

SMART THERMOSTAT

Home Energy Automation
Done Smartly




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Smart Thermostat Project Requirements

Project Overview

The project aims to develop a smart thermostat capable of remote operations via UART, utilizing a modified HTTP request format. It includes encryption for secure communication and simple authentication to ensure authorized access. The system will parse JSON payloads for data handling and apply basic energy-saving algorithms to optimize HVAC system usage.



1. Front End Communication

Detailed Requirements:

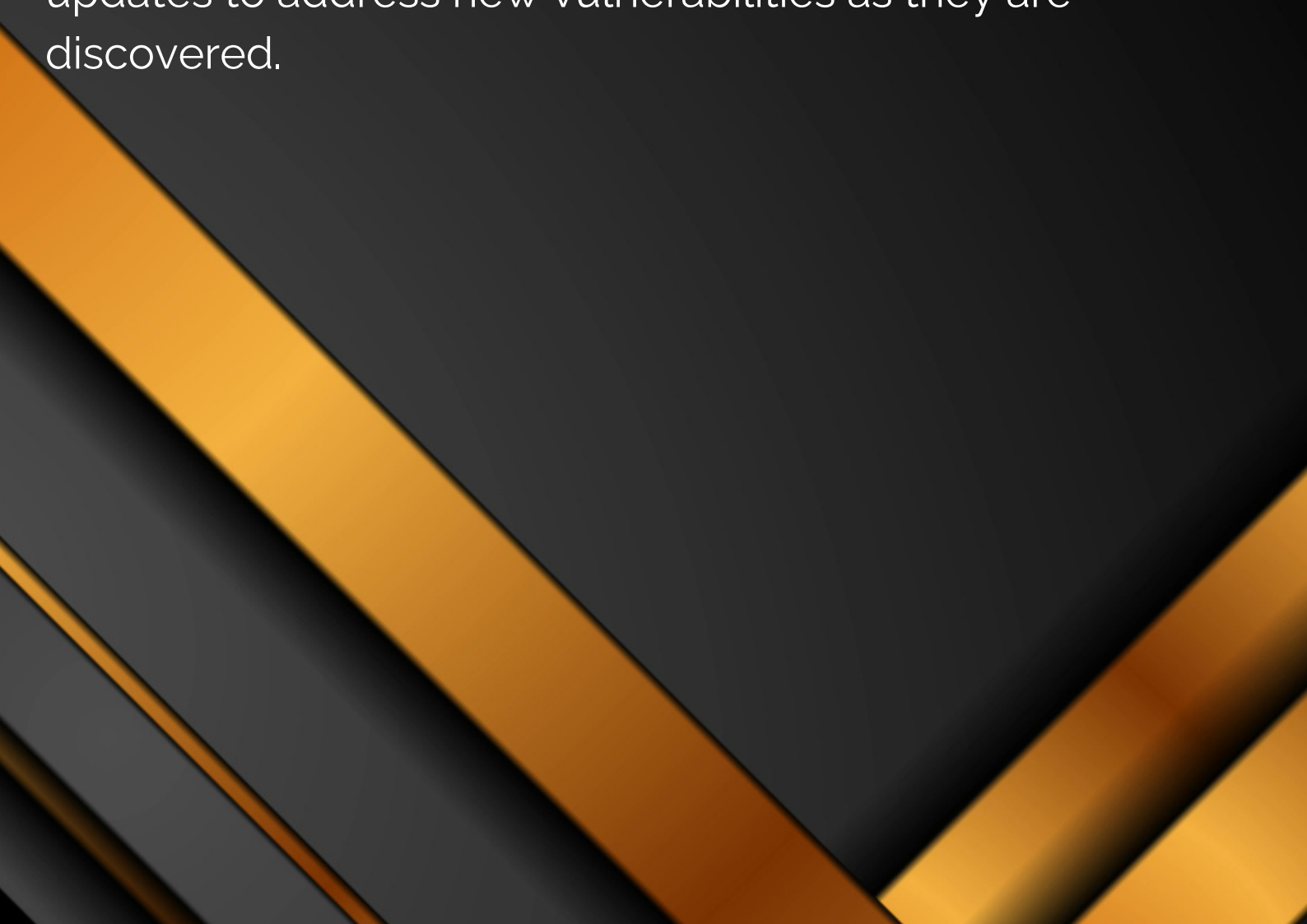
- **Protocol Design:** Develop a custom protocol based on HTTP for UART communication. This protocol should support essential HTTP methods like GET and POST within the constraints of UART's serial communication.
- **Command Structure:** Define a structured command set for temperature control, settings retrieval, and system status updates. Commands should be intuitive and human-readable for ease of testing and debugging.
- **Error Handling:** Implement robust error handling and feedback mechanisms to inform users of invalid commands or communication errors.

