The schematic 1 graph will be used as system to determine hair strength, and the flowchart is also attached. The whole system consists of 6 parts: Arduino, Motor Shield, Stepper Motor, Hair, Strain Gauge and Wheatstone Bridge.

The Arduino and Motor shield will work together to control the operation of stepper motor, and in this case, to exert force on the hair. While force on the hair is applied and increasing, resistance of strain gauge will change, which will then affect the output voltage of the Wheatstone Bridge. By reading Vout (The difference between V1 & V2), the resistance of strain gauge can be obtained, and based on the datasheet of strain gauge, we can conclude the force applied on the hair.

The formula of the Wheatstone Bridge is demonstrated below:

Since R1 & RSG (Resistance of strain gauge), R2 & R3 can form two pairs of voltage divider, V1 and V2 can be represented as:

In addition, since Vout=V1-V2, the only variable in this equation is RSG. By rewriting the equations, the relationship between RSG and Vout is:

In this way, from the strain gauge’s datasheet, we can obtain the values of force exerted on the hair based on the values of Vout. The strength to be measured are based on the 4 locations, which are:

1. Elastic Region
2. 0.2% Offset Yield Strength
3. Maximum Withstand-able Stress
4. Failure or Fracture