A Synopsis Report on

SMART HOME AUTOMATION SYSTEM

Submitted in partial fulfillment of the requirements of the degree of

Bachelor of Engineering

by

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING (ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING)

Sindhudurg Shikshan Prasarak Mandals's College of Engineering. (Kankavali)

(2024-25)

CERTIFICATE

This is to certify that the project synopsis entitled **Smart Home Automation System** is a bonafide work of **Shivam Dhuri (06), Saniya Mahale (28), Danesh Parab (34), Prachi Tulaskar (52)** submitted to the University of Mumbai in partial fulfillment of the requirement for the award of the degree of **Bachelor of Engineering** in **Computer Science and Engineering (Artificial Intelligence and Machine Learning)**.

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Project Approval Sheet

This project synopsis entitled ***Smart Home Automation System*** by ***Shivam Dhuri, Saniya Mahale, Danesh Parab, Prachi Tulaskar*** is approved for the degree of **Bachelor of Computer Science and Engineering (Artificial Intelligence and Machine Learning)**.

Examiners

1.———————————-

2.———————————-

Date: October 21,2024

Place: Kankavali.

Declaration

We declare that this written submission represents our ideas in our own words and where others' ideas or words have been included, We have adequately cited and referenced the original sources. We also declare that We have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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Date : October 21,2024

Abstract

A Smart Home Automation System is an integrated system designed to automate and control various household functions and devices through a centralized platform, offering enhanced convenience, energy efficiency, and security. This system typically operates via a network of Internet of Things (IoT) devices, which communicate with each other and the user through mobile apps, voice commands, or dedicated control panels. The core objective of smart home automation is to make the daily management of home functions more seamless, efficient, and personalized, catering to the evolving needs of modern living.

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1 Introduction to IoT-Based Home Automation System

In today's fast-paced world, convenience is key. Home automation systems solve the problem of manual appliance control, offering features like remote access, scheduling, and energy-saving automation. Users can control their home appliances with just a few taps on their smartphones or even through automated schedules without being physically present at home. This offers significant benefits in terms of time management, energy efficiency, and overall user convenience.

The system described in this project consists of two primary components: a **transmitter** and a **receiver**. The transmitter communicates with the cloud through an **API**, receiving commands from the user interface (mobile or web app). These commands are processed and transmitted to the receiver via **LoRa (Long Range)** technology. LoRa is a long-range, low-power wireless communication protocol that is ideal for IoT applications that require reliable communication over large distances. The receiver, equipped with a microcontroller such as **ESP32** or **ESP8266**, processes these commands and controls the connected appliances via relays.

The **API (Application Programming Interface)** plays a crucial role in this system. It serves as the bridge between the user and the microcontroller, allowing commands to be sent and executed over the internet. The API ensures that the communication between the mobile/web app and the microcontroller is efficient and secure. The use of **HTTP** or **MQTT** protocols in the API ensures reliable communication, while security features such as **HTTPS encryption** and **authentication** protect user data and prevent unauthorized access.

One of the standout features of this system is its ability to provide long-range communication using **LoRa**. LoRa offers several advantages, including low power consumption and the ability to communicate over distances of several kilometers. This makes it ideal for large homes or properties where Wi-Fi coverage might be limited. Additionally, the system's reliance on low-power communication ensures that it is energy-efficient, an important factor in today's environmentally conscious world.

Another key feature of this system is **automation**. The user can schedule appliances to turn on or off at specific times, improving energy efficiency and convenience. For example, lights can be set to automatically switch on at sunset or the air conditioning can be scheduled to cool the home before the user arrives. This kind of intelligent scheduling reduces energy wastage and offers a seamless experience for the homeowner.

Security is another critical aspect of the IoT-based home automation system. The system uses **encryption** to protect data transferred over the internet and **authentication tokens** to prevent unauthorized access to the API. This ensures that user data is kept secure, and only authorized users can control the home appliances.

