



SMART HOME AUTOMATION

¹Sanket Jatale, ²Somnath Hake, ³Tanmay Mulik, ⁴Gaurav Avachar, ⁵Aditya Kolekar
⁶Sarika Awate

¹UG Scholar, Electrical Dept. JSPM's Bhivrabai Sawant polytechnic, Wagholi

²UG Scholar, Electrical Dept. JSPM's Bhivrabai Sawant polytechnic, Wagholi

³UG Scholar, Electrical Dept. JSPM's Bhivrabai Sawant polytechnic, Wagholi

⁴UG Scholar, Electrical Dept. JSPM's Bhivrabai Sawant polytechnic, Wagholi

⁵UG Scholar, Electrical Dept. JSPM's Bhivrabai Sawant polytechnic, Wagholi

⁶Asst. Prof. Electrical Dept. JSPM's Bhivrabai Sawant polytechnic, Wagholi

ABSTRACT:-

The ESP32 microcontroller is used in this research to build and execute an affordable, stand-alone smart home automation system. This system makes use of local processing and Bluetooth connection, in contrast to traditional systems that depend on human operation or cloud-based infrastructure, which may have network latency and connectivity problems. The system combines a number of sensors, including IR, LDR, MQ2, and DHT11, to continuously monitor ambient factors like temperature, smoke, light intensity, and human presence. To improve safety and energy economy, the ESP32 uses this data to control actuators on its own, such as relays, a buzzer, and a DC motor.

I. INTRODUCTION

Modern technology has been greatly impacted by the Internet of Things' (IoT) explosive growth, which has made it possible for digital systems and physical devices to connect seamlessly. IoT systems enable wired or wireless communication between sensors, controllers, and actuators, creating intelligent environments with the ability to make decisions on their own. This paradigm shift has improved operational efficiency, responsiveness.

Intervention. One of the most significant applications of IoT technology is smart home automation. Numerous sensors continuously check for things like temperature, humidity, light intensity, smoke, and human presence in a smart home setting. Automated systems can regulate ventilation, lighting, appliances, and safety features using this data. Particularly in residential and commercial structures, this kind of automation increases user comfort, maximizes energy utilization, and boosts general safety. The advancement of embedded systems has made it possible to design compact and cost-effective controllers for IoT applications. Among these, the ESP32 microcontroller stands out due to its high processing capability, low power consumption, and integrated wireless



communication features. The ESP32 supports dual-core processing, real-time operations, and a wide range of communication protocols, making it suitable for handling multiple sensor inputs simultaneously.

Furthermore, the availability of open-source development tools, libraries, and extensive community support has accelerated the adoption of ESP32 in academic, industrial, and hobbyist projects. These advantages make the ESP32 an ideal choice for developing scalable and reliable automation systems that can be deployed in real-world environments with minimal complexity.

II. PROBLEM STATEMENT

The majority of traditional industrial and home automation systems rely on human control techniques, which can be unreliable and inefficient in dynamic contexts. Manual systems don't react automatically to changing environmental conditions and need constant operator attention. Because of this, important issues like gas leaks, smoke, or overheating could go unnoticed until serious harm is done. Existing smart automation solutions often rely on cloud-based platforms for data processing and monitoring. While cloud services provide remote accessibility, they also introduce challenges such as network dependency, latency, data privacy concerns, and increased operational costs. In regions with unstable internet connectivity, cloud-dependent systems may fail to function reliably.

Additionally, many commercially available automation systems are expensive and complex, making them unsuitable for small-scale applications, educational institutions, or low-budget households. These systems may require specialized installation, maintenance, and technical expertise.

Hence, there is a strong requirement for a cost-effective, locally controlled, and easy-to-implement automation system. A Bluetooth-based solution offers reliable short-range communication, faster response times, and improved data security without relying on continuous internet connectivity.

III. OBJECTIVES

Designing and implementing an ESP32-based smart automation system that offers automatic device control and real-time monitoring is the primary goal of this project.

