Smart Home Control Unit for Energy Optimization

SDDEC25-08

INTRODUCTION

Problem Statement : Many households—especially low-income residents—struggle with high energy bills due to inefficient heating, cooling, and lighting systems and the high cost of existing smart home solutions. This project develops a low-cost, user-friendly home automation system with multi-zone HVAC control to reduce energy waste, lower expenses, and improve comfort.

Intended Users :

Homeowners – Residents who want an affordable, simple system that lowers utility bills and improves comfort.
Property Managers – Users who need reliable energy tracking to reduce costs and guide upgrade decisions.
Business Owners – Profit-driven users who want to cut energy expenses while improving workplace comfort.
Tech-Enthusiast Homeowners – Homeowners who enjoy advanced technology and want a modern, high-tech automation system.
Contractors – Builders who want to add smart features to new homes without increasing project costs.
Environmentalists – Eco-focused users who want to track and reduce energy usage for sustainable living.
Homeowners with Multi-Room Temperature Needs – Residents who need efficient, customizable temperature control across different areas of their home.

DESIGN REQUIREMENTS

Easy Installation & Communication – Fast setup with clear instructions; reliable Wi-Fi/Zigbee/Z-Wave connectivity.
Power, Reliability & Safety – Low-power operation; stable signaling with error protection; safe line-voltage control with surge protection and relay isolation.
HVAC & Environmental Control – Supports up to eight zones; controls dampers/valves with fail-safe defaults; prevents HVAC conflicts.
Compatibility & Security – Works in old/new buildings; supports standard 24VAC HVAC systems; encrypted and authenticated access.
Monitoring & Hub Performance – Accurate energy measurement with calibration; efficient local server operation with cloud support.
Physical, Aesthetic & Cost – Compact, unobtrusive design; visually compatible with homes; affordable for broad users.
Project Constraints – Limited two-semester development window, restricted budget, and no support for proprietary HVAC buses in the first prototype.

