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Documentation	Smart home Automation system
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Problem Statement

In daily life, room lighting systems are mostly controlled manually. This often results in energy wastage, inconvenience, and lack of automation. Traditional systems cannot detect human presence accurately, do not provide environmental awareness, and offer no remote monitoring or voice-based control.

Existing motion-based systems commonly rely on heat detection, which can lead to false triggers due to temperature variations. Therefore, there is a need for a more precise and controllable smart lighting solution that responds to actual object movement, allows manual control, and integrates modern IoT and voice control for enhanced user experience.

Objectives

The objectives of this project are:

- To design a smart room lighting system using ESP32.
- To control room lighting automatically using an ultrasonic distance sensor.
- To toggle the room light ON or OFF on each valid detection within 5 cm.
- To allow **manual control of the room light through:**
 - Blynk mobile application
 - **Google Assistant voice commands**
- To monitor temperature and humidity using a DHT sensor.
- To control a separate relay based on temperature conditions.
- To display sensor readings on both:
 - Serial Monitor (VS Code)
 - Blynk cloud dashboard
- To reduce energy consumption while maintaining user flexibility.

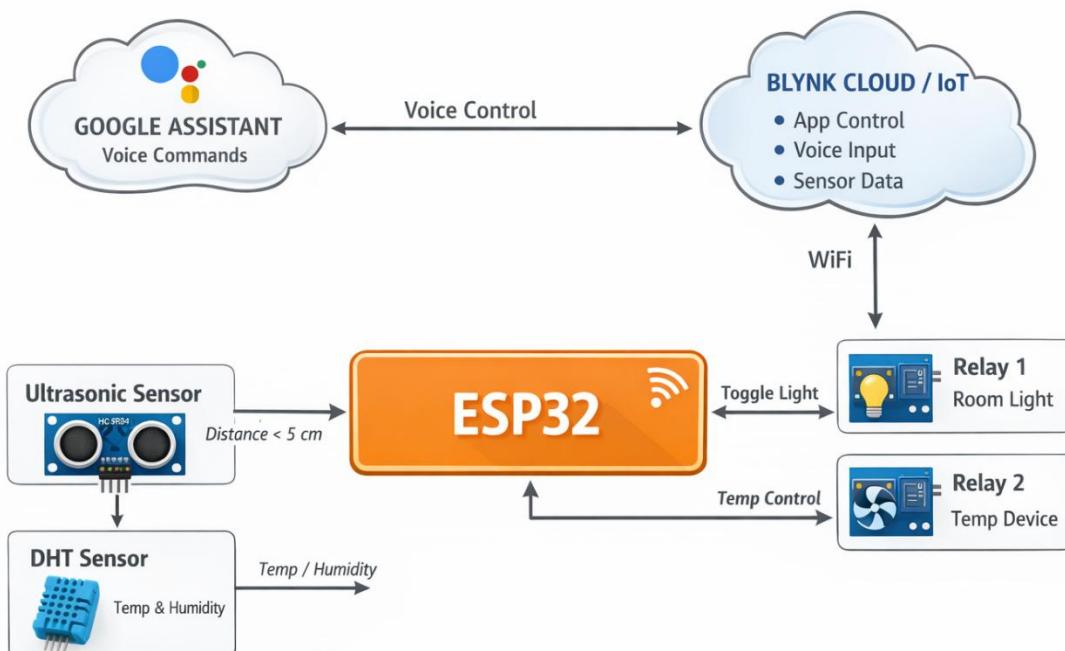
System Architecture / Block Diagram

System Architecture Description

The system is built around the ESP32 microcontroller, which serves as the central controller. It receives inputs from sensors, processes automation logic, and controls output devices (relays). Communication with the user is handled through both the Blynk cloud platform and **Google Assistant for voice control**.

Main Components Interaction

- **Ultrasonic Sensor:** Continuously measures distance and detects object movement within a defined range (≤ 5 cm).
- **DHT Sensor:** Measures temperature and humidity for environmental monitoring.
- **ESP32:** Processes sensor data, executes automation logic, communicates with Blynk via WiFi, and receives commands from Google Assistant.
- **Relay Module:** Controls room lighting and temperature-based devices.
- **Blynk Cloud:** Allows manual ON/OFF control, monitoring, and voice command forwarding.
- **Google Assistant:** Enables voice control of the room light through Blynk integration.