Overall, this IoT-based home automation system is a scalable, efficient, and secure solution for modern households. It leverages the power of IoT to create a more connected and intelligent living space, offering users greater control, convenience, and energy efficiency. The integration of long-range communication through LoRa and the flexibility provided by the API make it a robust solution that can be expanded to include more devices or advanced features like **voice control** in the future. The advent of smart technology has revolutionized the way we interact with our homes. **IoT-based home automation systems** are at the forefront of this transformation, enabling users to control appliances and monitor their homes remotely. This system leverages the **Internet of Things (IoT)**, a network of interconnected devices that communicate with each other and exchange data over the internet. It provides homeowners with the ability to control various home appliances such as lights, fans, air conditioners, and security systems using mobile or web applications, creating a more efficient, secure, and comfortable living environment.

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2 Research Gaps

2.1 Communication

- Vulnerabilities in communication protocols and data storage
- User privacy concerns regarding data collection and usage

2.2 Energy Efficiency

- Optimizing energy consumption of IoT devices
- Development of energy harvesting solutions for devices

2.3 Scalability

- Challenges in managing and controlling large numbers of devices
- Network congestion and latency issues with increased device count

2.4 Integration with Smart Grids

- Exploring synergies between home automation and energy management systems
- Real-time demand-response systems

2.5 Regulatory and Ethical Issues

- Lack of clear regulations on data protection and user consent
- Ethical implications of surveillance and data use

Table 1: Literature Review

Authors & Year	Method	Result	Future Scope
1) - Vaishnavi .S. Gonge, Pratibha .S. Yalagi. (Year-2016) **?**	Work focuses on home automation where controlling operations on smart devices installed in buildings. It is controlled by Arduino or (Raspberry Pi).	Through this the project system is created in which we can operate the several devices automatically.	- The assurance of security. - Energy efficiency.
Ana Marie. D. Celebre, Ian Benedict A. Medina etc. Year-9-12 December 2015**?**	Home Automation development through Siri's capability. It is controlled by Raspberry Pi. It is voice controlled. .	In this system we can operate home devices like air cooler, lights, doors, t.v, etc.	1) It assures security 2) It desires to provide convenience to users
Syarif Hidayat, Syahrial Farid Firmanda (Year -2015) **?**	In this project of home automation system, they implemented the simplest task of turning on or off lights . They have used Raspberry Pi.	In this system, we can turn on / off lights or other equipments automatically or remotely.	It assures the energy efficiency. ° Reduces the efforts.
MD.Abdullah Al Mamun, Mohammad Alamgir Hossain, etc (Year- 2 May-August, 2020) **?**	In this project of home automation system, it describes system of Bluetooth and Mobile application. In the application we set the light/fan button . Water motor on/off automatically.	Through this project automated system has been created. We can control several devices.	1) New technologies which reduces the human efforts. 2)The system which saves electricity. 3) Energy Management.

3 Problem Statement And Objectives

In modern homes, managing and controlling appliances manually can be inefficient, especially when convenience, energy efficiency, and security are becoming key priorities. Homeowners often face the challenge of controlling multiple devices while away from home or ensuring that energy is used efficiently. Traditional systems lack remote control, automation, and integration with smart technology, leading to unnecessary energy consumption and inconvenience. There is a need for a smart home automation system that allows users to control their appliances remotely and automatically, while also being scalable, secure, and easy to use.

3.1 Objectives

1. **Remote Control**: Enable users to control household appliances like lights, fans, and other devices remotely via a mobile or web application.

2. **Long-Range Communication**: Utilize **LoRa** technology for long-range, low-power communication between the transmitter and receiver, ensuring reliable appliance control over large distances.

3. **API Integration**: Implement a custom API for secure and efficient communication between the user interface (app/web) and the microcontroller.

4. **Automation and Scheduling**: Provide options for scheduling appliances to turn on/off automatically at specified times.

5. **Security**: Ensure secure communication through encryption and authentication methods, protecting user data and system integrity.

6. **Scalability**: Design the system to be easily expandable, allowing the addition of more appliances or future features like voice control.

7. **Energy Efficiency**: Optimize the system to reduce energy consumption by automating appliances and providing intelligent control options.

These objectives address the need for a smarter, more efficient, and secure home automation solution.

