# Arduino Based Home Automation

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***Abstract*— This smart home automation project aims to create an intelligent, energy-efficient, and safe residential environment by integrating a variety of sensors, controllers, and remote-control capabilities. The system is designed to automate lighting, monitor environmental conditions, and ensure safety through the use of alarms and real-time data analysis. The project consists of two rooms, each with distinct automation functionalities. Room 1 uses a light-dependent resistor (LDR) to detect ambient light levels and automatically turn the bulb on or off based on darkness. Room 2 features an ultrasonic sensor that detects motion, allowing the bulb to turn on when someone enters the room. This automation reduces energy consumption by ensuring lights are only on when needed. A key feature of this system is the ability to control the lighting through a mobile application built with MIT App Inventor. The app provides remote control, enabling users to turn lights on or off in both rooms from anywhere. This functionality enhances convenience and flexibility for homeowners. The system includes various sensors for environmental monitoring and safety. A DHT sensor measures temperature and humidity, providing data to maintain a comfortable indoor environment. The MQ6 gas sensor detects smoke or harmful gases, triggering an alarm if levels exceed a predefined threshold. This feature helps prevent potential fires or gas leaks. A soil moisture sensor measures the moisture level in soil, allowing users to monitor garden or plant watering needs. Additionally, a water level sensor detects potential water overflow, activating an alarm when levels are too high. All sensor data is sent to ThingSpeak, a cloud-based platform for real-time data collection and analysis. This integration allows users to monitor environmental conditions remotely and track historical data for trend analysis or anomaly detection. The smart home automation system outlined in this project demonstrates a comprehensive approach to creating a smarter, safer, and more efficient residential environment. By integrating automation, remote control, environmental monitoring, and safety features, this system offers a significant improvement in energy efficiency and security, enhancing the overall quality of life for homeowners.**

**Keywords—Home Automation, MQ6,DHT11, Ultra Sonic Senor, Water Level Senor, Soil Moisture Sensor, LDR Sensor, Actuators, Bluetooth**

## I. Introduction

Automation has become a revolutionary force in the quickly changing world of contemporary living, bringing unmatched efficiency and convenience to everyday tasks. The incorporation of technology into different aspects of life, such as smart houses and automated transportation, has evolved from a luxury to a need. The notion of home automation has acquired considerable traction in this context, offering a picture of homes furnished with intelligent technologies that can manage tasks autonomously and improve quality of life. We provide a complete home automation model that aims to transform how we interact with our living spaces in response to the growing desire for seamless living experiences.

Our suggested home automation concept uses a variety of advanced sensors to create a genuinely smart environment, embodying the spirit of innovation. Fundamentally, the concept is around the smooth incorporation of technology into routine domestic tasks, permitting adaptable management and observation of necessary facilities. With a careful selection of sensors, each designed for a particular function, our model provides homes with a level of simplicity, effectiveness, and safety never before possible.

Ultrasonic sensors, LDR sensors, water-level sensors, soil-moisture sensors, DHT11 sensors, MQ6 gas sensors, and Bluetooth sensors are some of the essential elements of our home automation model. Each of these sensors has a unique role that improves the performance of the smart house. While the LDR sensor automatically modifies lighting, levels based on ambient light conditions, the ultrasonic sensor senses motion to trigger lighting systems. Furthermore, by keeping an eye on tank levels and soil moisture content, respectively, water-level sensors and soil-moisture sensors guarantee effective management of water resources. Precise room temperature and humidity monitoring is made possible by the incorporation of DHT11 sensors, and early detection of possible gas leaks is ensured by MQ6 gas sensors. Furthermore, Bluetooth sensors enhance user convenience by enabling smooth management of lighting systems through mobile applications.

Our proposed home automation architecture provides a preview of smart living to come thanks to the smooth integration of various sensors. Our strategy improves homeowner quality of life and paves the way for future developments in smart-home technology by leveraging technology to automate necessary tasks and optimize resource utilization. We see a time where smart homes are synonymous with efficiency, sustainability, and unmatched comfort as we work to further develop and enhance our model.

## II. LITERATURE RIVEIW

The literature survey reflects a comprehensive exploration of various aspects of smart home automation (SHA) systems. It begins by highlighting the growing significance of SHA systems, driven by the proliferation of IoT technologies and AI advancements, offering a wide array of life-enhancing benefits ranging from energy control to home security and healthcare management. However, with the increasing complexity and interconnectivity of these systems, security and privacy concerns emerge as critical challenges. Therefore, the literature emphasizes the importance of access control mechanisms to safeguard sensitive data and protect against unauthorized access or malicious manipulation of smart devices within SHA environments. This includes analysing potential vulnerabilities and threats, proposing requirements for secure communication-based access control solutions, and discussing the necessity of fine-grained access control, least privilege communication, and minimizing access delays for ensuring safety and security [1,2].

Moreover, it deals into the landscape of available home automation systems, comparing both commercial and open-source solutions. It evaluates key features, functionalities, and limitations of various open-source platforms, aiming to assist developers and practitioners in making informed decisions when selecting a suitable home automation solution. Additionally, it identifies common architectural components among these systems and highlights the importance of extensibility and user experience in driving adoption and satisfaction [3,4].

The innovative approaches to enhance the usability and accessibility of home automation systems, particularly focusing on natural language processing techniques and automation scripting. By leveraging Chinese texts and first-order logic, the proposed methods aim to simplify the process of generating executable scripts for home automation, thereby reducing the programming knowledge required from users and facilitating seamless integration with different platforms. These efforts align with the broader goal of making home automation systems more user-friendly, cost-effective, and adaptable to evolving user needs and technological advancements [5,6].