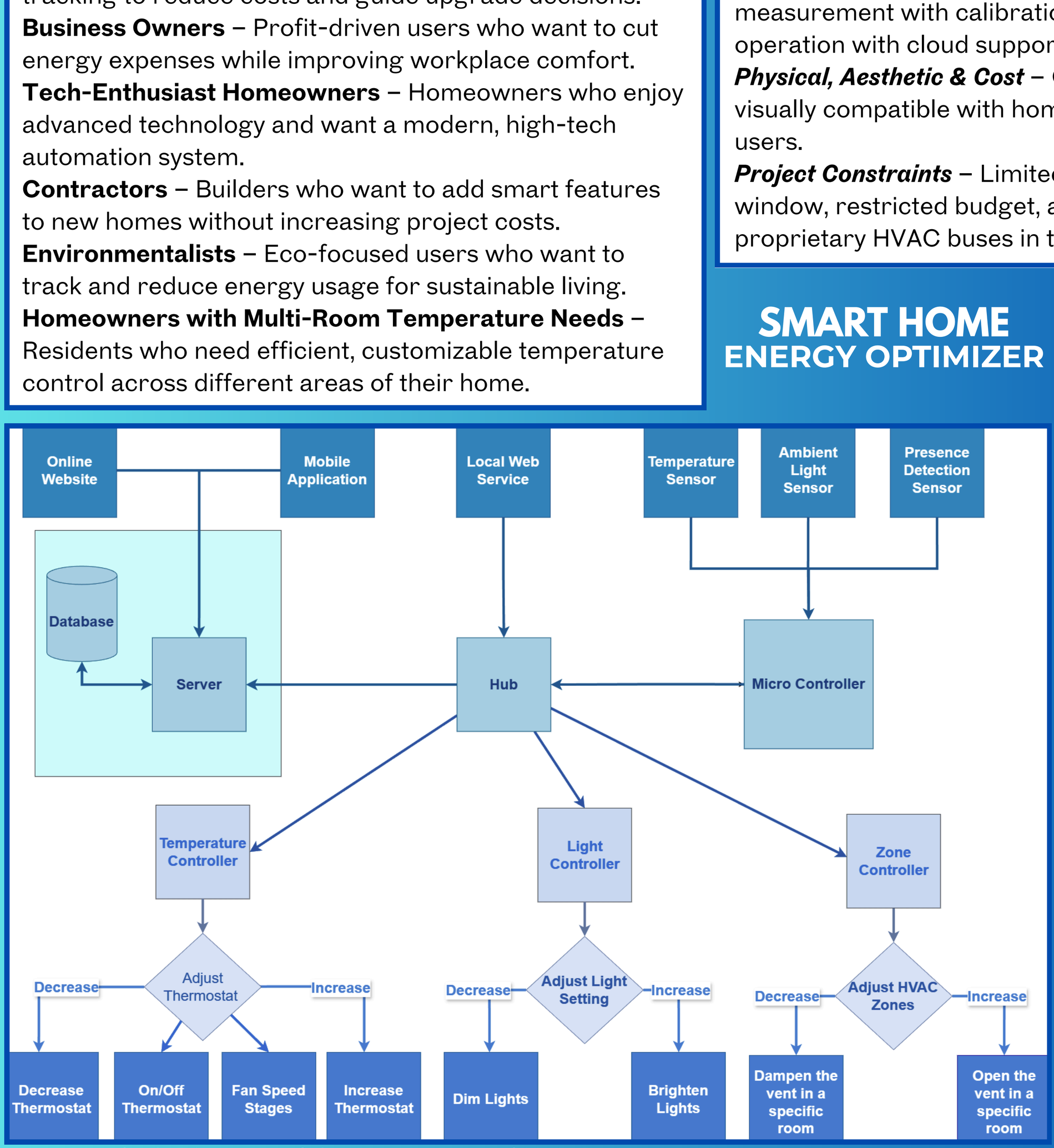

Figure 1: Block Diagram of the Home Control Unit System

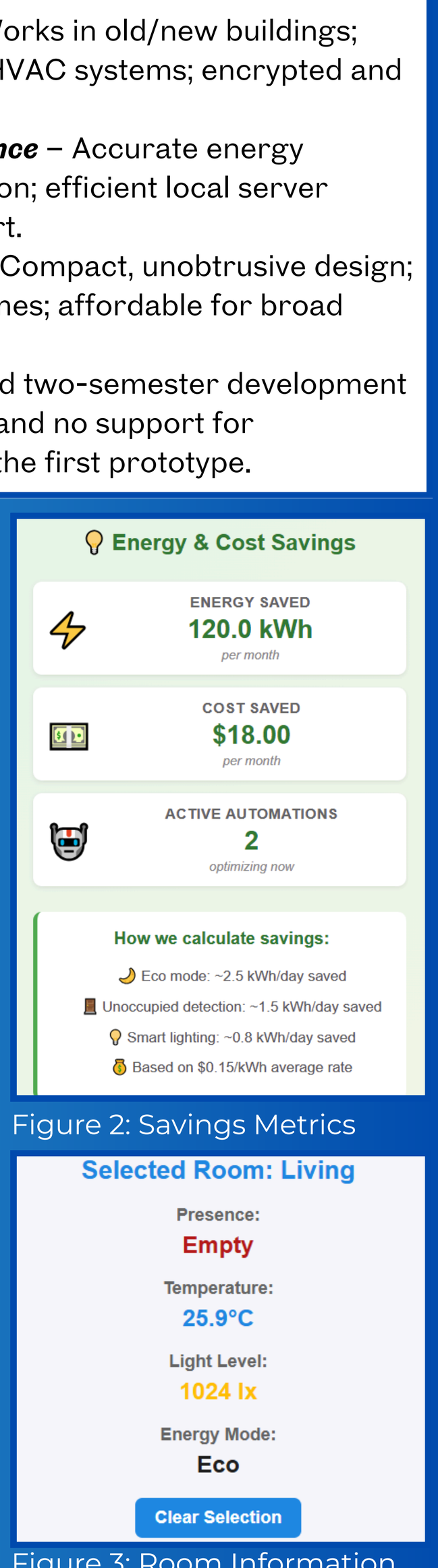

Figure 2: Savings Metrics

Figure 3: Room Information

TESTING PROCEDURE

Unit Testing – Test each hardware module individually (hub, sensors, furnace controller, dimmer, HVAC zone controller) and each software function in the dashboard.
Integration Testing – Verify communication between modules (Hub ↔ Sensors, Hub ↔ Controllers, Dashboard ↔ Server) to ensure coordinated operation.
Regression Testing – Re-test lighting, temperature, presence detection, zone control, and dashboard features after updates to ensure nothing breaks.