Data Flow Overview

1. Ultrasonic sensor sends distance data to ESP32.
2. ESP32 checks detection condition (≤ 5 cm).
3. Room light state is toggled accordingly.
4. DHT sensor sends temperature and humidity data.
5. Temperature relay is controlled based on threshold.
6. Sensor data is displayed on Serial Monitor and Blynk.
7. User can override automation using Blynk or **voice commands via Google Assistant**.

Hardware and Software Description

Hardware Description

- **ESP32 Development Board:** Central controller, handles WiFi, sensors, relays, Blynk, and Google Assistant integration.
- **Ultrasonic Sensor (HC-SR04):** Measures distance for accurate object detection.
- **DHT Sensor (DHT11/DHT22):** Monitors temperature and humidity.
- **Relay Module:**
 - Relay 1: Room light (controlled by ultrasonic detection, Blynk, and voice commands)
 - Relay 2: Temperature-based device (controlled by DHT sensor)
- **WiFi Network:** Connects ESP32 with Blynk Cloud for app control and Google Assistant.

Software Description

- **Arduino IDE / VS Code:** Used for writing, compiling, and uploading ESP32 firmware. Serial Monitor used for real-time debugging.
- **Blynk IoT Platform:** Cloud dashboard for manual control, sensor visualization, and integration with Google Assistant.
- **Google Assistant:** Used for voice-based ON/OFF control of the room light via Blynk.

Libraries Used

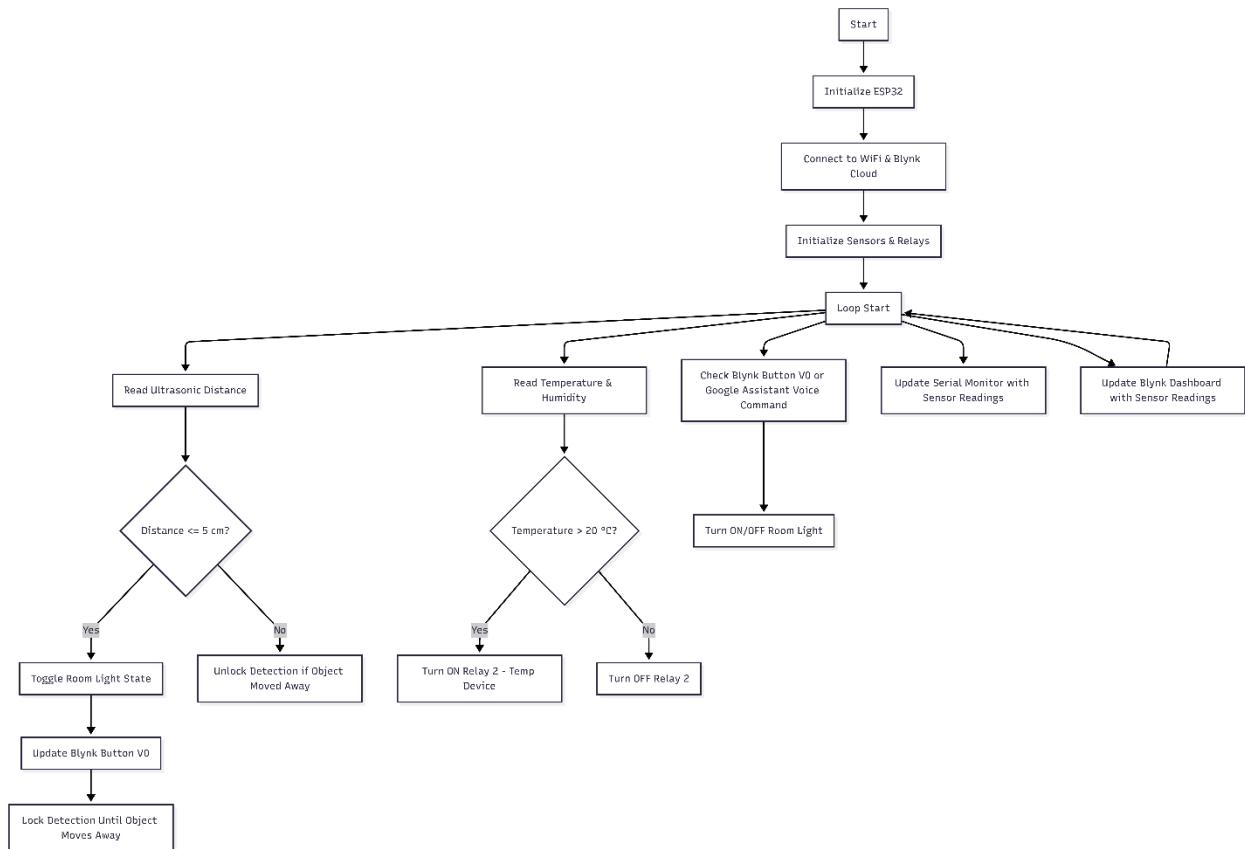
- WiFi.h – WiFi connectivity
- BlynkSimpleEsp32.h – Cloud communication
- DHT.h – Temperature and humidity sensing