The system's goal is to merge several sensing and control features into one cohesive platform. Interfacing and integrating several sensors, such as an IR sensor for object recognition, an LDR for ambient light sensing, a MQ2 smoke sensor for gas and smoke detection, and a DHT11 sensor for temperature and humidity measurement, is another important goal.

The use of many sensors enables thorough environmental monitoring. The project also focuses on the automatic control of actuators such as relays, a DC motor, and a buzzer. These actuators



respond dynamically to sensor data, enabling automated lighting control, ventilation, and emergency alerts without user intervention.

An important objective is to implement Bluetooth-based communication for real-time monitoring of sensor values. This allows users to access system data on a mobile device, providing transparency and control while maintaining system simplicity and reliability.

Finally, the project aims to enhance safety and energy efficiency by generating timely alerts during hazardous conditions such as smoke detection or abnormal temperature rise, thereby minimizing potential risks and losses.

IV. SYSTEM ARCHITECTURE AND DESIGN

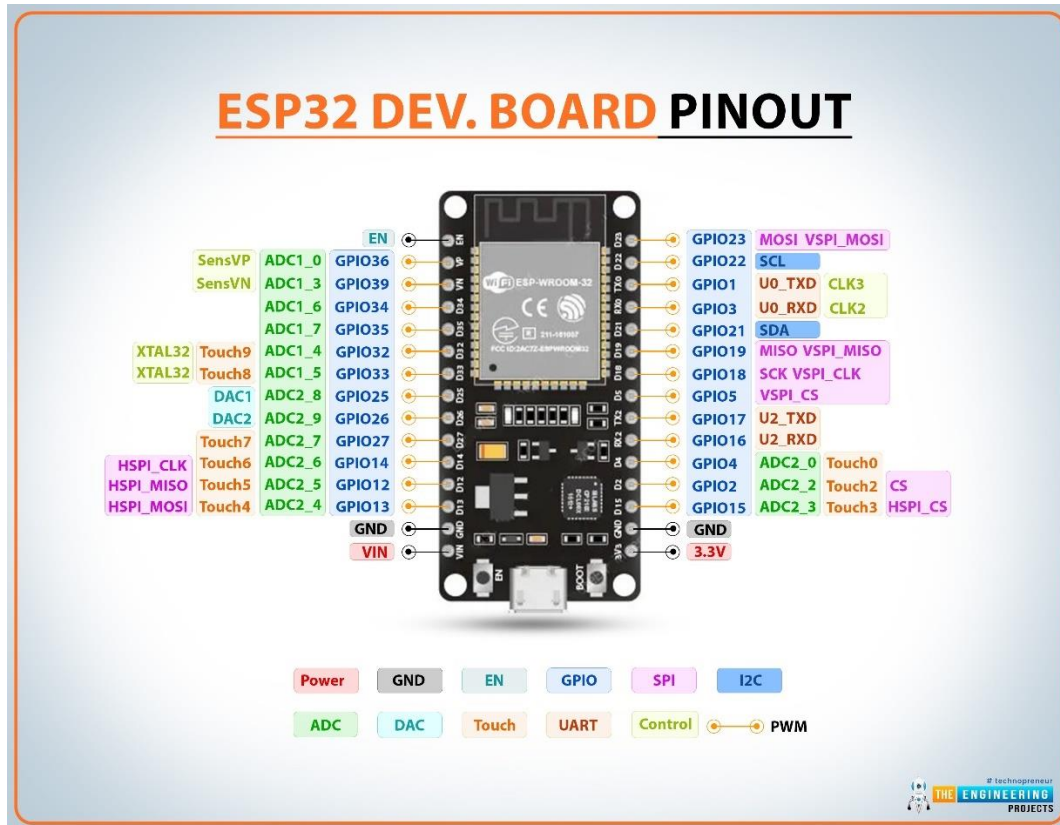
4.1 Block Diagram Description

The system consists of the following blocks:

- ESP32 Microcontroller
- Sensors (IR, LDR, MQ-2, DHT11)
- Actuators (Relays, Buzzer, DC Motor)
- Bluetooth Communication Module
- Power Supply Unit

4.2 Hardware Components

ESP32



This dual-core design allows ESP32 to efficiently manage communication tasks and application logic simultaneously, improving system stability and performance.