System Testing – Run the entire system together to confirm full automation functionality: multi-zone HVAC control, lighting dimming, data reporting, and real-time responses.
User Testing – Have users operate the dashboard and interact with the system to confirm ease of use, reliability, and expected comfort/energy improvements.

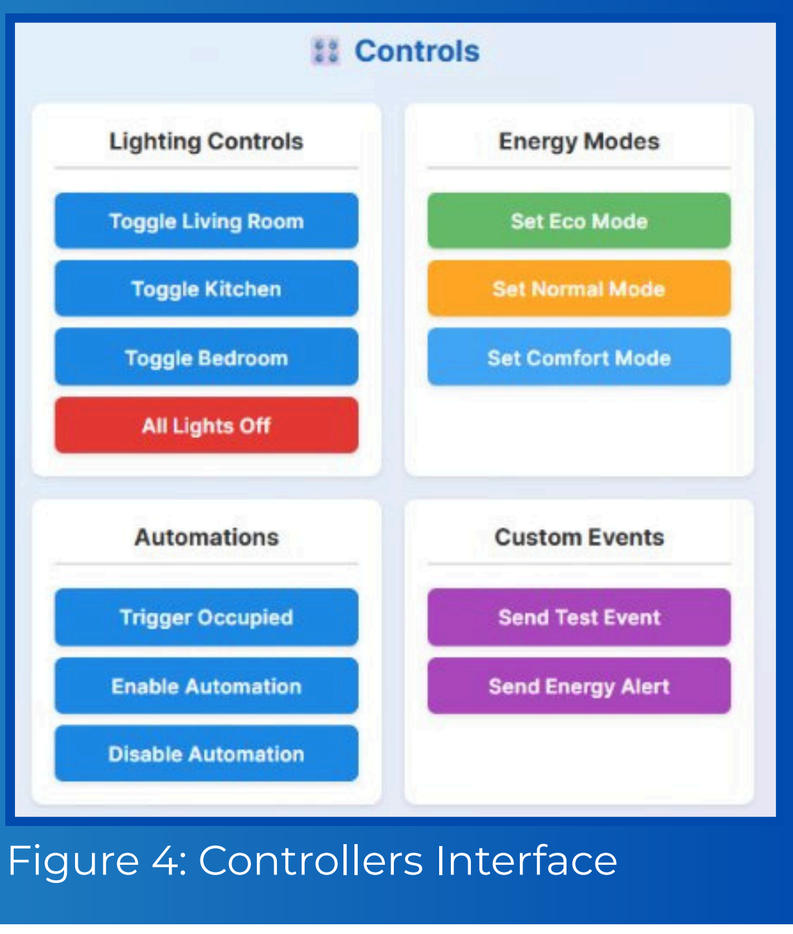

Figure 4: Controllers Interface

PROJECT MEMBERS :
Arie Kraayenbrink, Alexander Ryan, Erik Schmidt, Gamage Binula Karunaratne, Mitchell Jensen, Seth Proctor & Jacob Carnesi

CLIENT & FACULTY ADVISOR :
Md Maruf Ahamed