

**Research Article**

# Development of Internet of Things (IoT) Based Electric Equipment Control

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**Abstract:** The Internet of Things (IoT) is one of the new trends in the world of technology that is likely to be one of the big things in the future. IoT is a concept that aims to expand the benefits of continuously connected internet connectivity. IoT can combine physical and virtual objects by exploiting data capture and communication capabilities. This development research aims to produce an IoT-based electrical equipment control system. The development model used in this research is the prototype development model. The development procedure consists of 6 steps: Requirements Analysis, Building Prototypes, Evaluation of Prototypes, Coding the System, Testing and Evaluating the System, and Implementing the System. The equipment used for the IoT-based electronic control system that will be designed consists of raspberry pi, power supply, relays, speakers, sound sensors, and lights. The results of this study resulted in an electronic control system that was carried out by voice commands. In this study, IoT devices were programmed to respond to commands to turn on/off the porch light, turn on/off the living room light, turn on/off the kitchen light, and turn on/off the bedroom light. The results of testing and evaluation of the system indicate that the development of this control system can work well, and the device works according to the instructions. The minimum distance for the voice command response to the device is 0 - 10 cm, and the maximum length for the voice command response to the device is 500 cm.

**Keywords:** Control System; Internet of Things (IoT); Prototypes; Voice Command.

## 1. Introduction

The development of control system technology has now developed in automation systems that are integrated with computer networks and applications so that human intervention in controlling is minimal. As technology evolves, it spurs Information Technology (IT) people to develop their ideas regarding automatic control systems [1]. In general, computational science is concerned with preparing mathematical models and numerical solution techniques and using computers to analyze and solve scientific problems. Computing technology is the user activity and development of computer technology, hardware, and software. It is a computer-specific part of information technology. Computer science is the study

and basic science of information theory and computing, as well as its implementation and application in computer systems.

The development of science and technology positively impacted human life at this time, but household electrical load equipment control is still manually controlled [2]–[4]. While the location of the buttons between one button and another is far from each other, it is very ineffective if people want to turn off and turn on electrical equipment. Currently, various efforts are being made, such as turning off lights that are no longer used, turning off the television when it is not being watched, turning off the air conditioner when leaving the room, and using energy-saving lamps.

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The development of computing technology is widely implemented in housing and is known as an intelligent home [5]. Innovative home products develop messages with various concepts and systems built because of savings in different electronic devices. The smart home can be integrated with an android-based electrical equipment control system. Control is carried out using mobile phones, Bluetooth, or Wireless Fidelity (Wi-Fi) connected to electrical equipment. The range of Wi-Fi-based control is more comprehensive than that of Bluetooth-based control, even though the power is both using the help of a cellphone. The combination of information and computing technology relies on efficiency, device automation, convenience, and savings in electronic devices. Following technological developments, the production of smart homes has developed a lot, with various concepts and systems being built [6].

IoT is a unified system of computing devices that are interconnected or communicate, both mechanical and digital mechanisms, such as humans, and any object equipped with unique identification and capable of transferring data over the internet without requiring human-to-human or human-to-computer assistance [7]–[9]. IoT (Internet of Things) is a concept that aims to expand the benefits and connectivity of a continuously connected internet [10]. IoT devices can send information and perform follow-ups over the network with minimal human intervention to perform various functions automatically. The internet becomes a liaison between the two machine interactions and humans in IoT, and their job is only to be directly regulated and supervised by the machines that work [11], [12].

The internet makes it easier to control system technology for electrical equipment such as lights. The internet has a wide range of control, so it is very efficient in terms of energy and time. The internet can provide various functions and facilities to be used as a medium of information and communication. Room lighting equipment can be operated online through the website, so users can still monitor or control the lights anytime and anywhere with an adequate internet connection.

