HOME AUTOMATION
USING ARDUINO

A PROJECT REPORT

Submitted by

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RAJALAKSHMI ENGINEERING COLLEGE,

CHENNAI BONAFIDE CERTIFICATE

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ABSTRACT

The project aims to create an advanced home automation system using Arduino, integrating various sensors and actuators to enhance energy efficiency and convenience. Key components include an LDR for ambient light sensing, a PIR motion sensor for human presence detection, and a relay module to control a DC motor powering a plastic fan. The system also includes a blinking LED indicator that responds to ambient light levels. This project aligns with the growing trend of smart home technology, offering a cost-effective and customizable solution for improving comfort and reducing energy consumption. Basic systems may only offer simple on/off functionality without considering factors such as ambient light levels or human presence. The proposed home automation system addresses these limitations by providing a comprehensive and user-friendly solution. By integrating sensors such as the LDR and PIR motion sensor, the system can autonomously adjust appliance settings based on real-time data, improving energy efficiency and user comfort. The system's use of Arduino as a platform ensures affordability and flexibility, allowing users to customize and expand their automation setup as needed. Overall, this project aims to contribute to the advancement of smart home technology by providing an accessible and efficient solution for modern homes.The project will follow a modular design approach to integrate various sensors and actuators, creating a versatile home automation system. Arduino will act as the central controller, orchestrating system operations based on sensor inputs. Programming will be done using Arduino IDE, focusing on efficiency and reliability. The system will not include wireless protocols for remote monitoring and control. This approach ensures a reliable and efficient home automation system that enhances energy efficiency and user convenience.

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1. INTRODUCTION

In contemporary living, home automation stands out as a notable trend, providing innovative solutions to enhance convenience, safety, and energy efficiency. This project is centered around the development of a versatile home automation system using Arduino, a renowned open-source hardware platform lauded for its adaptability and user-friendliness. By seamlessly integrating a variety of sensors and actuators, this system aims to autonomously control household appliances based on environmental conditions and user presence, ushering in a new era of smart living.

1.1 PROBLEM STATEMENT

Conventional home appliances operate in a static manner, oblivious to ambient light levels or human presence, resulting in unnecessary energy consumption and inconvenience. This project seeks to address these shortcomings by implementing an intelligent automation system capable of adjusting appliance settings in real-time based on sensor data. Through this approach, the project endeavors to enhance both energy efficiency and user comfort, bringing about a more responsive and intuitive home environment.

1.2 SCOPE OF THE WORK

The project's scope encompasses the comprehensive design, development, and deployment of a home automation system using Arduino as the primary platform. The system's key components include an LDR for monitoring ambient light levels, a PIR motion sensor for detecting human presence, and a relay module to regulate a DC motor driving a plastic fan. Additionally, the system features a blinking LED indicator that provides visual feedback based on ambient light conditions, further enhancing user interaction and system feedback. It typically involves the integration of various sensors, actuators, and

controllers to automate tasks and enhance the functionality of a home. This can include controlling lighting, HVAC systems, security cameras, and appliances, as well as implementing features like motion detection, voice control, and energy monitoring. The scope also encompasses the design and implementation of a user interface, which allows users to interact with and control the automated systems. Additionally, the project may involve considerations for scalability, interoperability with existing systems, and security measures to protect against unauthorized access. Overall, the scope of a home automation project is broad and can be tailored to meet the specific needs and preferences of the homeowner.

1.3 AIM AND OBJECTIVES OF THE PROJECT

The primary aim of this project is to create an intelligent home automation system that enhances both energy efficiency and user convenience. The specific objectives include integrating an LDR sensor to monitor ambient light levels, utilizing a PIR motion sensor to detect human presence, controlling a DC motor using a relay module for fan automation, and implementing a blinking LED indicator based on ambient light conditions. By achieving these objectives, the project seeks to demonstrate the potential of smart home technology in improving daily living experiences.

1.4 RESOURCES

Successful implementation of this project will require a range of resources, including an Arduino Uno board, LDR sensor, PIR motion sensor, relay module, DC motor, plastic fan, LED, jumper wires, breadboard, and power supply. These resources are essential for building a functional and efficient home automation system that meets the project's objectives and requirements.

