Home Automation System

A project proposal submitted to the

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

On 16th July 2023

In completing an assignment for the module

EE6304 EMBEDDED SYSTEMS DESIGN

By

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Abbreviations

I/O – Input Output

LDR - Light Dependent Resistors

LCD – Light Crystal Diode

CHAPTER 1 – INTRODUCTION TO THE PROJECT

1 Introduction

1.1 Background

The Home Automation project addresses the need for a more convenient and efficient way to control and manage household objects within a residential setting. Traditional methods of operating appliances and controlling lighting often involve manual intervention, leading to inconvenience. To overcome these challenges, the project proposes the development of a prototype home automation system utilizing embedded systems and advanced technologies.

The project focuses on solving a significant problem: the lack of centralized control over interior objects in modern homes. As homes become more complex, individuals face difficulties in efficiently managing multiple appliances and lighting systems simultaneously. The manual operation of each device becomes time-consuming and burdensome, leading to reduced comfort and productivity.

To address this issue, the project aims to simplify and improve the interaction with various objects within the home. Imagine having a single, user-friendly interface that allows you to effortlessly control all your devices from one place. Whether it's adjusting the temperature, setting the lighting, or activating specific appliances, you can regain control with just a few clicks or voice commands.

By eliminating the need for manual operation of each device, the project saves you valuable time and energy. This enhanced efficiency translates into increased comfort, improved productivity, and a more enjoyable living experience. With a centralized control system in place, you can focus on important tasks while your home seamlessly adapts to your needs and preferences. The Home Automation project aims to revolutionize the way homeowners interact with their living spaces. By providing an intuitive and automated solution to control interior objects, the system enhances convenience, energy efficiency, and overall comfort within the home. With the integration of embedded systems, keypad input, and LDR sensor technology, the project offers a comprehensive solution to the existing challenges faced by individuals in managing their home environments effectively.

1.2 Objectives

The Home Automation System project is to develop an advanced prototype of a home automation system using embedded systems. The project aims to achieve the following specific objectives:

1. Centralized Control: Establish a centralized control system that enables users to efficiently manage multiple appliances, lighting fixtures, and other objects from a single user interface. The inclusion of an LCD display provides an additional visual component for seamless and intuitive control of the home automation system.

2. Seamless Communication: Implement a robust communication network between the user interface, the microcontroller, and the appliances to ensure reliable and efficient transmission of commands. The LCD display, controlled by the microcontroller, acts as an intermediary for displaying relevant information and receiving user input.

3. User-Friendly Interface: Develop a user-friendly interface that combines the keypad and LCD display to provide a comprehensive and interactive control experience. The LCD display can present status updates, menu options, and feedback, enhancing the user's understanding and control over the system's operations.

4. Automatic lighting control: The LDR sensor will enable the system to automatically adjust the lighting levels based on the ambient light conditions. This ensures that the appropriate amount of light is provided in different situations, such as during daytime or nighttime, leading to enhanced energy efficiency and user comfort.

By accomplishing these objectives, the Home Automation project aims to deliver an innovative and comprehensive home automation system prototype. The inclusion of an LCD display controlled by the microcontroller enhances the user interface, providing visual feedback and enabling intuitive control of appliances, lighting, energy monitoring, and other features.

1.3 Scope

The implementation of the Home Automation project has certain limitations and a defined scope, which are as follows.

1. Hardware Compatibility: The system's compatibility is limited to the specified hardware components, such as microcontrollers, keypad and LCD display. Integration with other hardware configurations may require additional considerations and modifications

2. Appliance and Lighting Compatibility: The system is designed to control a specific set of appliances and lighting fixtures. Compatibility with all types and brands of appliances and lighting systems may vary, requiring customization or additional interfaces for seamless integration.

3. Scalability: While the system architecture is designed with scalability in mind, the prototype itself may have limitations in terms of handling a large number of devices or expanding functionalities. Extending the system's capabilities beyond the initial scope may require further development and adjustments

4. User Interface Complexity: The keypad and LCD display provide a user-friendly interface; however, the system may not support advanced graphical user interfaces or sophisticated interaction techniques. Complex visualizations or intricate control mechanisms may fall outside the system's current capabilities.

5. Advanced Artificial Intelligence (AI) or Machine Learning (ML) Techniques: The project scope does not include the implementation of advanced AI or ML algorithms for automated decision-making or adaptive learning. The focus is on providing manual control and intelligent features based on predefined rules and user inputs.

It is important to note that the scope of the project defines the specific boundaries and objectives of the implementation. While the project may have limitations in certain areas, it remains a valuable and functional prototype that addresses the central challenges of home automation.

