MONITORING SYSTEM OF PARALLEL LOADS ELECTRICITY CONSUMPTION BASED ON IOT

M. TEGUH ADKHAR, *HASTI AFIANTI

Electrical Engineering, Faculty of Engineering, Universitas Bhayangkara Surabaya

Jl. Ahmad Yani 114, Surabaya

e-mail: hasti_afianti@ubhara.ac.id

*Corresponding author

ABSTRACT

This paper discusses the design of a power consumption monitoring using telegrams and LCDs. Monitoring of electrical energy consumption is carried out for overconsumption does not occur as well as safeguarding the electronic devices used. The relay will automatically disconnect the power source in every room when the power is overloaded and this condition is reported via the internet network with the Telegram application. To monitor power usage, it is necessary to measure it. Measurement in this study used a digital multi-meter and the PZEM-004T sensor. Measurements were made on ten electrical loads including Lights, fans, laptop chargers, cell phone chargers, soldering iron, grinders, iron hand drills, drill bits, and circular grinding wheels. The test to compare PZEM-004T and multimeter has been done, resulting in voltage error values of 0.048-1.347% and current error values of 0-35.484%. From the error value obtained in this test, it can be concluded that the PZEM004T is suitable for measuring current and voltage. Automatic control in the relay works when rooms 1, 2, 3, or 4 experience power readings that exceed the desired capacity. It will automatically cut off the voltage from the source so that excess power does not occur, the goal is to protect an electric circuit.

Keywords: *Monitoring, Node-MCU, Telegram, PZEM-004T*

1. INTRODUCTION

Currently, the development of technology is very rapid. This technological advancement can be applied and used in everyday life. One of the technological advances that can be felt is in the field of control. With the internet today, the problem of distance and time barriers can be solved. An example is the use of computer systems applied in banking, trade and so on.

The Internet is a medium that is used to increase work efficiency. The Internet gets information and communication can be done quickly. The technology that can be utilized from this internet connection is the Internet of Things (IoT). This technology using microprocessor equipment namely Node-MCU ESP8266. Internet connectivity using working Wi-Fi connecting Android with data logger subsystem. Wi-Fi connection using the Node-MCU ESP8266 module. Order from Android applications will be received by the data logger subsystem via the Node-MCU ESP8266 module and the data logger subsystem will send the data requested by the Android application. Communication will occur if the data logging subsystem is connected to the Android application via the Node-MCU ESP8266 module. Process of sending data done in real time.

One of the uses of IoT as a monitor, for example, is to monitor the use of electric power in the household sector. Unmonitored electricity consumption will lead to wasteful consumption of electricity by PLN customers. To save electricity consumption, an electric power monitoring system is needed so that electricity consumption can be monitored and controlled by customers. Electrical energy measuring instruments can be converted and prices monitored in rupiah based on Arduino Uno-Lab View [1]. This tool is capable of measuring a maximum power of 491.9524 W with an average error of 0.33017% and an average electricity cost error of 0.011708%. The digital kWh meter prototype uses the Atmega8535 microcontroller for the scope of two different rooms [2]. The tool designed in the form of a digital Wattmeter is able to measure the power of incandescent lamps with precision in the power range of 100 W-500 W with an average error of 0.41% [2]. A digital KWH meter based on the AT89S51 microcontroller to monitor electricity consumption [3].

A number of load identification methods and management technologies, electricity consumption and carbon emissions in buildings to reduce electricity costs through good and efficient management of energy use [4]. Three-phase kWh meter technology with an Atmega 32 microcontroller to calculate energy and electricity usage costs is monitored by a laptop using Visual Basic programming [5].

