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IoT based Early Warning System for 10 KVA UPS

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Abstract: Uninterruptible Power Supply (UPS) has an important role for a system that requires a backup voltage source to keep the system running even if the main voltage source is interrupted. When the main voltage source of a system is disturbed, the UPS will switch from the main voltage source to the battery owned by the UPS without disconnecting the source to the system so that the system continues to operate as if it were getting a main voltage source. When the main power source is off, the UPS cannot be a source of power for the system forever because the UPS has certain limitations such as battery capacity. In this case, it happened at the Balikpapan State Polytechnic data center, the server died because the battery was not charged by the generator when the power source from the State Electricity Company (PLN) went out. To anticipate UPS outages in the Balikpapan State Polytechnic data center, this monitoring tool needs to be built so that it can monitor the capacity level of battery usage, by designing early warnings in the form of several indicators such as pilot lights, alarm bells and mini sirens. For a system that has a large infrastructure, the death of one of the large infrastructure will cause disturbances and can even completely shut down the system. Therefore, UPS can only back up the system for a certain time or condition. In fact, it is very difficult to monitor the UPS manually. The experimental results obtained data that the values on the UPS can be viewed and monitored online and it was found that the value of the voltage sourced from PLN was 230 VAC while the value of the voltage sourced from the battery was 12 VDC.

Keywords: Uninterruptible Power Supply (UPS), Arduino Uno, PZEM-004T, Relay Module, pilot lamp alarm Buzzer, miniature sirine

1. INTRODUCTION

In today's modern world, plenty equipment relied heavily on electrical energy. To secure these critical devices from potential drop off of the power supply which typically cause unpleasant effect on responsible users, an UPS system is installed. At large scale infrastructure, the UPS system has been running as a means for power-back up, ensuring all critical apparatus remain operational during power disruption [1]). UPS application has also been useful in supporting data centre by minimizing the risk of significant data loss when power source is interrupted [2]. Nevertheless, the UPS system contains shortcomings in terms of its fixed amount of power generated and its limited battery capacity [3]. In other words, the UPS can only function over a certain amount of time and condition. Therefore, to prevent complete failure of the system, the UPS should be properly monitored.

Full control of the UPS system on-site manually seemed inconvenient and costly. To resolve this, internet technology might be integrated, allowing timely monitoring and predicting. Parameters output of the UPS could be viewed at real time, such that in light of a sudden decline of voltage or current from an ideal condition, early warning notification would be informed to in-charged person via mobile network.

Internet of Things (IoT) concept for surveillance and forecasting has been widespread. Supplemented by sensors and actuators, technology become more instance in various areas including smart home [4], agriculture [5], intelligent transportation and smart cities [6,7,8]. Previous studies on UPS monitoring built-on IoT concept had reported the utilization of MQTT protocols [9], GSM900 module [2], and wimos component, thingspeak, and virtuino application [10]. Their overall results had been compelling.

Therefore, motivation of this study is to develop a 10kVA UPS surveillance and early warning system based on IoT technology. This prototype design has been implemented on Campus infrastructure of Balikpapan State Polytechnic. In this prototype, The UPS related outputs/parameters encompassing: voltage, current, the battery capacity, discharge rate/ the remaining power/ the magnitude of utilised power had be monitored at real time using PZEM-004T as sensor node (digital meter), connected to Arduino uno microcontroller, and Blynk application at user side. Results of this project would add to the body of knowledge towards IoT field by providing improved energy management within infrastructure telecommunication in Indonesia

2. RESEARCH METHODS

2.1. System design

a. Node MCU-ESP32

Node MCU is a compact development board, designed for IoT project. It contains a built-in USB port, hardware reset button, wi-fi antenna, and standard sized GPIO pin. ESP-32 is a latter derivative of ESP8266, manufactured by Esspresif, having superior qualities as compared to other microcontroller, including: more pins, higher RAM, larger memory, and augmented by low energy 4.0 bluetooth.

b. Arduino IDE

Arduino IDE is a software to develop a coding program which would be uploaded to Arduino board. Its main features are: Code Editor (that help developer to write and edit the sketch programs), Library dan Board Manager, Serial Monitor (that allow developer to receive or send data for debugging/ monitoring), Compilation and Upload.

c. Sensor PZEM-004T

PZEM-004T is used in this project in conjunction with microcontroller ESP32 and Arduino, permitting developers to build smart power monitoring system. PZEM-004T as sensor node (digital meter) provides electrical parameters such as voltage and current measurements, frequency, active power, energy consumption, and power factor. (Some versions can

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also detect Voltage Sag &Surge). A serial communication must be established to connect PZEM-004T to Arduino. Hardware connection of PZEM-004T to Arduino is shown in Table 1.

Table 1. Connection PZEM-004t to Arduino

PZEM-004T V3.0	Arduino UNO / Mega2560
VCC	+5V
GND	GND
TX	RX (Software Serial / Harware Serial)
RX	TX (Software Serial / Harware Serial)

d. Blynk

Blynk is a platform for IOS and Android used to control Arduino module via the internet. Blynk has three main components: app, server, and libraries, such that it handles communication between smartphone and hardware, and also function as data storage-visualization.

2.2. System workflow

Step 1. Designing Hardware lay-out: setting up the lay out for all modules and electric components. Arduino Mega as the centre for data monitoring process.

Step 2. Developing software programming: utilizing Ardunio. This is executed after simulation on visual studio case.