CHAPTER 2 – SPECIFICATIONS OF THE PROJECT

1 Project Specifications

1) User Roles and Access Control:

    a) The system will have two user roles: Admin and Normal User.
    b) Admin will have full control over all lights and fans.
    c) Normal User will be able to control specific lights or fans assigned to them.
    d) User authentication will be implemented to ensure secure access control.

2) Microcontroller Communication:

    a) The master and slave microcontrollers should communicate seamlessly and reliably.
    b) A robust communication protocol should be established between the microcontrollers.

3) User Interface:

    a) The system will be featured a keypad for user input.
    b) An LCD display will be used to provide clear and understandable feedback to users.

4) Light and Fan Control:

    a) The system will be capable of controlling multiple lights and fans.
    b) Users will be able to turn on/off lights and fans by using the keypad.

5) Sensor Integration:

    a) An LDR sensor will be incorporated to detect ambient light levels.
    b) The system will automatically adjust the lights based on the detected light levels.

6) The final system will be resilient to errors and exceptions.

2 Future Extensions

1) Light and Fan Control:

    a) The system will provide options for adjusting light intensity and fan speed.

3 Preliminary Work

1. Smart Home Automation—Use Cases of a Secure and Integrated Voice-Control System

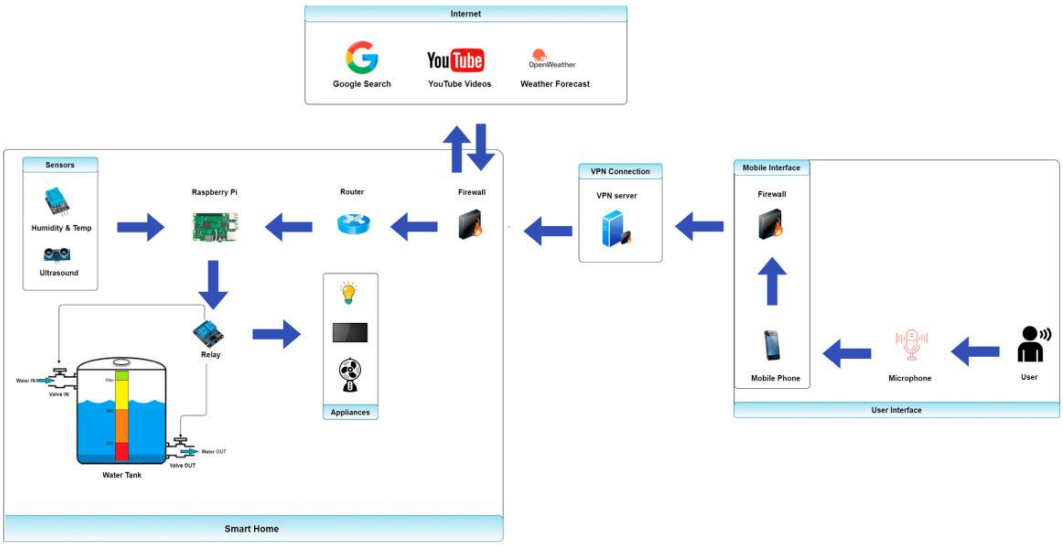

Figure 1: Smart Home Automation System that Use Voice Control System

According to Figure 1, the smart home architecture includes three main components: a secure VPN for connecting devices to the Raspberry Pi, an integrated Smart Home system for controlling various devices, and a Mobile Interface with voice recognition for user commands. These components work together through a secure IoT network to provide a user-friendly smart home experience. [1]

2. An IoT-Based Smart Home Automation System

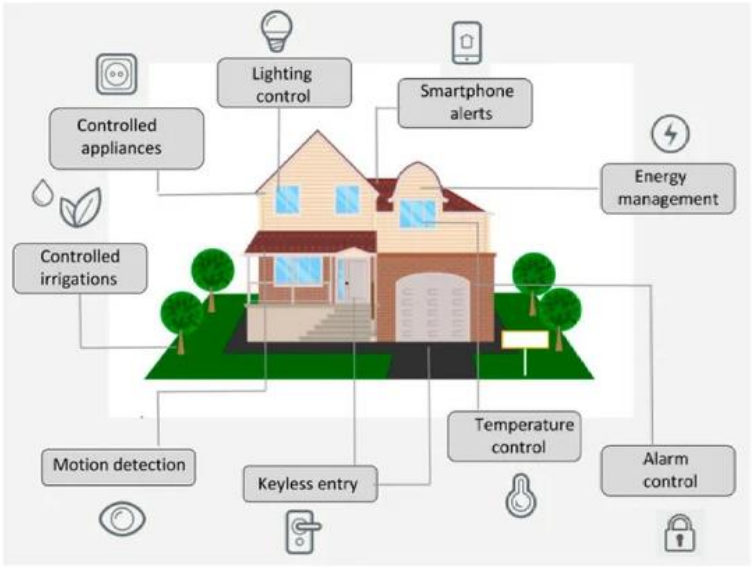

Figure 2: A smart home built on the IOT (Internet of Things) that shows how smart sensing equipment is used for various tasks.

