CaYPT
Canadian Young Physicists' Tournament

FORCE AND PRESSURE SENSITIVE COMPONENTS: LOAD CELLS

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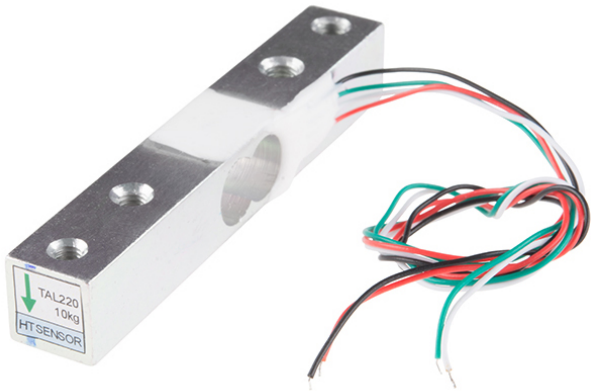
Abstract

In this SOP, the basic functions and operations for load cells are described. The ways to code, wire, and control load cells are detailed..



Contents

1 Overview

Load Cell Overview: The purpose of a load cell is to accurately measure weight/mechanical force. Load cells are usually metal beams with strain gauges inside. When a 'load' is applied to the beam, the strain gauge is bent which changes the resistance. An amplifier (i.e. the HX711) is often used to accurately measure the small change in resistance. [1]

2 Common Load Cell Types

2.1 Strain-Gauge Load Cells

Usually have 4 strain gauges inside. Operate on the principle that when there is an applied load, the resistance in the strain gauge varies which causes a change in output voltage. This change in output voltage is measured and converted using a digital meter to readable values (have a Wheatstone bridge system inside load cell).

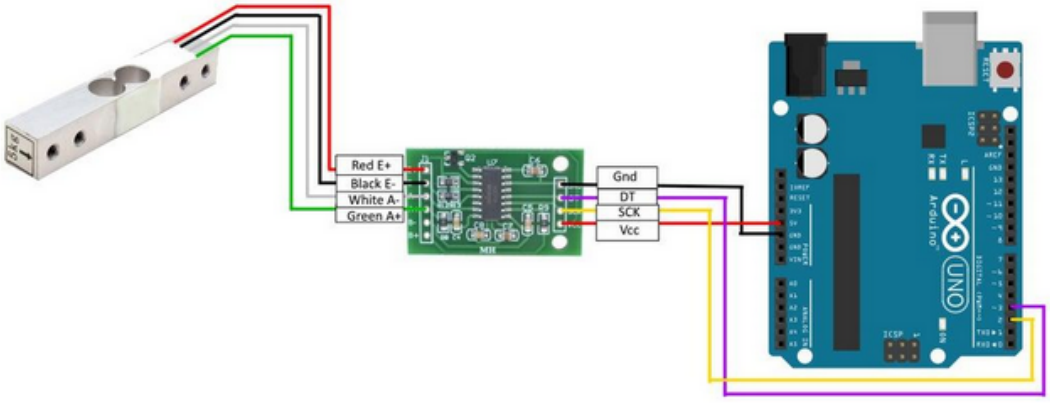
2.2 Hydraulic Load Cells

Work on a force balance principle. They measure weight based on change in pressure of the internal filling fluid. An advantage of this type of load cell is that it involves no electrical components.

2.3 Pneumatic Load Cells

Work on a force balance principle. Pneumatic load cells are capable of measuring 'small' weights. Advantages of this type of load cell is that it is insensitive to temperature changes, and don't contain internal fluids. However, disadvantages include having relatively slow response speeds.

3 How to Wire



1. Connect the load cell to the amplifier by following the diagram above. Note, to connect the ends of the load cell wires to the amplifier, first solder/use heat shrink to bind end of load cell wires to thicker wires and then connect the wires to female to female jumper wires. [2]

2. Use male to female jumper wires to connect the amplifier to the Arduino board.

3. Run the following code on the Arduino IDE.

```
HX711 scale;

float calibration_factor = -1303; //-7050 worked for my 440lb max scale setup

void setup() {
  Serial.begin(9600);
  Serial.println("CLEARSHEET");
  Serial.println("LABEL,Date, Time, Timer, Mass, calibration_factor ");
  Serial.println("HX711 calibration sketch");
  Serial.println("Remove all weight from scale");
  Serial.println("After readings begin, place known weight on scale");
  Serial.println("Press + or a to increase calibration factor");
  Serial.println("Press - or z to decrease calibration factor");

  scale.begin(DOUT, CLK);
  scale.set_scale();
  scale.tare(); //Reset the scale to 0

  //long zero_factor = scale.read_average(); //Get a baseline reading
  //Serial.print("Zero factor: "); //This can be used to remove the need to tare the scale. Useful in permanent scale projects.
  //Serial.println(zero_factor);
}

void loop() {

  scale.set_scale(calibration_factor); //Adjust to this calibration factor
  Serial.print("DATA,DATE,TIME,TIMER,");
  //Serial.print("Reading: ");
  Serial.println(scale.get_units(), 4);
  //Serial.print(" g"); //Change this to kg and re-adjust the calibration factor if you follow SI units like a sane person
  //Serial.print(" calibration_factor: ");
  Serial.print(",");
  Serial.print(calibration_factor);
  Serial.println();

  if(Serial.available())
  {
    char temp = Serial.read();
    if(temp == '+' || temp == 'a')
      calibration_factor += 10;
    else if(temp == '-' || temp == 'z')
      calibration_factor -= 10;
  }
}
```

4. Then to get live readings directly into your excel file, install the PLX-DAQ. The link can be found here.

4 Calibration

To accurately obtain force readings, calibration factor is needed. Setup your scale and start the sketch without a weight. Once readings are being displayed, place a known weight on the cell and press +/- to adjust the readings being shown to match the value of the known weight. Note that the calibration factor may be positive or negative as this depends on the direction the beam deflects from its zero reference.

REFERENCES

[1] Load cell. https://en.wikipedia.org/wiki/Load_cell. Accessed: 2022-05-25.

[2] Arduino scale with 5kg load cell and hx711 amplifier. https://www.instructables.com/Arduino-Scale-With-5kg-Load-Cell-and-HX711-Amplifi/. Accessed: 2022-05-25.