FINAL REPORT FOR SMART THERMOSTAT

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EMBEDDED SYSTEMS DESIGN CDA 4630]

Brief Summary:

The smart thermostat, now fully integrated with Internet of Things (I.O.T) capabilities, optimizes energy usage, and enhances convenience in modern homes. Leveraging sensors for motion and temperature, it dynamically adjusts settings for optimal comfort. With IoT cloud connectivity, users can remotely monitor temperature and control the system with ease.

Table Of Contents

1 Introduction

1.1 Problem Description The problem being addressed is the need for an advanced smart thermostat system that optimizes energy usage, enhances convenience, and integrates seamlessly into modern homes.

1.2 **Significance of the Problem**: This problem is crucial to address due to the increasing demand for energy-efficient solutions in residential settings. An effective smart thermostat benefits homeowners by reducing energy costs, improving comfort, and contributing to environmental sustainability. Existing solutions often lack comprehensive integration, user-friendly interfaces, or efficient energy management algorithms, leading to suboptimal performance and user dissatisfaction.

1.3 **Overview of the Solution**: Our solution involves the development of a fully IoT-integrated smart thermostat system. Leveraging advanced features and connectivity options, the system will include displays on the serial monitor and smaller LCD, along with IoT cloud integration. This will allow users to monitor and control temperature settings remotely, ensuring optimal comfort and energy efficiency.

1.4 **Goals and Objectives:** The goal of the project is to develop an innovative smart thermostat system that meets the diverse needs of modern homeowners. The specific objectives include:

1. Design and implement IoT integration, including displays on the serial monitor and smaller LCD .
2. Develop and deploy cloud integration for remote monitoring and control of temperature settings.
3. Implement advanced energy management algorithms to optimize energy usage based on user preferences and environmental conditions.
4. Design and integrate a user-friendly interface for manual temperature adjustment and system control.
5. Conduct thorough testing and evaluation to ensure the system's reliability, efficiency, and user satisfaction.

2 System Design

Project Requirements

The IOT cloud device shall detect temperature change of(+,-) 0.5^0 F.

Project Requirements Not Met:

Due to voltage requirements and spacing needed on the bread board,

the LCD monitor had to be changed as well as the servo usage amount.

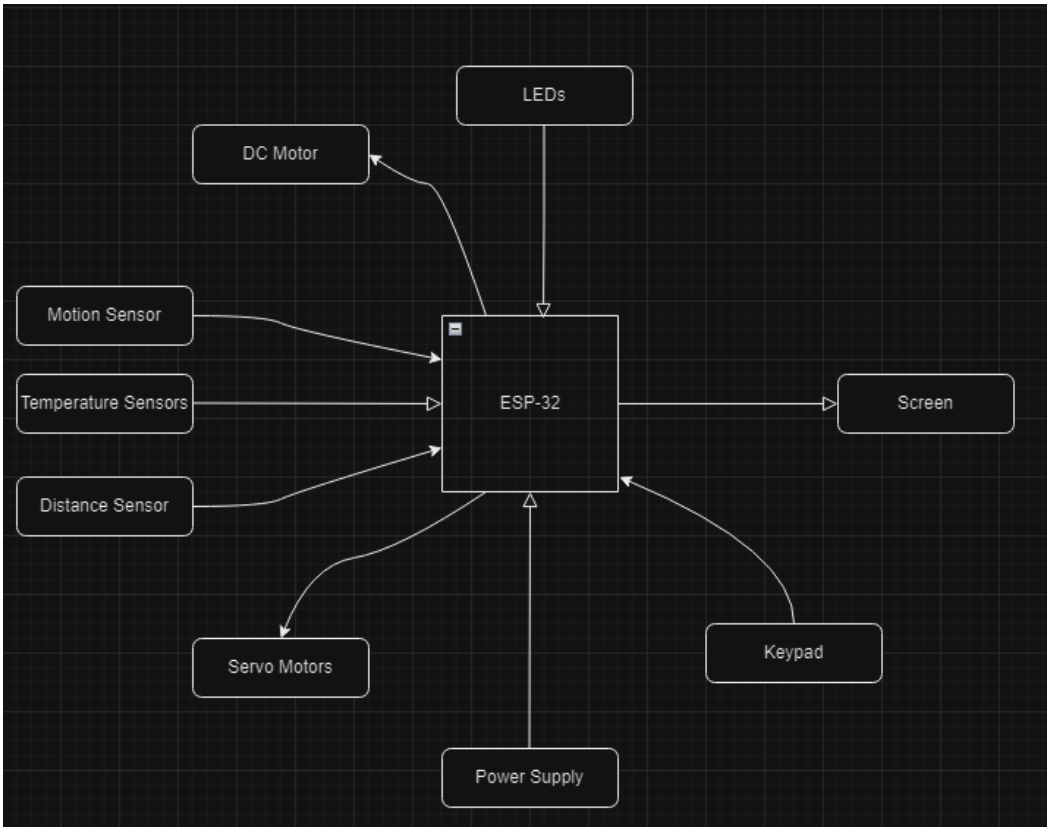
Keypad was removed. The others still functional but not optimal.