1.5 MOTIVATION

The motivation behind this project is rooted in the growing demand for smart home solutions that offer convenience, energy efficiency, and customization options. By developing a cost-effective and scalable home automation system, this project aims to contribute to the advancement of smart home technology, ultimately improving the quality of life for users.Home automation projects are motivated by a desire for convenience, energy efficiency, security, safety, accessibility, customization, learning, and increased property value. The convenience aspect stems from the ability to control various devices and systems from a centralized interface, making tasks like adjusting lighting, thermostats, and security cameras easier. Energy efficiency is achieved through scheduling and automation, which can reduce energy consumption by turning off lights and adjusting thermostats when not needed. Security features such as remote monitoring of security cameras and automated door locks enhance home security. Safety is improved with features like automated fire detection and gas leak detection. Home automation also makes homes more accessible to individuals with disabilities. Customization allows users to personalize their living spaces with lighting scenes, temperature adjustments, and automated routines. For hobbyists, these projects provide an opportunity to learn new skills in programming, electronics, and system integration. Finally, home automation can increase property value by making homes more modern and desirable to potential buyers.

2. LITERATURE SURVEY

"Design of a home automation system using Arduino" by David et al. (2015) explores various facets of home automation technology. Researchers have investigated the integration of Arduino platforms for building home automation systems, leveraging its accessibility, affordability, and versatility. Studies in this domain typically encompass discussions on wireless communication protocols, sensor and actuator integration, user interfaces, energy efficiency considerations, security measures, and integration with existing smart home ecosystems. Additionally, literature often includes real-world deployments and case studies to illustrate the practical implementation and effectiveness of Arduino-based home automation solutions. Overall, the research surrounding David et al.'s work contributes to the broader understanding of home automation technology and its potential applications in enhancing residential environments.

"Intelligent smart home automation and security system using Arduino and Wi-Fi" by Chandramohan et al. (2017) addresses several key themes in the field of smart home technology. Researchers have extensively explored the integration of Arduino microcontrollers and Wi-Fi connectivity to develop intelligent systems capable of automating various household tasks and enhancing security measures. Topics covered in the literature include the utilization of sensors for environmental monitoring and occupancy detection, the implementation of actuators for remote device control, the development of user-friendly interfaces for seamless interaction, and the incorporation of advanced algorithms for intelligent decision-making. Furthermore, discussions often extend to considerations of energy efficiency, scalability, and interoperability with existing smart home ecosystems. Case studies and real-world deployments featured in the literature provide valuable insights into the practical implementation and performance of Arduino and Wi-Fi-based smart home solutions. Overall, the research surrounding Chandramohan et al.'s

work contributes to the advancement of intelligent home automation and security systems, offering innovative approaches to enhance residential living experiences.

"IoT based home automation using Arduino" by Mahalakshmi and Vigneshwaran (2017) encompasses various aspects of Internet of Things (IoT) technology applied to home automation. Researchers have explored the integration of Arduino microcontrollers with IoT protocols and platforms to create intelligent and interconnected home automation systems. Discussions in the literature often revolve around the utilization of sensors and actuators for monitoring and controlling various home devices and appliances remotely. Additionally, studies address the implementation of communication protocols such as Wi-Fi, Bluetooth, or Zigbee to enable seamless connectivity between IoT devices and the Internet. Researchers also investigate the development of user interfaces, mobile applications, or web-based dashboards to provide users with intuitive control and monitoring capabilities. Moreover, the literature discusses energy-efficient strategies, security measures, and scalability considerations in IoT-based home automation systems. Real-world implementations and case studies presented in the literature offer insights into the practical deployment and performance of Arduino-based IoT home automation solutions. Overall, the research surrounding Mahalakshmi and Vigneshwaran's work contributes to advancing the field of IoT-enabled home automation, offering innovative approaches to enhance residential living experiences through connectivity and automation.

"Smart home automation and security system using Arduino and IoT" by Wadhwani et al. (2018) encompasses a range of topics within the realm of smart home technology. Researchers have focused on integrating Arduino microcontrollers with IoT (Internet of Things) technologies to develop sophisticated home automation and security systems. Discussions in the

literature often revolve around the utilization of various sensors and actuators for monitoring and controlling different aspects of home environments, such as temperature, humidity, lighting, and security devices. Additionally, studies delve into the implementation of IoT communication protocols, such as Wi-Fi or Bluetooth, to enable seamless connectivity between devices and the internet, facilitating remote access and control. Researchers also explore the development of user-friendly interfaces, such as mobile applications or web-based dashboards, to empower users with intuitive control and monitoring capabilities. Furthermore, considerations regarding energy efficiency, scalability, and security are addressed to ensure the robustness and reliability of these systems. Real-world implementations and case studies presented in the literature offer valuable insights into the practical deployment and performance of Arduino-based IoT smart home solutions. Overall, the research surrounding Wadhwani et al.'s work contributes to advancing the field of smart home automation and security, offering innovative approaches to enhance residential living experiences through connectivity, automation, and enhanced security measures.

