

## Management maintenance system for remote control based on microcontroller and virtual private server

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### Article Info

#### Article history:

Received Feb 1, 2019

Revised May 28, 2019

Accepted Jul 8, 2019

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#### Keywords:

Maintenance  
Microcontroller  
Remote control  
Virtual private server

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### ABSTRACT

Open loop shaped control system is a form of system control without any feedback from the system. One example is the on-off condition which functions to connect and disconnect electricity. The condition to be studied is a dc motor that can be set to live and die via internet server-based client service. The server in this system is a virtual private server (VPS) device that will provide a source of service to the client in the form of a collection of information on dc motor conditions. In addition, its function is also to record the working time of the dc motor. So that a schedule can be determined when the dc motor is maintained. While the client is a control unit consisting of a microcontroller device, an ethernet module enc28j60 and a dc motor. In general the working principle of the system is beginning with the user accessing the desired VPS IP address through a web browser application. From the web browser the user chooses a dc motor to be activated. But before the client has been connected to the VPS regularly (every second), the point is to always get the latest dc motor condition information. Then the microcontroller will set the dc motor in active or off condition. The research method used is research and development. The results obtained from this study are that the amount of bandwidth needed for communication between VPS and microcontrollers via the internet network, when the control unit works is 6.02 kbps, while the response time for dc motor is 3.16 seconds and the response time for dc motor 2 is 3.46 seconds.

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## 1. INTRODUCTION

Nowadays, everything can be informed via the internet, which can be done in many ways, such as through web sites, social media, e-mail and others. The concept of extending the benefits of internet connectivity continuously is the concept of the Internet of Things (IoT). One of the effects of the IoT concept is that control of electronic devices can be carried out remotely through computer networks or the internet [1-3]. In addition, the concept of IoT indirectly led to the emergence of the issue of 4th generation industrial revolution. The Ministry of Research, Technology and Higher Education 2018 National Working Meeting held at USU alluded to many things about industrial revolution in which universities must take an active role in responding to the challenges. In addition, research on IoT was carried out by Moh. Wildan Habibi and friends entitled The Design of the Cloud IoT Platform Based on the MQTT Communication Protocol. Broadly speaking, he explained the application of the Message Queuing Telemetry Transport protocol on IoT. The application of security systems to the microcontroller can already be applied with

existing algorithms [8, 9]. With this issue, the researchers raised the theme of research regarding remote control systems involving virtual private servers (VPS) and microcontrollers. The shifting to have access online to every business process have been evidenced by the introduction of initiative of electronic voting to reduce cost and number of operation [10], the formation of blended learning system to deliver teaching learning in university [11] as well health management system in the hospital to manage various activities such monitoring, transfer and collaboration [12] even controlling the robot from far distance [18, 19].

In this study, we will discuss the application of IoT to control the condition of on-off electrical equipment using VPS and microcontrollers. The use of VPS is an interface to the user and to the microcontroller that will be paired with the application made. In addition, its function is to record the working time of each control unit. By knowing the working time, a schedule can be determined when maintenance will be carried out on the control unit. Or in other words that there is a maintenance management system. While the microcontroller used will be in the form of a ready-made board, namely Arduino. The function of this microcontroller is the interface to electrical equipment. Broadly speaking, the process is that the microcontroller will work in accordance with the data available on the VPS. Specifically, the purpose of this research is to make a prototype of a remote control device through the internet network by utilizing a virtual private server. Then, find out the response time of each control unit and the amount of data bandwidth that appears on the control unit during work. The last is to find out the hardware specifications needed by the client or control unit. Finally, this study will contribute to optimizing the use of the internet and VPS (virtual private server), which has only been used for information system applications, then can be used for applications with microcontrollers (related to remote control) and add learning modules for Interfacing subjects regarding applications microcontroller. Finally, this study will contribute to optimizing the use of the internet and VPS (virtual private server), which has only been used for information system applications, then can be used for applications with microcontrollers (related to remote control) and add learning modules for Interfacing subjects regarding applications microcontroller.