2. Security

Detailed Requirements:

- **Encryption Scheme:** Select an encryption algorithm suitable for the low-computational power typically available on embedded systems. This could involve symmetric-key cryptography for efficiency.
- **Authentication Mechanism:** Design a lightweight authentication protocol, possibly based on pre-shared keys or simple token-based authentication, to ensure that only authorized users can make adjustments to the thermostat settings.

Security Audits: Plan for regular security reviews and updates to address new vulnerabilities as they are discovered.



3. Middleware

Detailed Requirements:

3.1 Lightweight Webserver


- **Functionality:** Create a server capable of parsing a simplified HTTP-like request over UART. It should support basic methods and content negotiation.
- **Scalability:** Ensure the server can handle multiple requests in a queue, prioritizing based on urgency (e.g., immediate temperature adjustments over routine status checks).

3.2 JSON Parser

- **Integration:** Incorporate a JSON parsing library or develop a custom parser to handle data serialization and deserialization efficiently.
- **Flexibility:** The parser should support nested objects and arrays to accommodate complex data structures for future feature expansions.


4. Main Application

Detailed Requirements:

- **Sensor Interaction:** Implement a module for accurate and reliable temperature readings. This includes calibration routines and error compensation.
 - **User Commands:** Develop a command processor to interpret requests from the UART interface, adjusting the thermostat's operation as needed.
 - **Scheduling:** Allow users to set temperature schedules, including different settings for specific times of the day or days of the week.
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5. Energy Saving Algorithms

Detailed Requirements:

- **Algorithm Design:** Craft algorithms that adjust temperature settings based on user patterns, outside weather conditions, and time of day to maximize energy efficiency without compromising comfort.
 - **User Preferences:** Incorporate user preference settings into the energy-saving logic, allowing for manual overrides and customized comfort levels.
 - **Adaptive Learning:** Implement basic machine learning or heuristic algorithms to improve energy savings over time based on user behavior and feedback.
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Resources

- Understanding UART Communication
<https://www.maximintegrated.com/en/design/technical-documents/tutorials/2/2141.html>
- HTTP Basics - https://developer.mozilla.org/en-US/docs/Web/HTTP/Basics_of_HTTP
- Introduction to Encryption and Cryptography
<https://www.khanacademy.org/computing/computer-science/cryptography>
- Simple Authentication Techniques
https://www.owasp.org/index.php/Authentication_Cheat_Sheet
- Building a Simple Web Server in C
<https://developer.ibm.com/tutorials/l-lpic1-303-2/>
- JSON Parsing in C
<https://github.com/DaveGamble/cJSON>
- Interfacing Temperature Sensors with Microcontrollers
<https://www.electronicshub.org/temperature-sensors-types-working-principle/>
- Controlling HVAC Systems
https://www.researchgate.net/publication/325930783_Design_and_Implementation_of_a_Wi-Fi_based_Home_Automation_System
- Energy Efficiency Techniques in Smart Home Automation
<https://ieeexplore.ieee.org/document/7879226>