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IoT BASED SMART CONTROL OF DOMESTIC ELECTRICAL APPLIANCES

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***Abstract*—This paper aims to create a smart home automation system by combining Arduino, ESP01, IR remote, Google Home, and the Alexa app. The system enables users to control various appliances and devices within their home using voice commands or mobile applications or an IR Remote. The ESP01, acting as a Wi-Fi module, establishes a connection between the Arduino and the internet, allowing for seamless communication with Google Home and the Alexa app. The paper involves setting up the hardware components which include the Arduino board and the ESP01 module. The IR receiver serves the remote operation of the appliances when there is no internet. Overall, this paper offers a comprehensive solution for building a smart home automation system.**

Keywords—IoT, Home Automation, Arduino UNO, ESP01, IR receiver, Google Home, Alexa app.

I. INTRODUCTION

A. SMART CONTROL THROUGH IoT

IoT (Internet of Things) technology has revolutionized the way we interact with and control our environment. Smart control through IoT refers to the ability to remotely monitor and manage devices and systems using internet-connected sensors and actuators. Smart control refers to the use of technology and automation to manage and regulate various systems and devices. It involves using sensors, data analysis, and intelligent algorithms to monitor and control processes in a more efficient and effective manner. Smart control can be applied to various domains such as home automation, industrial processes, energy management, and transportation systems. It enables remote monitoring, real-time adjustments, and optimization of operations, leading to improved efficiency, convenience, and sustainability. Smart control utilizes advanced technologies such as Internet of Things (IoT), artificial intelligence (AI), and automation to enable intelligent and automated control of various systems and devices.

B. SCOPE AND OBJECTIVES

The scope of this paper encompasses the design and implementation of an advanced IoT-based smart control system customized for domestic electrical appliances. The system aims to provide users with versatile and user-friendly control over their appliances, ensuring remote access and operation via the internet and a traditional IR remote. Key aspects within the scope of this paper include:*Hardware Integration*, *Software app Integration* (Google Home and the Alexa app), *Internet and Offline Control* (Wi-Fiand IR remote), *User Experience*, *Versatile Appliance Control.*

The objectives of this paper are as follows:

1) Design and Architecture*: To present the architectural design of the IoT-based smart control system, detailing the interconnections between Arduino UNO, ESP01, Google Home, Alexa app, and the IR Remote.*

2) Hardware Setup*: To provide a comprehensive explanation of the hardware components used, including their specifications and integration methods.*

3) Software Implementation*: To describe the software stack employed in the system, highlighting the programming of Arduino UNO, the integration with Google Home and Alexa, and the control interface design through Sinric Pro API for mobile devices.*

4) Internet and Offline Control*: To discuss the system's capability to enable remote control over the internet, emphasizing the reliability and responsiveness of the system. Additionally, to detail how the traditional IR remote ensures operation in the absence of internet access.*

5) Real-World Applications*: To showcase the practical applications of the IoT-based smart control system in domestic settings, illustrating its benefits and use cases.*

II. SYSTEM DESCRIPTION

A. SYSTEM ARCHITECTURE

This paper presents a sophisticated and adaptable system designed to enable the remote control of domestic electrical appliances. Leveraging a blend of hardware and software components, this system offers users a comprehensive and versatile approach to manage home appliances through both internet-connected mobile devices and a traditional IR remote.

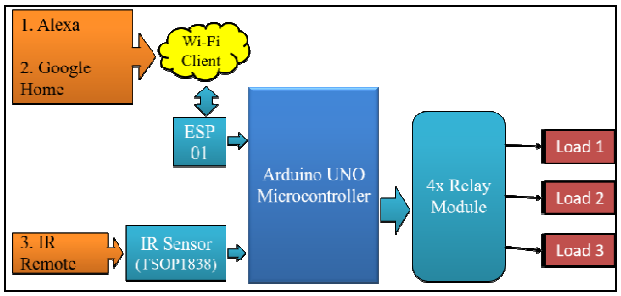

Fig. 1. Block Diagram of Proposed model

1) Arduino UNO*: The Arduino UNO serves as the central processing unit of the system, responsible for orchestrating and coordinating interactions between various components.It interfaces with the ESP01, IR Remote, and home appliances, managing data exchange and command execution.*