Non-Intrusive Load Monitoring (NILM) method to collect specific energy consumption data while keeping costs and installation complexity low through measuring equipment and sensors[6]. A digital wattmeter based on the ATmega8 microcontroller to measure electric power. A number of measurements resulted in an average percentage error of 6.64% for resistive loads, 3.39% for capacitive loads, and 23.2% for inductive loads [7]. A digital power meter based on the AVR ATmega 8535 microcontroller to measure and display the electrical power of a household electronic equipment [8]. From the testing and calibration that has been carried out on this electric power measuring instrument, an average percentage of error is 4.3214% with a measurement accuracy rate of 95.67%. A personal computer-based kWh meter monitoring system is equipped with an electricity cost calculator program [9]. The proposed system is capable of measuring and monitoring voltage, current, frequency, and load power factor in per-second ranges. The monitoring tool for electricity consumption parameters uses a current sensor ACS712 and an ATmega 328 microcontroller with a 20x4 character LCD display [10].

This tool is designed to be able to measure electric current accurately enough on a purely resistive load with an error of less than 1% but not very accurate for measuring energy-saving lamps and LED lamps. A prepaid electricity monitoring system and real-time electricity consumption control using Arduino Uno [11]]. Arduino functions as a data collection control system, before the data is processed on the server. Current data is censored AC712-20A and the electric power is cut off by the relay when the pulse is insufficient. Remote household electric power calculators use internet-based data transmission and are monitored from web pages [12]. The design of the tool is capable of monitoring household electrical power through web pages compared to direct measurements with relatively good accuracy. Smart Meter with current sensor ACS712 to identify and monitor household electricity consumption using neural [13]. The proposed method is capable of providing significant results because it produces a load identification accuracy of up to 99%. One-phase digital kWh meter prototype to monitor current, power-factor voltage, and load energy using Arduino Mega 2560 [14]. In the measurement process, the tool is capable of producing an average error of 0% for current readings, 0.4 for voltage readings, 0.07 for load factor readings and 4.5% for kWh readings. Monitoring of electricity consumption using LabVIEW in real time via a computer [15].

The implementation of the tool is able to monitor the use of load energy within a relatively small average error limit. Implementation of a system for monitoring electricity consumption in real time using LabVIEW [16]. The monitoring results show that the performance of the device is very good in monitoring energy use using household loads. Digital KWh meter to calculate the cost of electricity consumption based on Arduino UNO R3 [17]. The digital kWh meter design is capable of producing a measurement accuracy of 95% with an average error rate of 5%. 6 and is able to absorb power of 2 watts. The power measurement and cost estimation system uses an ACS 712 current sensor, Arduino Uno, and is monitored by a 2 × 4 LCD [18]. Current measurement results obtained an average error of 3% and voltage measurement obtained an average error of 0.33%. Measurements of power, kWh, and cost estimates for a number of electrical equipment (fans, refrigerators, rice cookers and irons) for 5 minutes show that rice cookers and irons are the tools that consume the most electricity. Rice-cooker absorbs 278 W of power, 0.02323 kWh of energy, and an estimated cost of IDR 34.11. The iron absorbs 284 W of power, 0.02374 kWh of energy, and an estimated cost of IDR 34.85.

2. RESEARCH METHODS

In general, the configuration of the monitoring of electric power consumption on this prototype has two functions, the first is monitoring and the second is automatic off-control of electronic devices that consume high power. The prototype consists of hardware and software. On the hardware there is a PZEM-004T sensor which is useful for determine the power consumption, current and voltage that goes into electronic devices. The results of current, power, and voltage readings enter the monitoring sub-program which can be seen on the LCD screen, and with the NodeMCU and ESP 8266 based on microcontroller, the reading results can also be seen through the Telegram application. Figure 1 is a block diagram of the system used in this study, and Figure 2 is a flowchart how is the monitoring proses for monitoring electricity consumption.