"Arduino based home automation using Internet of Things (IoT)" by Satapathy et al. (2018) encompasses various facets of IoT-enabled home automation systems. Researchers have focused on leveraging Arduino microcontrollers and IoT technologies to create intelligent and interconnected home automation solutions. Discussions in the literature often revolve around the integration of sensors and actuators for monitoring and controlling various aspects of home environments, such as temperature, humidity, lighting, and appliances. Additionally, studies explore the implementation of IoT communication protocols, such as Wi-Fi or Bluetooth, to enable seamless connectivity between devices and the internet, allowing for remote access and control. Researchers also delve into the development of user-friendly interfaces, such as mobile

applications or web-based dashboards, to empower users with intuitive control and monitoring capabilities. Furthermore, considerations regarding energy efficiency, scalability, and security are addressed to ensure the robustness and reliability of these systems. Real-world implementations and case studies presented in the literature offer valuable insights into the practical deployment and performance of Arduino-based IoT home automation solutions. Overall, the research surrounding Satapathy et al.'s work contributes to advancing the field of IoT-enabled home automation, offering innovative approaches to enhance residential living experiences through connectivity, automation, and enhanced functionality.

"Low-cost home automation using Arduino and Modbus protocol" by Hassanpour et al. (2017) addresses the development of affordable home automation systems leveraging Arduino microcontrollers and the Modbus protocol. Researchers have focused on exploring cost-effective solutions to enable automation and control of various household devices and systems. Discussions in the literature typically revolve around the integration of Arduino boards with Modbus communication protocol, enabling seamless communication between different automation devices. Moreover, studies delve into the implementation of sensors and actuators for monitoring and controlling environmental parameters, appliances, and security systems within the home environment. Additionally, considerations are given to the development of user interfaces and control mechanisms to facilitate user interaction and customization. Real-world applications and case studies presented in the literature provide insights into the practical deployment and performance of Arduino-based home automation systems utilizing the Modbus protocol. Overall, the research surrounding Hassanpour et al.'s work contributes to advancing low-cost solutions for home automation, making such technology more accessible to a wider range of users.

"Smart home automation system using Bluetooth technology" by Asadullah and Ullah (2017) delves into the development of intelligent home automation systems leveraging Bluetooth technology. Researchers have focused on harnessing the capabilities of Bluetooth to create interconnected and adaptable home automation solutions. Discussions in the literature often center around the integration of Bluetooth modules with microcontrollers, such as Arduino or Raspberry Pi, to enable communication between various smart devices within the home environment. Moreover, studies explore the implementation of sensors and actuators for monitoring and controlling different aspects of home automation, including lighting, temperature, security systems, and appliance control. Additionally, considerations are given to the development of user-friendly mobile applications or interfaces to facilitate remote access and control of smart home devices. Real-world implementations and case studies presented in the literature provide insights into the practical deployment and performance of Bluetooth-based smart home automation systems. Overall, the research surrounding Asadullah and Ullah's work contributes to advancing the field of smart home technology, offering innovative solutions to enhance residential living experiences through seamless connectivity and automation.

"Home security and energy efficient home automation system using Arduino" by Nayyar, Valarmathi, and Santhi (2017) explores the intersection of home security and energy efficiency within the context of home automation systems. Researchers have focused on leveraging Arduino microcontrollers to develop integrated solutions that not only enhance security measures but also optimize energy usage within residential environments. Discussions in the literature often revolve around the integration of sensors and actuators for monitoring and controlling various aspects of home security, such as intrusion detection, surveillance, and access control. Moreover, studies explore the implementation of energy-efficient algorithms and scheduling mechanisms to regulate the usage

of home appliances and lighting systems, thereby reducing energy consumption. Additionally, considerations are given to the development of user-friendly interfaces and mobile applications to enable remote monitoring and control of the smart home environment. Real-world implementations and case studies presented in the literature provide insights into the practical deployment and performance of Arduino-based home security and energy-efficient automation systems. Overall, the research surrounding Nayyar et al.'s work contributes to advancing smart home technology, offering comprehensive solutions that address both security concerns and energy conservation objectives.

"Smart Home Automation based on different sensors and Arduino as the master controller" by Chattoraj (2015) explores the integration of various sensors and Arduino microcontrollers to create intelligent home automation systems. Researchers have focused on leveraging Arduino as the master controller to orchestrate the functionalities of different sensors and actuators within the smart home environment. Discussions in the literature often revolve around the types of sensors employed, including but not limited to temperature, humidity, motion, light, and gas sensors, and their respective roles in monitoring and controlling different aspects of the home environment. Moreover, studies explore the implementation of Arduino-based algorithms and logic to process sensor data, make decisions, and trigger appropriate actions to automate tasks such as climate control, lighting, and security. Additionally, considerations are given to the development of user interfaces and control mechanisms to facilitate user interaction and customization of automation settings. Real-world implementations and case studies presented in the literature provide insights into the practical deployment and performance of Arduino-based smart home automation systems. Overall, the research surrounding Chattoraj's work contributes to advancing the field of smart home technology, offering innovative solutions to enhance residential living experiences through connectivity,

automation, and sensor intelligence.