3. Wireless Communication Capabilities

One of the most significant advantages of ESP32 is its built-in wireless communication support.

3.1 Wi-Fi

ESP32 supports IEEE 802.11 b/g/n Wi-Fi, operating in the 2.4 GHz band. It can function in:

- Station mode
- Access Point mode
- Station + Access Point mode

This enables seamless integration with cloud servers, mobile applications, and web dashboards.

3.2 Bluetooth

ESP32 supports both:

- Bluetooth Classic (BR/EDR)
- Bluetooth Low Energy (BLE)

Bluetooth Classic is commonly used for serial communication (e.g., Android control apps), while BLE is ideal for low-power sensor data transmission. This makes ESP32 suitable for mobile-controlled automation systems.

5. IR Sensor

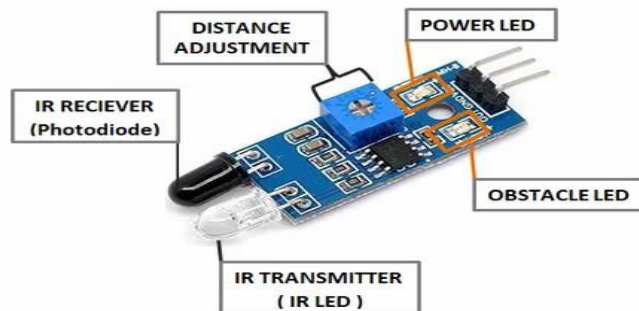


Fig.1 - IR Sensor

An Infrared (IR) sensor is an electronic device that detects infrared radiation to sense the presence, distance, or motion of objects. IR sensors work on the principle that all objects emit infrared radiation, and this radiation can be measured or reflected to determine information about the object. Due to their low cost, reliability, and simple design, IR sensors are widely used in automation, robotics, consumer electronics, and industrial applications.



1. Principle of Operation

IR sensors operate based on infrared light emission and detection. The sensor system usually consists of two main parts:

- IR Transmitter (Emitter) – emits infrared light
- IR Receiver (Detector) – detects reflected or emitted infrared light

When infrared light emitted by the transmitter strikes an object, it gets reflected back toward the receiver. The receiver senses this reflected IR light, and based on its intensity or interruption, the sensor determines the presence or proximity of an object.

2. Main Components of an IR Sensor

1. IR LED (Transmitter)

Emits infrared radiation, usually at a wavelength of around 700 nm to 1 mm.

2. Photodiode / Phototransistor (Receiver)

Detects incoming infrared radiation and converts it into an electrical signal.

3. Signal Conditioning Circuit

Includes resistors, amplifiers, and comparators to process the received signal.

4. Output Interface

Provides digital output (HIGH/LOW) or analog output, depending on the sensor type.

3. Types of IR Sensors

a) Active IR Sensor

- Uses both IR transmitter and receiver
- Detects reflected IR light
- Example: Obstacle detection sensor

b) Passive IR Sensor (PIR)

- Does not emit IR radiation
- Detects IR radiation emitted by living bodies

- Commonly used in motion detectors and security systems

4. Working Mechanism

1. The IR LED continuously emits infrared light.
 2. When an object comes in front of the sensor, the IR light is reflected.
 3. The reflected light is captured by the IR receiver.
 4. The received signal is amplified and compared with a threshold value.
 5. If the signal exceeds the threshold, the sensor output is triggered.
- Suitable for short-range detection
 - Accuracy depends on object color and surface reflectivity