The Internet of Things (IoT) enables devices to be connected and monitored remotely over the Internet. According to Figure 2, this project presents a system for home automation that connects sensors, actuators, and other data sources. It utilizes a versatile API for communication, supporting devices like ESP8266/ESP8285 chips and Raspberry Pi boards. Through a smartphone app, users can control appliances and sensors. [2]

CHAPTER 3 – PROJECT STRUCTURE

1 Block Diagram

The following block diagram in Figure 3 illustrates the components and connections of our home automation system, showcasing the integration of various devices and technologies to create a smart and secure living environment.

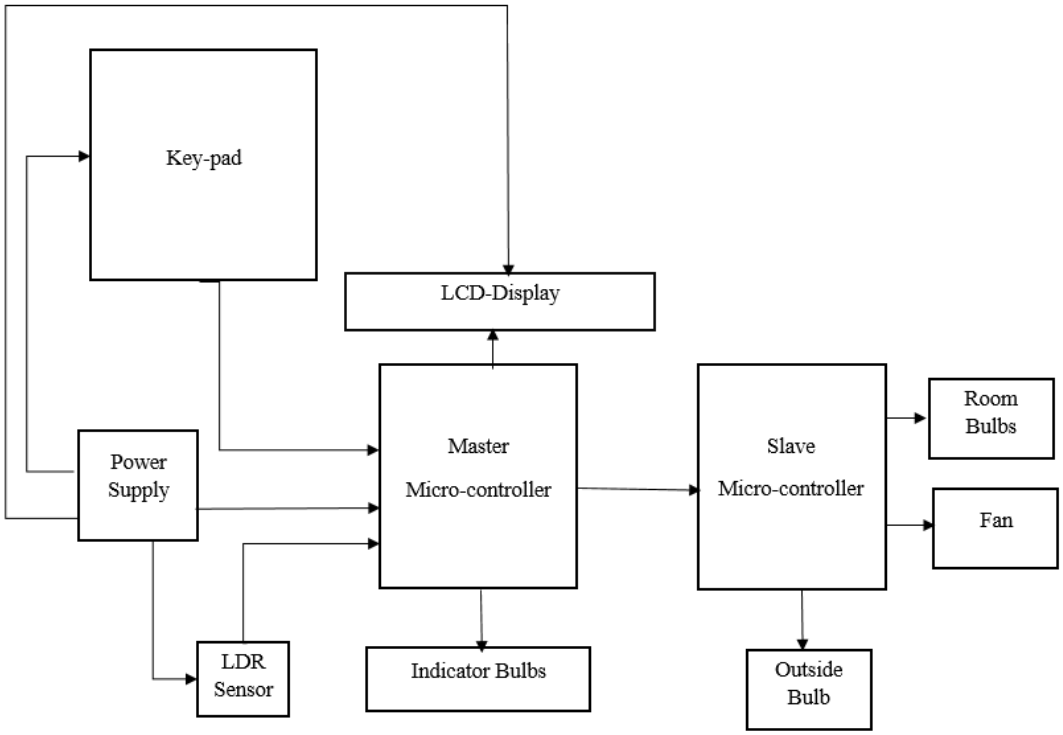

Figure 3 : Block Diagram Representation of the Home Automation System

1.1 Function Descriptions of Each Block

1. Power Supply

In the block diagram in Figure 3, where the power supply is connected to the master microcontroller, the function of the power supply is to provide the necessary electrical power to the entire system. It supplies the DC voltage required for the operation of the master microcontroller, LDR sensor, keypad, and LCD display. By providing a reliable power source, the power supply enables the master microcontroller to execute its control functions, process

inputs from the LDR sensor and keypad, and display relevant information on the LCD display. It plays a crucial role in ensuring the proper functioning of the entire home automation system by supplying the necessary power to all the interconnected components.