## 2. LITERATURE REVIEW

The rapid development of science allows practitioners to always carry out new ideas that are useful, among others, to help human work as well as overcome certain problems, this shows the progress of science and technology that is currently characterized by the emergence of tools that use digital and automatic system. Electronics is one of the technologies that helps human life to become easier. On the other hand, wireless media has undergone a process of rapid innovation in finding reliable, simple and viable technologies for companies to conduct rapid, easy and inexpensive diagnosis of errors in processing the higher mode of computation such as plants management [20] or even cultivation of agriculture [22]. One form of electronic access control system that is currently being developed is on a remote control system, this allows one to control a load on-off at a great distance, this is certainly very useful to support the lives of modern people who need very high mobility. The studies relating to remote control such as Andrianto and Arief [7] discussed the use of single-on-chip computers, namely raspberry pi, to be used as a server while being used as a light switch control. While the client or control unit uses a browser to access the server. Communication media uses wifi between server and client. On the other hand, Fiqri et al [6] discusses how to use SMS services available on cellular phones to be able to control electronic devices at home. The equipment he uses consists of a microcontroller with a GSM module to be installed on the side of the house while the control device is in an application on an Android-based mobile phone.

Shalini and Sivasakthi [4] discusses the control in the industry by utilizing the client server model through the Labview application must be connected to computers and computers to be connected to industrial devices that will be controlled remotely. Then the computer is equipped with a public IP so that it can be accessed by its workers. The creation of a maintenance card for a device aims to help the team in terms of information regarding maintenance schedules. The card is generally in the form of paper or cardboard and is attached to the device. In the current internet era it can be replaced with a computer that is connected to the internet network in order to reach the control unit. So that the maintenance management is scheduled automatically. In addition, the internet connection must be maintained which the command used is in the form of testing with ping. An alternative graphics display and graphical control of a device is a system that shares the VNC (Virtual Network Computing) desktop, which provides control function using graphical screen updates from remote device and capture events such as mouse or keystrokes [13]. A useful feature when controlling multiple devices is firmware management. This function is very important in the system, because if it is not properly, the device can be locked. However, some manufacturers offer alternative ways to modify firmware because the purpose of the architecture is to embrace Android devices that offer generic ways to be suggested [14].

The dependency information makes it easy for designers to identify specifications and help create automatic interfaces that generate higher quality results [15]. An important consideration in designing the architecture of remote control of devices is the security within the system [16]. Furthermore, the server side is responsible for accepting client-side requests and providing services to users by processing client-side requests, similar to traditional server-client architectures but it can allow the process to be implemented effectively and efficiently [17]. Connecting through local sockets is very similar to network connectivity with the client server socket connection must be open but the channel must be converted to a USB interface. In this case, the system's ability is determined absolutely by the developer because it specifies the hand-exchange protocol [14]. The IT scenario can be heavily influenced by Internet technology things, which determine the competitive advantage of companies, where the studies are designed, and provides the proposed system Data Acquisition Unit (DAQ), made from model B for Raspberry Pi, Wi-Fi module, MPU 6050 accelerometer, thermal thermal imaging module FLIR lepton for temperature monitoring, and a 3350 mAh power bank provides sufficient battery life for this unit. This system can collect acceleration and temperature data at 1 kHz with a transmission rate of 100 Kbps in 14 unit readings and more than I2C at a maximum speed of 400 kbps. The thermal camera unit captures infrared radiation within a wavelength range of 8 to 14 microns [21].

### 3. RESEARCH METHODOLOGY

The system that will be created is a control system on electrical equipment. The minimum control requirement for electrical equipment is generally to turn on and turn off electrical equipment represented by dc motors. Seen in Figure 1 is a block of system design diagrams created. Figure 1 explains that the role of a server system is very important because as an intermediary user (user) and electronic equipment to be controlled. The server hardware used is a virtual type that is rented to one of the providers around the researcher with the following specifications: AMD64bit type processor, 256MB memory, and 20GB hard drive capacity, IIX 1 Mbps and IX 512 Kbps bandwidth, and Ubuntu 12.04 Linux operating system with the Linux kernel 4.15.17-3-pve. The way the system works can be explained as follows:

- 1) Users (users) are connected to the internet using a PC or Mobile station to give orders to change the status of electrical devices. The user goes to VPS with the address: <http://202.74.238.139/control>.
- 2) Number 202.74.238.139 is the address of the web server that is the display for electrical devices on the user. And at the same time produce string data that contains the number of controlled electrical equipment.
- 3) The control unit functions to process all instructions and also as a control center for the entire system. The control unit component is a router modem, ethernet module and microcontroller. The tasks or functions of the components in the control unit are as follows:
  - a) Modem router functions as a network source (ISP) internet for microcontroller devices that will take instructions from the user.
  - b) Ethernet module is a hardware device that functions as a microcontroller bridge to get internet network through a router modem.
  - c) Arduino is in charge of executing incoming instructions so as to give a visual impact, namely a live and dead dc motor in the simulation performed.

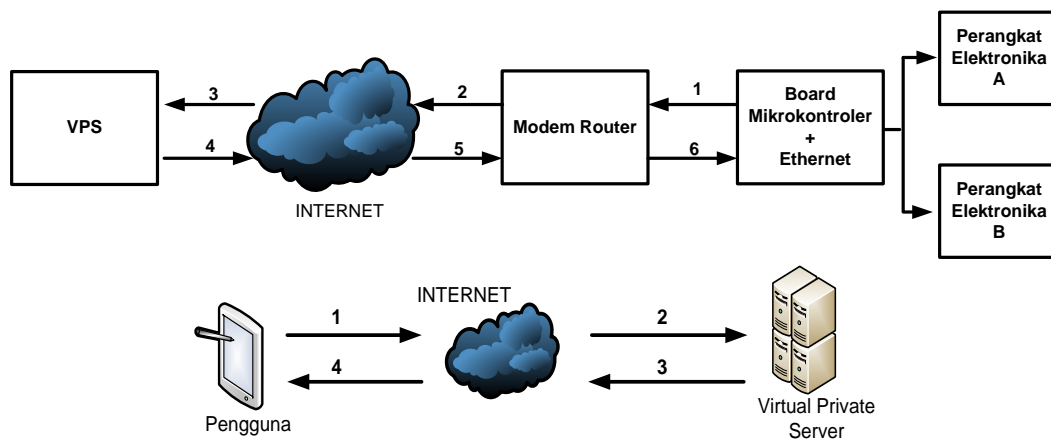


Figure 1. (Top) Client system design or control unit, (Bottom) server system design

## 4. DISCUSSION AND RESULTS

### 4.1. Communication of Virtual Private Servers with users

The VPS has a fixed public IP address that is installed at 202.74.238.xxx at the time of initial use, so that during the research it will use it. Departing from here the protocol used in this study is TCP/IP. TCP/IP is used as a protocol in the internet network. Similar to the OSI (Open System Interconnection) model, TCP/IP is also divided into several multilevel protocol layers. Figure 2 shows the protocol layer in the protocol structure of the TCP/IP model. On the user side (user) to access the server using a browser application with http (hypertext transfer protocol). Http services can be provided by the server if a web server application is installed, which in this study uses the Linux-Apache-Mysql-PHP package which consists of versions of Apache 2.0, versions of PHP 5.3.10-1ubuntu3.26, Mysql version 5.5.54. After the application is installed properly, the next step is to make a display to the user (user interface) that is installed on the server with the display that appears on the user side can be seen in Figure 4 and Figure 5.

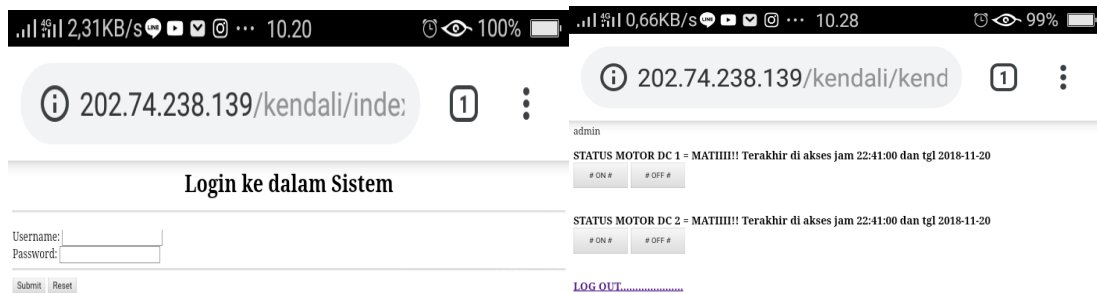


Figure 3. (Left) Initial view when accessing, (Right) Display when the login is received and information about the control unit

