Smart Home Automation System

A Proposal submitted to the

Department of Electrical and Information Engineering
Faculty of Engineering
University of Ruhuna Sri Lanka

On the 10th of February 2025

In partial completion of the module
EE6352 Embedded Systems Design

By

Surasinghe R.L.D.T.H. - EG/2021/4820
Tharshihan R. - EG/2021/4825
Jackshan Venujan G.S. - EG/2021/4566
Dinojan V. - EG/2021/4487

Table of Contents

Table of Figures

1. INTRODUCTION

1.1 INTRODUCTION TO THE PROBLEM

Home automation has become an essential aspect of modern living, enhancing convenience, energy efficiency, and safety. Traditional home systems require manual operation, leading to unnecessary energy consumption and potential safety hazards. One major challenge in households is the inefficient use of electrical appliances, such as fans and lights, which often remain turned on when not needed. Additionally, gas leaks pose a significant threat, as they can lead to severe accidents if not detected early.

The current reliance on manual control or basic automated systems limits efficiency and response time in emergencies. Many existing solutions lack intelligent decision-making based on environmental factors, leading to unnecessary energy waste and increased electricity costs. Furthermore, conventional safety measures depend on human intervention, making them unreliable in critical situations like gas leaks, where immediate action is required.

To address these challenges, we propose a **Smart Home Automation System** that integrates sensor-based automatic fan speed adjustment, intelligent lighting control, and an emergency gas detection mechanism. The system will use environmental sensors to monitor temperature, ambient light levels, and gas leaks. Based on real-time data, it will adjust fan speed, control lighting, and trigger safety mechanisms in case of emergencies. This automation enhances energy efficiency, improves user convenience, and strengthens household safety.

By implementing this solution, we aim to create an efficient and reliable home automation system that minimizes energy wastage and enhances safety through smart, automated decision-making.

1.2 OBJECTIVE OF THE PROJECT

The main objective of this project is to design, develop, and implement a **Smart Home Automation System** that enhances energy efficiency, convenience, and safety. The system aims to address the inefficiencies of manual control and the risks associated with gas leaks by automating key household functions.

Specifically, the system will:

- **Automatically adjust fan speed** based on temperature sensor readings to optimize cooling and reduce energy consumption.
- **Control room lighting** using an LDR sensor to ensure lights operate only when necessary, promoting energy efficiency.
- **Prioritize cutting the power supply** using the gas sensor upon detecting a gas leak, to prevent hazards, and trigger an emergency response.

1.3 SCOPE OF THE PROJECT

1. **Single-home automation**: The system is designed for individual household automation.
2. **Sensor-based automation**: The system relies on environmental sensors (temperature, LDR, and gas sensors) for automation.
3. **Power cut using gas sensor**: The system immediately cuts the power supply upon detecting a gas leak, prioritizing safety and preventing potential hazards.

This scope ensures a **functional and efficient** smart home automation system while acknowledging its operational limitations.

2. SPECIFICATIONS

2.1 AUTOMATIC FAN SPEED CONTROL

- The system should **monitor room temperature** using a temperature sensor.
- Fan speed should be **adjusted dynamically** using PWM control based on temperature variations.
- If the temperature exceeds a predefined threshold, the fan should automatically **increase speed**, and if it drops, the speed should decrease.
- For DC fans, the system should **switch ON/OFF** instead of adjusting speed.

2.2 AUTOMATIC LIGHT CONTROL

- The system should use an **LDR sensor** to measure ambient light levels.
- If the surrounding light level drops below a certain threshold, the system should **turn ON the lights automatically**.
- If sufficient natural light is present, the system should **turn OFF the lights** to conserve energy.

2.3 EMERGENCY POWER RESPONSE IN CRITICAL SITUATION

- The system should continuously monitor **gas concentration levels** using a gas sensor.
- If the gas concentration exceeds the safe threshold, the system should:
  - **Trigger an alarm** to alert occupants.
  - **Cut off the main power supply** using a relay to prevent fire hazards.
  - **Display a warning indicator** for users.

This ensures the **Smart Home Automation System** operates efficiently by enhancing **energy savings, safety, and convenience** for users.

3. BLOCK DIAGRAM

3.1 PROPOSED SYSTEM

The proposed Smart Home Automation System consists of a microcontroller, temperature sensor, LDR sensor, gas sensor, fan control module, light control module, and an emergency response system, as described in Figure 1. The temperature sensor monitors room temperature and adjusts the fan speed dynamically using PWM signals or ON/OFF switching for DC fans. The LDR sensor detects ambient light levels and automatically controls lighting to optimize energy usage. The gas sensor continuously monitors gas concentration, and upon detecting a gas leak, the system triggers an alarm, warning display, and a power cut using a relay to prevent hazards. The microcontroller acts as the central processing unit, collecting data from sensors and controlling the system accordingly. The warning display provides user notifications, while the alarm system ensures an audible alert for emergency situations. This automation enhances energy efficiency, safety, and convenience within the household.