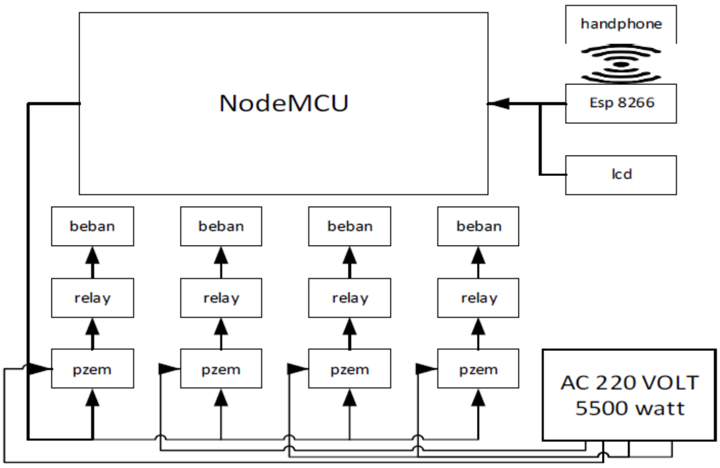


Figure 1. Block Diagram of The System

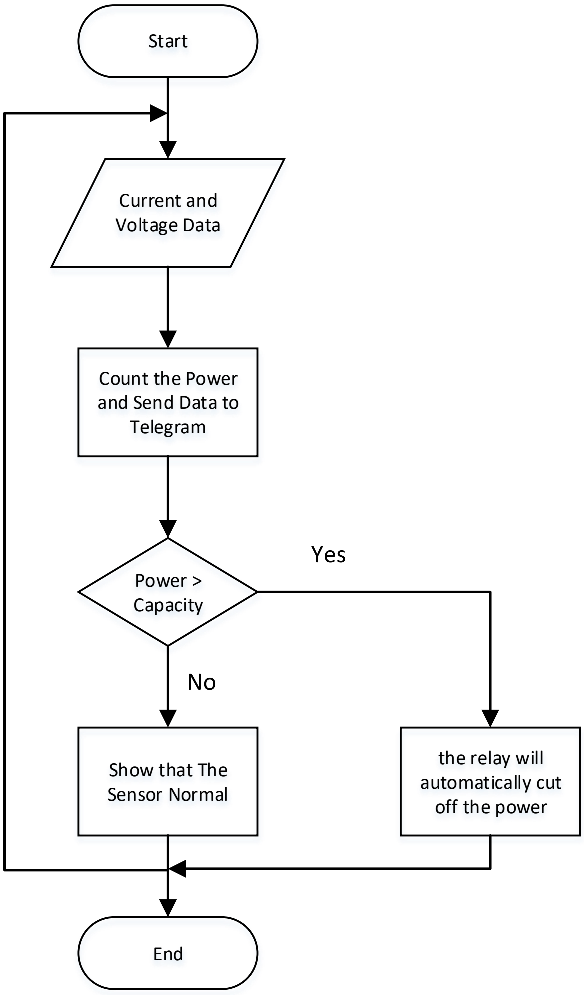


Figure 2. Flowchart of Monitoring Power System.

3. RESULTS AND DISCUSSION

Prior to the monitoring process, a test was carried out on the PZEM-004T sensor first. The purpose of this experiment is to find out the percentage error from the comparison between the Pzem sensor and the Volt Meter (Multimeter), so that later Pzem is ready to be used for measurement. If the sensor has a measurement comparison with a high difference in error, the PZEM-004T will be recalibrated. The results of these measurements are in Table 1, Figure 3 for voltage measurement, and Figure 4 for current measurement.