4 Proposed System

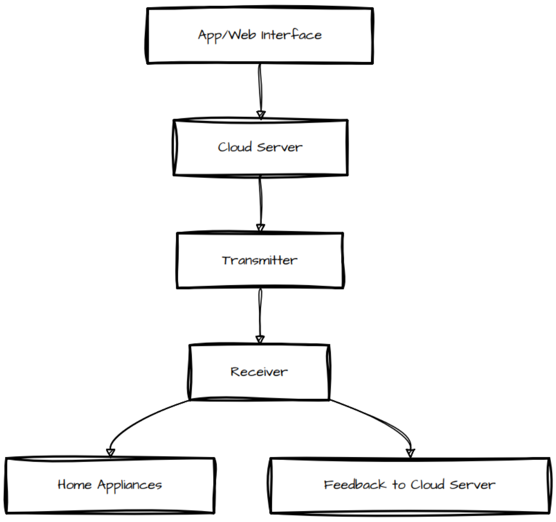

Figure 1: Proposed System

4.1 Algorithm for IoT-Based Home Automation System

1. **System Initialization**:

    - Power on the microcontroller (ESP32/ESP8266) and initialize the **Wi-Fi** connection.
    - Initialize the **LoRa module** for long-range communication between the transmitter and receiver.
    - Setup communication with the cloud API (using HTTP/MQTT) to receive user commands.

2. **User Command Input**:

    - The user sends a command through the **mobile or web app** (turn appliance on/off, schedule, etc.).
    - The command is sent to the cloud server via the API.

3. **API Communication**:

    - The microcontroller receives the user command through the cloud API.
    - The command is parsed and verified for security and authenticity.

4. **Transmit Command via LoRa**:

- For long-range communication, the transmitter sends the command to the receiver using **LoRa** technology.

5. **Execute Command at Receiver**:

   - The receiver receives the LoRa signal and processes the command.
   - Based on the command (e.g., turn on/off the light), the **GPIO** pins on the microcontroller are activated to control the **relay module** connected to the appliance.

6. **Status Feedback to User**:

   - Once the command is executed, the system sends an acknowledgment back to the cloud API.
   - The user receives a notification on the app/web interface that the command has been successfully executed.

7. **Error Handling and Alerts**:

   - If any error occurs (e.g., communication failure, appliance not responding), the system retries or sends an error message to the user.
   - In case of a receiver interruption or failure, an alert is sent to notify the user.

4.2 Analysis of the System

4.3 Efficiency

The use of **LoRa** ensures long-range communication with low power consumption, making it ideal for large homes or remote appliance control. **API integration** allows real-time control and monitoring, making the system more efficient and user-friendly.

4.4 Security

Secure communication is ensured through **HTTPS** for API calls and **encryption** for LoRa communication, reducing the risk of attacks. While basic security is implemented, there are opportunities to enhance security through advanced authentication methods and encryption protocols.

4.5 Scalability

The system is scalable and can integrate more appliances or expand with additional features like voice control. New devices or functionalities can be added to the system through the API, without significant changes to the core infrastructure.

4.6 Reliability

LoRa ensures reliable communication over long distances, even in environments where Wi-Fi may not reach. However, the system relies heavily on network availability. In case of Wi-Fi or LoRa failure, redundancy mechanisms (like backup communication protocols) could improve reliability.

4.7 Energy Consumption

The system is designed to automate appliances, thus improving energy efficiency. However, the microcontroller's Wi-Fi module consumes significant power when continuously connected. Future optimization may include using low-power modes or more energy-efficient communication protocols.

4.8 User Experience

The system provides a simple, intuitive interface via mobile/web apps, making it easy to use for non-technical users. The ability to schedule appliances adds convenience and automation, further enhancing the user experience.

