PalArch's Journal of Archaeology of Egypt / Egyptology

ELECTRIC ENERGY CONTROL SYSTEM USING INTERNET OF THINGS TECHNOLOGY

Sukenda, S.Kom., M.T[1], *Muhammad Irfan Abdurrasyid*[2]

[1,2]Department of Informatics, Faculty of Engineering, Widyatama University, Cikutra Bandung

E-mail: [1]kenda@widyatama.ac.id, [2]irfan.abdurrasyid@widyatama.ac.id

Sukenda, S.Kom., M.T, Muhammad Irfan Abdurrasyid. Electric Energy Control System Using Internet Of Things Technology-- Palarch's Journal Of Archaeology Of Egypt/Egyptology 17(10), 3154-3162. ISSN 1567-214x

Keywords: Electrical Energy, Internet Of Things, Nodemcu, PZEM-004T, Google Firebase, Android.

ABSTRACT

With the increasing of population in Indonesia, it is definitely proportional to the load of electrical energy consumption which will continue to increase. As people who use electrical energy, efforts that can be made to save electrical energy are to control more electricity consumption at home. The use of electricity in the house is often not noticed, for example, electrical devices that are not in use have not been turned off or the user does not know the current usage of their home electricity consumption and indirectly has used excessive electrical energy. By using Internet of Things technology, this problem can be resolved through a system that can help users control their electrical energy. This system uses a Node MCU microcontroller which already has an ESP8266 module to be able to connect to the internet, the PZEM-004T sensor to detect the electricity consumption, relays to disconnect and connect electric currents, the Android application as the main control device in the system, and finally Google Firebase as a link between microcontrollers with Android devices.

INTRODUCTION

Electrical energy has now become a basic requirement for modern society. With the increasing population, especially in Indonesia, it is certain that the burden of electricity consumption will increase. As a community that uses electrical energy, several efforts that can be made to save electrical energy are turning off unused electrical appliances and also controlling more electricity consumption at home.

Currently, Internet of Things (IoT) technology has been applied in many aspects of human life. IoT is a technology that connects a device or device via an internet connection. The use of electricity from household appliances such

as lights, televisions, air conditioners, with current IoT technology, all of them can be connected and can be controlled or restricted through other devices such as smartphones.

Android is a Linux-based operating system designed for touch-screen mobile devices such as smartphones and tablets. Android since 2011 is the most widely used smartphone operating system. In May 2017 Android had more than 2 billion active users, the most among other operating systems installed on smartphones, and in September 2019 the Google Play Store had more than 2.6 million applications on it (Clement, 2019).

Several studies related to the control of electrical energy have been carried out. As in Anuja et al. (2017) which use GSM signals along with Bluetooth and also Madhu and Vyjayanthi (2018) which use Wi-Fi as connectivity, where this research uses Node MCU as a Wi-Fi module to control electrical devices home remotely. The systems built on research by Anuja et al. (2017), Madhu and Vyjayanthi (2018) can all be connected to Android devices. Wawan (2019) measures electrical power to be displayed on the LCD with the PZEM-004T sensor has also been carried out, where the research focuses more on optimizing the use of electrical power using the PZEM-004T sensor, relay, and also a microcontroller. In this study the authors will create a system that can display information on electricity consumption in kWh units and also control the use of electrical energy using relays, besides that the system can also provide a warning if the electricity consumption has exceeded the desired limits where everything can be controlled using an application-based Android.

II. LITERATURE RESEARCH

Internet of things

Internet of Things (IoT) is a concept that aims to expand the benefits of internet connectivity that is connected continuously. As for capabilities such as data sharing, remote control, including objects in the real world. For example, foodstuffs, electronics, collectibles, any equipment, including living things which are all connected to local and global networks through embedded sensors and are always on. Basically, Internet of Things refers to uniquely identifiable objects as virtual representations in an Internet-based structure. The term Internet of Things was originally suggested by Kevin Ashton in 1999 and gained prominence through the Auto-ID Center at MIT.