A broad spectrum of topics related to smart home automation, ecological home networks, device fingerprinting for home security, and efficient energy usage in smart homes. Firstly, the emphasis is placed on the importance of developing elaborate systems that encompass various technological components and management functions to support overall functions of smart homes and ecological home networks. This includes considerations such as network connections, digital device management, cost-saving, energy-saving, and human responsibility saving, all crucial for the sustainability and efficiency of modern home networks [7,8].

The survey delves into the realm of home security, particularly focusing on device fingerprinting as a means of verifying both the user and the device accessing the home over the internet. By proposing a two-stage verification process using device fingerprints and login credentials, coupled with geolocation data, the paper addresses security concerns associated with remote access to smart homes. Furthermore, it discusses the potential for improving identification accuracy and adding additional fingerprint parameters to enhance security measures [9,10].

The optimization of energy usage in smart homes, particularly during emergency situations or voltage distortions. By implementing intelligent automation models and remote-control capabilities through web-based or app-based interfaces, the proposed solutions aim to save energy and ensure the safety of household appliances. The research highlights the effectiveness, reliability, and cost-efficiency of these solutions, paving the way for future advancements in home automation and the integration of IoT technologies for enhanced efficiency and convenience [11,12].

The encapsulation has a diverse range of research endeavors aimed at enhancing smart home functionality, security, and energy efficiency. Firstly, there is a notable emphasis on the development of secured smart home switching systems leveraging wireless communications and self-energy harvesting technologies. These systems integrate access control mechanisms, energy harvesting, and wireless communication to optimize electricity usage and enhance security. Access control features such as security pin codes and energy harvesting through photovoltaic systems contribute to improved energy management and security within smart homes [13,14].

The challenges posed by the Internet of Things (IoT) in smart home environments, particularly concerning security and privacy. With the proliferation of IoT devices in smart homes, concerns regarding unauthorized access to user data and potential security vulnerabilities have surfaced. Researchers are exploring solutions to address these challenges, including robust security measures and privacy-preserving techniques. Furthermore, the study highlights the need for manufacturers to prioritize security in IoT devices to mitigate risks associated with smart home deployments [15,16].

Lastly, the literature explores innovative sensing mechanisms for smart home applications, with a focus on leveraging Wi-Fi technology for various sensing tasks such as gesture recognition, fall detection, and health monitoring. Wi-Fi sensing offers a cost-effective and non-invasive approach to gather contextual information within smart home environments. While promising, these systems are still evolving and face practical challenges that need to be addressed, such as accuracy and deployment concerns. Nevertheless, recent advancements, particularly in deep learning, hold promise for further improving the efficacy of Wi-Fi-based sensing systems in smart homes [17,18].

This encompasses a wide array of research endeavors focused on enhancing the efficiency, security, and functionality of home automation and control systems. One notable area of investigation involves the development of network intrusion detection systems (NIDS) tailored specifically for Building Automation and Control Systems (BACS). Recognizing the unique challenges posed by BACS environments, researchers have proposed protocol-agnostic NIDS solutions capable of monitoring and analyzing fieldbus traffic within these systems. By addressing the lack of domain-specific security tools, these NIDS implementations aim to bolster the security posture of BACS ecosystems and mitigate potential cyber threats [19,20].

Additionally, research efforts have been directed towards optimizing the scheduling of smart home appliances and energy usage. Leveraging mixed-integer programming techniques, researchers have developed algorithms to minimize electricity costs, peak load demands, and energy consumption while accommodating user preferences and constraints. Furthermore, the integration of photovoltaic panels as power-producing appliances has been explored to enhance energy efficiency and reduce reliance on the main power grid. Through simulation and experimentation, these studies demonstrate the efficacy of proposed solutions in achieving cost savings and promoting sustainable energy practices within smart home environments [21].
Moreover, advancements in brain-computer interface (BCI) technologies have paved the way for innovative approaches to home automation and control. Researchers have developed BCI-based systems that enable individuals, particularly the elderly or disabled, to interact with smart home appliances using electroencephalogram (EEG) signals or eye-tracking mechanisms. By integrating BCI with augmented reality (AR) environments and voice commands, these systems offer intuitive and accessible interfaces for controlling home devices. Through usability testing and performance evaluations, these studies showcase the potential of BCI-driven home automation systems to enhance accessibility and quality of life for diverse user populations [22].

The a burgeoning interest in enhancing the security, efficiency, and user experience of smart home automation systems, driven by the rapid proliferation of Internet of Things (IoT) devices. Concerns over security vulnerabilities in IoT devices have spurred research into novel approaches, including the adoption of blockchain technology. By leveraging the decentralized nature of blockchain, researchers aim to address the security challenges inherent in smart home environments, where traditional security schemes have fallen short. Investigations into blockchain-based architectures for smart homes, such as consortium blockchain frameworks, offer promising avenues for bolstering security and privacy while exploring new paradigms for device interaction and management [23].

Another key area of research focuses on improving the authentication mechanisms for smart home applications to mitigate security threats such as phishing attacks and unauthorized access. Lightweight and privacy-preserving authentication protocols, leveraging techniques like Photo Response Non-Uniformity (PRNU) and geometric secret sharing, have been proposed to provide secure access to IoT devices while minimizing computational overhead. These protocols offer alternatives to traditional password-based authentication methods and smart card systems, enhancing usability and security for smart home users [24].

