Jordan Mitchell

2/20/2025

Professor Moscon

Thermostat Lab: Report

The goal of this project was to develop a smart thermostat prototype that makes use of temperature sensing, user controls, and data transmission. The thermostat cycles through three modes: off, heat, and cool. Then it communicates data via a UART interface. The final product is expected to support Wi-Fi connectivity for cloud integration. This report examines the thermostat's peripheral support, cloud connectivity, and compares three potential architectures: Raspberry Pi, Microchip, and Freescale.

**Peripherals**

The prototype effectively makes use of the required peripherals:

* Temperature Sensor (I2C): For reading room temp and converting it to Fahrenheit.
* LEDs (GPIO):
  + Red LED pulses/fades when heating is enabled. Turns solid when at the set temperature.
  + Blue LED pulses/fades when cooling is enabled. Turns solid when at the set temperature.
* Buttons (GPIO):
  + Green button cycles through the thermostat's three modes.
  + Red button increases the set temperature point.
  + Blue button decreases theset temperature point.
* LCD Display (GPIO): For displaying live date, temperature, and thermostat state.
* UART: To send formatted thermostat data in 30 second intervals to a simulated server.

**Cloud Connectivity**

The prototype does not yet support Wi-Fi connectivity. The final product must integrate with the cloud. Achieving this would involve:

* Using a Wi-Fi-enabled microcontroller or a module capable of UART communication.
* Connecting to a cloud server via an IoT platform like AWS, Google Cloud, etc.
* Sending live temperature and mode updates for remote monitoring and analysis.

**Architecture Comparison**

The Raspberry Pi offers full support for GPIO, I2C, and UART, meaning it is highly compatible with the thermostat’s requirements. However, it requires an external Wi-Fi module unless you use a model with integrated Wi-Fi functionality. Its advantages include high processing power with a power CPU and adequate memory, making it easy to develop applications in Python. On the other hand, Microchip and Freescale architectures are mainly used in embedded systems. These require additional components for complete GPIO/I2C/UART support. While some models contain built in Wi-Fi, they have lower RAM and storage capacity compared to the Pi. Both Microchip and Freescale also require development in embedded C, which can be more complex than the use of Python with Raspberry Pi. Additionally, while Raspberry Pi can be pricey, Microchip and Freescale solutions can be more cost effective depending on the specifics.

**Recommended Choice**

I believe the Raspberry Pi is the best choice for this prototype. Its ease of use in development, great hardware support, and ability to integrate Wi-Fi are all major factors. Microchip and Freescale are good embedded solutions, however, they may require additional components for greater support.

**Conclusion**

I've evaluated the thermostat’s hardware compatibility, potential for cloud connectivity, and compared hardware architectures. The Raspberry Pi is my recommended option due to its expansive support for GPIO, I2C, UART, and scalability. Down the line, the thermostat can be improved with Wi-Fi connectivity and a cloud-based dashboard for real time monitoring, both of which are easily enabled by using a Rasbperry Pi.

References

Voronova, A. (2022, February 3). *Did you know that the Raspberry Pi 4 has more SPI, I2C, UART ports?* Hackaday. <https://hackaday.com/2022/02/01/did-you-know-that-the-raspberry-pi-4-has-more-spi-i2c-uart-ports/>

Uk, A. E. (2024, September 23). *Raspberry Pi GPIO Pins | I2C, SPI and UART*. AB Electronics UK. <https://www.abelectronics.co.uk/kb/article/4/raspberry-pi-gpio-pin-usage>

Nayyar, Anand & Puri, Vikram. (2015). Raspberry Pi-A Small, Powerful, Cost Effective and Efficient Form Factor Computer: A Review. International Journal of Advanced Research in Computer Science and Software Engineering (IJARCSSE). 5. 720-737. <https://www.researchgate.net/publication/305668622_Raspberry_Pi-A_Small_Powerful_Cost_Effective_and_Efficient_Form_Factor_Computer_A_Review>

Slade, M., Jones, M. H., & Scott, J. B. (2011). *Choosing the right microcontroller: A comparison of 8-bit Atmel, Microchip and Freescale MCUs*. <https://www.semanticscholar.org/paper/Choosing-the-right-microcontroller%3A-A-comparison-of-Slade-Jones/db3c684d94b533ebd8869a8c5b37b1c22c88382e>

Parai, M. K., Das, B., & Das, G. (2013). An Overview of Microcontroller Unit: from Proper Selection to Specific Application. In *International Journal of Soft Computing and Engineering (IJSCE)* (Vol. 2, Issue 6, pp. 228–229). <https://www.ijsce.org/wp-content/uploads/papers/v2i6/F1161112612.pdf>

*What are alternatives to Raspberry Pi for industrial computing applications?* (2023b, January 20). Premio Inc. <https://premioinc.com/blogs/blog/industrial-raspberry-pi-alternatives>