Node MCU

Node MCU ESP8266 is a module for the development of the Internet of Things (IoT) platform that comes from the ESP8266 family of type ESP-12 made by Express if System. Node MCU can be described as an Arduino microcontroller that is connected to the ESP8266 module because this module can be said to be a complete board because it contains a processor, memory, and also a GPIO.

PZEM-004T

PZEM-004T is a current sensor that can also work as a separate board with a physical size of 3.01 x 7.4 cm. PZEM-004T is used in this study because it has a function that is classified as complete in measuring the current and electricity consumption being used (Siriwat et al., 2017). The PZEM-004T also has a transformer coil that is inseparable from the main board. The main component of this sensor is the SD3004 chip made by SDIC Microelectronics Co., Ltd. In addition, the PZEM-004T also has an EEPROM 24C02C made by Atmel (now a microchip) which is a 2K bit Serial Electrically Erasable PROM with a voltage of 4.5V to 5.5V. This module has the main function of measuring current, voltage and total electricity consumption. There is also serial communication that can be used to connect to a microcontroller.

Relay

Relay is a switch (switch) that is operated electrically and is an electromechanical component consisting of 2 main parts, namely electromagnet (coil) and mechanical (a set of switch contacts). Relays use the electromagnetic principle to move the switch contacts so that a small electric current (low power) can deliver higher voltage electricity. For example, a relay that uses 5V and 50mA electromagnets is able to move an armature relay (which functions as a switch) to deliver 220V 2A electricity.

Firebase real time database

Firebase Real time Database is a database that is hosted in the cloud. Data is stored as JSON and synchronized in real time to each connected user. When building cross-platform applications with the Android SDK, iOS, and JavaScript, all users will share an instance of the Real time Database and receive the latest data updates automatically.

Firebase cloud functions

Firebase Cloud Functions is a server less feature that allows running backend code automatically in response to events triggered by other Firebase features and HTTPS requests. Written using JavaScript or type script code stored in the Google cloud and running in a managed environment so there is no need to manage or scale servers yourself.

Firebase cloud messaging

Firebase Cloud Messaging (FCM) is a cross-platform messaging solution that can be used to send messages reliably at no cost. With Firebase Cloud Messaging users can be notified that new email or other data is available for synchronization. Notification messages can also be sent to encourage interaction or provide certain information to users. For instant messaging use cases, messages can send a payload of up to 4 KB to user apps.

Android

Android is a Linux-based operating system designed for touch screen mobile devices such as smartphones and tablet computers. Android was originally developed by Android, Inc., with financial support from Google, which bought it in 2005. This operating system was officially released in 2007 and the first Android phones went on sale in October 2008.

ANALYSIS AND DESIGN

Problem analysis

Currently, information on electricity consumption for home electricity users can be done through the official PLN application on Android. However, the information displayed is more about the total monthly usage along with the number of bills that need to be paid from the use of all electrical devices in one house, if the user wants to know the electricity consumption of one or more electrical devices this cannot be done, besides this application also cannot can provide notification when electricity consumption has reached a certain usage limit. Meanwhile, to be able to control electrical devices remotely, this official application from PLN cannot do this so users need to turn off or turn on the electric device directly.

System analysis

This system uses two input data, namely PZEM-004T as a sensor that detects electric current, and also an Android application as input data to control electrical devices. As can be seen in Figure 1 below, the input data from the PZEM-004T will be processed using a Node MCU microcontroller which will then be sent to the Firebase Real time Database via an internet connection using the ESP8266 Wi-Fi module. The data in the Firebase Real time Database will then be processed by Firebase Cloud Functions to send notifications through Firebase Cloud Messaging and also the Android application to display information on electricity consumption. Meanwhile, data from Firebase Cloud Messaging will be used to display notifications on the Android application when electricity consumption exceeds the set limit.

