International Journal of Artificial Intelligence & Robotics (IJAIR) E- ISSN:2686-6269
Vol.2, No.2, 2020, pp.62-69

Switching Systems Designing Based on IoT

Dian Ahkam Sani[1], Immilda Lailatul Fijriyah[2]
[1,2]Universitas Merdeka Pasuruan, Pasuruan, 67129, Indonesia
[1]achcomes@gmail.com*, [2]immilda1812@gmail.com
*Corresponding Author

ABSTRACT

The development of technology has progressed very rapidly in a short period, as has technology that has recently been developed in various aspects of life, namely the Internet of Things. In the past, controlling household electrical appliances was usually done directly by pressing a button on the house's wall and was very ineffective when the house owner was out of town while the house was empty. With the Internet of Things technology, a system can be applied in everyday life, namely controlling household electrical appliances to turn off and remotely using internet communication via an android smartphone. In this system design, a control design using a series of microcontrollers and relays connected to a smartphone via the internet is used because the microcontroller already has a Wireless Fidelity (WIFI) module. The results of controlled tests on household electrical appliances can run well. All components of the design of the device are well integrated with smartphones and the internet. Control can be done anywhere and anytime. System response during the day between 1-4 seconds and at night between 1-2 seconds.

Keywords: Switching System Design, Internet of Things, Microcontroller, On / Off, Smartphone, Internet.

Article History

Received : October, 12th 2020	Revised: November, 29th 2020	Accepted : November, 30th 2020

I. INTRODUCTION

The development of technology in a short period has progressed very rapidly, such as technology that has recently been developed into various aspects of life, namely the Internet of Things (IoT) or also known as the IoT acronym, is a concept that aims to expand the benefits of internet connectivity that connected continuously[1]. As for abilities such as data sharing, remote control, and so on, including objects in the real world. For example, foodstuffs, electronics, collections, and any equipment, including living things, are connected to local and global networks through embedded and always active sensors.

IoT technology is created and developed by humans to facilitate every job and business in various aspects of life. One can be applied in everyday life, namely controlling household electrical appliances to turn off and turn on from a remote using internet communication via an Android smartphone[2].

There are too many lamps, fans, televisions, and other electronic devices, a house in every house. It will be very ineffective and uncomfortable to turn on or turn off these devices directly. When we are traveling for a long time, we often remember our homes' state to make us feel about is electronics on or off.

Based on previous research with the title Internet of Things-Based Smart Home System Prototype Design, it functions with an average response time of 35ms for the actuator to perform its action. The results of this test are carried out at a distance of 9.5 Km from the prototype. This study still depends on the distance, so it is not effective if the testing distance is very far from the prototype, the response process will also be very long[3]. Based on research, Home Appliance Control System Based on Raspberry PI. Researchers here use the LDR sensor for lamps to be less effective because when using the sensor, it will depend on the surrounding light[4]. The author [5] makes the research with title Switching of Security Lighting System Using GSM shows how ATMEGA168 microcontroller can remotely control security lighting via SMS (Short Message Service) from GSM Phone anywhere outside the home.

By implementing the IoT "Internet Of Things" system at home or office, electrical devices will work automatically according to user needs. Users can control electrical devices in the house remotely through a communication channel such as through the internet network with a smartphone.

To make this tool, a NodeMCU esp8266 device is needed as an intermediary tool to connect the device to the internet network to be connected to an Android smartphone and Relay as a breaker connector for electricity. This research is precisely applied to make it easier for homeowners to control electrical equipment remotely.

II. METHOD

This chapter will describe the research methodology used in this study, which consists of (1) Literature Study, (2) Needs Analysis, (3) Design and Draft, (4) Testing, (5) Evaluation of Test Results.