Efforts have been directed towards assessing and ranking the security of consumer IoT devices, providing consumers with objective metrics to make informed decisions about device purchases. Methodologies based on Analytic Hierarchy Process (AHP) have been proposed to systematically evaluate the security risks associated with various types of smart home devices. By quantifying factors such as network security, application security, and vulnerability severity, researchers aim to provide stakeholders with valuable insights into the security landscape of smart home technologies, informing future research directions and guiding industry practices. Through comprehensive assessment frameworks like the Smart Home Product Competitiveness Index (PCI), researchers seek to promote the development of user-centric smart home products that prioritize security, reliability, and user experience [25].

## III. System Design

The smart home automation system is a comprehensive solution designed to integrate various devices and sensors within a residential setting. This system aims to offer automated control, remote monitoring, and improved safety features. The following is a detailed overview of the key components and functionalities within the smart home automation system.

**1. Structure of the System**
The system encompasses two rooms they are Room 1 and Room 2-each with specific automation functionalities. The smart home system is designed to enable both automated and manual control of lights, alongside various sensors that monitor environmental conditions. The system architecture comprises several layers: sensors, controllers, actuators, and communication modules.

**2. Automation and Sensors**
Room 1 Lighting: Room 1 is equipped with a light-dependent resistor (LDR) sensor, which detects ambient light levels. When the light level drops below a certain threshold (indicating darkness), the sensor triggers the bulb to turn on automatically. This feature provides energy-efficient lighting control, ensuring that lights are only on when needed.
Room 2 Lighting: Room 2 uses an ultrasonic sensor to detect motion or presence. When a person enters the room, the ultrasonic sensor triggers the bulb to turn on automatically. This automation ensures that lights are not left on unnecessarily, contributing to energy conservation.

### 3. Remote Control via Mobile App

A key feature of this system is the ability to control it remotely through a mobile application. The app, built using MIT App Inventor, allows users to manually turn the lights on or off in both Room 1 and Room 2. This remote-control capability provides flexibility and convenience, allowing users to manage the lighting even when they are not physically present in the rooms.

### 4. Environmental Monitoring

- Temperature and Humidity Monitoring: The system includes a DHT sensor that provides real-time temperature and humidity readings. This data is sent to a cloud-based platform, ThingSpeak, allowing users to monitor environmental conditions remotely.
- Safety and Smoke Detection: An MQ6 gas sensor detects smoke and harmful gases. If smoke or gas levels exceed a predefined threshold, an alarm is triggered to alert the occupants. This safety feature is crucial for preventing fires or other hazardous situations.
- Soil Moisture Monitoring: A soil moisture sensor measures the moisture level in the soil, which is useful for monitoring garden or plant watering needs. The data is sent to ThingSpeak for analysis and remote monitoring.
- Water Level Detection: The water level sensor monitors water levels and triggers an alarm if the level exceeds a certain threshold. This feature helps prevent potential water overflow or flooding.

### 5. Data Collection and Analysis

All sensor data is transmitted to ThingSpeak, a cloud-based platform for data collection and analysis. This integration allows users to access real-time data and historical records to track trends, identify anomalies, and respond to specific events promptly.