Methodology and Flowchart

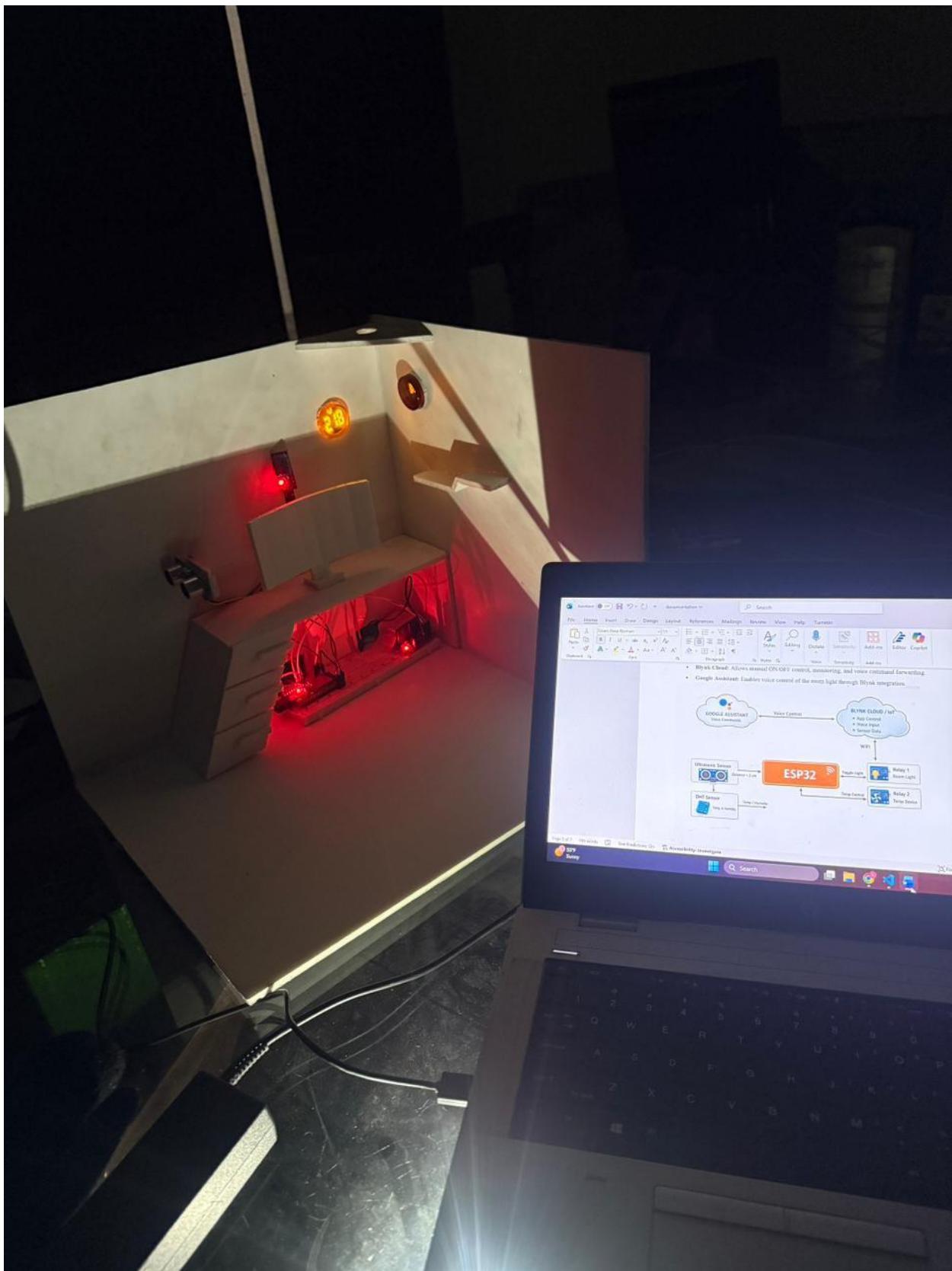
Methodology

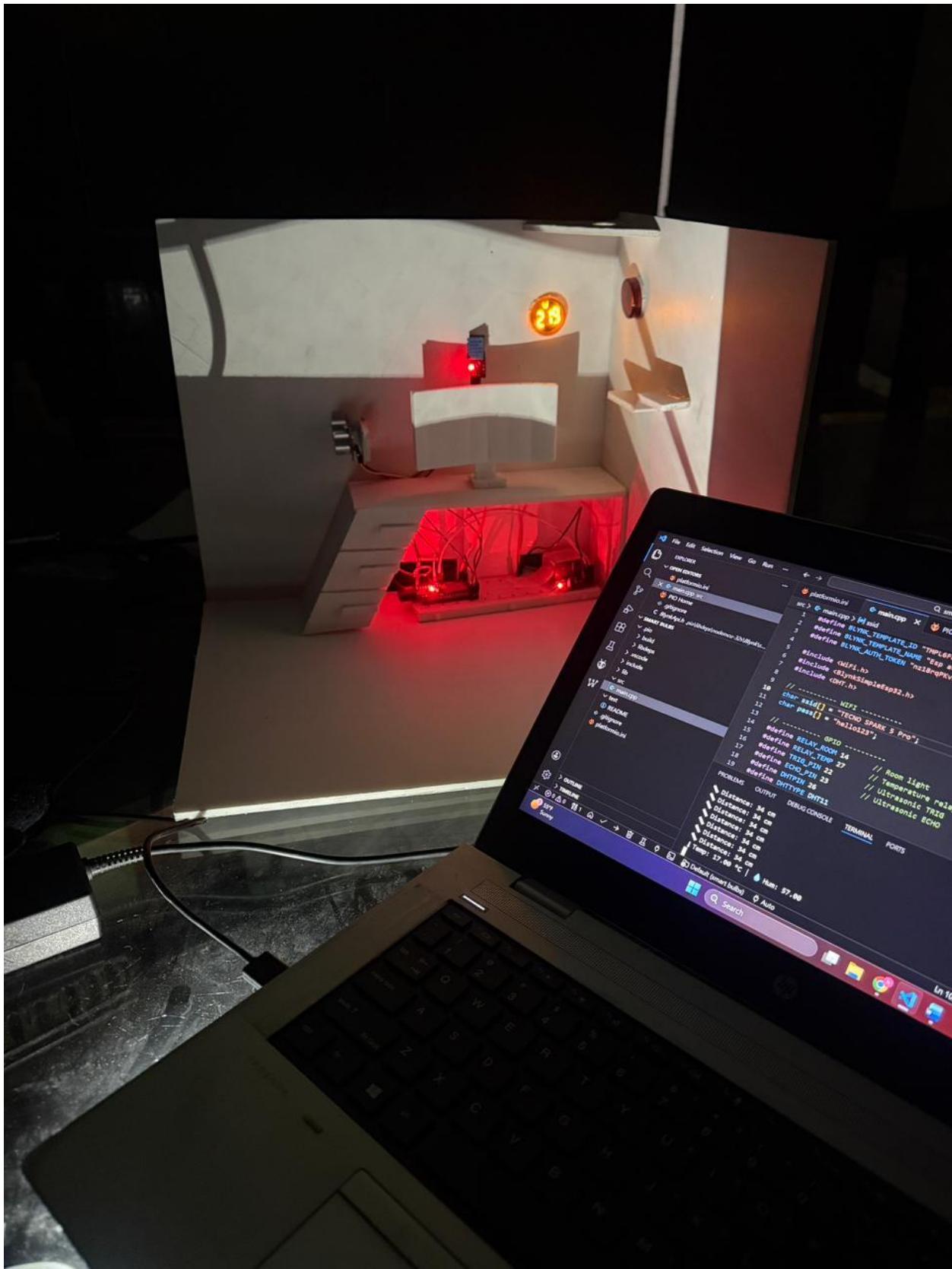
1. ESP32 initializes sensors, relays, WiFi, and Blynk Cloud connection.
2. Ultrasonic sensor continuously measures distance.
3. When an object is detected within 5 cm, the room light toggles ON/OFF.
4. Detection lock prevents repeated toggling until the object moves away.
5. DHT sensor reads temperature and humidity periodically.
6. Temperature relay is activated when threshold is exceeded.
7. **User can override automation using:**
 - o Blynk app
 - o Google Assistant voice commands
8. Sensor readings are displayed on Serial Monitor and Blynk dashboard.