People still use mechanical controllers that work manually in daily activities, especially electrical devices. This is observed through the still use of the switch. The development of lifestyle and social dynamics today shows the increasing importance of the practicality and efficiency of electrical energy. People who enter a dark room will look for a switch to turn on the light, likewise if the person goes out of the room to turn off the light.

On the other hand, most people do not apply the behavior of turning off the lights in the room. What often happens is that the lights are left on. The leading cause is

laziness in turning off the light. This condition results in wasted use of electrical energy.

The target of industrial technology, in addition to factories, is also included in the household industry shutter of the extensive use of electrical power loads, namely lights/households. The industrial revolution developed intelligent home technology, one of which is to streamline control of turning on and off lights. The challenge of the industrial revolution 4.0, one of the revolutions issued is IoT [13]–[15].

## 2. Material and Methods

### 2.1. Research Approach

The development method used is Research and Development (R&D) research. Research and Development or Research and Development (R&D) is a process or steps to develop a new product or improve an existing product [16]. In this research, the development model used is the prototype model. Prototyping can be interpreted as a process used to assist software developers in forming a model of the software created.

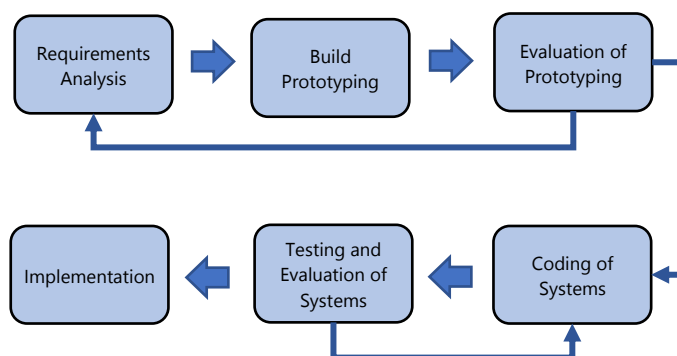


Figure 1. Prototype Development Model.

### 2.2. Building IoT Prototyping

The designed IoT uses a voice control system. The equipment used for the IoT-based electronic control system that will be designed consists of raspberry pi, power supply, relays, speakers, sound sensors, and lights. The following is a design drawing of a prototype design for IoT that will be implemented.

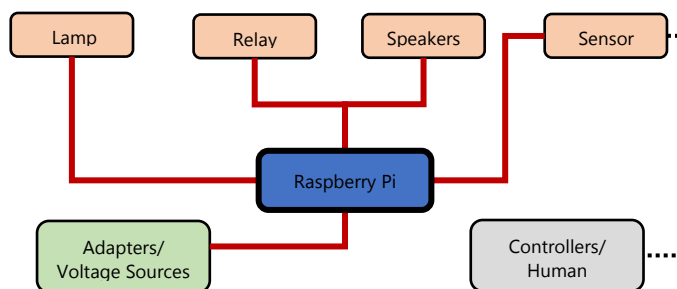


Figure 2. IoT Prototype Design

### 2.3. Requirements Analysis

This research's analysis needs to obtain/collect data. The data collection technique uses observation techniques related to household electrical loads, especially lighting installations, apart from observation and questionnaires from users related to equipment that already exists in their home systems. Control of lighting installations. This needed data analysis will then be formulated into an instrument validated by experts related to the development instrument to be carried out.

### 2.4. Prototype Evaluation

This evaluation is carried out by experts in which this evaluation consists of two parts. First, assessment of the validation of testing instruments related to hardware and evaluation of proof of testing instruments related to software. The measurement scale of this type will provide clear answers, namely yes-no, true-false, never-never, and positive-negative. Responses can be made in the form of a checklist with a high score of one and a low score of zero.