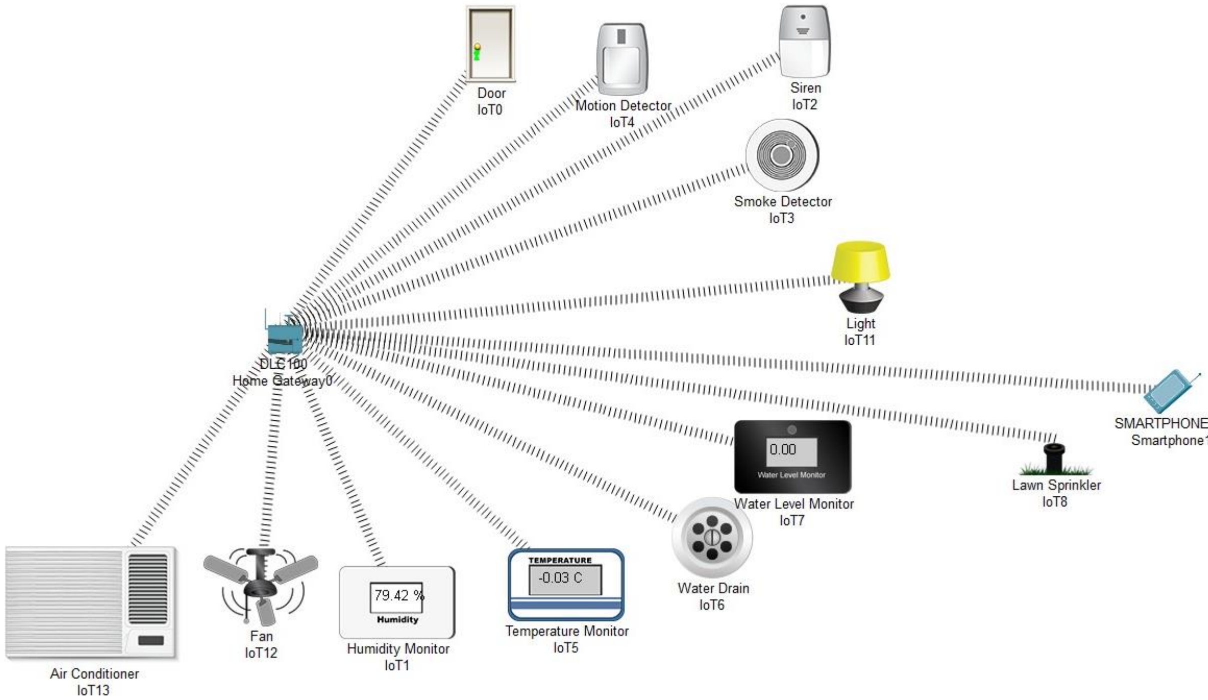



**Figure.1 Home Automation**

## IV. Methodology

1. **Identify Sensor Locations:** Determine where to place each sensor in your home. For example, place the LDR sensor in rooms where low light is common, the ultrasonic sensor in areas where motion detection is needed, the water level sensor in the water tank, the soil moisture sensor in the plant pots, the MQ6 gas sensor near potential gas leak sources, and the DHT11 sensor in a central location for temperature and humidity monitoring.

2. **Hardware Setup:**

- Connect the LDR sensor to an analog pin of the Arduino Uno.
- Connect the ultrasonic sensor to appropriate digital pins (trigger and echo pins) of the Arduino Uno.
- Connect the water level sensor to a digital pin of the Arduino Uno.
- Connect the soil moisture sensor to an analog pin of the Arduino Uno.
- Connect the MQ6 gas sensor to a digital pin of the Arduino Uno.
- Connect the DHT11 sensor to the digital pin of the Arduino Uno.

3. **Data Acquisition:** Create code to periodically read data from every sensor. Use the ultrasonic sensor to detect motion, the soil moisture sensor to monitor soil moisture, the MQ6 sensor to detect gas leakage, the DHT11 sensor to read temperature and humidity data, and the LDR sensor to read the analog value to determine the light level, for every instance.

4. **Logic of Decision Making:**

- Turn on lights if the value of the LDR sensor falls below a predetermined threshold.
- Turn on the lights if the ultrasonic sensor picks up movements.
- Set the buzzer to alert you if the water level sensor notices that the tank is full.
- In the event that the soil moisture sensor identifies dry soil, turn on the plant irrigation system automatically.
- The buzzer should sound to inform people if the MQ6 sensor detects a gas leak.
- Activate the fans if the DHT11 sensor registers a low temperature.

5. **Integration and Control:** Incorporate the reasoning behind the decisions into a centralized control system, like a microcontroller equipped with WiFi or a hub for home automation. Receiving sensor data, processing it with pre-programmed logic, and controlling different actuators (such as lights, buzzers, irrigation systems, and fans) should be the capabilities of this system.

6. **User Interface:** To communicate with the home automation system, create a user interface. This could be a web interface, an app for a smartphone, or voice commands via a smart speaker. It should be possible for users to get messages and warnings, modify automated settings, and keep an eye on sensor data.

7. **Testing and Optimization:** To make sure the home automation system performs as intended, test it under actual operating circumstances. Adjust automation rules, fine-tune sensor thresholds, and fix any problems or flaws to maximize the system.

8. **Implement security** measures to prevent unauthorized users from accessing or altering the home automation system. Password protection, communication channel encryption, and routine software updates to fix bugs are a few examples of this.

9. **Deployment and Maintenance:** Install the home automation system in your residence and give regular upkeep and assistance as required. To guarantee optimal functionality, periodically check the performance of the system, replace any needed batteries or sensors, and update the software.

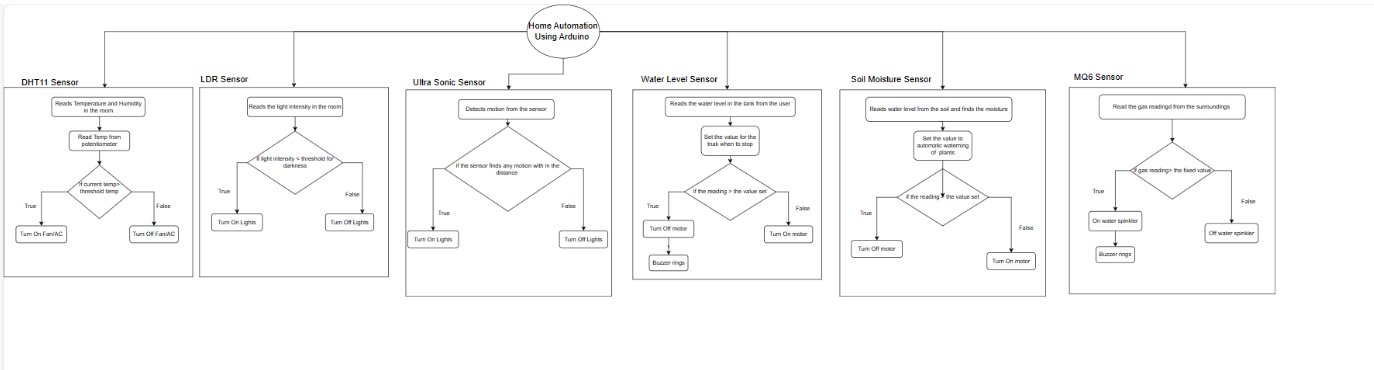



**Figure.2 Conditions for working of each sensor**

## V. Results

A paradigm shift in domestic life is represented by home automation, where technology is seamlessly incorporated into daily activities to improve convenience, effectiveness, and safety. Homeowners may automate processes like lighting, temperature management, security monitoring, and even garden irrigation by utilizing sensors and smart devices. In order to provide automatic responses to environmental stimuli and human requests, sensors such as ultrasonic sensors, LDR sensors, water-level sensors, soil moisture sensors, DHT11 sensors, MQ6 sensors, and Bluetooth sensors are essential. This all-encompassing method of home automation not only makes life easier, but it also encourages energy efficiency, improves security, and supports sustainable lifestyle choices. The potential for developing intelligent, networked homes is endless as