DOI: 10.25139/ijair.v2i2.3138

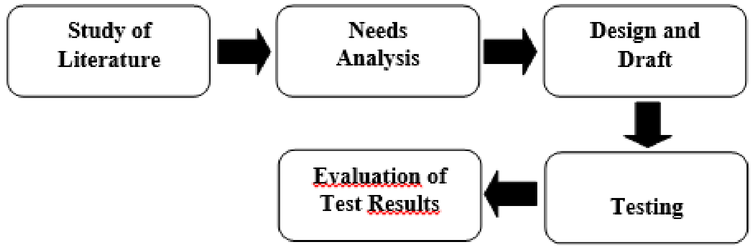

Fig.1. Research Workflow Flowchart

A. Study of Literature

The initial stage was a literature study based on the research topics taken to conduct this research. The literature study conducted is by studying various reference sources obtained from several scientific works such as thesis journals and books. This literature can contribute to the research undertaken, namely reviewing, designing, and analyzing the built system.

1) Functional Requirements Analysis

Functional requirements analysis is a type of requirement that contains what processes the system can carry out. Functional requirements also include any information that must be present and generated by the system. The following are the applicable requirements contained in the system to be built:

- Users can turn on electrical devices that are connected to the socket remotely using an android smartphone.
- Users can remotely turn off electrical devices that are connected to the socket using an Android smartphone.

2) Hardware Requirements Analysis

Analysis of hardware requirements aims to analyze the hardware needed to design an IoT-based switch system in Table I.

TABLE I
HARDWARE REQUIREMENTS ANALYSIS

Hardware Name	Amount	Function
Computer / Laptop	1	To create scripts and upload scripts that have been created in the Arduino IDE to the NodeMCU device
NodeMCU ESP8266	1	The main component of the control system. Which consists of an IC, an ESP 8266 WiFi control module that connects the communication between an Android smartphone with a NodeMCU, and a microprocessor containing coding commands that have been made and then uploaded so that they can run commands according to the sketch made
4 Channel 5V Relay Module	1	As a switch on / off
Female to female jumper cable	3	To Connect NodeMCU to Relay Module
Electric socket	1	For connecting electrical devices to NodeMCU
USB cable	1	To transfer the coding commands that have been made in the Arduino IDE to NodeMCU and to connect NodeMCU to power
Power cable	2 M	Power cable to connect AC voltage
Android smartphone	1	As a remote control that interacts directly with the user

3) Software Requirements Analysis

Software requirements analysis aims to analyze the software needed for the design of an IoT-based switch system. Table II explains about software Requirements.

TABLE II
SOFTWARE REQUIREMENTS ANALYSIS

Platform	Information
Windows 10 64bit	Operating system
Arduino IDE	Creating software at NodeMCU
Blynk application	For control of the NodeMCU module on Android

B. System Design And Design

System design and design are needed to facilitate the manufacture of IoT-based switch systems. In this section, we will describe the flowchart design and system design and design.

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1) Flowchart Design

The system design that will be carried out is to create a workflow from an IoT-based switch system using a flow chart.

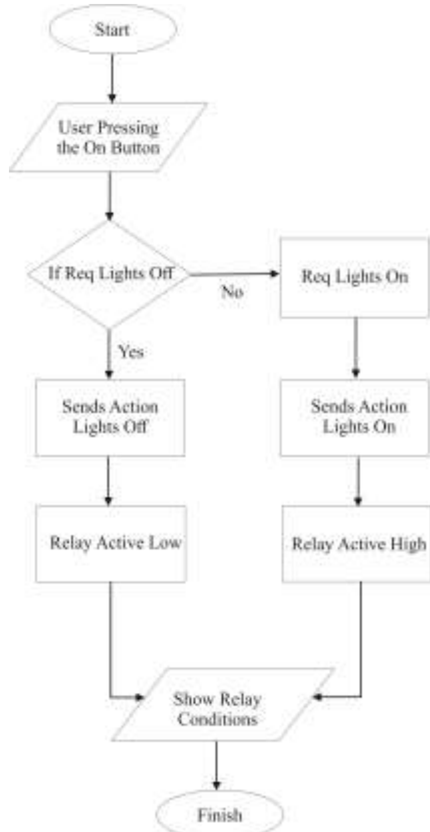

Fig.2. Flowchart flow of an IoT-based switch system

This system has two buttons, namely the On button and the Off button. If the user presses the Off button, the controller will receive the "Off" command and send it to the actuator, the Relay, to take action, which is to cut off the electric current with an active low relay output. Likewise, if the user presses the power on button, the controller will receive the request "On" and send an action to the Relay by connecting the electric current with the active high relay output.

