

***Misr University of Science and Technology***

***College of Engineering and Technology***

***Department of Mechatronics Engineering***

B. Eng. Final Year Project

**PROJECT TITLE**

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DECLARATION

I hereby certify that this material, which I now submit for assessment on the programme of study leading to the award of Bachelor of Science in Mechatronics Engineering is entirely my/our own work, that I/we have exercised reasonable care to ensure that the work is original, and does not to the best of my knowledge breach any law of copyright, and has not been taken from the work of others and to the extent that such work, if any, has been cited and acknowledged within the text of my work.

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# ABSTRACT

The concept of smart homes has rapidly evolved with the integration of Internet of Things (IoT) devices, providing homeowners with enhanced control, convenience, and security. This project proposes a comprehensive smart home automation system utilizing IoT technologies to control various home appliances and provide real-time alerts for safety and comfort.

The system comprises five main features:

1-Smart Lighting System: This feature enables remote control of home lighting through the mobile mobile application. Users can turn lights on or off using their smartphones, offering convenience and energy efficiency by managing the lighting remotely.

2-Alert System (Gas Sensor and Environmental Monitoring): Safety is a crucial aspect of smart homes. This system uses a gas sensor to detect hazardous gas leaks and immediately sends an alert to the user through the mobile app. Additionally, a DHT11 sensor monitors temperature and humidity levels, providing real-time environmental data to enhance comfort and safety.

3-Water Level Monitoring for Tank: To ensure water supply management, the system includes a water level alert mechanism for the household tank. When the water reaches critical levels, users receive notifications, allowing them to take action to refill or conserve water.

4-Smart Door Access (RFID/NFC Module): Security is enhanced through a smart door system that utilizes RFID or NFC technology. Only authorized users with registered RFID tags or NFC devices can unlock the door, providing a secure and automated entry system.

5-Smart Curtain Control: Through the mobile app, users can remotely open or close curtains, adding a layer of comfort and energy efficiency by controlling sunlight exposure inside the home.

# Chapter one: Introduction and Literature review

## Introduction

The concept of smart homes has transformed modern living by incorporating technology and automation into everyday household activities. Leveraging the Internet of Things (IoT), smart homes create an interconnected network of devices and systems, allowing for remote control and monitoring of various functions such as lighting, security, environmental management, and access control. The result is a more convenient, efficient, and secure living environment.

This project proposes a smart home system implemented on a Raspberry Pi, integrating multiple smart subsystems: lighting control, environmental alert systems, water level monitoring, door access management, and automated curtains. All these systems are centrally controlled using the mobile IoT platform, which provides a unified interface for managing the various components.

The smart light system allows remote control of household lighting via the mobile app, providing the convenience of managing lighting from anywhere. The environmental alert system, which monitors conditions such as gas leaks, temperature, and humidity through gas and DHT11 sensors, sends real-time notifications when abnormal conditions are detected. The water level monitoring system uses an ultrasonic sensor to ensure that household water storage is efficiently managed, notifying users when water levels are too high or too low. For enhanced home security, the smart door system uses RFID or NFC technology for secure and contactless access control. Lastly, the smart curtain system automates the opening and closing of curtains, helping regulate natural light and potentially improving energy efficiency.

By using mobile as the central platform, users can control all these smart home systems from a single interface on their mobile devices. The integration of these components into a unified system demonstrates the potential for smart homes to provide a seamless and intelligent living experience.

## Literature Review

The development of smart home technologies has been driven by advancements in IoT devices, wireless communication, and automation systems. Smart lighting has been a popular area of research, with studies such as those by Suryady et al. (2016) demonstrating how automated lighting systems that respond to user presence or environmental conditions can significantly enhance energy efficiency. mobile has emerged as a favored IoT platform for integrating remote control features into such systems, offering users real-time control via smartphones, as highlighted by Patel et al. (2018).

In the area of environmental monitoring, gas sensors and DHT11 temperature and humidity sensors are commonly utilized to detect hazardous situations in smart homes. According to Kumar et al. (2017), incorporating these sensors into home automation systems greatly improves household safety by allowing early detection of gas leaks and ensuring indoor air quality. Such systems can provide real-time alerts, enabling users to respond promptly to potential hazards.

Water level monitoring is another critical aspect of smart home systems. Gupta and Purohit (2020) demonstrate the benefits of ultrasonic sensor-based systems, which, when integrated with IoT platforms, allow users to monitor water levels in real time. This not only helps prevent overflow but also optimizes water consumption, a vital feature in regions experiencing water shortages.

Smart access control systems, utilizing RFID or NFC technology, are gaining popularity due to their enhanced security and convenience. Research by Le et al. (2019) highlights how these systems, when combined with IoT platforms, allow homeowners to control door access via smartphones. This adds flexibility and reduces the risks associated with traditional key-based entry.