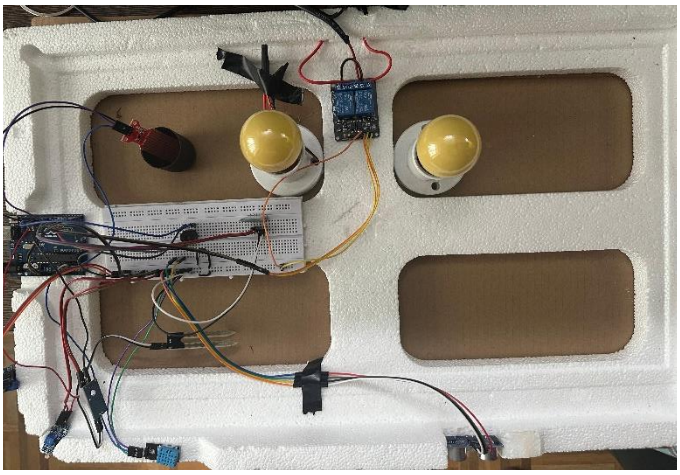


**Figure.3 Working Prototype**

technology develops further, bringing in the age of "smart living," in which residences automatically adjust to the wants and needs of their occupants.

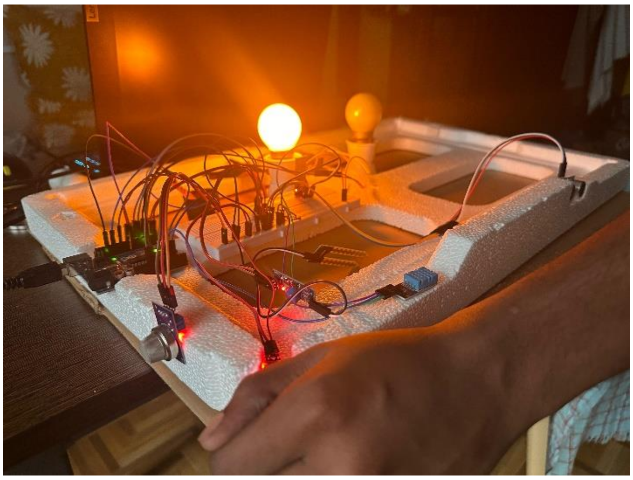


**Figure.4 Working of LDR sensor in dark**

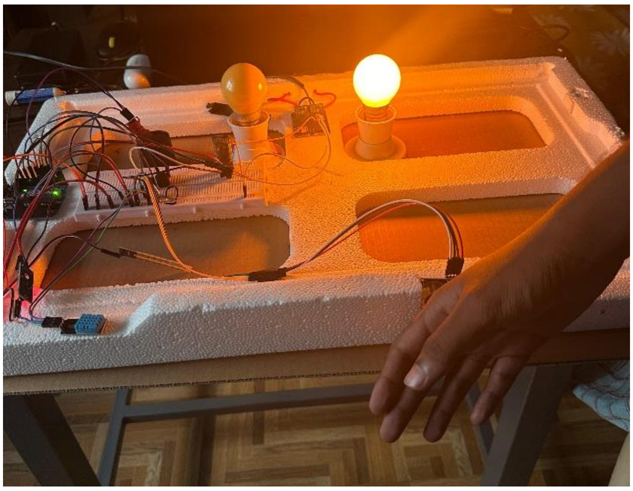


**Figure.5 Working of Ultra Sonic Sensor when motion is detected**

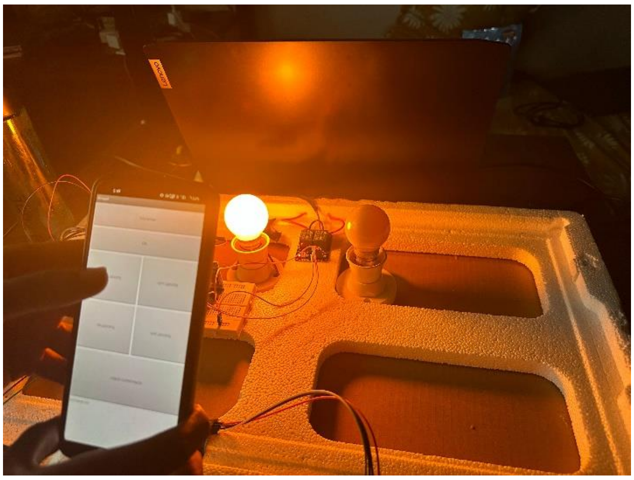