2) Block Diagram System

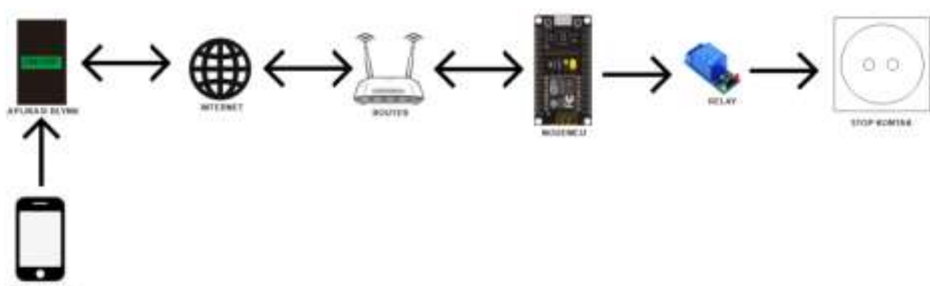

Fig.3. System design

In Figure 3, it can be seen that there is one access to be able to control the system, namely via a smartphone that is already connected to the Blynk application. First, the configured Blynk application gives the command. The command is forwarded via the internet and will enter the router, then processed by the controller, namely NodeMCU. The controller will process the data then send a signal to the actuator. The actuator can send its condition back to the controller, then the signal sent by the controller is processed into action, and the action will be caught by the Relay, which will then send the data to the controller. The controller will process the data, forward the data to the internet, and displayed it on Blynk on the smartphone.

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3) Schematic of Tools

This scheme is a combination of the NodeMCU scheme and the 4 Channel Relay connected to a socket. Here is a schematic image of the whole series:

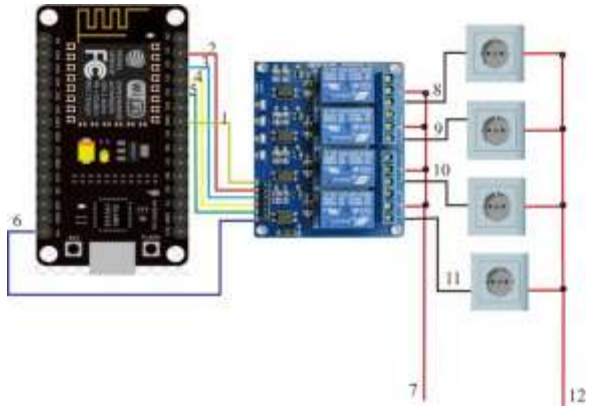


Fig.4. Tool Scheme

Description of the schematic of the whole series in figure 4 is:
1) NodeMCUGnd Pins are connected to Gnd Relay Pins
2) Pin D1 of NodeMCU is connected to Pin in1 of Relay
3) Pin D2 of NodeMCU is connected to Pin in2 of Relay
4) Pin D3 of NodeMCU is connected to Pin in3 of Relay
5) Pin D4 of NodeMCU is connected to Pin in4 of Relay
6) NodeMCU VIN Pin is connected to VCC Relay Pin
7) AC power source is connected to all in Relay
8) Relay 1 is connected to socket 1
9) Relay 2 is connected to socket 2
10) Relay 3 is connected to socket 3
11) Relay 4 is connected to socket 4
12) All cables in the socket circuit are connected to an AC power source

4) *Result of Interface Design*

Figure 5 results from a late layout design connected to the Blynk API to control the tool's design.