Table 1. Measurement Result between PZEM sensor and Multimeter

Tools	PZEM (V)	Multi Meter (V)	Error (%)	PZEM (A)	Tang Amper (A)	Error (%)
HP Charger	236,5	236,5	0	0,13	0,129	0,7751
Solder	236,8	237,5	0,294	0,136	0,135	0,7407
Laptop Charger	236,3	236,4	0,0423	0,09	0,058	1,7241
Fan (fast)	239,9	239,9	0	0,228	0,226	0,8849
Fan (middle)	239,8	239,9	0,0412	0,2	0,197	1,5228
Fan (low)	239,9	240	0,0412	0,185	0,182	1,6483
Lamp	237,5	237,2	0,1264	0,89	0,885	0,5649
Iron	236,3	236,6	0,0845	1,58	1,57	0,6369
Seated Drill	236,5	236,8	0,12667	1,161	1,171	0,8539
Grinding	235,9	235,9	0	1,53	1,51	1,3244
Hand Drill (fast)	239,6	239,2	0,1672	1,27	1,25	1,6
Hand Drill (middle)	240	240	0	0,76	0,76	0
Hand Drill (low)	240	240	0	0,65	0,65	0
Gerinda	234,5	234,6	0,0426	3,95	3,8	0,7537

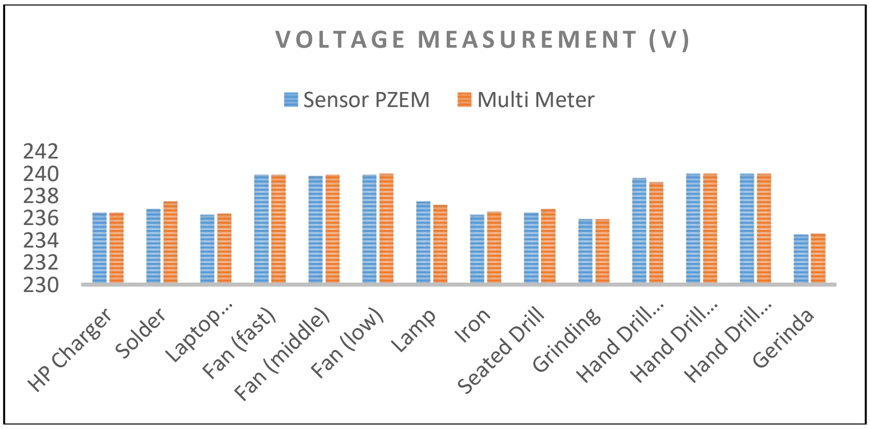


Figure 3. Voltage Measurement

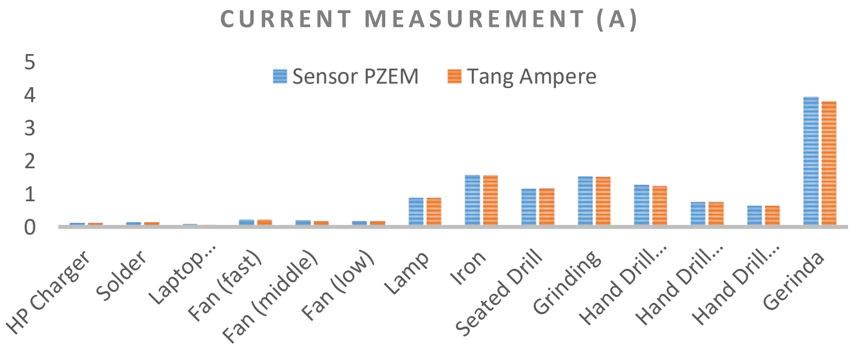


Figure 4. Current Measurement

P-ISSN: 2528-0260 E-ISSN: 2579-5392
p.63-70

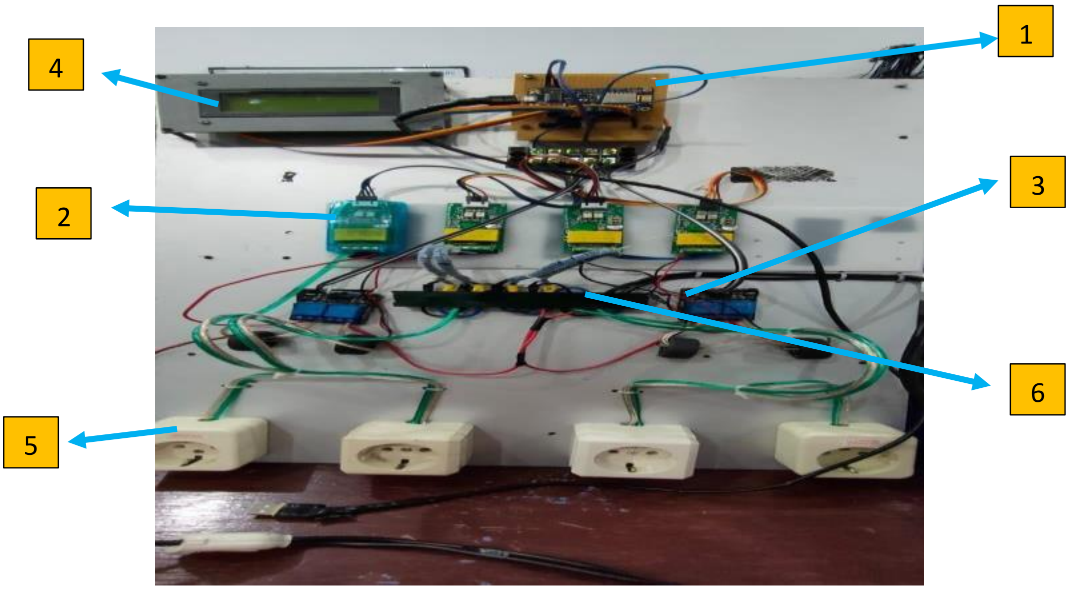
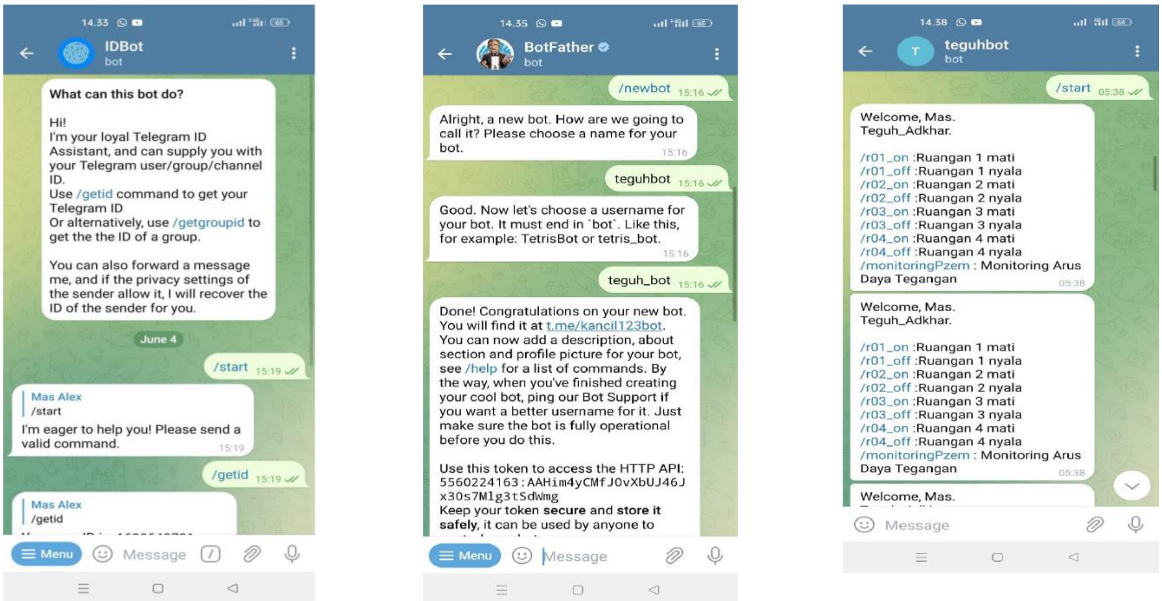