6 LDR Sensor

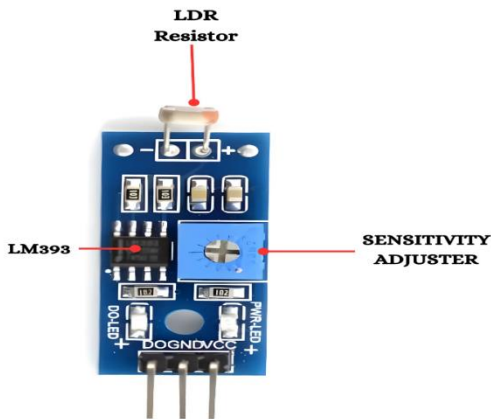


Fig2. - LDR Sensor

1. Introduction

A Light Dependent Resistor (LDR), also known as a photoresistor, is a passive electronic component whose resistance varies according to the intensity of incident light. It is widely used in automatic lighting systems, light-controlled switches, security systems, and energy-efficient automation applications.

In this project, the LDR is used to detect ambient light conditions and automatically control electrical loads through a relay using the ESP32 microcontroller.

2. Working Principle

The working principle of an LDR is based on photoconductivity. When light falls on the surface of the LDR, photons transfer energy to electrons in the semiconductor material, causing them to move freely. This results in a decrease in resistance.



- In bright light: Resistance is low
- In darkness: Resistance is very high

This change in resistance is converted into a digital or analog signal, which is then processed by the microcontroller to make control decisions.

7 MQ-2 Smoke Sensor

The MQ-2 Smoke Sensor is a widely used gas and smoke detection sensor designed to detect the presence of smoke and combustible gases in the air. It is commonly used in smoke alarms, gas leakage detection systems, industrial safety devices, and home security applications. The MQ-2 sensor is popular because of its low cost, high sensitivity, and simple interfacing with microcontrollers.

1. Working Principle

The MQ-2 sensor works on the principle of chemiresistance. It contains a sensitive material (SnO_2 – Tin Dioxide) whose electrical resistance changes when exposed to smoke or combustible gases.

- In clean air, the sensor's resistance is high.
- When smoke or gas is present, the resistance decreases.
- This change in resistance is converted into an electrical signal.

The sensor includes a built-in heating element that heats the sensing material to the required operating temperature, enabling accurate detection.