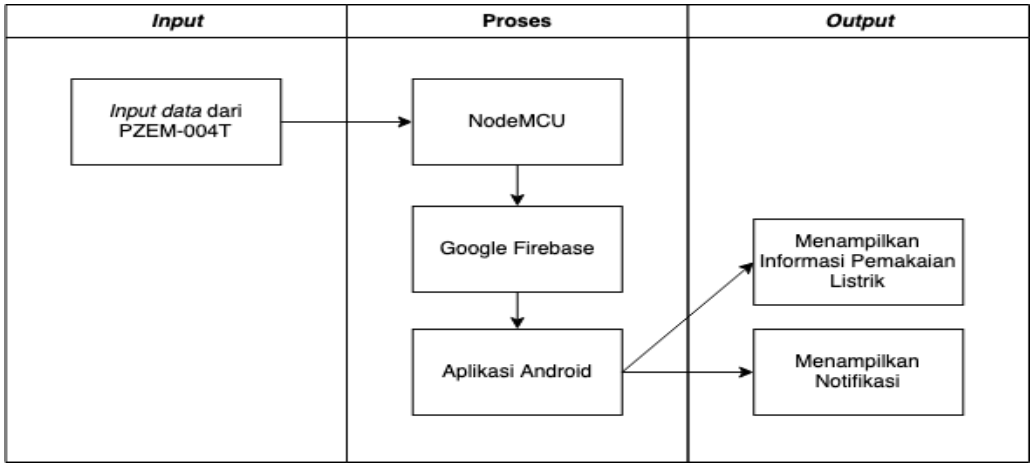

Figure 1 Schematic of How the System Works Part 1

For input data originating from the Android application as can be seen in Figure 2, this data will also be sent to the Firebase Real time Database via an internet connection which is then read by the Node MCU microcontroller to control the current from electrical devices.

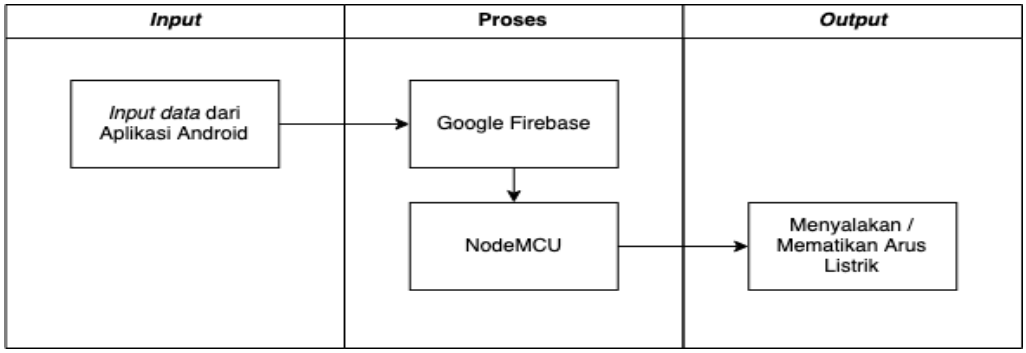

Figure 2 Schematic of How the System Works Part 2

System design

The following is a block diagram of the system used in this study.

