SMART HOME AUTOMATION SYSTEM

A Capstone Project report submitted

in partial fulfillment of requirement for the award of degree

BACHELOR OF TECHNOLOGY

in

SCHOOL OF COMPUTER SCIENCE AND ARTIFICIAL INTELLIGENCE

by

K. Sri Tej	**2103A51410**
A. Swapna	**2103A51117**
G. Mounika	**2103A51405**
K. Akhila	**2103A51**469

Under the guidance of

Dr. A Vamshi Naik

Assistant Professor, School of CS&AI.

SR UNIVERSITY

SR University, Ananthsagar,Warangal,Telagnana-506371

SR University

Ananthasagar, Warangal.

SR UNIVERSITY

CERTIFICATE

This is to certify that this project entitled **"SMART HOME AUTOMATION SYSTEM**" is the bonafied work carried out by **K. SRI TEJ, A. SWAPNA, G. MOUNIKA, K. AKHILA ,** as a Capstone Project for the partial fulfillment to award the degree **BACHELOR OF TECHNOLOGY** in **School of Computer Science and Artificial Intelligence** during the academic year 2024-2025 under our guidance and Supervision.

Dr. A Vamshi Naik
Assistant Professor,
School of CS&AI,
SR University
Ananthasagar, Warangal.

Dr. M.Sheshikala
Professor & HOD
School of CS&AI,
SR University
Ananthasagar, Warangal.

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Project Report on Smart Home Automation System

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1. Abstract

The Smart Home Automation System integrates IoT technology to enhance the convenience, safety, and energy efficiency of modern living spaces. This system automates household functions such as lighting, ventilation, security, and garden irrigation. It features automated fans and lights controlled by an ultrasonic sensor, gas leak detection using an MQ-2 gas sensor with an alarm, and garden irrigation regulated by a soil moisture sensor. The project employs microcontrollers for data processing, relay modules for appliance control, and cloud connectivity for remote monitoring. Designed to be scalable and cost-effective, this system addresses energy conservation, resource management, and user convenience while ensuring a secure and intelligent living environment. Comprehensive testing validated its functionality and reliability, paving the way for future enhancements like AI-based automation and integration with renewable energy systems.

2. Introduction

2.1 Objectives

1. Automate household functions to enhance convenience.
2. Monitor air quality with gas sensors and alarms.
3. Save water through automated garden irrigation systems.
4. Provide remote access and control via mobile/web interfaces.

2.2 Scope of the Project

The project is suitable for residential and commercial spaces. It offers modular features, enabling customization based on user requirements.

2.3 Problem Statement

Manual operation of household appliances is inefficient, leading to energy and resource wastage. Additionally, safety hazards like gas leaks remain undetected in traditional homes. This project addresses these challenges through automation.

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3. Literature Review

3.1 Background of Smart Homes

Smart homes integrate IoT to allow centralized control of appliances. Early systems were expensive and lacked modularity.

3.2 Trends in Home Automation

- **Energy Monitoring**: Systems monitor power usage for optimization.
- **Voice Assistance**: Compatibility with Alexa and Google Assistant.
- **AI Integration**: Predictive models for improved automation.

3.3 Comparison of Existing Systems

Feature	Existing Systems	Proposed System
Cost	High	Affordable
Features	Limited customizability	Modular
Energy Savings	Moderate	High

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4. System Overview

4.1 Components and Architecture

- **Hardware Components**:
  - Ultrasonic sensor for occupancy detection.
  - Gas sensor (MQ-2) for detecting gas leaks.
  - Soil moisture sensor for garden irrigation.
  - Microcontroller (Arduino/Raspberry Pi) for processing.
- **Software Components**:

  - Arduino IDE for microcontroller programming.
  - MQTT for IoT communication.
  - Mobile app for remote monitoring.

4.2 Unique Features

1. Energy-efficient automation for lights and fans.
2. Enhanced safety through gas leak detection.
3. Resource conservation in garden irrigation.

4.3 Applications

1. Residential: Automated appliance control and safety systems.
2. Commercial: Efficient management of energy and resources.

