HDU-ITMO Joint Institute
杭州电子科技大学 圣光机联合学院

INFORMATION SENSORS
LAB WORK REPORT
For Lab Work №4
“Mechanical Sensors II”

Student Name: Zhu Chenhao

Student ID: 375462

HDU-ITMO joint institute,

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I. The circuit

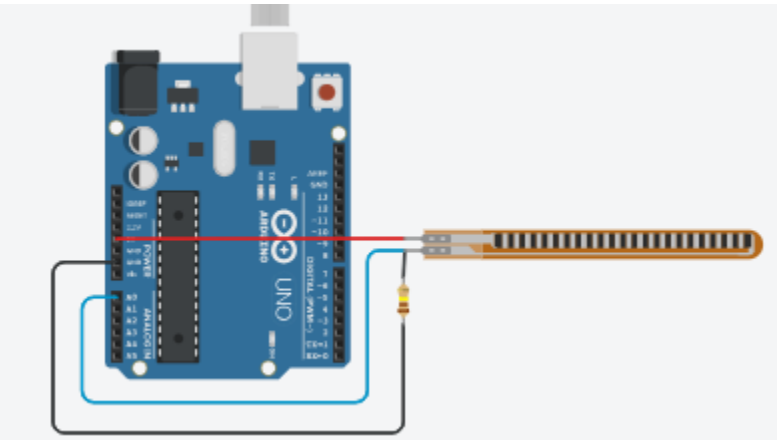

Figure 1. Wheatstone bridge circuit

II. Table 1. Experimental estimation of strain gauge's resistance.

Supply voltage = 5000 mV, Resistance = 107 kOhm

Angle	Voltage divider output	Resistance, calcuted	Resistance, measured	Error
alpha, deg	Vout, mV	Rcalc, kOhm	Rmeas, kOhm	%
0	3905	30.0	30	-0.01%
15	3778	34.6	34.5	-0.32%
30	3646	39.7	39.8	0.16%
45	3499	45.9	45.8	-0.22%
60	3347	52.8	52.7	-0.27%
75	3191	60.7	60.7	0.07%
90	3025	69.9	69.9	0.06%
105	2854	80.5	80.5	0.05%
130	2561	101.9	102	0.10%
150	2326	123.0	123	-0.01%
160	2209	135.2	135	-0.14%
170	2096	148.2	148	-0.17%
180	1984	162.7	163	0.21%

III. Table 2. Measurement of voltage output of the sensor circuit.

Resistance = 107 kOhm

Angle	Output voltage, calculated	Output voltage, measured	Error
alpha, deg	Vout, mV	Vout, mV	%
0	1405	1402	-0.21%
15	1278	1280	0.16%
30	1146	1143	-0.26%
45	999	1001	0.20%
60	847	850	0.35%
75	691	689	-0.29%
90	525	522	-0.57%
105	354	351	-0.85%
130	61	63	3.17%
150	-174	-171	-1.75%
160	-291	-288	-1.04%
170	-404	-405	0.25%
180	-516	-518	0.39%

