Midterm Individual Project

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Temperature Prediction and Fan Control System

1. Introduction

Temperature control is critical in many environments to maintain comfort or protect equipment. In this project, I used Raspberry Pi combine with a DHT11 sensor, which provides ambient temperature and humidity readings. Based on these readings, I create a linear regression model to predict temperature in the future. If this average rises above a set threshold (27.5°C), the system activates a DC motor—acting as a fan—using PWM control through an H-bridge. This integration not only ensures real-time monitoring but also implements a simple control mechanism for environmental management.

2. Objectives

- **Data Acquisition:** Continuously collect temperature and humidity data using a DHT11 sensor.
- **Predictive Modeling:** Apply a simple linear regression model on a sliding window of recent temperature readings to forecast the next temperature value.
- **Control Logic:** Activate a fan through an H-bridge and PWM if the predicted temperature exceeds a preset threshold (e.g., 27.5°C).
- **User Interface:** Provide real-time feedback by displaying current readings, predictions, and fan status on an I2C LCD.

3. Hardware Components

- **DHT11 Sensor:** For measuring temperature and humidity.
- **DC Motor (Fan):** Provides physical cooling when activated.
- **H-Bridge Motor Driver:** Controls the fan by enabling PWM-based speed control.
- **I2C LCD:** Displays sensor data, predicted temperature, and fan status.

4. Software Components

- **Python Programming:** The project is implemented in Python using libraries such as:
    - **RPi.GPIO** for GPIO control,
    - **adafruit_dht** for interfacing with the DHT11 sensor,
    - **board** for pin referencing,
    - **RPLCD.i2c** for LCD communication, and
- **Predictive Model:** A simple linear regression model implemented from scratch calculates the slope and intercept over a sliding window of temperature data.

5. System Architecture and Implementation

1. **Sensor Readings:**
    - The DHT11 sensor periodically provides temperature and humidity values.
2. **Data Buffering:**
    - The system maintains a history of the latest N temperature readings (here I use 5 samples).
3. **Prediction via Linear Regression:**
    - The next temperature value is predicted using the formula: $y_{pred} = intercept + slope \times n$
    - If the predicted temperature is at or above the threshold (e.g., 27.5°C), the fan is activated at a preset PWM duty cycle. Otherwise, the fan remains off.
4. **Feedback Display:**
    - The current temperature, humidity, predicted temperature, and fan status are updated on the LCD in real time.

6. Testing and Results

- **Real-Time Monitoring:**
    - The system reliably reads and displays the sensor data.
- **Control Response:**
    - When the prediction indicates a potential temperature rise above 27.5°C, the fan is activated; otherwise, it remains off.

7. Conclusion

This system is an edge AI system built on a Raspberry Pi that monitors environmental conditions in real time using a DHT11 sensor. It not only reads current temperature and humidity but also predicts future temperature trends using a simple linear regression model. When the predicted temperature exceeds

a defined threshold, the system activates a fan. The current sensor data, prediction, and fan status are displayed on an I2C LCD.

8. Future Work

- **Enhanced Modeling:**
    - Explore more complex predictive models (e.g., ARIMA or machine learning-based models) for improved forecasting.
- **More Sensor:**
    - To detect multiple environment variables for more precise predictions.