**Figure.6 Turning on light using a mobile app**

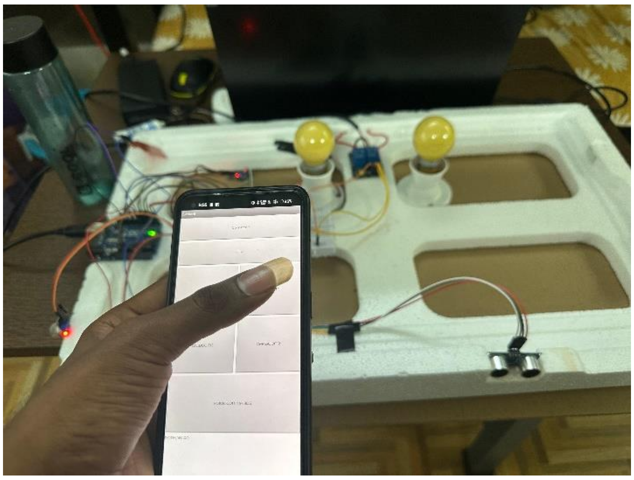


**Figure.7 Turning off light using a mobile app**

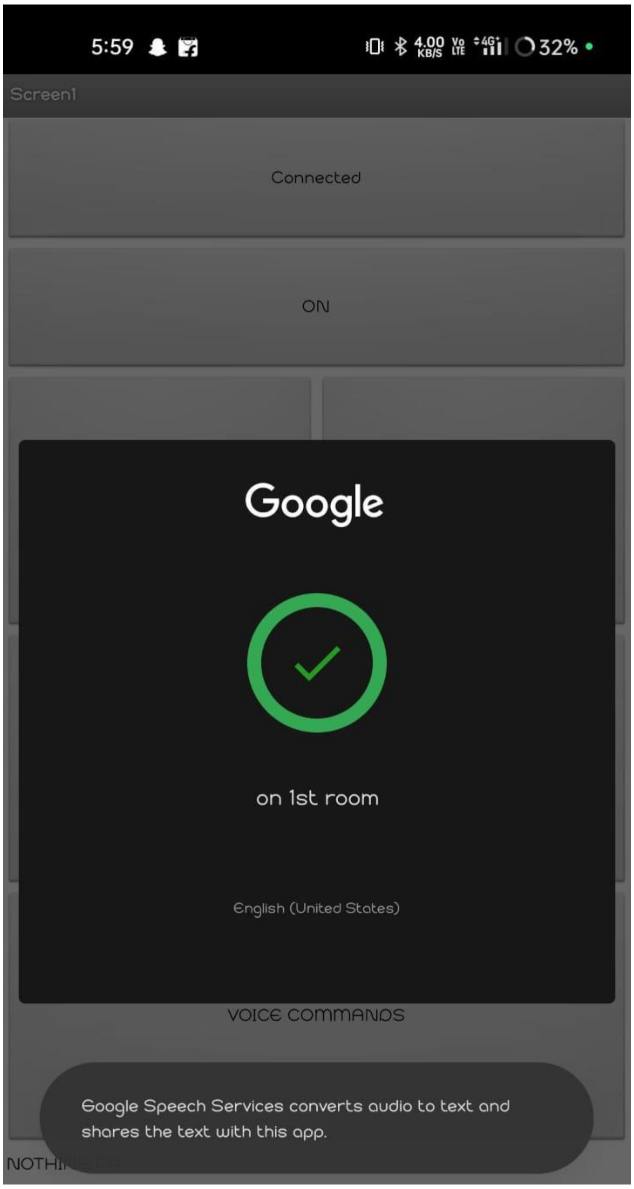



**Figure.8 Turning on light using voice commands**

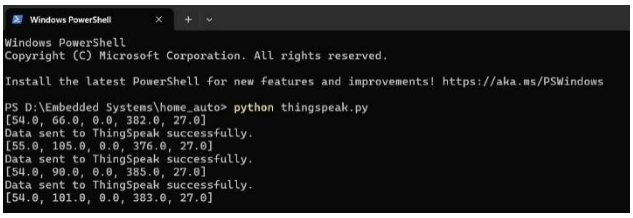



**Figure.9 Collecting the data from sensors from Arduino in staring**

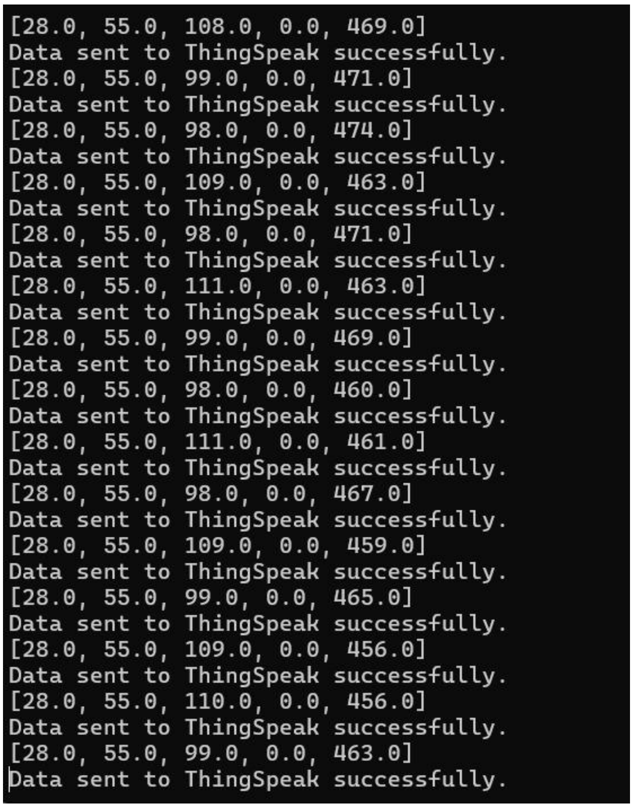