IV. Calibration plot for the Wheatstone bridge

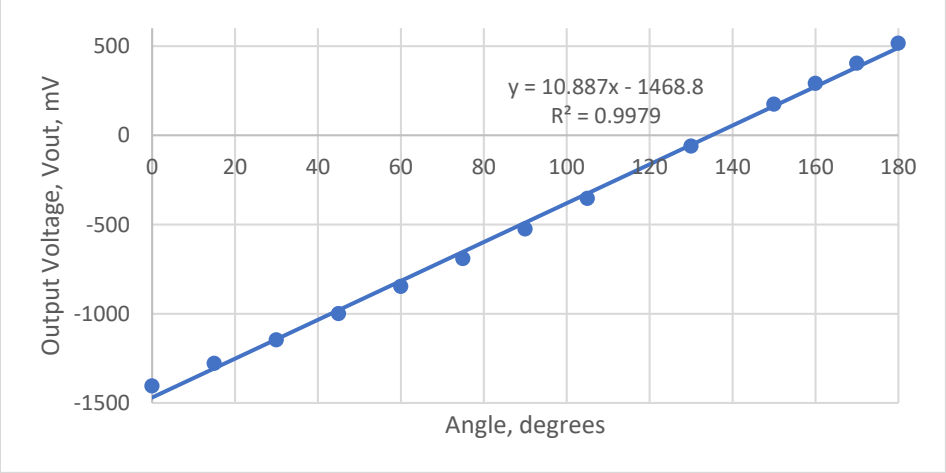

Figure 2. Calibration plot

V. Example of calculation of Wheatstone bridge's voltage output.

$$V_0 = \left(\frac{R_3}{R_3 + R_4} - \frac{R_2}{R_1 + R_2} \right) \cdot V_{in}$$

VI. Circuit's transfer function formula.

$$\mathbf{G} = \frac{\mathbf{R3}}{\mathbf{R3 + R4}} - \frac{\mathbf{R2}}{\mathbf{R1 + R2}}$$

VII. Table 3. Estimation of measured angle and error.

Angle, Measured	Angle, Calculated	Error
0	6	
15	17	-13.33%
30	29	3.33%
45	42	6.67%
60	56	6.67%
75	71	5.33%
90	86	4.44%
105	102	2.86%
130	129	0.77%
150	150	0.00%
160	161	-0.63%
170	172	-1.18%
180	182	-1.11%

VIII. Link to a TinkerCAD project:

https://www.tinkercad.com/things/hG1cxyOkX3G-lab-work-4?sharecode=WKAd8XPX8TGmuGb_x8wMqN21a-uJtNfZ2kHQEjNSkps

IX. The circuit

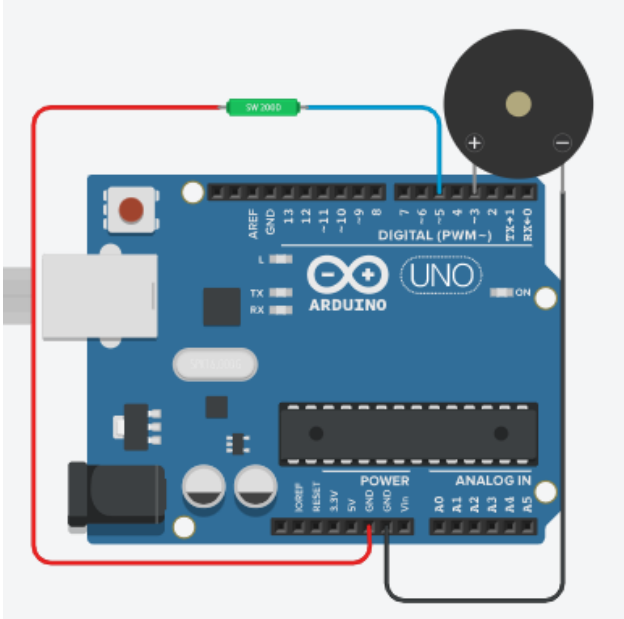

Figure 2. Tilt sensor circuit

X. The code

```
// C++ code
//
int state = 0;
int BUZZER = 3;
int TILT = 5;

void setup()
{
    pinMode(BUZZER, OUTPUT);
    pinMode(TILT, INPUT_PULLUP);
    Serial.begin(9600);
}

void loop()
{
    state=digitalRead(TILT);
    if (state==0)
    {
    analogWrite(BUZZER, 255);
    }
    else
    {
    analogWrite(BUZZER, 0);
    }
    Serial.println(state);
}
```

Figure 3. Code for the tilt sensor circuit

XI. Link to a TinkerCAD project:

https://www.tinkercad.com/things/hG1cxyOkX3G-lab-work-4?sharecode=WKAd8XPX8TGmuGb_x8wMqN21a-uJtNfZ2kHQEjNSkps