2. Key-Pad

The keypad in a serves as an input interface that allows users to interact with the system. It consists of a set of buttons or keys that users can press to input commands or make selections. The function of the keypad is to provide a convenient and user-friendly means for controlling and managing various aspects of the home automation system. By pressing different buttons on the keypad, users can enter commands to control devices (bulbs and fan), adjust settings, or activate specific functions within the system. The keypad acts as a primary input device, allowing users to communicate their intentions to the system. The keypad's inputs are received and processed by the master microcontroller, which interprets the commands and triggers the appropriate actions within the system.

3. LDR Sensor

When the ambient light level detected by the LDR sensor falls below a certain threshold, indicating that it is dark, the LDR sensor sends a signal to the master microcontroller. The master microcontroller then communicates with the slave microcontroller, instructing it to turn on the connected light. Conversely, when the ambient light level rises above the threshold, indicating that it is light, the LDR sensor sends a signal to the master microcontroller, which then communicates with the slave microcontroller to turn off the connected light.

4. LCD Display

The LCD screen is a vital component of the home automation system, providing a visual interface for users to interact with the system effectively. Its main function is to display important information, feedback, and options, improving the user experience. Users can enter passwords on the LCD screen to securely authenticate themselves and access specific features. The screen provides visual feedback to ensure accuracy and ease of use. Additionally, the LCD

screen shows user and admin modes, allowing users to switch between access levels and enjoy specific privileges. This makes it easy for users to navigate the system and access functionalities based on their authorized roles.

5. Master Micro-Controller

The master microcontroller serves as the central control unit, responsible for managing and coordinating various components. It is connected to the power supply, LDR sensor, keypad, and LCD display. The power supply provides the necessary electrical power to the entire system, ensuring stable and regulated voltage levels for reliable operation. The master microcontroller receives power from the power supply to function effectively. The LDR sensor, attached to the master microcontroller, detects the ambient light level. It provides input to the master microcontroller about the light conditions in the environment. The keypad is connected to the master microcontroller and acts as an input interface for users to interact with the system. Users can enter commands, passwords, or make selections using the keypad, which are then processed by the master microcontroller. The LCD display, also connected to the master microcontroller, serves as an output interface. It provides visual feedback, displaying password entries, user modes, control options, and other relevant information to enhance the user experience and provide a clear interface for interaction. The master microcontroller is further connected to the slave microcontroller. The slave microcontroller is responsible for controlling the room bulbs, fans, and an outside bulb, which are linked to it. The master microcontroller communicates with the slave microcontroller to relay commands and instructions for turning on/off the room bulbs, switching fan and managing the outside bulb based on the input received from the LDR sensor.

6. Slave Micro-Controller

The slave microcontroller serves as an essential component in the home automation system, responsible for managing and controlling specific devices within the system. It receives instructions, commands, and data from the master microcontroller, which acts as the central control unit. One of the key functions of the slave microcontroller is to control the outside bulb based on the input from the LDR sensor. It receives signals from the LDR sensor, which is connected to the master microcontroller, through the master microcontroller itself. This data

indicates the ambient light level, allowing the slave microcontroller to determine when to activate or deactivate the outside bulb accordingly.

Additionally, the slave microcontroller handles user input from the keypad, which is connected to the master microcontroller. The master microcontroller receives the user's commands or selections from the keypad and communicates this information to the slave microcontroller. Based on the received data, the slave microcontroller executes the necessary actions to control the room bulbs according to the user's instructions. The slave microcontroller serves as the intermediary between the master microcontroller and the controlled devices. It effectively receives and interprets the data provided by the master microcontroller, allowing it to carry out the appropriate control actions for the outside bulb and the room bulbs.

7. Room Bulbs

The room bulbs block consists of the lighting devices located within individual rooms in the home automation system. These bulbs are connected to the slave microcontroller, which acts as the central control unit for their operation. Based on these commands, the slave microcontroller activates or deactivates the corresponding room bulbs, allowing users to control the lighting according to their preferences.

8. Outside Bulb

The outside bulb is a key component that simulates providing lighting for an external area. It is connected to the slave microcontroller, which controls its operation based on input from the LDR sensor. The outside bulb automatically turns on when the LDR sensor detects darkness, ensuring proper illumination for enhanced security and visibility. Conversely, it turns off when the LDR sensor detects ample natural light, conserving energy. By integrating with the slave microcontroller, the outside bulb offers convenient and automated lighting control, contributing to a safer and more aesthetically pleasing outdoor environment.