"Smart home automation system using Arduino microcontrollers" by Gota et al. (2020) delves into the development of intelligent home automation systems leveraging Arduino microcontrollers. Researchers have focused on harnessing the capabilities of Arduino boards to create interconnected and adaptable home automation solutions. Discussions in the literature often center around the integration of Arduino microcontrollers with various sensors and actuators to monitor and control different aspects of the home environment. Moreover, studies explore the implementation of communication protocols, such as Wi-Fi or Bluetooth, to enable seamless connectivity between devices and the internet, allowing for remote access and control. Real-world implementations and case studies presented in the literature provide insights into the practical deployment and performance of Arduino-based smart home automation systems. Overall, the research surrounding Gota et al.'s work contributes to advancing the field of smart home technology, offering innovative solutions to enhance residential living experiences through connectivity, automation, and ease of use.

3. PRESENT TECHNOLOGY

Present technology for home automation, including the use of sensors, microcontrollers, and communication protocols, offers significant benefits but also comes with certain limitations.

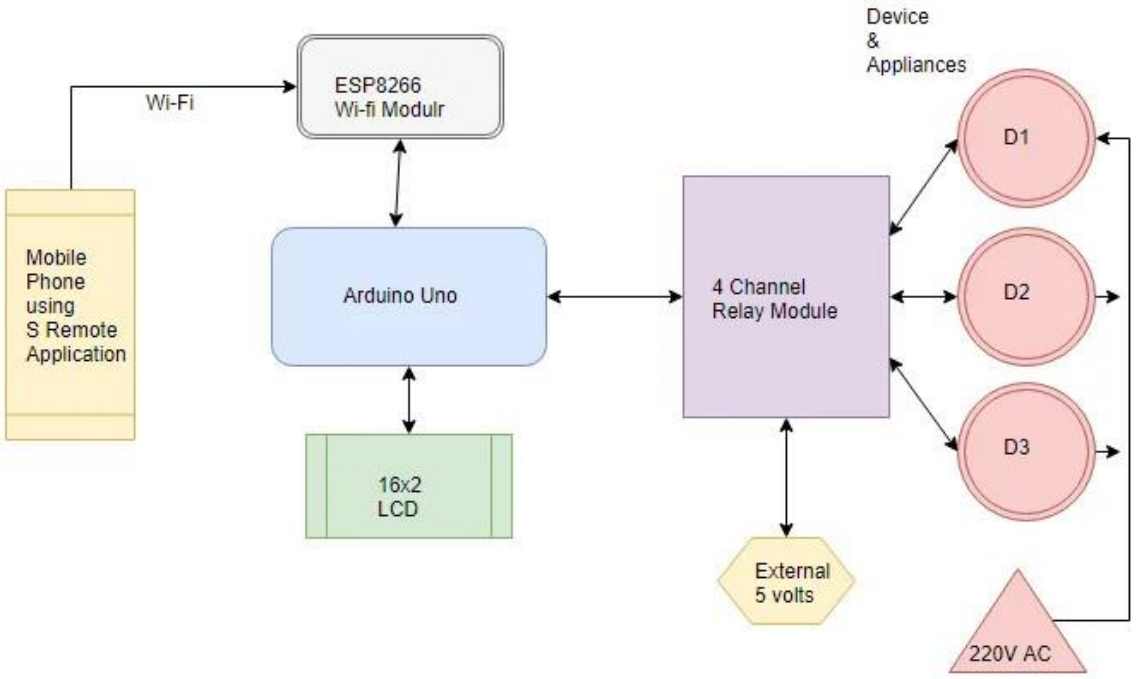
One limitation is the complexity of setup and configuration, especially for users with limited technical knowledge. Setting up sensors, configuring microcontrollers, and integrating devices can be challenging for some users, potentially limiting the adoption of home automation technology.

Another limitation is the cost associated with implementing a comprehensive home automation system. While the components themselves, such as Arduino boards and sensors, are relatively affordable, the cost can add up when integrating multiple sensors and actuators throughout a home. This cost can be a barrier for some users looking to adopt home automation technology.

Interoperability is also a limitation in present home automation technology. Different devices and systems may use different communication protocols, making it challenging to integrate them seamlessly. This can result in a fragmented system where devices do not communicate effectively with each other, limiting the overall functionality and convenience of the system.