2) ESP01*:The ESP01 module provides vital internet connectivity to the system, enabling remote control and interaction with cloud-based voice assistants. It acts as a bridge between the Arduino UNO and cloud services, facilitating communication with Google Home and the Alexa app.*

3) Google Home and Alexa app*:These popular voice assistant and automation application serve as user interfaces, enabling voice-controlled and UI/UX appliance management. Users can give switch and voice commands through Google Home and the Alexa app respectively, which are transmitted to the system via Sinric Pro API. The commands are then executed by the Arduino UNO.*

4) IR Remote*: The IR Remote is a traditional handheld remote control that uses infrared signals to communicate with appliances. It offers an alternative means of controlling appliances, sending specific IR signals to the appliances to turn them on or off.*

5) Electrical Appliances*: These appliances include lights, fans, heaters, air conditioners, and more, which are commonly found in domestic settings. The appliances are controlled through IR signals sent by the IR Remote. Alternatively, they can be managed via voice commands through the Alexa app and Google Home app when internet connectivity is available.*

6) Internet Connectivity*: A stable internet connection is crucial for enabling remote control via Google Home and the Alexa app. Internet access is required to transmit voice commands from mobile devices to the cloud-based voice assistants and subsequently to the system for appliance control.*

7) IR Receivers*: The systemis equipped with IR receiver to receive and interpret IR signals. This IR receiver respond to IR commands sent by the IR Remote for local control when internet access is unavailable.*

B. SYSTEM OPERATION

Users interact with the system through voice commands via the Alexa app and switches/buttons via the Google Home and Amazon Alexa app interface on theirmobile devices. These commands are sent to the Sinric Pro API for processing and the API respond to the ESP01 module.The ESP01 module ensures that voice/switch commands are transmitted to the Arduino UNO, which interprets and executes them based on the appliance control logic(Relays).In cases where internet access is unavailable, users can use the IR Remote to directly control the appliances by emitting IR signals.

III. SOFTWARE IMPLEMENTATION

A. SINRIC PRO API INTEGRATION

The integration with the Sinric Pro API is a crucial part of the software. It enables seamless communication between the ESP01 module and cloud services, such as Google Home and Amazon Alexa. The Sinric Pro API interprets button/voice commands received from Google Home and Amazon Alexa, processing them and converting them into actionable commands for the appliances.Users open the Google Home or Amazon Alexa mobile application and give button/voice commands to control appliances. The mobile applications convert these button/voice commands into text and send them to the Sinric Pro API. The API will make a decision based on the text received and send a return text/command to the ESP01. Then that command is sent to Arduino, which interprets and executes it.

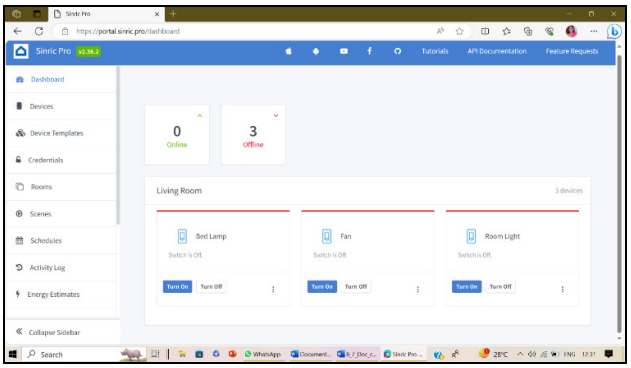

Fig. 2. Overview of Sinric Pro API

The above figure shows an overview of the Sinric Pro API. Here, in the homepage we can see all the devices that are added into it. Each API key can hold 3 devices at free of

cost. If we want to add more devices, we have to pay as per their terms and conditions. We can ON and OFF the devices from the homepage of Sinric Pro API.

Steps to use Sinric Pro:

1) Create a Sinric Pro account.

2) Add your devices to Sinric Pro.

3) Connect your devices to Alexa, Google Home, or other platforms.

4) Control your devices using voice commands, automations, or the Sinric Pro app.