9. Indicator Bulbs

The indicator bulbs in the diagram in Figure 3 serve as visual indicators for the current system mode, whether it is user mode or admin mode. These bulbs are connected to the master

microcontroller, which controls their operation based on the selected mode. When the system is in user mode, the corresponding indicator bulb illuminates, indicating that regular user privileges are active. Similarly, when the system is in admin mode, the respective indicator bulb lights up, signifying elevated administrative privileges. By integrating with the master microcontroller, the indicator bulbs provide users with a clear and immediate visual indication of the system mode, ensuring efficient navigation and utilization of the appropriate functionalities.

10. Fan

When the user indicates through the keypad that the fan should be turned on, the slave microcontroller activates the fan. Conversely, when the user inputs a command to turn off the fan, the slave microcontroller deactivates it.

2 Future Extensions

We are hoping to develop our home-automation system and add more features into it in the coming future. The below diagram in Figure 4 shows the amendments that we hope to make to the existing block diagram.

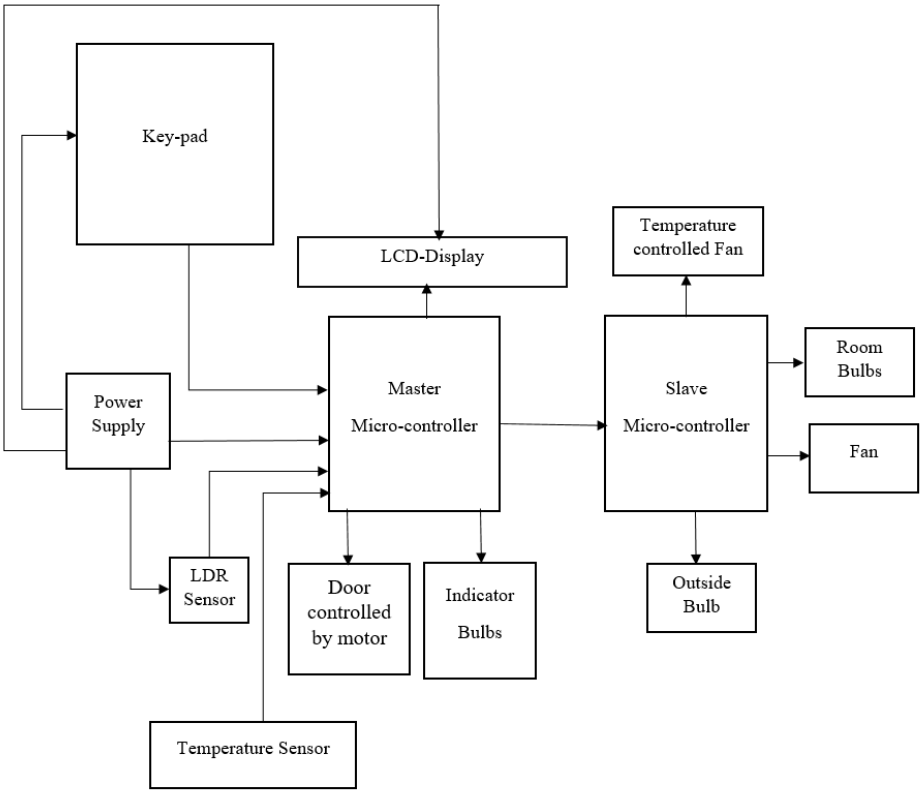

Figure 4: Block Diagram Representation of the Home Automation System After Future Extensions

2.1 Function Descriptions of Newly Added Blocks

1. Temperature Sensor

The temperature sensor is a critical component that measures the ambient temperature of the environment. Connected to the master microcontroller, it continuously monitors the temperature and provides accurate readings. The temperature sensor enables the system to respond to temperature changes and implement appropriate control actions. By integrating temperature data, the system can make informed decisions, such as adjusting the fan speed. The temperature sensor contributes to creating a smarter and more efficient home automation system by providing crucial temperature information for temperature-based control and automation.

2. Motor to Control the Door

The motor is directly connected to the master microcontroller, which governs its operation based on signals received through the keypad. The motor block functions as the intermediary between user input and mechanical motion, allowing users to command and control devices connected to the motor. By interpreting signals from the keypad, the master microcontroller sends appropriate instructions to the motor to open and close it.

3. Temperature Controlled fan

The function of a temperature-controlled fan is to automatically adjust the fan's speed based on the detected temperature. The temperature sensor, connected to the master microcontroller, continuously monitors the ambient temperature. When the temperature exceeds a predetermined threshold, the master microcontroller sends commands to the slave microcontroller, which controls the fan.

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[2] C. Stolojescu-Crisan, C. Crisan, and B.-P. Butunoi, “An IOT-based Smart Home Automation System,” MDPI, https://www.mdpi.com/1424-8220/21/11/3784 (accessed Jul. 15, 2023).