Security and privacy are also concerns with present home automation technology. Wireless communication protocols, if not properly secured, can be vulnerable to hacking and unauthorized access. Additionally, the collection of data from sensors raises privacy concerns, as users may be uncomfortable with the amount of data being collected and how it is being used.Despite these limitations, ongoing advancements in technology are addressing many of these issues. Efforts are being made to simplify setup and configuration, reduce costs, improve interoperability, and enhance security and privacy in home automation.

3.1 BLOCK DIAGRAM



The home automation system comprises a mobile phone application as the user interface, communicating with an ESP8266 Wi-Fi module over a wireless network. The ESP8266 module serves as a bridge, connecting the mobile application to an Arduino Uno microcontroller through a serial connection. The Arduino Uno is the central control unit, managing a 4-channel relay module responsible for controlling various 220V AC devices. Additionally, the Arduino Uno communicates with an LCD display to provide real-time feedback or status updates. Both the Arduino Uno and the ESP8266 module are powered by an external 5V power source, ensuring reliable operation of the system. This integrated setup allows users to remotely monitor and control devices in their home through a convenient and user-friendly mobile application interface, enhancing convenience, energy efficiency, and overall home automation capabilities.

3.2 LIMITATIONS

The limitations in present home automation technology include -

- complex setup and configuration, which can be challenging for users with limited technical knowledge, potentially limiting adoption.
- Additionally, while components like Arduino boards and sensors are affordable, integrating multiple sensors and actuators throughout a home can become expensive, acting as a barrier for some users.
- Interoperability is another issue, as different devices and systems may use different communication protocols, making it challenging to integrate them seamlessly and resulting in a fragmented system.
- Security and privacy concerns also exist, as wireless communication protocols can be vulnerable to hacking and unauthorized access raises privacy concerns.
- Maintenance and updates can be another challenge, as keeping the system up-to-date with the latest software and firmware updates can be time-consuming and require technical knowledge.
- Lastly, expanding the system to include more devices or functionalities may require significant reconfiguration or upgrades.

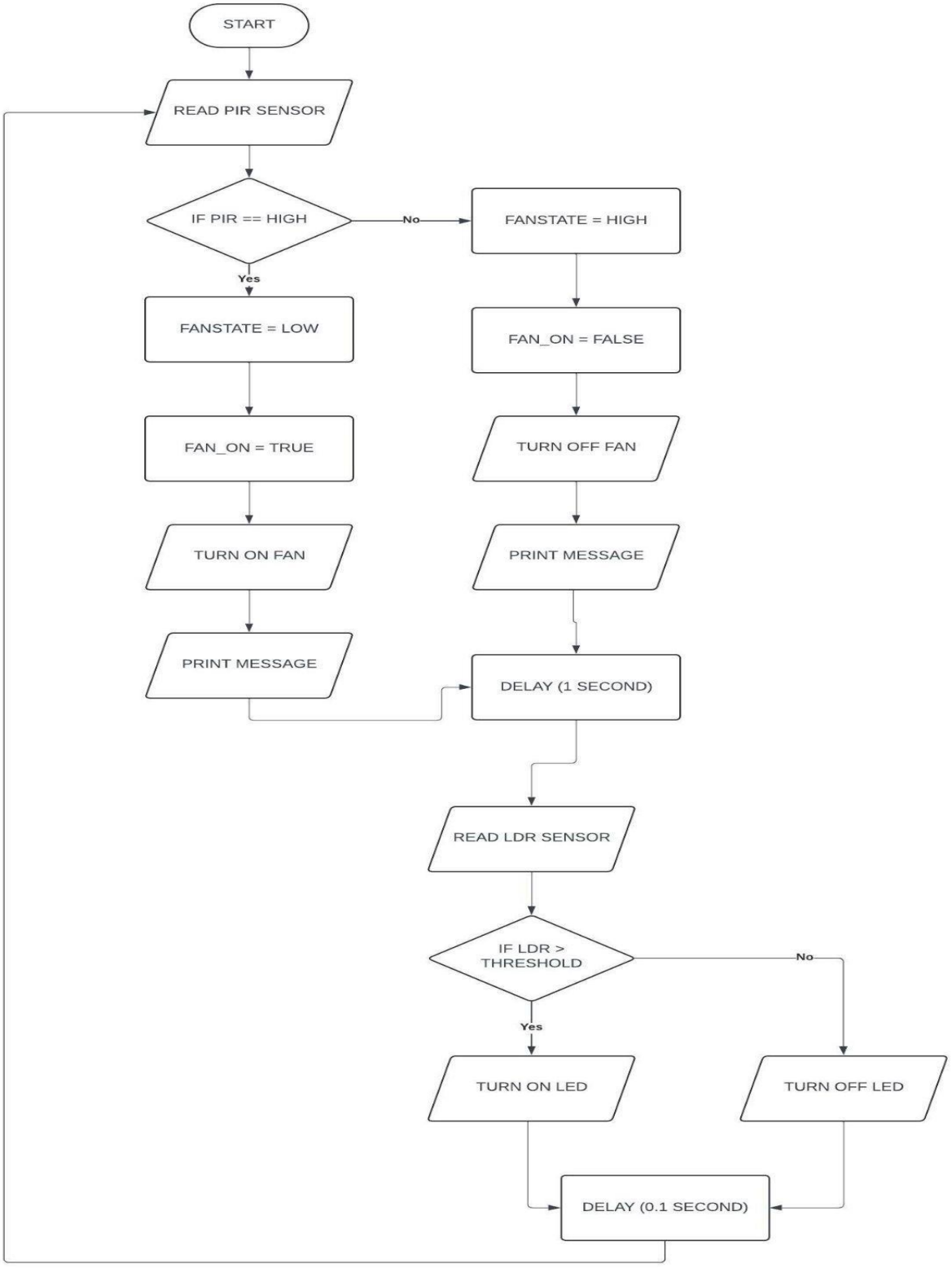
Despite these limitations, ongoing advancements in technology are addressing many of these issues, aiming to simplify setup, reduce costs, improve interoperability, enhance security and privacy, and increase functionality.