**Figure.10 Collecting the data from sensors from Arduino in after some instance**

**The data collected from the all sensors over period a time is plotted in thingspeak.**

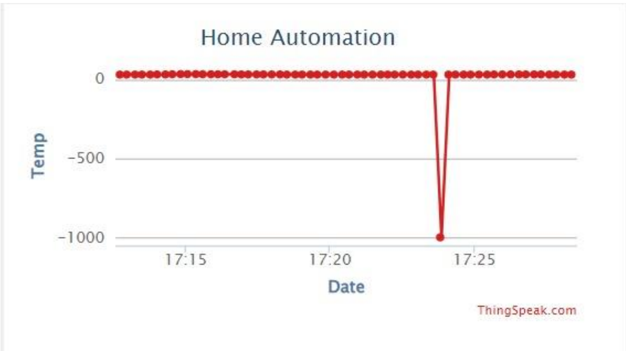



**Figure.11 Temperature readings**

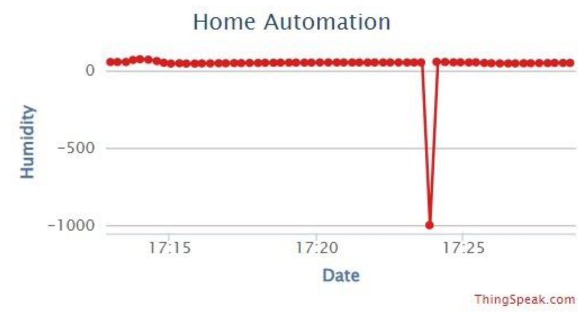



**Figure.12 Humidity readings**


**Figure.13 Smoke readings**

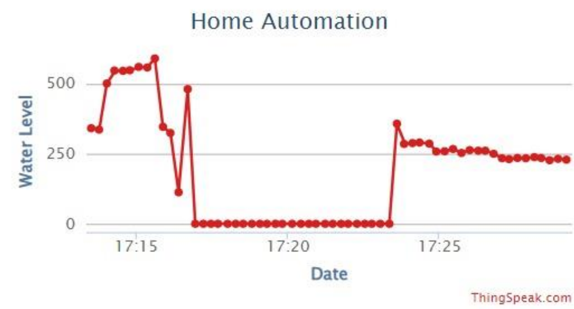



**Figure.14 Water Level readings**

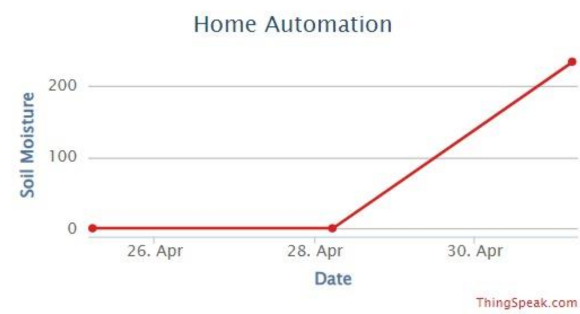
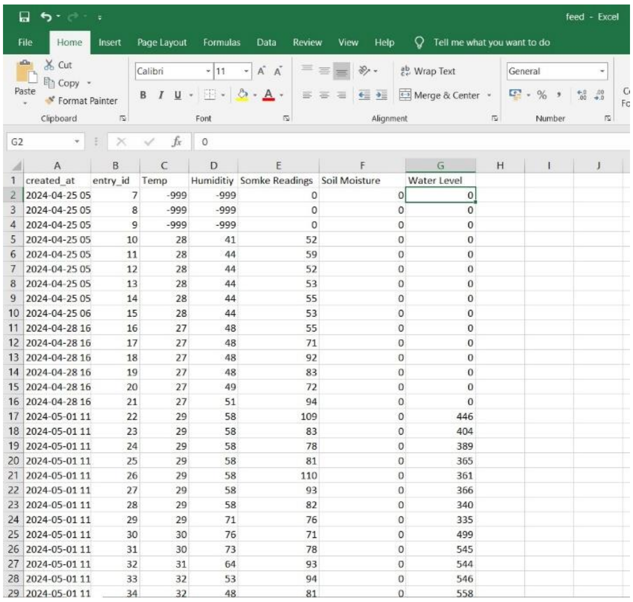