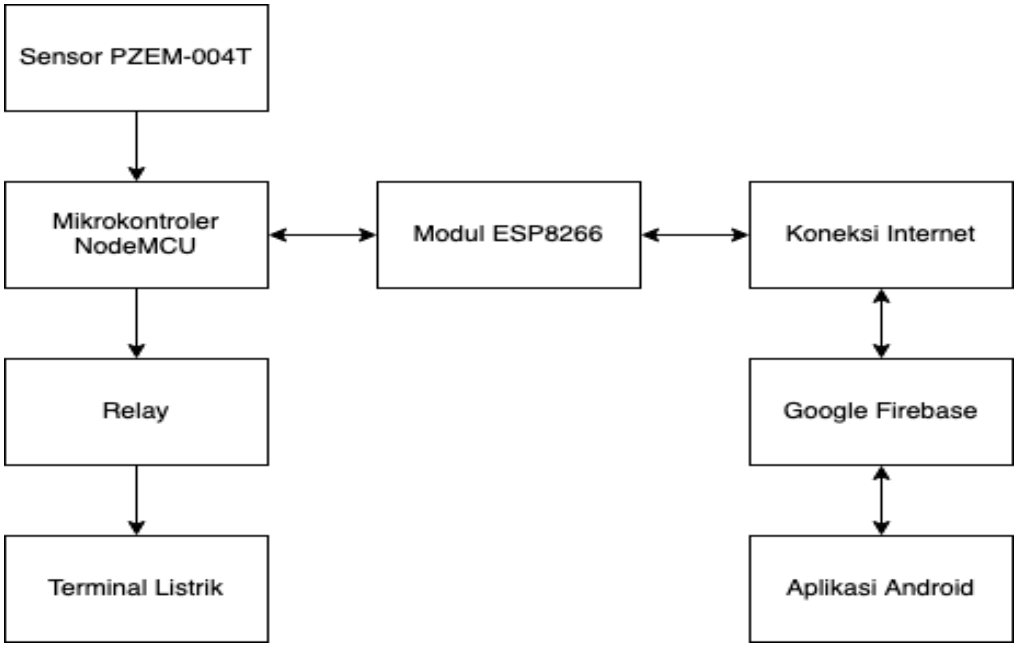

Figure 3 System Block Diagram

Based on Figure 3, in relation to the system block diagram above, it can be explained that the system input can come from the PZEM-004T sensor and also the Android application via Google Firebase using an internet connection as an intermediary; this input data will later be processed by the Node MCU microcontroller. On the microcontroller, data on electricity consumption from the sensor will be sent to the Firebase Real time Database so that the information can be displayed on the Android application. While the data

obtained from the application are of three types, namely relay status, reset status of electricity consumption data, and also limits on electricity usage used to display notifications.

IMPLEMENTATION AND TESTING

Implementation

This section describes the implementation of the system that has been designed. Figure 4 below is the result of the implementation of the whole circuit which illustrates the implementation of the transformer coil and also how the PZEM-004T sensor is connected directly to the electrical circuit used. To simplify the arrangement of the electrical circuit, in this study the PZEM-004T was directly connected using a plug so that there was no need to connect the power cable directly.

