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Implementation of IoT Technology for Android-Based Control of Household Electronic Equipment

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Abstract - The development of information technology has triggered innovation in various sectors, one of which is the Internet of Things (IoT). This study aims to develop a prototype controller for Android-based electronic devices using IoT technology. The method used involves object-focused techniques and uses Wookwi as the main tool. This prototype utilizes an internet connection to allow users to control electronic devices such as lights and others remotely. The user interface is presented through the Blynk platform. In this context, the study highlights the difficulty of controlling several electronic devices with a remote control separately. The implementation of IoT in controlling electronic devices at home is expected to overcome these obstacles. This study proposes the development of a system that uses an internet connection to control electronic devices, especially through smartphones. This not only increases user convenience but also helps reduce energy waste and high electricity costs. The research involves the stages of data collection, analysis, and system design with a focus on the use of the Blynk microcontroller, which acts as the brain in the control system. The result is a prototype application that allows users to control electronic devices efficiently via the internet, providing a practical solution to overcome challenges in remote control. In conclusion, the implementation of IoT in this prototype proves that users can easily control electronic devices remotely, increasing the efficiency of electrical energy use.

Kata kunci - Internet of Things (IoT), Electronic Device Controller, Android-Compatible, Remote Control

I. INTRODUCTION

The Internet of Things (IoT) signifies a framework wherein various physical entities are linked over the Internet to provide enhanced and efficient functionality. IoT technologies provide remote control and real-time data collecting via embedded sensors and communication networks [1], [2]. In the realm of swift technological progress, IoT has surfaced as an essential technical framework that improves automation and device compatibility. This study identifies the challenge of managing several electronic devices that depend on distinct remote controls, hence diminishing usability and operational convenience [3], [4].

This study investigates the application of IoT and contemporary technologies for the remote monitoring and management of electrical appliances, with the objective of minimizing energy waste and high power expenses [3], [5]. A primary problem in IoT is reconciling the disparity between the actual environment and digital information systems. This encompasses the collecting, processing, and transmission of data created by electronic equipment via user interfaces for significant interaction with end-users [6]. This constraint occurs as each remote control can manage only a certain quantity of devices. This study suggests the creation of a system that utilizes an Internet connection to manage electronic appliances via a centralized management interface, such as a smartphone. The aim of this system is to provide a more convenient and efficient method for controlling household electronic devices [7].

The significance of attaining effective control over electronic devices has increased alongside technical progress, especially in the realms of the Internet of Things (IoT) and Android smartphones. The Internet of Things (IoT) facilitates the remote operation of electrical devices via Internet access, establishing Android smartphones as prevalent

interfaces for this control. Despite these advancements enhancing the potential for network-based device administration, there persists a necessity to devise more pragmatic and efficient control solutions that can be directly handled using Android smartphones. A significant technical improvement is the enhanced capacity to access and administer equipment remotely.

This functionality enables users to oversee and manage equipment from a distance, contingent upon the presence of a reliable Internet connection in the setting where remote-control technologies are deployed. This functionality is also relevant for controlling remote building lighting systems, where Android smartphones may handle electronic devices like lamps [9], [10]. In addition to ease and efficiency, it is imperative to tackle the problem of electrical energy waste. Electricity has become essential to daily life, with the majority of human activities reliant upon it. Nevertheless, improper utilization—such as leaving lights or air conditioners operational when unnecessary can result in considerable energy wastage and heightened utility costs. This behavior may manifest in several rooms and, if repeated regularly, could lead to significant long-term energy inefficiency [11], [12].

To mitigate these concerns, numerous studies have suggested utilizing IoT technologies for the remote monitoring and control of electrical equipment. These systems can monitor real-time power use, archive usage data, send notifications to users, and control the on/off states of household electrical devices. This work seeks to devise an effective and efficient way to reduce electrical energy waste by leveraging the capabilities of IoT for electronic device management [7], [13]. Consequently, it can be stated that the integration of IoT in the suggested prototype effectively illustrates that users may effortlessly control electronic items, such as LED lights. Moreover, the technology allows users to remotely manage household appliances from any location, contingent upon an available Internet connection [14].

II. METHODOLOGY

2.1. Research Procedure

The research procedure comprised several components. Data collection was conducted by gathering information from scientific books, scholarly articles, academic journals, and various published document sources. These materials provided theoretical foundations relevant to the research problem and domain. The study employed both descriptive and experimental research designs. The researcher examined the literature related to the design of IoT-based control systems using the Blynk microcontroller platform, followed by a series of experiments and performance evaluations of the developed prototype.