**Table 1.** Conversion score from the Gutman scale.

Answer	Instrument Answer Score	Results
Yes	-	$\sum \text{Yes}$
No	-	$\sum \text{No}$
	Max Score	$\sum \text{Yes} + \sum \text{No}$

The percentages for each value are:

$$Yes = \frac{\sum Yes}{Max\ Score} \times 100\% \qquad No = \frac{\sum No}{Max\ Score} \times 100\%$$

The collected data were analyzed using descriptive qualitative analysis techniques expressed in the distribution of frequencies and percentages against the rating scale categories determined from the presentation in the form of shares.

### 2.5. System Testing and System Evaluation

At this hold, start testing the system. The data collection stage uses a Gutman scale related to the command of whether the coding hardware and software are correctly connected or not. Then it is formulated into an instrument for connectivity testing. At the time of testing, also evaluate the system.

## 3. Result and Discussions

### 3.1. IoT Device Development Design Results

Prototype of internet of things based electronic control system using raspberry pi, amazon echo dot-smart

speaker, and python programming language. The Raspberry Pi here functions as a central control for the Raspberry Pi microcontroller and acts as an API (Application Programming Interface) endpoint. Amazon echoes dot is used to capture voice commands. For this system to work correctly, the two devices above must be within the scope of a local network behind NAT (Network Address Translation) on a route board.



**Figure 3.** Prototype Design Results with Alexa.

The devices used to make the hardware series include Amazon Echo Dot, Raspberry Pi, Relays, lights, SD Cards, and DC and AC Power Supplies. Utilizing an Amazon Echo Dot device, the tool can receive commands in the form of voice and then send signals/orders to the Raspberry. The Raspberry Pi receives the signal/command, runs the python program then gives the command to activate the relay. When the relay is active, the light will turn on.

### 3.2. IoT Device Prototype Evaluation Results

#### 3.2.1. Amazon Echo Dot Testing

The amazon echo dot/Alexa testing is done by testing the command response. When the command given is indoors, the order is outdoors.

**Table 2.** Amazon Echo Dot/Alexa Device Condition.

Device Name	Device Condition	
	Working	Not Working
Amazon Echo Dot/Alexa indoor	√	
Amazon Echo Dot/Alexa outdoor	√	

### Raspberry Pi Testing

Testing the Raspberry Pi microcontroller is done by checking the Raspberry Pi pins, which will later be used as input and output to run the system. Test results of the Raspberry Pi circuit.

**Table 3.** Raspberry-Pi Pin Test Results on Control System Components.

Component	Raspberry Pin	Cable Condition	
		Connected	Not Connected
Relay 1	26	√	
Relay 2	16	√	
Relay 3	20	√	
Relay 4	21	√	

In addition to checking the Raspberry Pi Pin, checking is also carried out on the condition of the Raspberry Pi, which aims to see whether the Raspberry Pi can process data correctly or not.

### Relay testing

In relay testing, it is done by providing a DC voltage of 5 Volts. Then give the on/off command whether the relay responds to the given order.

**Table 4.** Relay Device Condition.

Device Name	Device Condition	
	Working	Not Working
Command Relay ON	√	
Command Relay Off	√	

### Lamp Test

The lamp test is carried out by providing an AC voltage of 220 Volts. Then give the voltage command. Does the light respond on/off.

**Table 5.** Relay Device Condition.

Device Name	Device Condition	
	Working	Not Working
Provide voltage 220 volt	√	
It does not provide voltage	√	

### Memory Test

Memory is a flash memory card format used in portable devices. Checking is done by inserting the memory into the laptop card reader to ensure that the memory is not damaged and can be read. The type of memory used by SanDisk Ultra is 16 GB.