Fig.5. Layout Design Results

III. RESULT AND DISCUSSION

Testing is an integral part of the software development cycle. In this research, Blackbox testing will be used. The Blackbox testing method emphasizes testing each part's existing functionality in the system that is made without knowing the existing program stanza. This test is carried out after the current program verse has been completed. This test aims to ensure that each part

DOI: 10.25139/ijair.v2i2.3138

is by the specified process flow and ensures that the system can handle all user input errors. In this chapter, several analytical tests will be carried out, including the microcontroller and relay testing, relay and socket testing, application and prototype testing, electrical equipment hardware testing, and system response testing. The testing of all systems is carried out after the system design process has been successful. This test is useful for determining the success of the prototype designed in this study.

A. Testing Integration Between Microcontroller and Relay

In this test, the aim is to determine if the microcontroller and Relay are connected to the internet. After the access point is activated, the Relay's will automatically turn on if the prototype is connected correctly. It can be seen that all the LEDs on the Relay can turn on and off. The microcontroller and Relay are well integrated. The result of microcontroller testing with Relay is shown in Table III.

TABLE III
MICROCONTROLLER TESTING RESULTS WITH RELAYS

Function Tested	Was Successful	Failed
Led Relay 1 On	Yes	-
Led Relay 1 Off	Yes	-
Led Relay 2 On	Yes	-
Led Relay 2 Off	Yes	-
Led Relay 3 On	Yes	-
Led Relay 3 Off	Yes	-
Led Relay 4 On	Yes	-
Led Relay 4 Off	Yes	-

B. Testing of Integration Between Relays and Sockets

Table IV, the Relay connection and the socket are connected correctly. It can be seen that the results are all the sockets are functioning correctly with a sign that the led socket is on, it means that the socket has no problem. The Relay and socket are well integrated. The receptacle is ready to be tested with electronic equipment that complies with the problem limits.

TABLE IV
RESULTS OF RELAY TESTING WITH A SOCKET

Function Tested	Was Successful	Failed
Socket 1 On	Yes	-
Socket 1 Off	Yes	-
Socket 2 On	Yes	-
Socket 2 Off	Yes	-
Socket 3 On	Yes	-
Socket 3 Off	Yes	-
Socket 4 On	Yes	-
Socket 4 Off	Yes	-

C. Testing Integration Between Applications and Prototypes

Table V, the application is connected to the prototype by pressing the on/off button on the application. The response to changing the prototype on / off will show that the two have been well integrated. It can be seen that all the on/off buttons are by the expected results. Applications with prototypes are well integrated.

TABLE V
TESTING RESULTS FOR APPLICATION INTEGRATION WITH PROTOTYPES

Function Tested	Was Successful	Failed
Fan Button is On	Yes	-
Fan Button is Off	Yes	-
The Power Button is On	Yes	-
The Power Button is Off	Yes	-
Light Button 1 is On	Yes	-
Light Button 1 is Off	Yes	-
Light Button 2 is On	Yes	-

DOI: 10.25139/ijair.v2i2.3138

 E- ISSN:2686-6269

Function Tested	Was Successful	Failed
Light Button 2 is Off	Yes	-

D. Hardware Testing Results

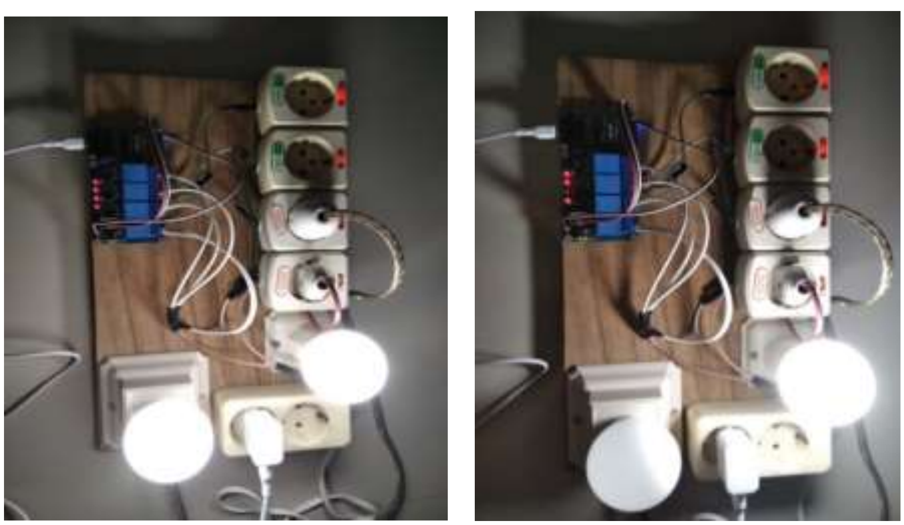
Table VI, the switching system design is running well. Testing is done by pressing a button on each field. Then the switch will respond to turn on or turn off electrical equipment. It can be seen from the test results that electronic devices can be controlled on / off properly using a smartphone connected to the internet. The entire series of prototypes, internet connections, and applications on smartphones are very well integrated.

