PT-100 Project Report

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***Abstract*—This project is a Linear regeression modeling of the voltage-temperature characteristics of the PT-100 using the least squares method. Data is collected using an Arduino Uno and the platformio framework. The model is also verified by the test data.**

1 Training Data

The training data - Temperature, Voltage reading of PT-100 collected from thermometer, arduino is shown in the following table 1.

Temperature (in °C)	Voltage (in Volts)
19	1.88
25	1.91
36	1.94
42	1.96
50	2.00
79	2.12
84	2.14

TABLE 1: Training Data

The circuit diagram that is used inorder to collect the data is shown in the below figure 1.

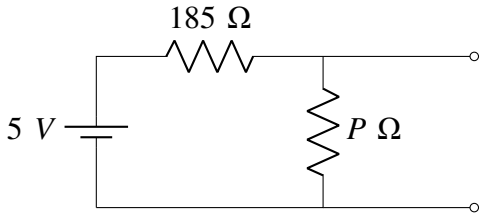

Fig. 1: Circuit Diagram

2 Model

The voltage reading of the arduino for the PT-100 varies with the temperature as follows

$$V(T) = A + BT \tag{1}$$

$$\implies y = \mathbf{x}^\top \mathbf{n} \tag{2}$$

where,

$$y = V(T),\ \mathbf{n} = \begin{pmatrix} A \\ B \end{pmatrix},\ \mathbf{x} = \begin{pmatrix} 1 \\ T \end{pmatrix} \tag{3}$$

Then for multiple points the equation (2) can be written as,

$$\mathbf{Y} = \mathbf{X}^\top \mathbf{n} \tag{4}$$

where

$$\mathbf{Y} = \begin{pmatrix} V(T_1) \\ V(T_2) \\ \vdots \\ V(T_n) \end{pmatrix} \tag{5}$$

$$\mathbf{n} = \begin{pmatrix} A \\ B \end{pmatrix} \tag{6}$$

$$\mathbf{X} = \begin{pmatrix} 1 & 1 & \cdots & 1 \\ T_1 & T_2 & \dots & T_n \end{pmatrix} \tag{7}$$

The aim is to estimate the best fit parameters A, B for the linear model.

3 Solution

We find $\mathbf{n}$ by using the least sqaures method i.e., The value of $\mathbf{n}$ such that error function is minimized.

$$e(\mathbf{n}) = \left\| \mathbf{Y} - \mathbf{X}^\top \mathbf{n} \right\| \tag{8}$$

From python code, The value of $\mathbf{n}$ is given by,

$$\mathbf{n} = \begin{pmatrix} 1.8011 \\ 0.0040 \end{pmatrix} \tag{9}$$

The Linear model relation between temperature and voltage is given by

$$V(T) = 1.8011 + 0.0040T \tag{10}$$

The plot of the training data, linear model curve is shown in the figure 2.

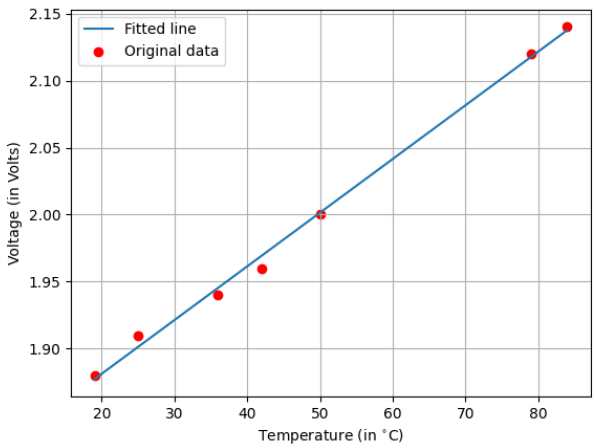

Fig. 2: Model Training

4 Model Evaluation

The data used to evaluate the model is shown in the following table 2.

Temperature (in °C)	Voltage (in Volts)
30	1.92
46	1.98
56	2.02

TABLE 2: Test Data

The test data, linear model curve are shown in the figure 3.

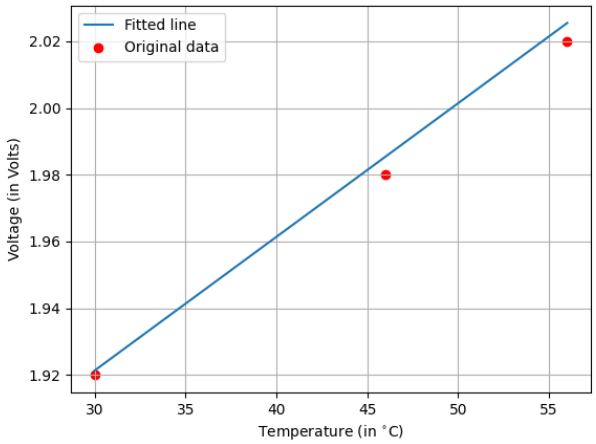

Fig. 3: Model Evaluation

5 Conclusion

In conclusion, this project effectively used machine learning to model the voltage-temperature characteristics of the PT-100, utilizing the least squares method and validating the model through test data. The project showcases the practical implementation of data collection and optimization using python.