5 Experimental Setup

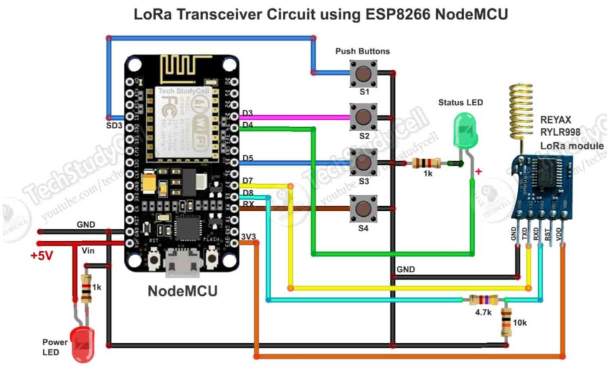

Figure 2: Circuit Diagram

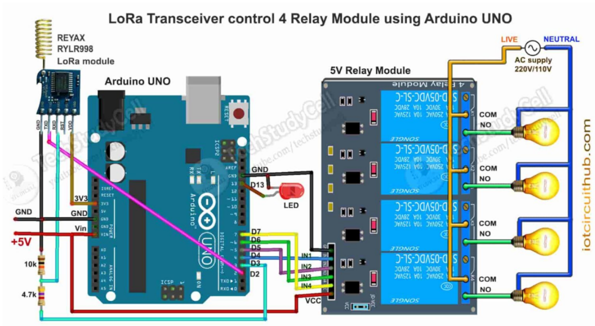

Figure 3: Circuit Diagram

5.1 Details About Input to Systems

System Inputs

The IoT-based home automation system receives inputs from various sources to control and manage home appliances. These inputs are categorized into four main types:

1. User Interface (Mobile/Web App Inputs)

The user interface, whether through a mobile app or web interface, accepts various inputs from the user to control the home appliances. These inputs include:

- **Control Commands**: Inputs from the user such as turning appliances on/off, adjusting settings (like fan speed or thermostat temperature), or setting a schedule for specific devices.
- **Scheduling Inputs**: Users can input specific times or conditions (e.g., sunrise, sunset) for when appliances should be automatically turned on or off.

- **Voice Commands (Future Development)**: The system will eventually accept inputs via voice commands to control devices (e.g., "Turn off the lights" or "Set the AC to 24°C").

2. API (Cloud Input)

The API serves as the bridge between the user interface and the system's transmitter. It receives and processes user inputs and transmits them to the transmitter. The API also receives feedback from the system and sends it back to the user interface. The inputs and outputs of the API include:

- **Commands from UI to Transmitter**: The API receives and processes user inputs (from the mobile/web app) and transmits them to the system's transmitter.
- **Device Status Updates**: Feedback such as whether a device is turned on or off, power consumption data, or any errors, which are sent back to the user interface.

3. Transmitter Inputs (LoRa Communication)

The transmitter receives inputs from the API and forwards them to the receiver using LoRa technology. The inputs to the transmitter include:

- Received Data from API: The transmitter receives control commands or scheduling instructions via the API and forwards these instructions to the receiver using LoRa technology.

4. Receiver Inputs

The receiver, equipped with a microcontroller like ESP32 or ESP8266, takes inputs from the transmitter and processes them to control relays connected to the appliances. The inputs to the receiver include:

5.2 System Evaluation Parameters

To ensure the reliability and efficiency of the IoT-based home automation system, several parameters need to be evaluated. These parameters include:
1. Range and Coverage LoRa technology is designed for long-range communication. Performance can be evaluated by testing the system's effective range and coverage in different environments (urban, rural, or indoor settings). This includes evaluating signal strength (RSSI) and signal-to-noise ratio (SNR) at various distances from the gateway.
2. Network Latency Low latency is essential for real-time responses in smart home systems, especially for critical applications like security or health monitoring. Measuring the time delay between sending a command and receiving a response helps determine if the system meets real-time requirements.
3. Data Throughput Though LoRa is not designed for high data rates, throughput is still

important in evaluating the system's ability to handle multiple devices and sensors. The number of packets successfully transmitted per second should be assessed, especially when scaling the number of devices.

4. Energy Efficiency Energy consumption is critical in smart home systems, especially for battery-powered devices. Evaluating the power usage of both the end devices (sensors and actuators) and the gateway helps in determining how long the devices can operate without recharging or replacement.

5. Scalability The ability of the system to support an increasing number of devices is crucial. The evaluation should focus on how well the system maintains performance as new sensors, actuators, or appliances are added.

6. Reliability and Fault Tolerance Assess the system's ability to handle faults such as network congestion, device failure, or interference. A reliable system should maintain functionality even with intermittent network connectivity or failed nodes.

7. Security Evaluate the system's encryption, data integrity, and authentication mechanisms. Ensuring secure data transmission and preventing unauthorized access are vital for user privacy and safety. By focusing on these parameters, a smart home automation system using LoRa technology can be optimized for performance and reliability.

