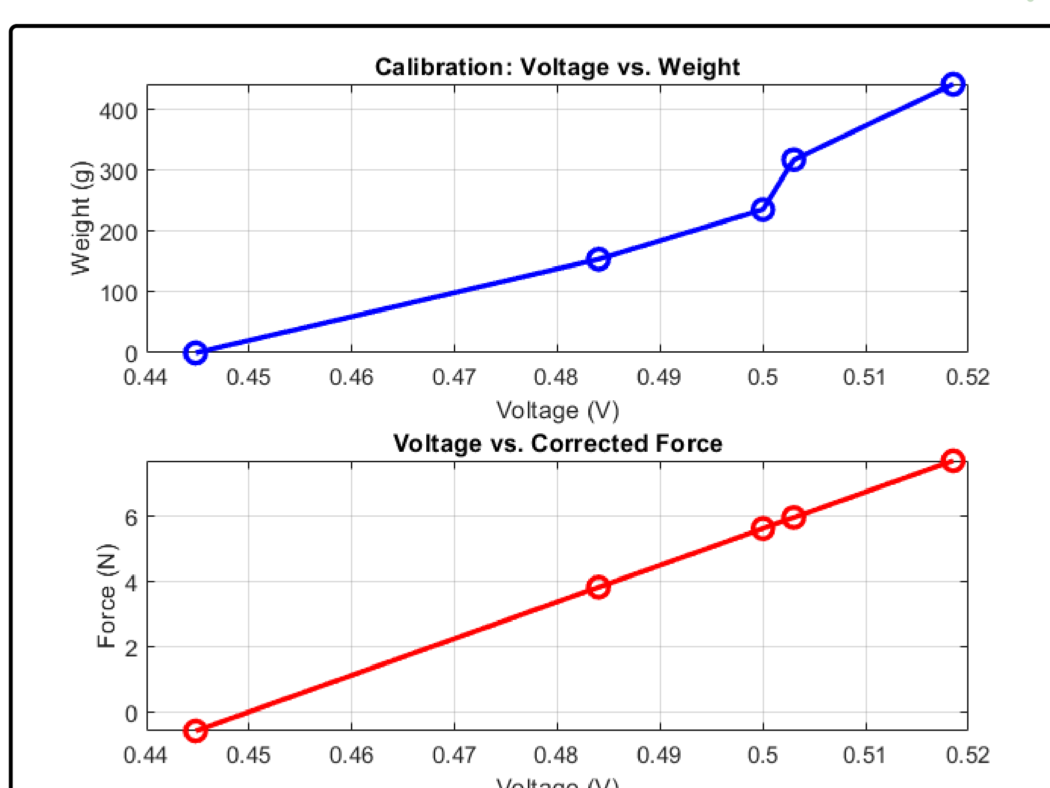
$$F = 2(aV + b)$$

This final equation adjusts the calibrated force to account for the sensor's 45° orientation, giving the true grip force.

RESULTS:

The top plot shows the calibration curve created by applying known weights and recording the corresponding output voltage. We converted weight (g) to force (N) and used linear regression to derive a model relating voltage to force.

The bottom plot applies a geometric correction factor (×2) to account for the 45° sensor angle, producing a corrected force value. This establishes a reliable transfer function to interpret voltage readings as real-world grip force, which is essential for meaningful measurement in practical applications.



Matlab Calibration & Final Voltage-to-Force Mapping