While still a relatively new area, the automation of curtains is another promising field in smart home technology. Pradeep and Sivabalan (2018) show that automated curtains can contribute to energy savings by controlling natural light and heat inflow, reducing the need for artificial lighting and air conditioning. The combination of comfort and energy efficiency makes this system an attractive addition to smart homes.

This project extends these individual smart home components by integrating them into a single system controlled by a Raspberry Pi and the ,mobile platform. The use of Raspberry Pi, with its more powerful processing capabilities compared to NodeMCU, provides greater flexibility in handling more complex tasks and adding future expansions to the system. Additionally, mobile app simplifies user interaction by offering real-time control and feedback through a single interface. This comprehensive approach demonstrates the potential for creating highly functional and user-friendly smart home systems.

# Chapter 2: Project Design

## Components and Circuit Design

### Raspberry Pi

The heart of the system is the \*Raspberry Pi\*, a single-board computer with built-in Wi-Fi capabilities. It handles data from the sensors and sends commands to relays, motors, and actuators. The Raspberry Pi interacts with the mobile app for real-time monitoring and control.

### Smart Lighting System

The smart lighting subsystem consists of:

- **Relay Module**: A relay controls the light, switching it on or off based on commands from the mobile app.

- **Light Bulb**: Connected to the relay, the light bulb is powered or unpowered by the relay's state.

- **mobile Interface**: Users control the light with a toggle button on the mobile app.

**Circuit Design:** The relay module is connected to a GPIO pin on the Raspberry Pi. The light bulb's power supply passes through the relay. When the user sends a control signal from the mobile app, it triggers the relay, toggling the light on or off.

### Environmental Alert System

This subsystem monitors for gas leaks and environmental conditions using:

- \*MQ-2 Gas Sensor\*: Detects harmful gases like methane and propane.

- \*DHT11 Sensor\*: Measures temperature and humidity.

- \*mobile Interface\*: Displays real-time sensor data and sends alerts when thresholds are exceeded.

**Circuit Design:** The MQ-2 gas sensor and DHT11 sensor are connected to different GPIO pins on the Raspberry Pi. The sensor data is processed and sent to the Mobile app, where it is displayed and alert thresholds can be set.

### Water Level Monitoring System

The water level in a tank is measured using an \*ultrasonic sensor\* (HC-SR04), which calculates the distance between the sensor and the water surface. When the water level reaches critical points, alerts are sent via the Mobile app.

- **Ultrasonic Sensor (HC-SR04):** Measures the distance from the sensor to the water surface.

- **Mobile Interface:** Notifies the user when water levels are too low or too high.

**Circuit Design:** The ultrasonic sensor is connected to GPIO pins of the Raspberry Pi. It measures the time taken for sound waves to reflect off the water surface, calculates the distance, and sends the data to the Mobile app for user alerts.

### Smart Door System (RFID/NFC)

The smart door system uses an \*RFID\* or \*NFC module\* for access control:

- **RFID/NFC Module:** Reads RFID tags or NFC-enabled devices to unlock the door.

- **Servo Motor:** Controls the physical locking mechanism.

- **Mobile Interface:** Allows users to monitor or remotely unlock the door.

**Circuit Design:** The RFID/NFC module connects to the Raspberry Pi’s GPIO pins. When an authorized RFID tag or NFC device is detected, the Raspberry Pi triggers the servo motor to unlock the door.

### Smart Curtain System

The smart curtain system uses a \*servo motor\* to open or close the curtains:

- **Servo Motor:** Moves the curtain based on user commands.

- **Mobile Interface:** Provides users with a remote option to adjust the curtain position.

**Circuit Design:** The servo motor is connected to a GPIO pin of the Raspberry Pi. The user sends a command via the Mobile app, controlling the curtain’s position by adjusting the servo’s angle.

**5. System Operation and Workflow**

**1. Power Initialization:** The Raspberry Pi is powered, initializing the sensors, actuators, and relays.

**2.Sensor Input:** Environmental sensors (e.g., gas, temperature, humidity) continuously monitor their parameters and send data to the Raspberry Pi.

**3. User Interaction:** Users view real-time data, control lights, unlock the door, or adjust curtains via the Mobile app.

**4. Automation and Alerts:** If a sensor detects an abnormal condition (e.g., gas leak or low water level), the system sends an alert through the Mobile app.

**5. Manual Control:** The user can manually trigger actions, such as turning on the lights or unlocking the door, from the mobile interface.

# Conclusion

This chapter detailed the design and implementation of a smart home control system using Raspberry Pi and IoT technologies. The system includes smart lighting, environmental monitoring, water level detection, access control, and automated curtain subsystems. All components are managed through the Raspberry Pi and mobile platform for remote control and real-time monitoring. This design's scalability and flexibility make it adaptable for future expansions, offering a versatile solution for modern smart homes.