The information that appears in figure above consists of the status, the last time to access and the last date of access. Information for dc motor status is obtained from the available keystrokes and the results are stored in the database. While the other information appears automatically when the dc motor status changes. So the control unit does not send the status of the dc motor.

### 4.2. Communication of a Virtual Private Server with a Control Unit

Since the protocol installed on VPS is TCP / IP, the control unit must also use it on the side. To facilitate the process, the control unit is divided into 3 parts, namely parts connected to computer networks, processing parts, and controlled electrical equipment parts. On the part that is connected to the computer network using ethernet enc28j60 module as shown in Figure 4.

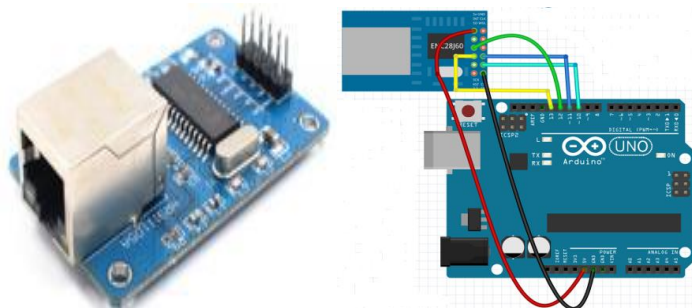


Figure 4. (Left) Ethernet enc28j60 module, (Right) Display of connections between ethernet modules and Arduino boards

The specifications are as follows

- a) IC based ENC28J60.
- b) Compatible with IEEE 802.3 Ethernet controllers.

- c) Integrated with MAC & 10 Base-T PHY.
- d) Available 1 port 10 Base-T which is equipped with automatic polarity detection and correction.
- e) Supports full duplex and half duplex modes.
- f) SPI interface with clock frequencies up to 20 MHz and 5V TTL levels.
- g) Ethernet data transfer speeds up to 10 Mbps.
- h) MAC address can be programmed.
- i) 5 VDC power supply

Between Arduino boards and ethernet modules using SPI (Serial Peripheral Interface) communication. While the cabling connection between the two can be seen as in figure above. Testing with observations carried out on the user side (user) with the success of the display appears as in Figure 5.5 and Figure 5.6. Next testing the protocol on Ethernet is testing with observations through retrieving string data that is on VPS, which is a command on the mikrocontroller to run. The command in the form of text is done by pressing the button on the application displayed on the web page. After getting the status of the dc motor, then the control process can be carried out by pressing the symbol buttons on the web to control on / off. Each push button for control, the system works with live or off instructions in the form of controlled dc motor initials. This instruction is stored on the VPS and the microcontrol accesses the instruction. This test is a measurement of the time needed when accessing a dc motor to be turned on and the dc motor is turned off. Testing of the access time of dc motor life and death is carried out as many as 6 times and the average value is calculated to get representative results. Table 1 is a table of test results on dc motor 1, the test carried out is to find out the response time needed to execute dc motor 1. Table 2 is a table of test results on dc motor 2, the test carried out is to find out the response time needed to execute dc motor 2.