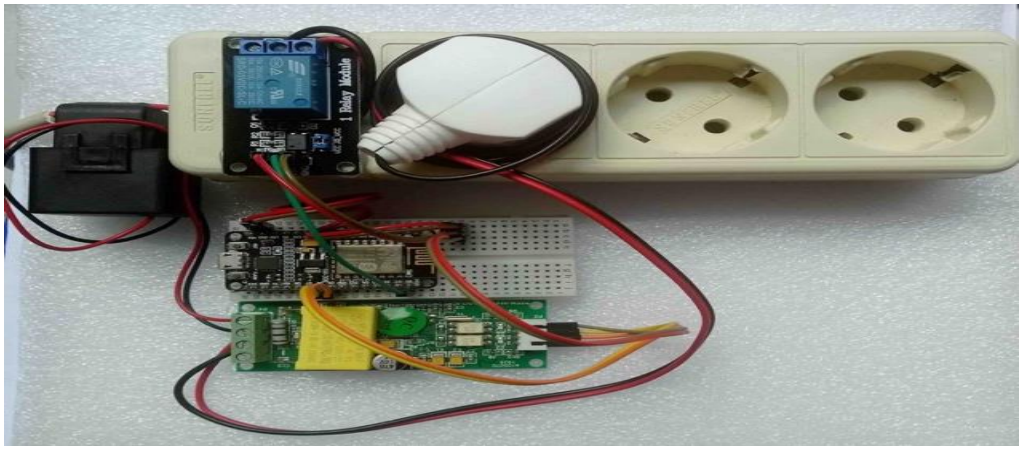

Figure 4 Implementation of the System Range

Meanwhile, Figure 5 is an implementation of the main Android application page. This page contains information on the total electricity consumption displayed in graphical form. In addition to containing information, this page also contains functions to control electrical energy connected to arranged electrical circuits such as turning on or turning off electrical devices and resetting electricity consumption. To be able to turn on or turn off an electrical device, a switch element is used which can be shifted to the right to connect electricity and to the left to cut off electricity. Meanwhile, resetting electricity consumption is displayed in the form of a dialog containing confirmation to reset electricity consumption.

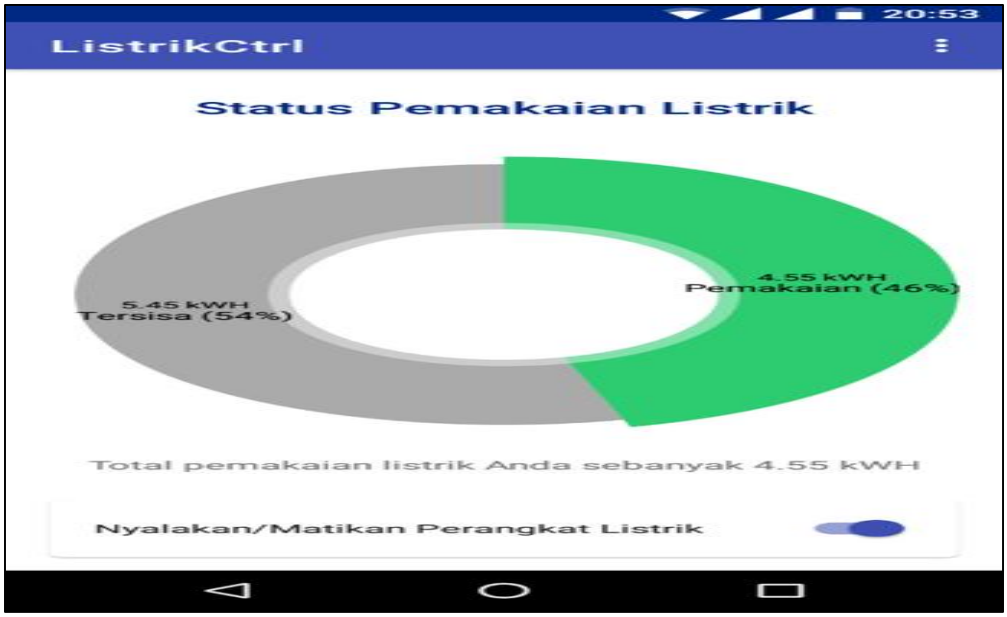

Figure 5 Android Application Implementation

Testing

This section will explain system testing carried out by the black box method or what is commonly called functional testing. This test is done by looking at the suitability of input and output on the system without paying attention to the logic structure of the software. This test will be carried out to find out whether Node MCU, PZEM-004T sensor, relay, Firebase, and also the Android application are working properly. Table 1 describes the plan for the tests carried out.

Table 1 Test Plan

Test Class	Test Items	Test Code
Carry out control of electrical devices	The Android application can control the electric current to be cut off	UJ-01
	The Android application can control the electric current to be connected	UJ-02
Displays electricity consumption information	The Android application can display information on the total electricity consumption in kWH	UJ-03
Displays a warning notification	The Android application can set limits on electricity usage.	UJ-04
	The Android application can display a warning notification when the total electricity consumption exceeds the set limit	UJ-05
	The Android application does not display a warning notification when the total electricity consumption has not exceeded the set limit	UJ-06
	The Android application can reset the total	UJ-07

	electricity usage	

CONCLUSION

The following are the conclusions obtained from this study.