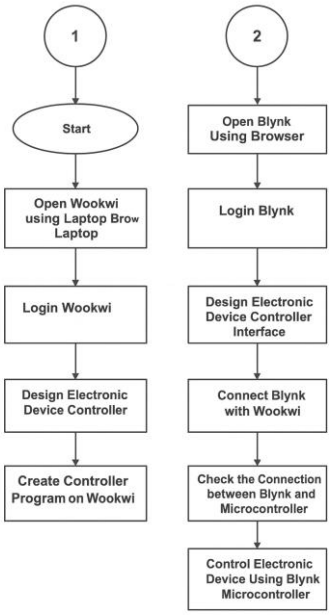

Fig.1. Flowchart of the Electronic Device Controller Prototype Design Process

2.2. IoT Design for Electronic Equipment Control Using Wokwi

The Internet of Things (IoT) is a concept aimed at extending the advantages of constant internet connectivity to physical things, facilitating data sharing, remote control, and real-time interaction between digital and physical realms. In the realm of home automation, electronic gadgets can be controlled using Android-based smartphones. This study examines the usage of a microcontroller equipped with Bluetooth or internet communication modules, in conjunction with an Android application, to provide remote device control. The hardware components consist of an Android smartphone, a microcontroller board, a Light Emitting Diode (LED) bulb, and a DC fan as the main controlled devices. The software components include Arduino Integrated Development Environment (IDE) version 1.8.3 for microcontroller programming and the Blynk application acquired from the Play Store. The amalgamation of hardware and software facilitates data transmission via the internet, permitting the Blynk platform to remotely control linked electronic gadgets. The subsequent illustration depicts the circuit schematic utilized for LED regulation.

Figure 2 depicts the architecture of the electronic device control system, wherein a microprocessor governs an LED bulb. The schematic illustrates the wiring layout, detailing the interconnection of each component. The Blynk-enabled microcontroller serves as the central controller, dispatching

commands to the linked electronic devices to ensure they perform according to the received instructions.

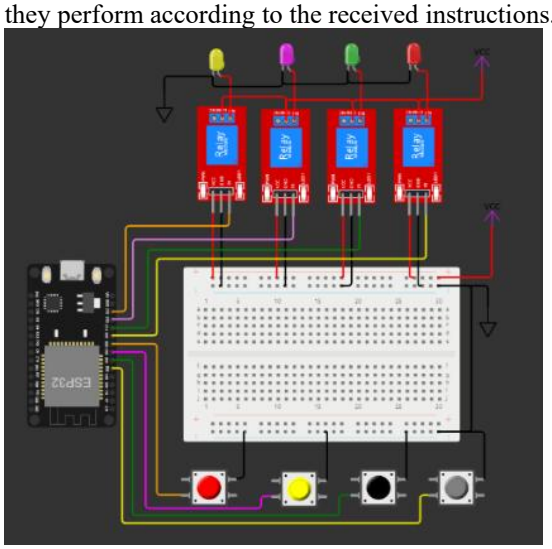

Fig.2. LED controller circuit

To enable this feature, the microcontroller must be designed with an embedded control algorithm. This routine consists of a series of instructions that specify how the microcontroller should handle input signals, engage with the Blynk platform, and execute output actions, such as switching the LED on or off. The encoded directives ensure that the device operates correctly as intended and responds appropriately to user commands given through the smartphone interface.

The microcontroller functions as the central processing unit of the electronic control system, coordinating communication, executing logic, and facilitating device actuation. Its function facilitates effortless coordination and regulation of diverse electronic devices from basic household appliances to intricate industrial automation systems illustrating the adaptability and significance of IoT-based microcontroller integration in contemporary electronic control applications.

III. RESULT AND DISCUSSION

The development of an electronic device control prototype requires the integration of both hardware and software components. The hardware utilized includes an Android smartphone, computer, or laptop, which serve as user interfaces for issuing commands. The software environment is composed of Wokwi and the Blynk platform, which together facilitate the design, simulation, and execution of the IoT-based control system.

The Wokwi microcontroller simulation platform provides two primary workspaces: a programming environment for writing and editing microcontroller code, and a circuit design workspace that allows users to assemble virtual hardware components using available input–output interfaces. This dual-environment structure significantly supports the creation and testing of IoT smart home systems, offering a wide range of features that simplify prototyping, component configuration, and system debugging.

Alongside Wokwi, the Blynk application—available on smartphones and laptops is utilized to provide input data for processing by the microcontroller. The microcontroller utilizes an active internet connection to communicate with the Blynk cloud platform, facilitating the transfer of control commands to the linked electronic devices. This interface enables users to remotely control home appliances with minimal exertion.

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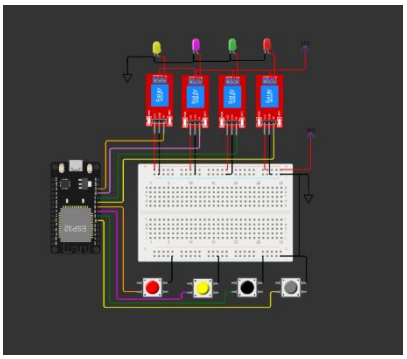

Fig.3. Display of several microcontrollers on the wokwi

Several microcontroller options are available within the Wokwi simulation platform, including Arduino, ESP32, STM32, and Raspberry Pi Pico. For the development of the IoT-based smart home system in this study, the ESP32 microcontroller was selected due to its built-in Wi-Fi capability, efficient processing performance, and strong suitability for remote control applications.