Table 1. DC Motor Test Results 1

Command	Initial State Of Dc Motor	Final State Of Dc Motor	Time (Seconds)	Status
Motor DC 1ON	OFF	ON	3,7	SUCCESS
Motor DC 1OFF	ON	OFF	2,5	SUCCESS
Motor DC 1ON	OFF	ON	3,4	SUCCESS
Motor DC 1OFF	ON	OFF	3	SUCCESS
Motor DC 1ON	OFF	ON	3,6	SUCCESS
Motor DC 1 OFF	ON	OFF	2,8	SUCCESS
AVERAGE			3,16	

Table 2. DC Motor Test Results 2

Command	Initial State Of Dc Motor	Final State Of Dc Motor	Time (Seconds)	Status
Motor DC 2ON	OFF	ON	3,1	SUCCESS
Motor DC 2OFF	ON	OFF	3,7	SUCCESS
Motor DC 2ON	OFF	ON	2,9	SUCCESS
Motor DC 2OFF	ON	OFF	4	SUCCESS
Motor DC 2ON	OFF	ON	3,3	SUCCESS
Motor DC 2 OFF	ON	OFF	3,8	SUCCESS
AVERAGE			3,46	

The next test is the amount of data bandwidth that appears when the microcontroller accesses the virtual private server. Assembly testing consists of internet access, one router unit, one computer unit and its control unit (microcontroller). So that the display can appear as in Figure 5 is related to the data bandwidth that appears as long as the control unit is connected to the router. In the graph, the vertical axis is a value of 1 kbps, while the horizontal axis has a value of 1 second of observation. Then there are two different color lines, namely for blue Tx and for red Rx. The term Tx arises because the data flow exits the router to the microcontroller while the term Rx is the incoming data flow from the microcontroller to the router. From Figure 5, the highest Tx value is approximately 9.3 kbps while the highest Rx value is approximately 4 kbps. Tx value is higher than Rx because the microcontroller gets a data stream containing an instruction command to set the condition of the dc motor on or dc motor off from the server. Whereas the opposite is that the value of Rx is lower because the microcontroller sends the data stream for connection to the server only. To find the average amount of bandwidth of data that appears, the observation table is made based on Figure 5 with the average value of the data bandwidth that appears when the control unit works is 6.02 kbps.

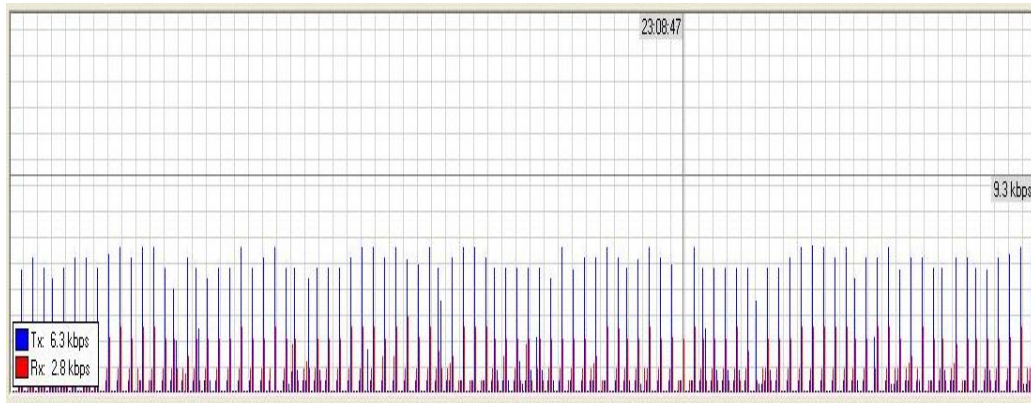


Figure 5. Display data bandwidth on eth2 port on the router

Table 3. The Average Amount of Bandwidth

Observation Order	Time (Seconds)	Total Bandwidth (Kbps)
1	0	5,8
2	5	5,8
3	10	5,8
4	15	6,7
5	20	5,3
6	25	6,7
7	30	6,1
8	35	5,9
9	40	6,1
10	45	6,1
11	50	5,9
12	55	6,7
13	60	6,2
14	65	4,9
15	70	6,3

## 5. CONCLUSION

The conclusions obtained are as follows: Ethernet module enc28j60 is used to connect microcontrollers with internet networks. The average response time needed to execute dc 1 motor is 3.16 seconds and dc 2 motor is 3.46 seconds. The value of data bandwidth that appears when the control unit works is 6.02 kbps. One of the parameters of maintenance management is to know when the dc motor condition is on or off and this is recorded in the database in the virtual private server.

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