Project Requirements Added

The requirements that you did not have in your proposal but were added to the implementation.

was using the IOT for movement, responses, signaling changes in the state of the ESP32,

and more Wifi usage than previously planned. **System Diagram / Sketch:**



3 System Implementation

3.1 **Hardware**

For the hardware implementation, the following components were selected:

- ESP32 microcontroller for processing and connectivity.
- Motion sensor for detecting occupancy.
- Temperature sensors for monitoring room temperatures.
- OLED Display Screen Module for providing a user interface.
- 5V Fan for temperature adjusting.
- LED for status monitoring

Each component was tested and calibrated as follows:

- Team member responsible for testing and calibration: [Michael & Luis]
- Testing and calibration methods: [Arduino IDE, Arduino Cloud]
- Integration responsibility: [Michael & Luis]
- Integration description: [The project integration was performed back and forth between the Arduino IDE and the Arduino Cloud]

3.2 **Software**

The software design includes the development of various modules tailored to the smart thermostat's functionality. These modules include:

Temperature monitoring module

OLED screen module

User interface module

Interfaces to other software and hardware modules were established to ensure seamless communication and operation within the system. Sources of software used include publicly available libraries and frameworks for IoT development.

3.3 **User Interface**

The user interface of the smart thermostat allows users to interact with and configure the system. Users can adjust temperature settings manually through the touchscreen LCD interface. Configuration parameters such as temperature thresholds and scheduling can be changed through intuitive menu navigation.

3.4 **Data Communications**

The communications subsystem plays a crucial role in facilitating data exchange and connectivity. Data collected from sensors are stored locally and can be retrieved for analysis or display on the OLED screen.

Internet connectivity is achieved through the ESP32 microcontroller, enabling remote monitoring and control via IoT cloud services.

4 **Testing and Performance Evaluation**

System Testing Procedures:

- The system underwent rigorous testing procedures to ensure its functionality and reliability.
- Testing included both individual component testing and integrated system testing.
- Each subsystem was tested independently to verify its functionality before integration into the complete system.
- Integration testing was conducted to ensure seamless communication and interaction between subsystems.

Testing Procedures to Verify System Requirements:

- Testing procedures were designed based on the requirements outlined in Section
- Each requirement was tested systematically to ensure com
- Test cases were developed to cover all aspects of system functionality, including sensor accuracy, motor control, user interface responsiveness, and data communication.
- Test results were recorded and compared against expected outcomes to identify any discrepancies.

Performance Metrics Used for Evaluation:

- Performance metrics were established to evaluate the efficiency and effectiveness of the system.
- Metrics included response time for temperature adjustments, accuracy of sensor readings, reliability of motor control, and overall system stability.
- User feedback and usability testing were also conducted.

5 Project Management and Workload Distribution

Name	Effort
Luis Rodriguez-Baz	50%
Michael Bryan	50%
Total	100%

All task and responsibilities were shared.

Referenced materials:

Forums: https://forum.arduino.cc/c/using-arduino/6

https://forum.arduino.cc/c/hardware/12

https://forum.arduino.cc/c/software/164

Troubleshooting: https://docs.espressif.com/projects/arduino-esp32/en/latest/troubleshooting.html

https://docs.espressif.com/projects/arduino-esp32/en/latest/advanced_utils.html

https://docs.espressif.com/projects/arduino-esp32/en/latest/faq.html

Testing: https://app.arduino.cc/