5.3 Software and Hardware Setup

1. Hardware Setup

The hardware setup includes the transmitter, receiver, and optional add-ons.

a. Transmitter (Cloud to Receiver Communication)

The transmitter consists of:

- **Microcontroller (e.g., ESP32 or ESP8266)**: The microcontroller will be responsible for transmitting the user commands (received from the cloud via API) to the receiver. Both ESP32 and ESP8266 have Wi-Fi capabilities, making them suitable for IoT applications.
- **LoRa Transmitter Module (e.g., SX1278)**: LoRa module will be connected to the microcontroller for long-range, low-power communication with the receiver. This is essential for transmitting commands over a large distance, especially where Wi-Fi coverage is weak or unavailable.

b. Receiver (Controlling Appliances)

The receiver consists of:

- **Microcontroller (e.g., ESP32 or ESP8266)**: Another microcontroller will act as the receiver to handle the incoming commands from the transmitter. It will interpret the data and control connected devices accordingly.
- **LoRa Receiver Module**: Paired with the transmitter module, the receiver module will capture the commands sent via LoRa from the transmitter. It ensures reliable communication over long distances.
- **Relay Module**: This is used to control high-power appliances (like lights, fans, etc.) connected to the system. The relay acts as a switch that the microcontroller can control.
- **Power Supply**: A stable power source is required to power the microcontroller, LoRa modules, and relays. Ensure that the supply voltage is appropriate for the connected hardware (e.g., 5V or 3.3V depending on the microcontroller and modules).

c. Optional Add-ons

- **Sensors (Future Scope)**: For future enhancements, you could integrate sensors (such as motion sensors, temperature sensors, or light sensors) to provide feedback or enable more advanced automation.

d. Communication Protocols

- **Wi-Fi**: Used by the ESP32/ESP8266 to connect to the cloud API and receive/send data.
- **LoRa (Long Range)**: Provides long-distance communication between the transmitter and receiver, particularly in environments where Wi-Fi or Bluetooth may not be effective.

2. Software Setup

The software setup includes the cloud API, microcontroller programming, and mobile/web app interface.

a. Cloud API

- **API Development**: You'll need to develop or integrate an existing API that facilitates communication between the mobile/web app and the IoT system. The API will:
  * Receive commands from the user interface.
  * Transmit them to the ESP32/ESP8266.
  * Return device status or other data to the user.
- **Communication Protocols**: Common protocols for API communication include HTTP/HTTPS (for secure data transmission) or MQTT (a lightweight IoT protocol).

b. Microcontroller Programming (ESP32/ESP8266)

- **Arduino IDE / PlatformIO**: These are common development environments for programming ESP32 or ESP8266.
- **Firmware Code**:
  * For the transmitter, the code should handle receiving API commands, processing them, and transmitting them via the LoRa module.
  * For the receiver, the code should handle receiving commands from the LoRa module, processing them, and controlling the connected appliances through the relay module.
- **Libraries**: You'll likely use libraries such as LoRa.h (for LoRa communication), WiFi.h (for connecting to the internet), and relay control libraries.

c. Mobile/Web App Interface

- **User Interface**: The app should be intuitive and user-friendly, allowing users to control their appliances, view their status, and schedule automation.
- **Communication with API**: The app will send commands to the API, which will forward them to the microcontroller. It will also receive feedback