TABLE VI
HARDWARE TESTING RESULTS

No	Function Tested	Test Way	Expected Results	Test Results
1.	NodeMCU	Ensure that there are no lost lines between components	No components are cut off	There are no disconnected component lines

Fig.6. NodeMCU Testing

2.	Light	Lights on and off in the switch system design	Lights On and Off	Lights are on all and lights are off one



(a) ***(b)***

Fig.7. ***(a)*** The lights are all on; ***(b)*** One-Off Light

3.	Fan	The fan turns on and off in the switch system design	Fan Rotates and Fan Stops	Fan On and Fan Off

DOI: 10.25139/ijair.v2i2.3138

E- ISSN:2686-6269

No	Function Tested	Test Way	Expected Results	Test Results
		 *(a)* *(b)* Fig.8. ***(a)*** Fan On; ***(b)*** Fan Off		
4.	Charge of all kinds of electronic goods	Charge On and Off in the switch system design	Mobile Charge Functions as it should	Mobile Charge charges the battery and Stop charging the battery
		 *(a)* *(b)* Fig.9. ***(a)*** Charging the Battery; ***(b)*** Stop Charging		
5.	Lights, Fans, and Mobile Charge	Ensure all electrical equipment is turned on in the switch system design  Fig.10. Overall Testing	All electrical equipment is on	Two lights turn on, and one fan turns on. The mobile charge is on
6.	Lights, Fans, and Mobile Charge	Ensure that some electrical equipment can be turned on and some other electrical equipment can be turned off	Some of the electrical equipment is on, and some of the electrical equipment is off	One lamp and one mobile charge turn on, and one lamp and one fan die

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No	Function Tested	Test Way	Expected Results	Test Results

Fig.11. Partial Testing

E. Testing Interface Implementation (System Response Process)

Table 7 explain how long the system takes to turn on or turn off electrical equipment, which is directly controlled by an android application. Time is calculated starting from the light button on the application is pressed until the electrical equipment displays its output using a stopwatch. Time measurements are made during the day and night to ensure differences in traffic on the internet network. The following is a measurement table.

TABLE VII
RESULTS OF SYSTEM TIME PROCESS MEASUREMENT

Function Tested	Times	
	Noon	Night
Actuator Button 1 On	3 second	1 second
Actuator Button 1 Off	1 second	2 second
Actuator Button 2 On	3 second	1 second
Actuator Button 2 Off	4 second	2 second
Actuator Button 3 On	2 second	1 second
Actuator Button 3 Off	1 second	2 second
Actuator Button 4 On	4 second	1 second
Actuator Button 4 Off	3 second	2 second

The test results can be seen during the day that the system takes a long time to respond because due to the dense traffic during the day, many people access the internet. Meanwhile, the system can respond more quickly at night than during the day because the traffic at night is relatively quiet.

IV. CONCLUSION

From the results, it can be concluded that the IoT-based Switch System Design using a microcontroller has functioned and is integrated as expected and is successfully controlled by pressing the on/off button on a smartphone connected to the internet. Control can be done anywhere and anytime. The system response during the day between 1-4 seconds and at night between 1-2 seconds.

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DOI: 10.25139/ijair.v2i2.3138