Figure 5. Hardware of Monitoring Electric Power Consumption

The hardware of this study is shown in Figure 5. The parts used in the hardware design of the monitoring and control system of electric power consumption are as follows:

1. ESP 8266 which functions as data control to LCD and TELEGRAM
2. PZEM-004T sensor which functions as a sender of current, power and voltage data to ESP 8266.
3. Relay to control, regulate and distribute electric power.
4. LCD 20X4 which functions to display data from the pzem sensor reading
5. A socket that serves to provide a connection to the electronic device or load being tested
6. Electrical terminals that function to connect ESP 8266 to sensors and relays



(a) (b) (c)

Figure 6. (a) IDBot Registration on Telegram (b) Account Creation on Telegram (c) Control Settings on Telegram

To connect the Telegram application to the microcontroller MCU node, starting with registration and creation of the Telegram bot, preparing the ON OFF relay category, and remote testing. As can be seen in Figure 6, there are 3 processes for creating Telegram bots.

1. The start menu is used to start running the Bot, newBot is used to start creating a new bot, then proceed with creating a Bot name or creating a bot name that will be used for monitoring, the next step is to update the bot name by adding "/_bot", the first stage is complete, then go to the next stage.
2. The second step is to find out the telegram address or user ID so that the program can connect between Telegram and Node MCU Esp8266, first enter the "/start" menu to start running the bot, then type "/getid" to get the Telegram user ID, namely 1358268199 , next is to enter the Telegram ID into the ESP 8266 Program.
3. The final step is testing the remote control using telegram, /start to start the bot, and it will be sent in text form to the remote control. Type the text sent to activate the relay on each socket.

4. CONCLUSION

In this paper, a system for monitoring power consumption has been designed using Telegram and a 20X4 LCD. Control of electrical energy consumption is carried out by providing limits on the power used by disconnecting the power source by the relay according to the permitted electric power limits. The study used two measurement methods, namely using a digital multi-meter and PZEM-004T sensor through IOT-based programming with the telegram application. Measurements were made on ten electrical loads including: Lights, fans, laptop chargers, cell phone chargers, soldering iron, grinders, iron hand drills, drill bits, circular grinding wheels. The test results at 10 loads between the sensor and a multi-meter to measure voltage and current, produce a voltage error value of 0,069 % and a current error value of 0,930 %, respectively. From the error values obtained in this test, it can be concluded that the PZEM-004T sensor is suitable for measuring voltage and electric current.