B. IR REMOTE INTEGRATION

The integration of the IR (Infrared) Remote control is a vital component of the system, as it provides an alternative means of controlling home appliances when internet connectivity is unavailable. This integration ensures that users can reliably manage their appliances, even in situations where a mobile device or internet access is not accessible.The IR Remote control is a handheld device equipped with IR emitters. It emits specific infrared signals to communicate with appliances. When a user presses the buttons on the IR Remote, it sends IR signals corresponding to the desired appliance control action, such as turning an appliance ON or OFF.The Arduino UNO, acting as the central control unit, plays a critical role in the IR Remote integration. It receives and interprets IR signals from the IR Remote. When it deciphers the received signals, it processes the commands and sends the appropriate instructions to the appliances to execute the desired actions.

Fig. 3. IRRemote and Decipher

The above figure shows an IR decipher and IR remote of the proposed model.When a user wants to control an electrical appliance, they use the IR Remote control. They press the relevant buttons to send specific IR signals corresponding to the desired appliance control action.The IR Remote control emits the IR signals directed toward the target decipher/receiver, carrying information about the intended action (e.g., turning on, turning off).The electrical appliances, equipped with IR receiver(IR sensor), detect and interpret the incoming IR signals.The Arduino UNO, functioning as the central controller, receives the interpreted IR signals and processes the commands. It matches the received signals with predefined command patterns to identify the intended action.The Arduino UNO sends the appropriate instructions to the target appliance based on the interpreted command. The appliance executes the command, resulting in the desired action (e.g., turning on or off).

IV. RESULTS AND DISCUSSIONS

Fig. 4. Proposed Model of Home Automation

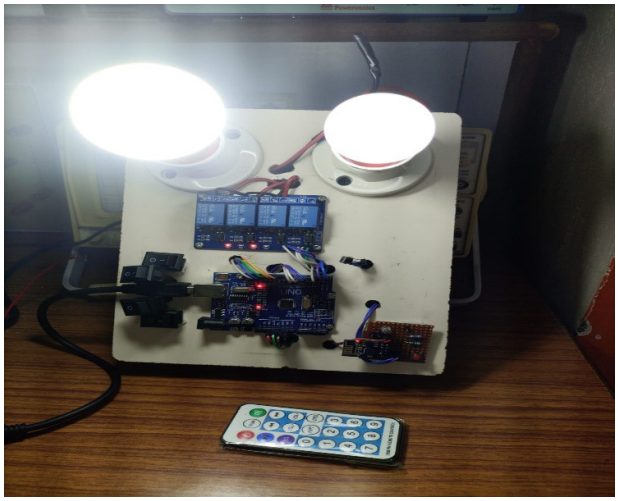

Fig. 5. System controlling with IR Remote

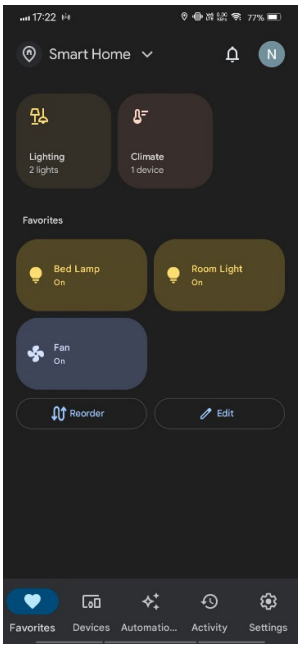

Fig. 6. Overview of Google Home app

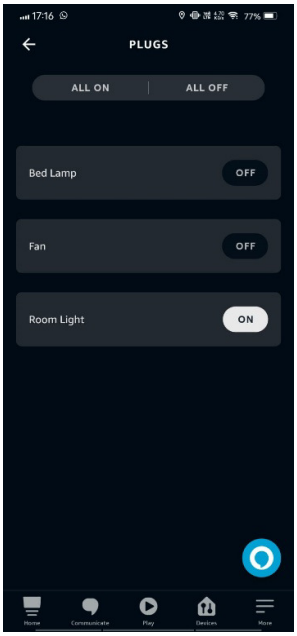

Fig. 7. Overview of Amazon Alexa app

V. CONCLUSION

In conclusion, the "IoT-Based Smart Control of Domestic Electrical Appliances" paper highlights the transformative potential of IoT technology in enhancing the control and automation of home appliances. It underscores the adaptability of the system to various control scenarios, ensuring that users have the means to manage their homes conveniently and efficiently. This research contributes to the ever-evolving landscape of smart homes, offering a blueprint for the future of domestic automation and appliance control.

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