4. PROPOSED TECHNOLOGY

In response to the increasing demand for smart home solutions, this project proposes the use of Arduino as the core technology for developing a versatile home automation system. Arduino's open-source hardware platform provides a flexible and cost-effective foundation for integrating various sensors and actuators, making it an ideal choice for creating intelligent automation systems. By leveraging Arduino's user-friendly development environment and vast community support, this project aims to deliver a robust and customizable solution that enhances the functionality of household appliances.

The proposed home automation system will utilize an array of sensors, including an LDR for monitoring ambient light levels and a PIR motion sensor for detecting human presence. These sensors will enable the system to adjust appliance settings in real-time based on environmental conditions and user activity, thereby improving energy efficiency and user convenience. Additionally, the system will feature a relay module to control a DC motor driving a plastic fan, providing automated ventilation based on user presence and environmental factors. By integrating these components, the proposed system will offer a comprehensive and intuitive solution for creating a smart living environment, showcasing the potential of Arduino-based home automation technology. Furthermore, the proposed home automation system will include a blinking LED indicator that provides visual feedback based on ambient light conditions. This feature adds an interactive element to the system, allowing users to easily understand and monitor the system's operations.

4.1 SEQUENCE DIAGRAM

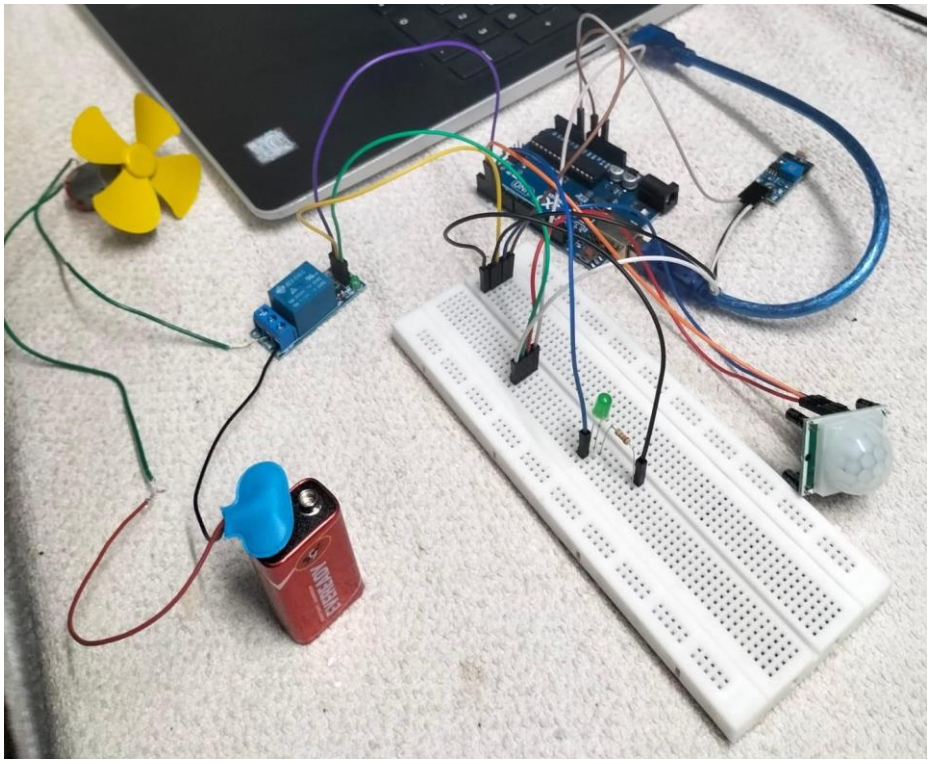


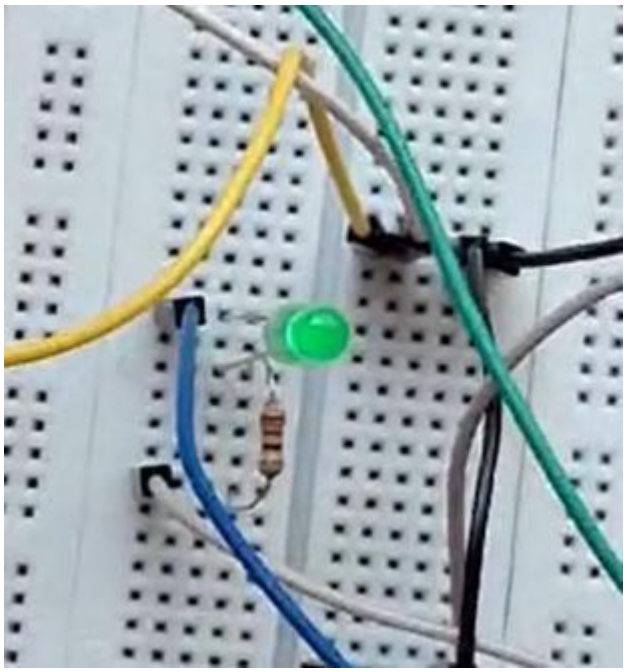
4.2 ADVANTAGES

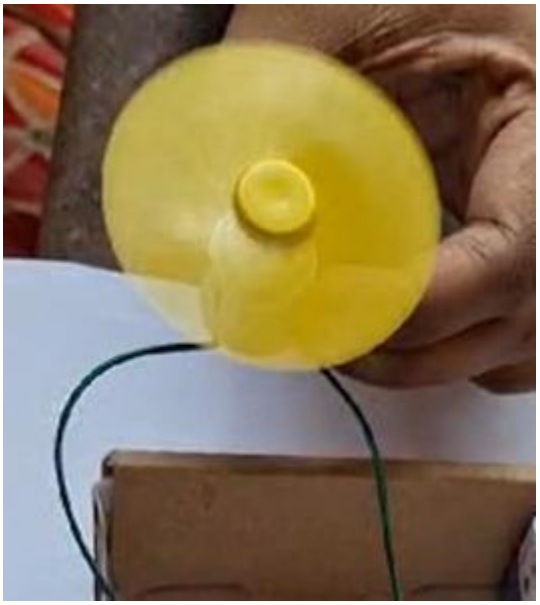
- The described home automation system offers a compelling array of advantages that revolutionize the way household appliances are controlled and managed.