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5. System Design

5.1 Hardware Components

1. **Ultrasonic Sensor**: Detects occupancy to control fans and lights.
2. **Gas Sensor (MQ-2)**: Detects LPG, methane, and smoke.
3. **Soil Moisture Sensor**: Monitors soil moisture levels for irrigation.
4. **Microcontroller**: Central processing unit for sensor data.
5. **Relay Modules**: Controls high-power devices like fans and alarms.

5.2 Software Architecture

- Sensor data is processed by the microcontroller.
- Control logic triggers relays to activate devices.
- Data is logged to a cloud database for monitoring.

5.3 Automated Fan and Light Control

Algorithm:

1. Read distance from the ultrasonic sensor.
2. If the distance is below a threshold, turn on the light and fan.
3. If no motion is detected for a specified time, turn them off.

Code Example (Arduino):

```
#define trigPin 9
#define echoPin 10
#define fanPin 7
#define lightPin 8

void setup() {
  pinMode(trigPin, OUTPUT);
  pinMode(echoPin, INPUT);
  pinMode(fanPin, OUTPUT);
  pinMode(lightPin, OUTPUT);
  Serial.begin(9600);
}

void loop() {
  long duration, distance;
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);

  duration = pulseIn(echoPin, HIGH);
  distance = duration * 0.034 / 2;

  if (distance < 100) { // If occupancy detected
    digitalWrite(fanPin, HIGH);
    digitalWrite(lightPin, HIGH);
  } else {
    digitalWrite(fanPin, LOW);
    digitalWrite(lightPin, LOW);
```

```
  }
  delay(100);
}
```

5.4 Gas Detection and Alarm

Algorithm:

1. Continuously monitor gas levels using MQ-2.
2. If the gas concentration exceeds a threshold, trigger an alarm and send a notification.

Code Example:

```
int gasSensor = A0;
int buzzer = 7;

void setup() {
  pinMode(gasSensor, INPUT);
  pinMode(buzzer, OUTPUT);
  Serial.begin(9600);
}

void loop() {
  int gasLevel = analogRead(gasSensor);
  if (gasLevel > 400) { // Threshold value
    digitalWrite(buzzer, HIGH);
    Serial.println("Gas leak detected!");
  } else {
    digitalWrite(buzzer, LOW);
  }
  delay(1000);
}
```

5.5 Automated Garden Watering

Algorithm:

1. Read soil moisture level from the sensor.
2. If the level is below a threshold, activate the water pump.
3. Stop the pump once moisture level is adequate.

Code Example:

```
int moistureSensor = A0;
int pumpPin = 7;

void setup() {
  pinMode(moistureSensor, INPUT);
  pinMode(pumpPin, OUTPUT);
  Serial.begin(9600);
}

void loop() {
  int moistureLevel = analogRead(moistureSensor);
  if (moistureLevel < 300) { // Threshold for dry soil
    digitalWrite(pumpPin, HIGH);
    Serial.println("Watering the garden...");
  } else {
    digitalWrite(pumpPin, LOW);
    Serial.println("Soil is sufficiently moist.");
  }
  delay(1000);
}
```

6. Implementation

6.1 Hardware Integration

- Circuit diagrams to connect sensors, relays, and actuators with the microcontroller.

6.2 Software Implementation

- Development and testing of code for each module.
- Cloud integration for remote monitoring.

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7. Testing and Validation

Test Case	Expected Result	Actual Result
Ultrasonic sensor	Detects motion correctly	Passed
Gas sensor	Detects gas leaks	Passed
Moisture sensor	Activates pump on dry soil	Passed

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8. Cost Analysis

Component	Unit Price (USD)	Quantity	Total (USD)
Arduino Uno	15	1	15
Ultrasonic Sensor	5	1	5
Gas Sensor	8	1	8
Soil Moisture Sensor	6	1	6

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9. Challenges and Limitations

1. Limited range of ultrasonic sensors.
2. Dependence on internet for remote access.

10. Future Scope

1. AI-based predictive control.
2. Integration with renewable energy sources.

11. Conclusion

The Smart Home Automation System demonstrates a practical, cost-effective solution for modern homes, enhancing convenience, safety, and efficiency.

12. References

1. "IoT for Home Automation," IEEE.
2. "Energy Efficiency in IoT Systems," Journal of Automation.