**Figure.15 Soil Moisture readings**



| created_at | entry_id | Temp | Humiditiy | Somke Readings | Soil Moisture | Water Level |
|---|---|---|---|---|---|---|
| 2024-04-25 05 | 7 | -999 | -999 | 0 | 0 | 0 |
| 2024-04-25 05 | 8 | -999 | -999 | 0 | 0 | 0 |
| 2024-04-25 05 | 9 | -999 | -999 | 0 | 0 | 0 |
| 2024-04-25 05 | 10 | 28 | 41 | 52 | 0 | 0 |
| 2024-04-25 05 | 11 | 28 | 44 | 59 | 0 | 0 |
| 2024-04-25 05 | 12 | 28 | 44 | 52 | 0 | 0 |
| 2024-04-25 05 | 13 | 28 | 44 | 53 | 0 | 0 |
| 2024-04-25 05 | 14 | 28 | 44 | 55 | 0 | 0 |
| 2024-04-25 06 | 15 | 28 | 44 | 53 | 0 | 0 |
| 2024-04-28 16 | 16 | 27 | 48 | 55 | 0 | 0 |
| 2024-04-28 16 | 17 | 27 | 48 | 71 | 0 | 0 |
| 2024-04-28 16 | 18 | 27 | 48 | 92 | 0 | 0 |
| 2024-04-28 16 | 19 | 27 | 48 | 83 | 0 | 0 |
| 2024-04-28 16 | 20 | 27 | 49 | 72 | 0 | 0 |
| 2024-04-28 16 | 21 | 27 | 51 | 94 | 0 | 0 |
| 2024-05-01 11 | 22 | 29 | 58 | 109 | 0 | 446 |
| 2024-05-01 11 | 23 | 29 | 58 | 83 | 0 | 404 |
| 2024-05-01 11 | 24 | 29 | 58 | 78 | 0 | 389 |
| 2024-05-01 11 | 25 | 29 | 58 | 81 | 0 | 365 |
| 2024-05-01 11 | 26 | 29 | 58 | 110 | 0 | 361 |
| 2024-05-01 11 | 27 | 29 | 58 | 93 | 0 | 366 |
| 2024-05-01 11 | 28 | 29 | 58 | 82 | 0 | 340 |
| 2024-05-01 11 | 29 | 29 | 71 | 76 | 0 | 335 |
| 2024-05-01 11 | 30 | 30 | 76 | 71 | 0 | 499 |
| 2024-05-01 11 | 31 | 30 | 73 | 78 | 0 | 545 |
| 2024-05-01 11 | 32 | 31 | 64 | 93 | 0 | 544 |
| 2024-05-01 11 | 33 | 32 | 53 | 94 | 0 | 546 |
| 2024-05-01 11 | 34 | 32 | 48 | 81 | 0 | 558 |

**Figure.16 All the readings stored in excel**

## VI. Conclusion

This article describes a smart home automation project that exemplifies a multimodal strategy for establishing a more convenient, safe, and effective living space. This technology helps create a more sustainable home by optimizing energy use and cutting waste through the integration of automation and sensors. Energy efficiency and user convenience are provided by automated lighting control systems that use ultrasonic sensors and Light Dependent Resistors (LDR) in various rooms.

Users may control their home lighting and other features remotely and conveniently from anywhere thanks to the system's connectivity with a mobile app. By giving users instant control, this remote capability improves their experience.

A thorough approach to monitoring and maintaining a safe home environment is further ensured by the inclusion of a variety of sensors for environmental monitoring, such as the DHT sensor for temperature and humidity, the MQ6 gas sensor for smoke detection, and water level and soil moisture sensors for safety and plant care. Users can analyze and monitor data in real time and gain insight into their home's conditions with the use of the ThingSpeak link.

All things considered, this smart home automation system does a good job of fusing automation, remote control, and environmental monitoring to produce a safe and convenient living environment. It provides a creative answer that satisfies the needs of contemporary life by emphasizing effectiveness, security, and convenience.

## VII. Future works

1. **Advanced Automation Algorithms:** Investigate and create sophisticated automation algorithms that maximize comfort, convenience, and energy efficiency in the house by utilizing data from several sensors. Machine learning systems, for instance, may employ sensor data analysis to forecast user preferences and modify settings appropriately.

2. **Remote Monitoring and Control:** By combining these sensors with mobile apps and cloud-based platforms, you may increase the possibilities of remote monitoring and control. With smartphones or other linked devices, homeowners would be able to monitor and manage their home environment from anywhere.

3. **Fault Detection and Diagnostics:** To find and fix problems with sensor performance or system functionality in real-time, use fault detection and diagnostics procedures. This can entail creating algorithms to find anomalies in sensor data or adding self-diagnostic capabilities to sensor firmware.

4. **Energy Harvesting and Efficiency:** Investigate methods for harnessing renewable energy sources, such solar or kinetic energy, to power these sensors. Optimize sensor power consumption as well to extend battery life and minimize maintenance needs.

5. **Improvements in Security and Privacy:** In order to safeguard sensor data and stop illegal access or manipulation, security and privacy safeguards should be strengthened. Establishing secure communication routes, authentication procedures, and encryption protocols between sensors and control systems may be necessary to achieve this.

6. **User Interface and Experience:** Create easily navigable dashboards and intuitive user interfaces for home automation systems that make it simple for users to monitor sensor data, change settings, and get alerts or messages.

| **Paper** | **Study Description** | **Findings** |
|---|---|---|
| Paper 1 | Learning about the sensors | Selecting the correct sensors based on the condition in every situation. |
| Paper 2 | Testing of a smart home automation system in a measuring soil temperature and moisture etc…. | On and off of water tanks when it is full, automatic watering for plants etc…same for other sensors depending on the scenario. |
| Paper 3 | Learning about the MQTT and Adafruit IO for building a app for controlling all the appliances in the home. | Creating a app/website for controlling all the appliances in the home. |
| Paper 4 | Learning about the wireless transmission | Creating a remote for controls like on and off of fans/AC, lights etc… for old aged people. |

| Paper | Study Description | Findings |
|---|---|---|
| Paper 5 | Comparison study showing significant difference in outcomes between home automation and normal. | The power consumption is were less without home automation and even it is every useful of old aged people. |

## VIII. BECNCHMARKINGS

**Efficiency:** Saves the time and money.

**Practical Implementation:** Evaluate the ease of installation, maintenance, and scalability of each system for real-world applications.

**Cost-Benefit Analysis:** Consider the initial setup costs, operational expenses, and easy to do works.

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