- Primarily, the system champions energy efficiency by intelligently regulating the operation of the fan and light based on real-time environmental cues. By activating these devices only when necessary, the system significantly reduces energy consumption, resulting in cost savings and environmental benefits.
- Moreover, the system enhances convenience by automating the activation and deactivation of the fan and light, eliminating the need for manual intervention. This hands-free approach simplifies daily routines and enhances the overall comfort of occupants.
- Safety is also prioritized through the system's automatic illumination of the LED light in low-light conditions, mitigating potential hazards and ensuring visibility.
- Additionally, the system's modular design facilitates scalability, enabling the seamless integration of additional sensors or devices to further enhance functionality. With the potential for remote monitoring and control, users can effortlessly manage their home environment from anywhere, adding an extra layer of convenience and peace of mind.

5. RESULTS AND DISCUSSIONS

5.1 OUTPUT







5.2 RESULT

The home automation system described utilizes Arduino along with various sensors and components to automate the control of a fan and LED light based on motion and light intensity.

The PIR (Passive Infrared) motion sensor detects motion within its range, triggering the fan to turn on when motion is detected and turn off when no motion is sensed. This functionality enhances energy efficiency by ensuring that the fan operates only when needed, contributing to both convenience and cost-effectiveness. In parallel, an LDR (Light Dependent Resistor) sensor measures ambient light levels. When the light intensity falls below a predefined threshold, indicating low light conditions, an LED light is automatically activated. This feature is particularly useful for ensuring adequate illumination in spaces such as corridors or rooms during evenings or in darker environments.