The microcontroller must be programmed with a specific control script to function as the primary controller of the electronic devices. This program comprises a series of directives that delineate how the ESP32 interprets input signals, interfaces with the Blynk platform, and performs the requisite operations on the linked electrical devices. In the absence of this embedded control program, the microcontroller would be incapable of operating as an automated device controller within the IoT system.

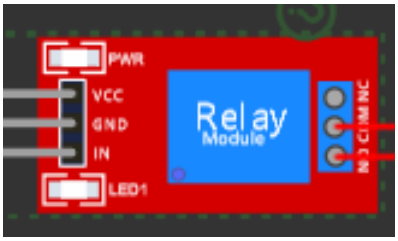

Fig.4. Relay display on wokwi

A relay, or electronic switch, is an electromechanical apparatus intended to regulate the functioning of a circuit by an electromagnetic mechanism. It comprises a coil of conductive wire encircling an iron core, which produces a magnetic field when electrical current traverses it. The magnetic field triggers the switching mechanism, enabling the relay to open or close circuits and so regulate the flow of electrical power to linked devices.

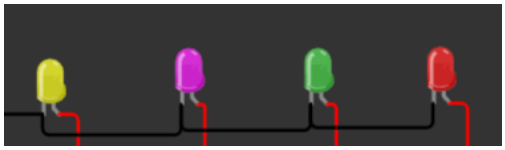
Fig.5. LED display on the wokwi

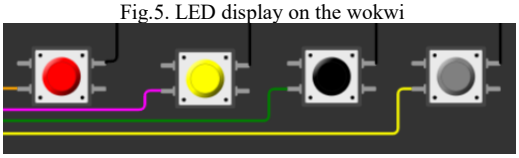
Fig.6. Pushbutton reference display on wokwi

3.1 Smart Home Circuit Schematic Design Using Wokwi

Figure 7 depicts the circuit architecture of the electronic device control system created with the ESP32 microcontroller to manage components like LED lighting and various household appliances. In this system, the ESP32 serves as the primary controller or the "brain" of the electronic control architecture. All commands and input signals are processed internally within the microcontroller's chip and subsequently relayed to each linked component, allowing them to function according to the received instructions.

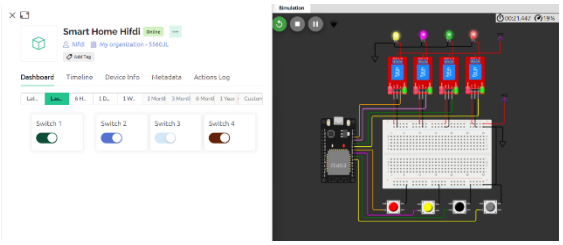

Fig.7. Schematic of IOT-based electronic equipment control circuit

3.2 Device Control Experiment using Blynk Connected to Wokwi

An Android-based smartphone application is necessary to facilitate remote control of electronic devices via the Internet by transmitting commands through an active network connection. This study utilizes the Blynk program as the control interface. Blynk operates as a cloud-based platform that transmits user commands from the Android device to the microcontroller for processing.

The electrical device was remotely operated using the Blynk program during the experiment. The illumination of the LED indication on the Wokwi simulation signified that the associated domestic electrical appliance had been successfully activated, confirming that the system was operating in the ON condition.

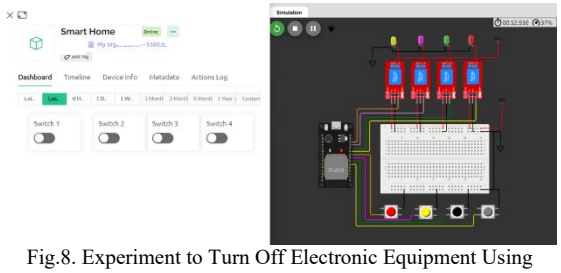

Fig.8. Experiment to Turn Off Electronic Equipment Using Blynk

The electronic device was deactivated remotely via the Blynk program during the trial. The extinguishing of the LED indicator on the Wokwi simulation indicated that the associated household electronic device had been effectively disabled or was in the OFF state within the actual control system.

IV. CONCLUSION

This study concludes that integrating lighting systems with a microcontroller via the Blynk application offers significant advantages for users in controlling household electronic gadgets. The use of Internet of Things (IoT) technology facilitates effective remote management of these devices using an internet-enabled smartphone. The principal benefit of this method is its capacity to enable customers to control electronic devices like lighting and fans remotely, even when they are not at home. This functionality not only augments consumer convenience but also boosts the effectiveness of household equipment management. The proposed solution represents a contemporary adaptation to user requirements, providing enhanced flexibility in the monitoring and control of household devices while fostering the creation of more intelligent and digitally interconnected surroundings.

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