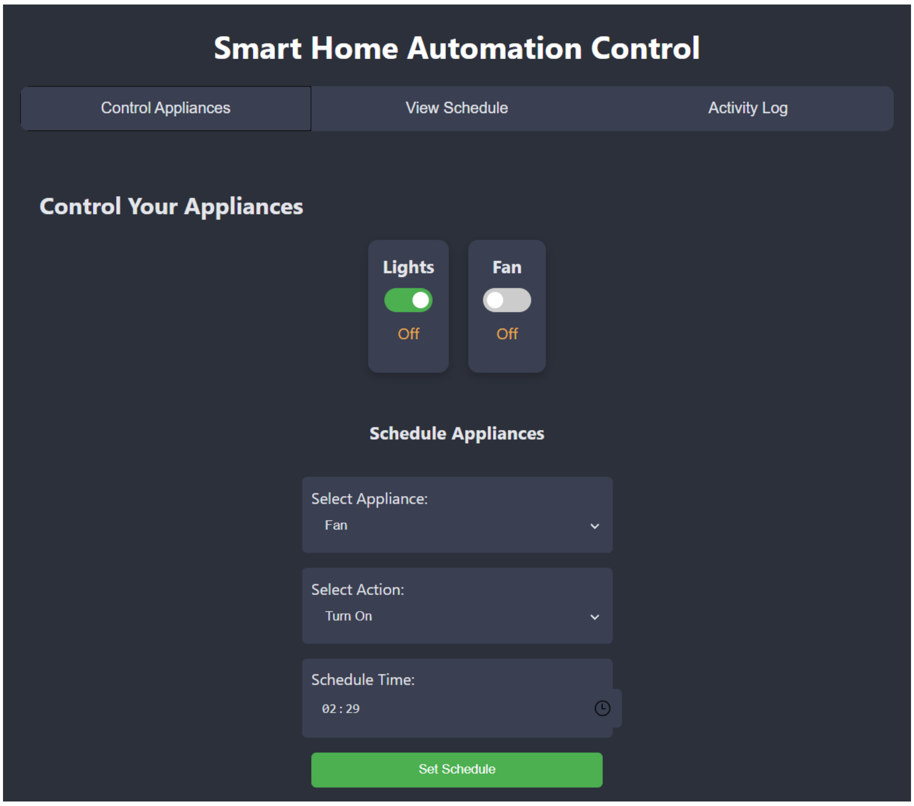

Figure 4: USER INTERFACE

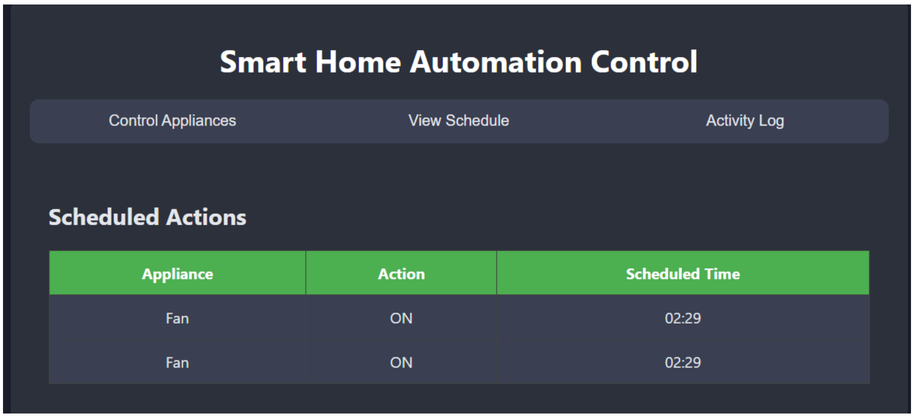

Figure 5: USER INTERFACE

6 Implementation Plan for Next Semester

Timeline Chart for Term 1 and Term II (Project Management tools can be used.)

Table 3: Plan for next Semester

Sr.no.	**Week**	**Task to be done**
1.	Week 1	Collecting various components
2.	Week 2	building the circuit
3.	Week 3,4,5	Working on code and UI of application
4.	Week 6	Implementing the code
5.	Week 7,8	Testing and Debuging
6.	Week 9	Finalization
7.	Week 10	Experimentation

7 References

1. Vaishnavi S. Gunge, Pratibha S. Yalagi "Smart Home Automation: A Literature Review"International Journal of Computer Applications,National Seminar on Recent Trends in Data Mining

2.Ana Marie. D Celebre, Ian Benedict A. Medina, Alec Zandrae D. Dubouzet,Adrian Neil M. Surposa, Engr.Reggie C. Gustilo "Home Automation Using Raspberry Pi through Siri Enabled Mobile Devices" 8th IEEE International Conference Humanoid, Nanotechnology, Information Technology,9-12 December 2015,

3.Syarif Hidayat, Syahrial Farid Firmanda "Scheduler and Voice Recognition on Home Automation Control System" 2015 3rd International Conference on Information and Communication Technology (ICoICT)

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Date: October 21,2024