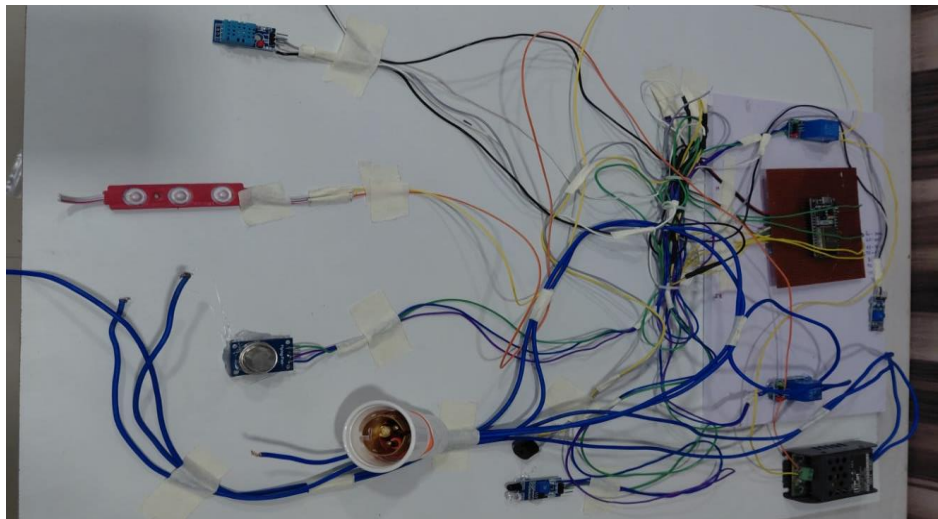
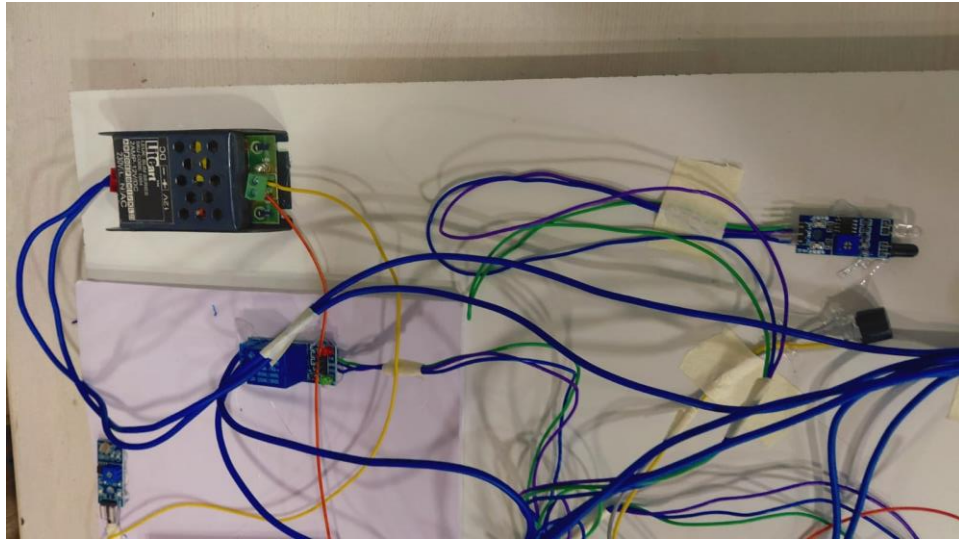
2. Gases Detected by MQ-2 Sensor

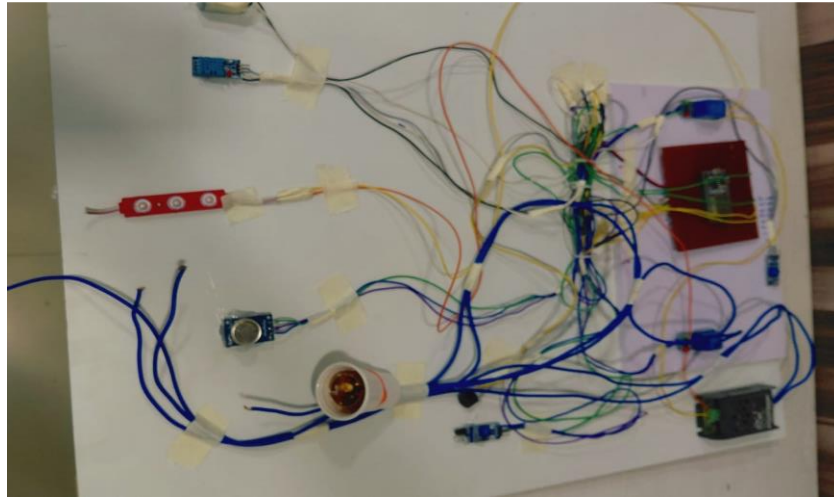
The MQ-2 sensor is sensitive to:

- Smoke
- LPG (Liquefied Petroleum Gas)
- Propane
- Methane
- Hydrogen
- Alcohol vapors

V. RESULTS

The system successfully monitored environmental conditions and controlled devices automatically. Bluetooth communication remained stable during operation.





VI. CONCLUSION AND FUTURE SCOPE

6.1 Conclusion

Using several sensors and Bluetooth, this project showcases an effective ESP32based smart automation system. The system is dependable, reasonably priced, and appropriate for real-time control and monitoring. The use of many sensors enables thorough environmental monitoring.

6.2 Future Scope

- Integration of Wi-Fi and cloud dashboard
- Mobile application development
- AI-based anomaly detection
- Camera integration for security