1. Implementation of the system using a Node MCU microcontroller and the PZEM-004T sensor can detect electricity consumption in kWh units. Information on electricity consumption can also be displayed on the Android application using Firebase, whose data is sent by the ESP8266 module to Node MCU using an internet connection.

2. Electrical devices connected to the system can be controlled by using the Android application. This electric current is controlled by a Node MCU microcontroller using a relay connected to an electrical circuit.

3. A warning notification is displayed on the Android application when the electricity consumption has exceeded the set limit. This notification is sent by Firebase by comparing the total electricity consumption data obtained from the PZEM-004T sensor and also the limits that have been set through the application.

SUGGESTIONS

The following are suggestions obtained from this research.

1. The total electricity consumption data should be able to be reset automatically by the system based on a certain period so there is no need to reset it manually when the electricity consumption limit has been reached.

2. To be able to manage the Wi-Fi connection used on the system, Bluetooth connectivity should be added so that the system can connect to certain Wi-Fi networks as desired.

3. It is recommended to add electrical control settings to each electrical device connected by using a relay consisting of more than 1 channel.

REFERENCES

Shinde, A., Kanade, S., Jugale, N., Gurav, A., Vatti, R. A., & Patwardhan, M. M. (2017). Smart home automation system using IR, bluetooth, GSM and android. IEEE Fourth International Conference on Image Information Processing, pp. 1-6.

Lin, C. M., & Chen, M. T. (2017). Design and implementation of a smart home energy saving system with active loading feature identification and power management. IEEE 3rd International Future Energy Electronics Conference and ECCE Asia, pp. 739-742.

Clement, J. (2019). Google Play: number of available apps 2009-2019. https://www.statista.com/statistics/266210/number-of-available-applications-in-the-google-play-store.

Google. (2019). Firebase Cloud Messaging. https://firebase.google.com/docs/cloud-messaging.

Google. (2019). Android. Taken back from https://www.android.com/.

Google. (2019). Firebase Realtime Database. https://firebase.google.com/docs/database.

Google. (2020). Firebase Cloud Functions. https://firebase.google.com/docs/functions.

InnovatorsGuru. (2020). PZEM-004T. https://innovatorsguru.com/pzem-004t-v3/.

Kho, D. (2019). Relay. https://teknikelektronika.com/pengertian-relay-fungsi-relay/.

Chooruang, K., & Meekul, K. (2018). Design of an IoT energy monitoring system. IEEE 16th International Conference on ICT and Knowledge Engineering, pp. 1-4.

Madhu, M. G., & Vyjayanthi, C. (2018). Implementation of Cost Effective Smart Home Controller with Android Application using Node MCU and Internet of Things (IOT).

Kusriyanto, M., & Setiawan, B. (2015). Android smart home system based on ATmega16. IEEE 4th International Conference on Instrumentation, Communications, Information Technology, and Biomedical Engineering, pp. 304-307.

Wasoontarajaroen, S., Pawasan, K., & Chamnanphrai, V. (2017). Development of an IoT device for monitoring electrical energy consumption. IEEE 9th International Conference on Information Technology and Electrical Engineering, pp. 1-4.

Sarkar, S., Gayen, S., & Bilgaiyan, S. (2018). Android Based Home Security Systems Using Internet of Things (IoT) and Firebase. IEEE International Conference on Inventive Research in Computing Applications, pp. 102-105.

Technopedia. (2019). Internet of Things (IoT). https://www.techopedia.com/definition/28247/internet-of-things-iot.

Wawan, H. (2019). Pengendalian Faktor Daya di Jaringan Listrik Tegangan Rendah pada Posisi Daya Optimal dan Efisien yang Dikendalikan Mikrokontroler.

Zeroday. (2019). NodeMCU. https://github.com/nodemcu/nodemcu-firmware.