Simple Weather Station Using ESP32

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Outline

Aim

Use machine learning to build a simple weather station with a web interface using a PT-100 and ESP32.

Hardware

1. ESP32 microcontroller with Type-B USB cable
2. PT-100 RTD (Resistance Temperature Detector)
3. Breadboard and Jumper Wires
4. Digital LCD Display (JHD 162A)
5. Android phone
6. (Optional) USB 2.0/3.0 Hub

Software

Relevant codes can be found here.

1. In the `client` directory, type `pio run` to generate the firmware to flash to the ESP32.
2. Using ArduinoDroid, flash it to the ESP32 from your Android phone.
3. Run the server by typing `flask run --host=<YOUR HOST IP>` in the `server` directory.

Circuit Diagram

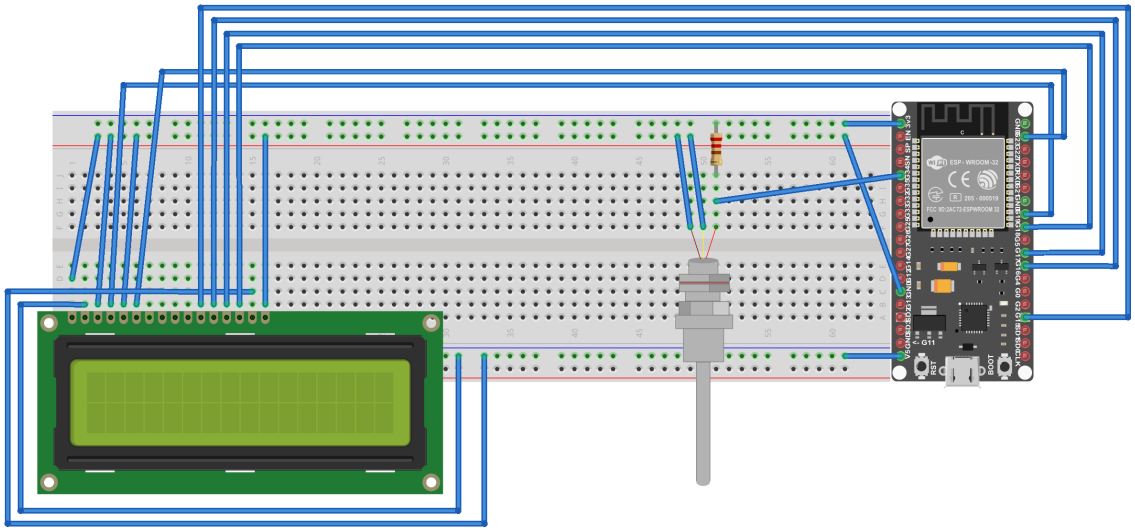

Figure: Setup for Weather Station.

Choice of Pull-up Resistance

Circuit is a pull-up resistor and PT-100 resistance in series across voltage supply V_0. Suppose we want V_T at temperature T across the PT-100 resistor $P_T = P_0\,(1 + \alpha T)$. Then, using voltage division,

$$V_T = \frac{P_T V_0}{P_T + R} \tag{1}$$

$$\implies R \approx P_T \left(\frac{V_0}{V_T} - 1 \right) \tag{2}$$

For this experiment, the pull-up resistance $R = 100\Omega$ (assuming requirement of $V = \frac{V_0}{2}$ at $T = 0°\text{C}$).

Underlying Principles

1. The PT-100 is a resistance temperature detector (RTD),
2. It is governed by the Callendar van Dusen Equation

$$V(T) = V(0)\left(1 + AT + BT^2\right) \tag{3}$$

$$= V(0)\begin{pmatrix}1 & A & B\end{pmatrix}\begin{pmatrix}1\\ T\\ T^2\end{pmatrix} \tag{4}$$

$$= \mathbf{w}^\top \mathbf{x} \tag{5}$$

3. We can use the least mean squares method to find the coefficients.
4. The calculated coefficients are

$$\mathbf{w}^* = \begin{pmatrix}1.568\\ 2.894 \times 10^{-3}\\ -3.975 \times 10^{-6}\end{pmatrix} \tag{6}$$

In-Class Demonstration

Thank You!