REFRENCES

[1] K. Wicaksono, (2021). EBT-41 implementasi sistem monitoring konsumsi energi dan penghematan harga listrik rumah tangga menggunakan ARDUINO-UNO dan LABVIEW. In Prosiding Seminar Nasional Teknologi Energi dan Mineral, Vol. 1, No. 2, pp. 828-840.
[2] A. Setiono, (2009). “Prototipe Aplikasi KWh Meter Digital Menggunakan Mikrokontroler ATMEGA8535 untuk Ruang Lingkup Kamar Tangerang”, Jurnal Ilmu Pengetahuan dan Teknologi TELAAH Volume 26, p. 32-39.
[3] N. Arif and A.D. Sutomo, (2010). “KWh Meter Digital Berbasis Mikrokontroller AT89S51”, Program Diploma III Ilmu Komputer. Fakultas Matematika dan Ilmu Pengetahuan Alam. Universitas Sebelas Maret Surakarta.
[4] Y. Du, L. Du, B. Lu, R. Harley, and T. Habetler, (2010). “A Review of Identification and Monitoring Methods for Electric Loads in Commercial and Residential Buildings”, IEEE, 2010.
[5] U.N. Sutedjo, M. Z. Efendi, (2011). “Sistem Monitoring kWh Meter 3 Phase dan Kalkulasi Biaya Pemakaian”, Jurusan Teknik Elektro Industri. PENS-ITS, Surabaya, 2011.
[6] Z. A. Gluhak, M.A Imram, and S. Rajasegarar, (2012).“Non-Intrusive Load Monitoring Approaches for Disaggregated Energy Sensing: A Survey”, Sensors, 2012, pp. 16838-16866.
[7] A. Pidaksa, (2011). “Wattmeter Digital AC Berbasis Mikrokontroller ATMEGA8”, Universitas Negeri Yogyakarta.
[8] H. H. Jufri, M.N. Nasruddin, P. Bisman, (2013) “Rancang Bangun Alat Ukur Daya Arus Bolak-Balk Berbasis Mikrokontroler Atmega8535”, Jurusan Fisika, Fakultas MIPA, Universitas Sumatera Utara Medan, 2013, Hal. 1-9.
[9] M.N. Arifin, R.H.R. For a, (2014). “Sistem Monitoring KWH Meter Berbasis PC Dilengkapi Dengan Program Penghitung Biaya Listrik”, Jurnal Teknik WAKTU Volume 12 Nomor 02, p. 39-42.
[10] N. Temy, S. R.U.A. Sompie, M. Rumbayan, (2015) “Sistem Monitoring Konsumsi Energi Listrik Secara Real Time Berbasis Mikrokontroler”, E-journal Teknik Elektro dan Komputer, Vol.4 No.5, p. 19-26.
[11] D. Risqiwati, A.G. Rizal, Z. Sari, (2016). “Rancang Bangun Sistem Monitoring Listrik Prabayar dengan Menggunakan Arduino Uno”, KINETIK, Vol.1, No.2, p. 47-54.
[12] S. Suryaningsih, (2016). "Rancang Bangun Alat Pemantau Penggunaan Energi Listrik Rumah Tangga Berbasis Internet”, Prosiding Seminar Nasional Fisika (E-Journal) Seminar Nasional Fisika, Prodi Pendikan Fisika dan Fisika, Fakultas MIPA, Universitas Negeri Jakarta, Volume V, p. 87-90.
[13] K. Hutoro, A. Soeprijanto, and O. Penangsang, (2015). "Desain Smart Meter Untuk Memantau Dan Identifikasi Pemakaian Energi Listrik Pada Sektor Rumah Tangga Menggunakan Backpropagation Neural Network," Jurusan Teknik Elektro, Fakultas Teknologi Industri, Institut Teknologi Sepuluh Nopember (ITS), p. 1-6.
[14] M.G. Afria B and H. Winarno, (2017). “Pembuatan kWh Meter Digital 1 Fasa Berbasis Arduino Mega 2560”, Gema Teknologi Vol. 19 No. 3, p. 25-31.

[15] M. Y. Yunus, M. Marhatang, (2017). “Rancang Bangun Pemantaun Pemakaian Energi Listrik Menggunakan LabVIEW”, Prosiding Seminar Hasil Penelitian (SNP2M), Politeknik Negeri Ujung Pandang, p. 197-202.

[16] M.Y. Yunus, M. Marhatang, (2018). “Implementasi Labview Untuk Pemantauan Pemakaian Energi Listrik”, Jurnal of Electrical and Electronic Engineering-Universitas Muhammadiyah Sidoarjo (JEEE-U), Vol. 2 No. 1, Hal. 21-30.

[17] M.I.L. Wahyu, A. Syaifurrahman, and M. Saleh, (2018) “Rancang Bangun kWh Meter Digital Sebagai Penghitung Biaya Pemakaian Energi Listrik Berbasis Arduino UNO R3”, Journal Of Electrical Engineering, Energy, And Information Technology, Vol. 1, No. 1.

[18] R. Akbar, H. Mubarok, (2018). “Rancang Bangun Alat Monotoring Tegangan, Arus, Daya, kWh, serta Estimasi Biaya Pemakaian Peralatan Listrik pada Rumah Tangga”, Jurusan Teknik Elektro, Fakultas Teknologi Industri, Universitas Islam Indonesia, Yogyakarta.