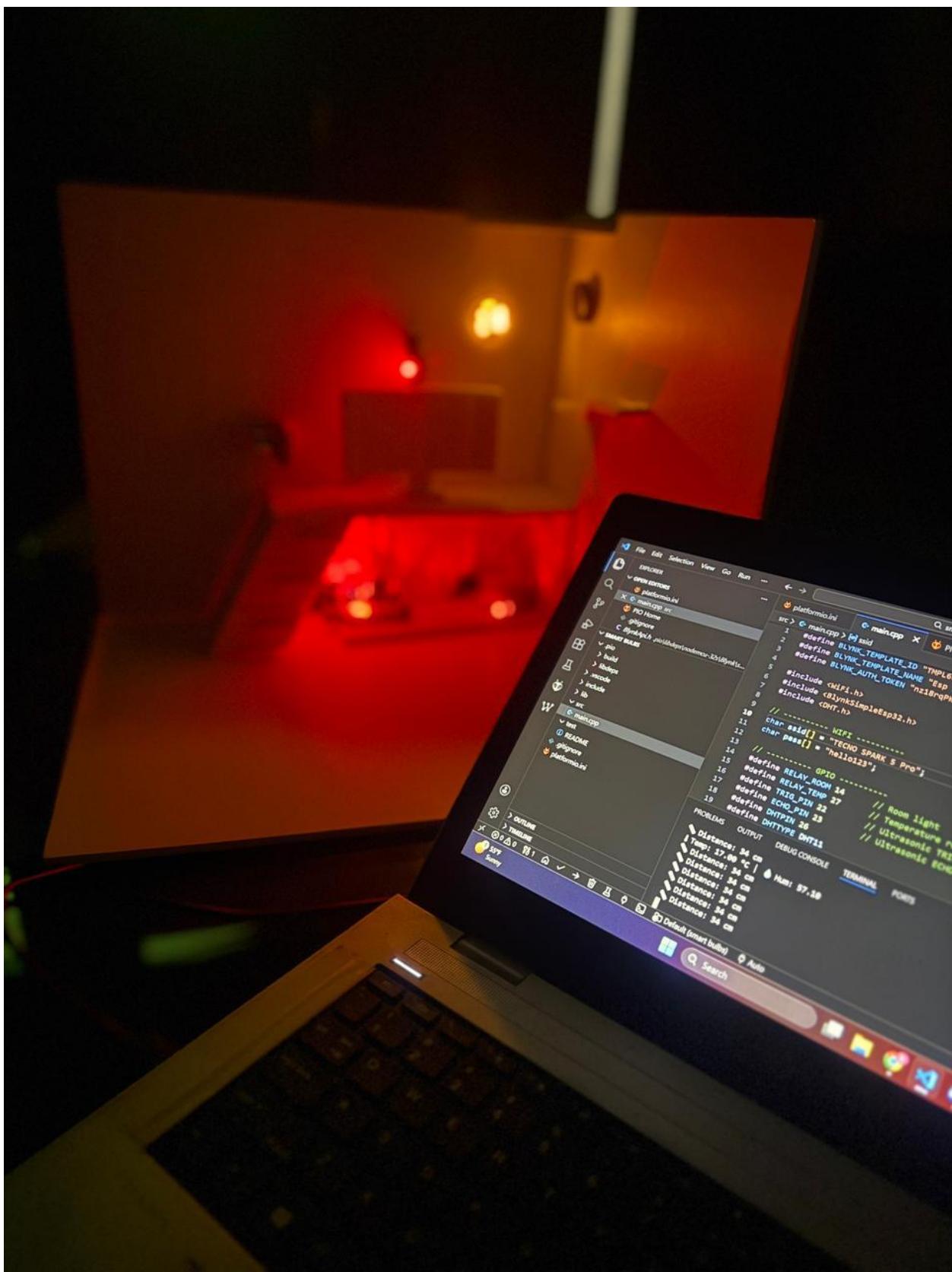
Flowchart

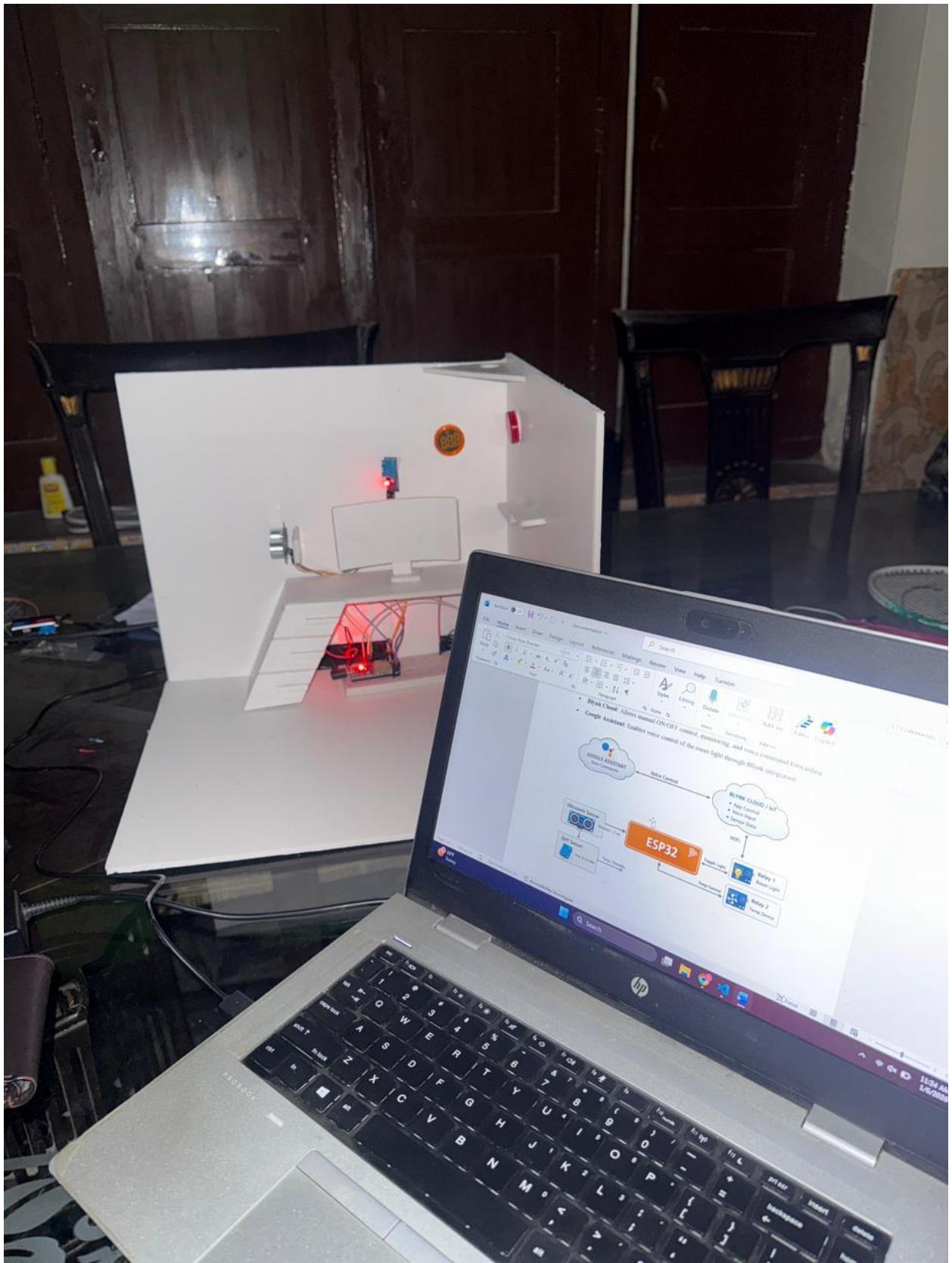


WORKING SCREEN SHOTS









Results, Conclusion, and Future Scope

Results

- Ultrasonic sensor detects object movement accurately within 5 cm.
- Room light toggles reliably without false triggers.
- **Voice control via Google Assistant works seamlessly** alongside Blynk and automation.
- Temperature and humidity readings update in real-time on both Serial Monitor and Blynk dashboard.
- Temperature-based relay operates correctly.
- System runs stably with continuous cloud connectivity.

Conclusion

The project demonstrates a **smart, reliable, and user-friendly room automation system** using ESP32, ultrasonic detection, and IoT. Integrating **Google Assistant** for voice commands adds convenience and modernity. Combining automatic control, cloud control, and voice control ensures flexibility and energy efficiency.

Future Scope

- Adjustable detection distance via Blynk and voice.
- Gesture-based lighting control.
- Enhanced voice commands (e.g., dimming or scheduling).
- Cloud data logging and analytics for energy usage.
- Multi-room automation and device integration.
- Notifications for object detection events.