By integrating these sensors with the Arduino microcontroller, the system achieves seamless automation, requiring minimal manual intervention. The relay module acts as a switch, controlling the power supply to the fan, while the Arduino serves as the central processing unit, executing the programmed logic

based on sensor inputs. The setup is not only efficient but also versatile. Users can adjust the sensitivity thresholds of both the motion and light sensors to suit their specific requirements. Additionally, the modular nature of the system allows for scalability, enabling the integration of additional sensors or devices for more comprehensive home automation functionalities.

Overall, this project illustrates the potential of IoT (Internet of Things) in enhancing home automation, offering users greater comfort, convenience, and energy savings by intelligently managing the operation of essential appliances based on environmental conditions. With its straightforward setup and customizable features, it represents a practical and accessible solution for modernizing home infrastructure.

6. CONCLUSION AND FUTURE ENHANCEMENT

6.1 CONCLUSION

In conclusion, the proposed advanced home automation system represents a significant step forward in the realm of smart home technology. By integrating various sensors and actuators, including an LDR for ambient light sensing, a PIR motion sensor for human presence detection, and a relay module for controlling a fan, the system offers a comprehensive solution for enhancing energy efficiency and convenience in modern homes. Following a modular design approach and utilizing Arduino as the central controller provide flexibility, scalability, affordability, and reliability to the system. Programming with Arduino IDE ensures efficient and reliable system operations, while the absence of wireless protocols for remote monitoring and control prioritizes stability and responsiveness. Overall, this project contributes to the advancement of smart home technology by providing an accessible, efficient, and customizable solution tailored to the needs of modern households. With its focus on enhancing energy efficiency and user convenience, the proposed home automation system addresses key limitations of basic systems, paving the way for more intelligent and sustainable living environments.

6.2 FUTURE ENHANCEMENT

For future enhancements, the advanced home automation system could benefit from the integration of wireless connectivity, such as Wi-Fi or Bluetooth. This addition would allow for remote monitoring and control via mobile devices or web interfaces, enhancing user convenience and accessibility. Moreover, implementing more sophisticated automation logic based on machine learning algorithms or artificial intelligence could further optimize energy usage and enhance user experience. By learning user preferences and adapting to changing

environmental conditions, the system could provide personalized and efficient automation tailored to individual needs. Expanding the sensor array is another avenue for enhancement. Integrating additional sensors, such as temperature, humidity, air quality, or occupancy sensors, would enable more comprehensive environmental monitoring. This, in turn, would empower the system to make more informed decisions regarding energy management, comfort control, and security. Additionally, leveraging smart grid technologies could lead to more advanced energy management strategies, allowing the system to adjust energy consumption based on real-time electricity prices or grid conditions, thus optimizing cost savings and grid stability. Overall, these future enhancements would elevate the capabilities of the home automation system, making it more intelligent, responsive, and energy-efficient while enhancing user comfort and convenience.

APPENDIX

```
int pirPin = 2;          // PIR sensor output connected to digital pin 2
int relayPin = 3;        // Relay module control pin connected to digital pin 3
int ldrPin = A0;         // LDR sensor output connected to analog pin A0
int pirState = LOW;      // Variable to store PIR sensor state
int fanState = LOW;      // Fan state (OFF by default)
bool fanOn = false;      // Flag to track if the fan is on
int ldrThreshold = 500; // LDR threshold value for LED control
void setup() {
  pinMode(pirPin, INPUT);
  pinMode(relayPin, OUTPUT);
  pinMode(ldrPin, INPUT);
  digitalWrite(relayPin, fanState); // Set initial fan state
  Serial.begin(9600); // Initialize serial communication
}
void loop() {
    pirState = digitalRead(pirPin);     // Read the PIR sensor state
    // If motion is detected and fan is off, turn on the fan
    if (pirState == HIGH && fanState == LOW) {
    fanState = HIGH;
    digitalWrite(relayPin, fanState); // Turn on the fan
    fanOn = true; // Set the flag
    Serial.println("Motion detected! Fan turned on."); // Print message
    delay(1000); // Delay to avoid multiple detections
```

```
  }
  // If no motion is detected and fan is on, turn off the fan
  else if (pirState == LOW && fanState == HIGH && fanOn) {
    fanState = LOW;
    digitalWrite(relayPin, fanState); // Turn off the fan
    fanOn = false; // Reset the flag
    Serial.println("No motion detected. Fan turned off."); // Print message
    delay(1000); // Delay to avoid multiple detections
  }
   int ldrValue = analogRead(ldrPin); // Read the LDR sensor and control the LED
  if (ldrValue > ldrThreshold) {
    digitalWrite(4, HIGH); // Turn on the LED
  } else {
    digitalWrite(4, LOW);  // Turn off the LED
  }
  delay(100); // Delay for stability
}
```

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