THE UNIVERSITY OF TEXAS AT ARLINGTON

COMPUTER SCIENCE AND ENGINEERING

MECHATRONICS LAB 7 REPORT

ELECTROMECHANICAL SYSTEMS & SENSORS

Submitted toward the partial completion of the requirements for CSE 5355-001

Submitted by,

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Date 11/17/2024

1. . Using the circuit shown in class, connect the HX711 device DATA and PD_CLK lines to the controller. Connect 350ohm fixed value resistors from E+ to A+, E+ to A-, and E- to A+. The intended use of the 4 banana jacks on the strain gauge block is:

   - RED: Excitation + (E+)

   - BLACK: Excitation – (E-)

   - GREEN: Signal + (A+)

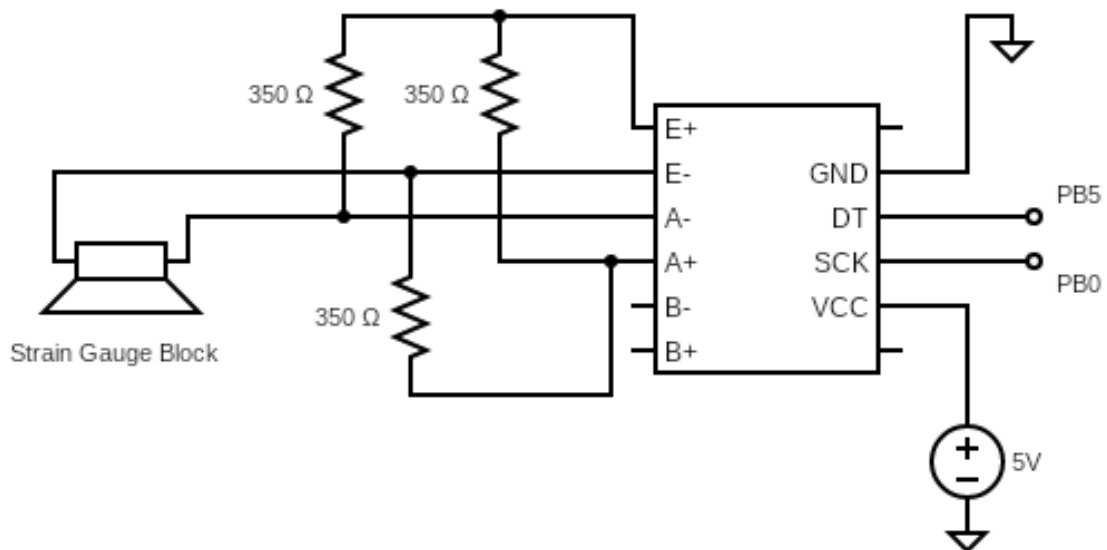   - YELLOW: Signal - (A-)

   Connect the E- to the BLACK banana jack and A- to the YELLOW banana jack on the strain gauge block.

2. Solder 30 AWG bare wires to the strain gauge while it is on a glass plate.
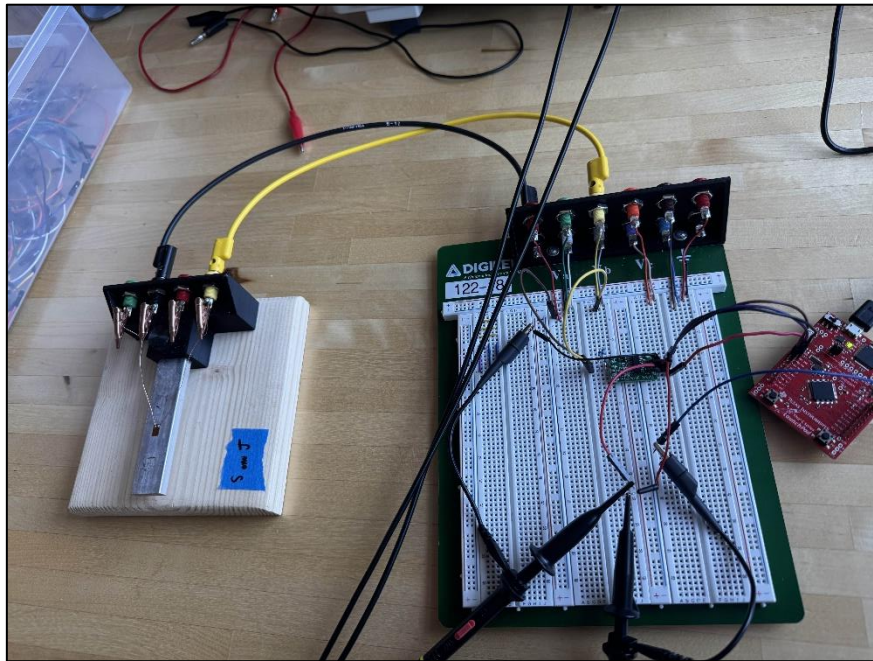

3. Glue the strain gauge to the aluminum beam.

4. Clip the wires to the BLACK and YELLOW banana jack toothless alligator clips.

Circuit Diagram

Circuit Built

5. Configure the clock line as a GPO and the data line as a GPI.

6. Write code to read out the value of the voltage across the A+ and A- in the Whetstone bridge repeatedly using these steps: - Wait for the DATA input to go high indicating the data is ready to be read - Output 24 clocks reading in the data bits from Msb to Lsb order as follows: - Pull PD_CLK high for less than 50 µs in length (if you exceed 60 µs, the HX711 will go to sleep) - Read the DATA line and store the bit in a variable - Pull PD_CLK low for no less than 200 ns - Repeat until all 24 clocks are sent - Output a 25th clock to indicate that you want to sample the A channel with 128 gain