### 3.2.2. Prototype Trial Results

#### Alexa test with correct sentences

**Table 6.** Alexa testing with the correct language.

No	English Sentence Commands	Expected Conditions on the Lamp	Conditions that occur in the Lamp
1	Alexa Tell thesis garden on	Light on	Light on
2	Alexa Tell thesis garden off	Light off	Light off
3	Alexa Tell thesis living room on	Light on	Light on
4	Alexa Tell thesis living room off	Light off	Light off
5	Alexa Tell thesis kitchen on	Light on	Light on
6	Alexa Tells thesis kitchen off	Light off	Light off
7	Alexa Tell thesis bedroom on	Light on	Light on
8	Alexa Tell thesis bedroom off	Light off	Light off

#### Alexa test using the wrong sentence

**Table 7.** Alexa is testing with the wrong (Indonesia) language.

No	Indonesia Sentence Commands	Expected Conditions on the Lamp	Conditions that occur in the Lamp
1	Alexa tolong nyalakan lampu taman.	Garden lights do not turn on	Garden lights do not turn on
2	Alexa tolong matikan lampu taman	Garden lights do not turn on	Garden lights do not turn on
3	Alexa tolong nyalakan lampu ruang tamu	The lights do not turn on	The lights do not turn on
4	Alexa tolong matikan lampu ruang tamu	The lights do not turn on	The lights do not turn on
5	Alexa tolong nyalakan lampu dapur	The lights do not turn on	The lights do not turn on
6	Alexa tolong matikan lampu dapur	The lights do not turn on	The lights do not turn on

No	Indonesia Sentence Commands	Expected Conditions on the Lamp	Conditions that occur in the Lamp
7	Alexa tolong nyalakan lampu kamar tidur	The lights do not turn on	The lights do not turn on
8	Alexa tolong matikan lampu kamar tidur	The lights do not turn on	The lights do not turn on

**Table 8.** Alexa testing with the correct language.

No	Voice Command Distance	Expected Conditions on the Lamp	Conditions that occur in the Lamp
1	50 cm	The lights turn on	The lights turn on
2	100 cm	The lights turn on	The lights turn on
3	150 cm	The lights turn on	The lights turn on
4	200 cm	The lights turn on	The lights turn on
5	250 cm	The lights turn on	The lights turn on
6	300 cm	The lights turn on	The lights turn on
7	350 cm	The lights turn on	The lights turn on
8	400 cm	The lights turn on	The lights turn on

### 3.2.3. Product Component Study

The results of the development of an internet of things-based electronic control prototype. These components consist of hardware and software.

#### Hardware

The hardware used to develop this prototype consists of three main parts in constructing this IoT-based electronic control prototype: input, process, and output. Amazon Echo Dot/Alexa as input device used to send command signals. Raspberry Pi is a data processor given by the input. The relay is used to forward the command/output on the lamp as an indicator. AC Power Supply is used to provide voltage to turn on the lights.

#### Software

The software developed for this prototype uses the Raspberry OS Raspbian operating system based on Debian/Linux. The programming language used is Python. The program created is then sent/uploaded via a USB cable connected between the laptop and the Raspberry Pi Microcontroller.

This development research produced an Internet of Things (IoT) based electronic control prototype that uses voice commands to perform control. Needs analysis activities are carried out by conducting observations and literature studies. The statement's object is to apply a

control system in the industrial 4.0 environment with a wireless control system developed into IoT-based technology. In this study, the authors designed an IoT-based electronic control system and implemented it in a smart home. In its operation, each user can get comfort and convenience anytime. The prototype was made using raspberry pi, amazon echo dot smart speaker, and python programming language.

## 4. Conclusion

Based on the results of research on the design of an Internet of Things (IoT) based electronic control system prototype, the following conclusions can be drawn:

- This electronic control system can help make it easier for the public to control electronic equipment because this tool is equipped with an IoT-based control and monitoring system. So, this electronic control system can be controlled using voice when connected to an internet connection.
- From the results of the tests, all the equipment used can work well in reading data/commands. Amazon Echo Dot/Alexa, a tool used as a receiver and sender of commands, successfully responds and works well. The Raspberry Pi can process data well and send data successfully. The relay receives orders well. When the command is received, it automatically locks the relay and forwards the command. The lamp has worked well. The lamp will automatically work and respond well when the order is given.

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