3.2 SYSTEM BLOCK DIAGRAM

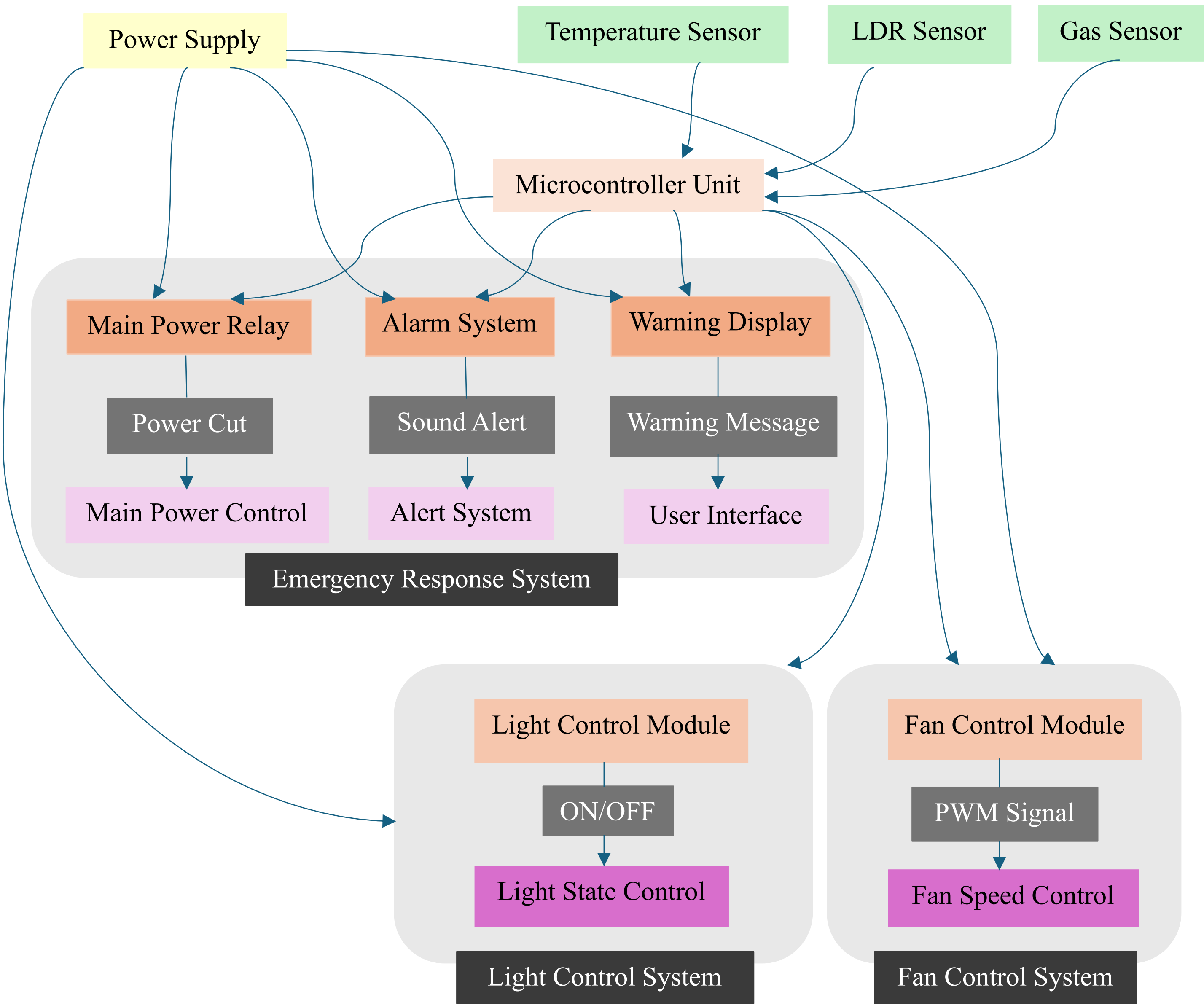

Figure 1-1 : Block Diagram of the system

1. **Microcontroller Unit (MCU)**

Acts as the brain of the system, processing data from sensors and controlling various components.

Takes inputs from temperature, LDR, and gas sensors and executes necessary actions like fan speed adjustment, light control, and emergency responses.

2. **Power Supply Unit**

Provides necessary voltage and current to all components, ensuring stable operation.

3. **Temperature Sensor**

Measures the room temperature and sends data to the microcontroller.

Used to control fan speed dynamically via PWM signals or ON/OFF switching for DC fans.

4. **LDR Sensor (Light Dependent Resistor)**

Detects ambient light levels and helps control room lighting.

If the surrounding brightness is low, it turns the light ON, and if there is enough natural light, it turns the light OFF to save energy.

5. **Gas Sensor**

Continuously monitors gas concentration levels in the environment.

If a gas leak is detected, it triggers an emergency response, including cutting off the power supply, activating an alarm, and displaying a warning.

6. **Fan Control System**

Consists of the Fan Control Module, which adjusts fan speed based on temperature sensor readings.

Uses PWM signals for speed control or switches.

7. **Light Control System**

Comprises the Light Control Module, which decides when to turn lights ON or OFF based on LDR sensor input.

Helps optimize energy consumption by preventing unnecessary use of lights.

8. **Emergency Response System**

Main Power Relay: Disconnects the main power supply in case of a gas leak to prevent fire hazards.

Alarm System: Produces a sound alert to notify users of a gas leak.

Warning Display: Shows visual warnings/messages on a user interface to inform occupants of critical situations.

4. References

1. Tech Trends Shameer, “Smart Exhaust Fan Control using MQ2 Sensor & ESP8266,” *YouTube*, https://www.youtube.com/watch?v=Zznk6X2xGwM (accessed Feb. 06, 2025).

2. “বিজ্ঞান প্রজেক্ট,” *বিজ্ঞান প্রজেক্ট*, 2024. https://bigyanproject.com/en/projects/48-smart-home-project?srsltid=AfmBOooYc9yehsYEYA64RPidrDlze7sz3O-RXm5Y99byQ2-E51BEKSyr&utm_ (accessed Feb. 07, 2025).

3. F. Sampayo, “Key Components for a Smart Home Automation System Explained,” *Schallertech*, Jan. 19, 2024. https://schallertech.com/en/components-of-a-home-automation-system/?utm_ (accessed Feb. 07, 2025).