- Display the value to the UART window

Readings	**UART Output**
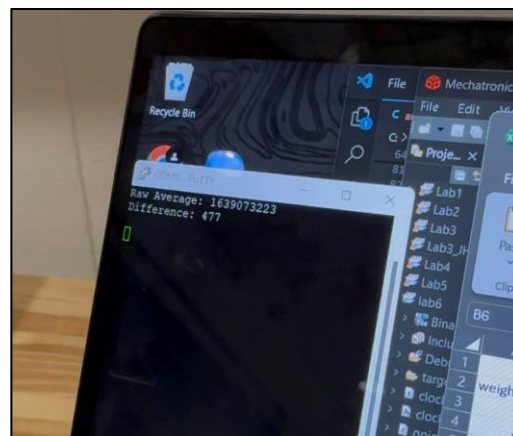
In code, two pins were configured for the clock input and data output of the of the HX711 chip. On the Tiva Board, PB5 was selected as the clock, and PB0 as the data. A function readData() was coded to wait for the data pin to go low, indicating we can start reading, and then proceeds to output 25 clocks. For every clock a read was performed on the data pin, and stored from Msb to Lsb. The 25th clock was not read as this one serves as an indication that we want to sample with 128 gain. Having stored all 24 bits in a uint32_t rawData, this value is returned.

In main, the 50 most recent data samples are stored in a buffer array. This buffer is used to calculate a continuously updating average. The newest value is compared to this average. A significant positive difference indicates the presence of a mass on the beam, and a significant negative difference indicates the removal of mass from the beam. When a positive spike in data is sensed, the code seeks the highest value produced and uses it to calculate the mass in grams and the applied force in Newtons.
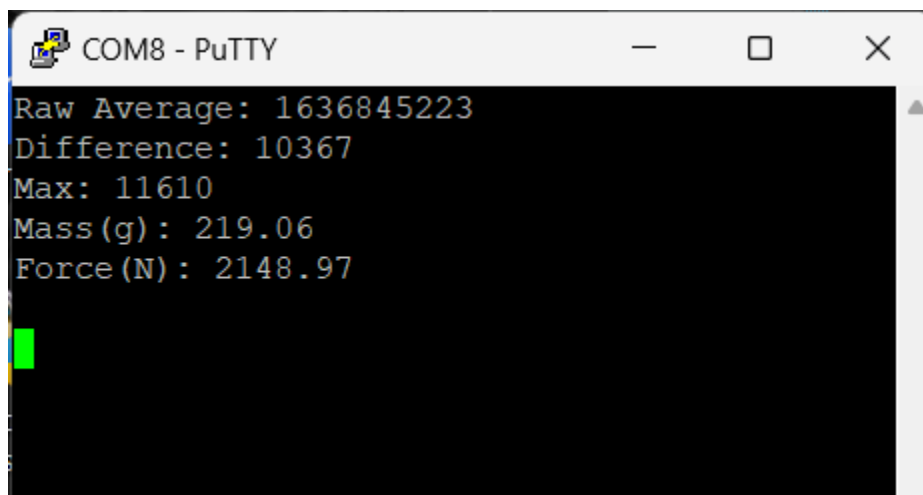
The equations to do so were produced empirically. Several sample outputs of various masses were taken and used to calculate the following linear approximation for calculating mass:

$$mass = 0.0198*(max\ output) - 10.819;$$

Force was then calculated using F=mass*g where g=9.81.

7. **Using the weight from the stepper lab and other items in the lab, empirically derive the equation for converting the 24-bit A/D result to a force in N and mass in g. Add a display of this force and mass to the loop in step 6.**

Displaying Mass & Force

8. Now press on the end of the beam (trying to shorten the beam). What force is detected? What additional strain gauges could be added to eliminate this error?

When pressing on the end of the beam, a compressive force is applied along the length of the beam, it is neither stretching or compressing along vertical axis, but rather compression on the horizontal axis. This force causes the strain gauge to "detect" a change in resistance that does not correspond to an object, or something on top of the beam. The HX711 will interpret this as a force due to the strain on the beam, but it will be a wrong reading.

To fix this, or account for it, an additional string gauge can be used. Having two strain gauges, one on the top and another one underneath, will provide readings that will cancel each other out. When a mass is applying downward force on the beam, the top gauge will experience a stretching force, and the bottom gauge will experience compressive force. This will ensure that a detected change in resistance is happening along the vertical axis of the beam.