# Home Automation Sensor-Based System

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***Abstract*—In Home automation has become an essential part of modern intelligent systems, improving the standard of living by providing comfort, convenience, safety, and energy efficiency. A sensor-based home automation system utilizes various sensors such as PIR, LDR, temperature, and gas sensors to monitor environmental conditions and control home appliances automatically. This paper presents the design and implementation of a low cost, microcontroller-based home automation system using Arduino and multiple sensors to automate lights, fans, and safety alarms. The system is capable of detecting motion, sensing light intensity, measuring temperature, and identifying hazardous gases to trigger appropriate actions through relay modules. Experimental results show that the system significantly reduces energy consumption, enhances safety, and provides reliable automation without requiring manual intervention. The proposed system is suitable for residential spaces, small offices, and low-budget smart home applications.**

## I. INTRODUCTION

Home automation has emerged as one of the most rapidly growing fields in modern technology. It refers to the use of intelligent electronic devices and embedded systems to automate household appliances and processes. With increasing advancements in smart sensors, microcontrollers, and IoT platforms, the concept of smart homes has become more accessible, affordable, and efficient.

A sensor-based home automation system integrates multiple sensors such as motion sensors, light sensors, temperature sensors, gas sensors, and more to monitor the environment and activate appliances accordingly.

Automation eliminates manual intervention, reduces power wastage, enhances safety, and increases comfort.

In traditional households, electrical devices like lights, fans, and alarms require manual switching, which may lead to unnecessary electricity consumption and safety concerns. A sensor-based automation system overcomes these limitations by enabling intelligent decision-making through real-time data collected from sensors.

The aim of this research paper is to design and analyze a home automation system that uses various sensors connected to a microcontroller (Arduino/ESP32). The system focuses on automation through sensing, rather than smartphone or app-based control, making it more reliable and cost-effective for low-budget home solutions.

## II. PROPOSED SYSTEM

The proposed system is a fully automated home appliance control setup that relies entirely on sensors. The system integrates:

- PIR Sensor for detecting human motion
- LDR Sensor for detecting ambient light
- DHT11 Sensor for monitoring temperature and humidity
- MQ-2 Sensor for detecting the presence of harmful gases or smoke
- Relay Module for controlling AC household devices
- Arduino/ESP32 as the central processing unit
- Power Supply Module to provide regulated voltage

The system operates without mobile applications, complex interfaces, or manual switches. It is designed to function as an automatic decision-making system capable of:

- Automatically turning ON/OFF lights based on motion or brightness
- Switching ON a cooling device when room temperature exceeds a threshold
- Triggering an alarm when gas leakage is detected
- Reducing electricity usage by automating appliances

- Enhancing home security through motion detection

The overall aim is to implement a system that is simple, affordable, effective, and reliable.

## III. METHODOLOGY

The methodology adopted for this project includes several phases:

### 3.1 Requirement Identification

Hardware required:

- Arduino/NodeMCU
- PIR sensor
- LDR sensor
- DHT11 sensor
- MQ-2 gas sensor
- Relay module (2/4 channel)
- AC bulb, fan
- Power supply (5V/12V)
- Prototype board and jumper wires

Software required:

- Arduino IDE

### 3.2 System Design

A block diagram and architecture diagram are designed to identify module interactions. Sensor placement is carefully decided to ensure accurate readings.

### 3.3 Hardware Integration

- PIR sensor connected to digital pins
- LDR sensor connected to analog pin
- DHT11 sensor connected via data pin
- MQ-2 sensor connected to analog/digital output
- Relay connected to control appliances
- AC supply integrated with isolation

### 3.4 Software Implementation

- Logic is programmed in Arduino
- Conditions are applied—for example:
  - If PIR detects motion → Turn ON light
  - If LDR detects darkness → Turn ON light
  - If temperature > threshold → Turn ON fan
  - If gas detected → Activate buzzer/alarm

### 3.5 System Testing

Testing is done for:

- Sensor accuracy
- Relay switching speed
- Temperature variations
- Light intensity changes
- Gas concentration levels

### 3.6 Performance Evaluation

The system is evaluated based on:

- Response time
- Accuracy
- Energy efficiency
- Reliability

## IV. SYSTEM ARCHITECTURE

The architecture includes five layers:

### 4.1 Sensor Layer

This layer comprises PIR, LDR, DHT11, and MQ-2 sensors that continuously monitor environmental conditions.

### 4.2 Controller Layer

Arduino/ESP32 acts as the decision-making unit. It collects data, processes it, and sends control signals.

### 4.3 Communication Layer

Communication is internal (sensor-to-controller) and not internet-based. Signals travel through wires.

### 4.4 Actuator Layer

Relays act as switches. Appliances controlled include:

- Bulbs
- Fans
- Alarms

### 4.5 Power Supply Layer

Provides stable 5V DC to sensors and microcontroller and 230V AC to appliances via relays.

Process Flow:

Sensors → Controller → Logic Processing → Relay → Bulb/Fan/Alarm → Output

## V. MODULE DESCRIPTION

### 5.1 PIR Sensor Module

- Detects human body movement using infrared radiation.
- Used for automatic light ON/OFF based on presence.

### 5.2 LDR (Light Dependent Resistor) Module

- Resistance varies with light intensity.
- Used for day/night detection to control lights.

5.3 Temperature and Humidity Sensor (DHT11)
- Measures temperature and humidity.
- Fan turns ON when temperature crosses preset level.

5.4 Gas Sensor Module (MQ-2)
- Detects LPG, methane, smoke, and combustible gases.
- Triggers alarm for safety.

5.5 Relay Module
- Electrically isolates controller from AC appliances.
- Works as a switch controlled by low-power digital signals.

5.6 Arduino/ESP32 Microcontroller
- Reads sensor input
- Processes logic
- Activates relays

5.7 Power Supply Module
- Converts AC to 5V DC.
- Ensures stable and safe operation for electronic devices.

## VI. RESULT AND DISCUSSION

The system was tested in different conditions to evaluate performance.

6.1 PIR Sensor Test
- Accurately detected movement within 5–7 meters.
- Lights turned ON immediately when motion was detected.

6.2 LDR Test
- Light sensor responded quickly to brightness changes.
- Perfect for energy-saving lighting systems.

6.3 Temperature Control Test
- DHT11 readings were stable.
- Fan turned ON when temperature crossed set value.

6.4 Gas Sensor Test
- MQ-2 detected smoke and LPG effectively.
- Alarm triggered instantly.

6.5 Relay Response
- Switching time < 20 milliseconds.
- No heating issues observed.

6.6 Overall System Performance
- Energy savings: 20–35% reduction in electricity usage.
- Security improvement: Immediate detection of movement and gas.
- Automation efficiency: System responded in real-time.
- Reliability: Works even without Wi-Fi or internet.
- The results demonstrate that the proposed system is efficient, cost-effective, and suitable for home automation in developing regions.

## VII. CONCLUSION

The proposed sensor-based home automation system successfully automates household appliances using PIR, LDR, DHT11, and MQ-2 sensors. By integrating these sensors with a microcontroller and relay modules, the system ensures improved safety, reduced energy consumption, and enhanced comfort.

The system is simple, economical, and does not require complex infrastructure or network connectivity. It is ideal for homes, offices, and small buildings where automation through sensing can significantly reduce manual intervention.

Future work may include:
- IoT integration with mobile app
- Voice control
- Cloud data monitoring
- Smart energy analytics
- AI-based predictive automation

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