Step 3. Software-hardware integration: data protocol creation on Arduino, followed by interfacing it into the module RS 485. Reading information on the hardware model, as indicated by a series of alarm detectors notification. (Interfacing software data into hardware apparatus)

Step 4. Producing Prototype output: a complete try out of the system which include sensors detection by Arduino, real time monitoring of power supply condition, detection of power supply problem triggering early warning system, transmitting information to mobile phone via Internet. (analysing & monitoring system try-out)

Figure 1. Flow chart of the prototype early warning system

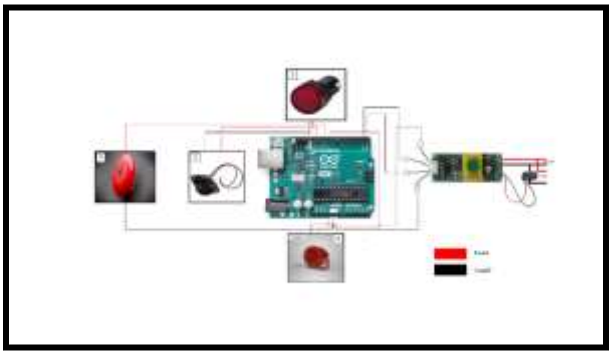

Figure 2. System Block Diagram

Figure 2. Showed the design of Arduino connection to pzem 004-t, and detectors viz: Pilot Lamp (1), Buzzer Alarm (2), Fire detector (3), and 12 volt mini Serien (4). A series of notification would be applied. First, interuption/disconnetion of power supply (either from PLN or getset) for 5 second would switch the Pilot Lamp ON. Then, when problem/disconnection continue for another 10 second triggered buzzer alarm ON. Disconnetion for another 15 second turned the fire detector ON. Lastly, when power interuption continued up to 20 second, mini sirine X dB would be ON.

3. RESULTS AND DISCUSSION

In this implementation, the entire component has been installed so that it becomes a monitoring tool. The implementation results show that the tool functions well and normally with the pzem-004t sensor indicator able to read the interrupted voltage. Furthermore, the Arduino Uno can receive output from the pzem-004t sensor and the relay module works well by receiving the program from the Arduino and turning on several indicators such as the pilot light, alarm bell and mini siren. In this implementation, Arduino is a microcontroller system designed to monitor, detect and provide early warning information when the Uninterruptible Power Supply (UPS) is about to go out. The pzem-004t sensor is a tool that aims to answer existing data needs in the form of information that can be read when PLN and the generator are not connected to the Uninterruptible Power Supply (UPS). The notification process when the power goes out and the UPS is working will be carried out in stages. If the power goes out and the Uninterruptible Power Supply (UPS) does not receive power from the generator for 5 seconds, the pilot light indicator will come on. Furthermore, if the PLN electricity still goes out and the Uninterruptible Power Supply (UPS) does not receive power from the generator for 10 seconds then the second notification will work in the form of a red pilot light. If the second notification is received, the PLN and generator are still not connected for approximately 15 seconds. then the third notification will appear with a sound indicator using a fire detector. If several attempts have been made to inform that the generator and PLN are not connected to the UPS within 20 seconds, then the 4 indicators will light up, informing you that the situation is very emergency and a technician is needed to go to the location of the equipment.

The following is a table of system testing results with 4 early warning indicators:

Figure 3. Working indicator results

To increase the effectiveness of the early warning process, a notification system with blynk can be installed so that cellphone messages can be given that the UPS is not getting electricity supply from PLN and generators. The notification process is adjusted to the time of the early warning monitor indicator, namely 5 seconds, 10 seconds, 15 seconds and 20 seconds. The following displays the notification results on the Blynk display.

Figure 4. Notification When UPS Is Using Battery

4. CONCLUSION

From the test results of the unloaded PZEM-004T sensor, the voltage accuracy was 231 volts. Meanwhile, if the load is given to a server with 7000 watts of power, the PZEM-004T sensor remains with a voltage of 231 volts and a current of up to 31.8 A.

From the test results of the PZEM-004T sensor, accuracy was obtained with an error percentage below 1%. With the resulting data it can be concluded that the sensor used is quite accurate and precise

5. REFERENCES

[1] P. G. Krishna, “UPS Parameter Monitoring and Controlling Using IOT and GSM,” Int. J. Pure Appl. Math., vol. 116, no. 6, pp. 133–139, 2017.

[2] Manasa KV, Prabu AV, Prathyusha MS, Varakumari S. (2018) Performance monitoring of UPS battery using IoT. International Journal of Engineering & Technology. 7 (2.7) (2018) 352-355.

[3] L. Fu and B. Zhang, “The Design and implementation of a UPS Monitor and Control System.,” Int. Conf. Comput. Sci. Netw. Technol., vol. 2, pp. 1322–1325, 2011.

[4] T. S. Gunawan, I. Rahmithul, H. Yaldi, M. Kartiwi, and N. Ismail, “Prototype Design of Smart Home System using Internet of Things,” Indones. J. Electr. Eng. Comput. Sci., vol. 7, no. 1, pp. 107–115, 2017.

[5] Mohanty, A., Roy, S. (2021). Smart Plant Monitoring System Using BLYNK Application. In: Banerjee, S., Mandal, J.K. (eds) Advances in Smart Communication Technology and Information Processing. Lecture Notes in Networks and Systems, vol 165. Springer, Singapore. https://doi.org/10.1007/978-981-15-9433-5_19

[6] S. Chen, H. Xu, D. Liu, B. Hu, and H. Wang, “A vision of IoT: Applications, challenges, and opportunities with China Perspective,” IEEE Internet Things J., vol. 1, no. 4, pp. 349–359, 2014.

[7] N. A. Hidayatullah and D. E. J. Sudirman, “Desain dan aplikasi internet of thing (iot) untuk smart grid power system,” 2017.

[8] N. Fajrin, I. Taufik, N. Ismail, L. Kamelia, and M. A. Ramdhani, “On the Design of Watering and Lighting Control Systems for Chrysanthemum Cultivation in Greenhouse Based on Internet of Things,” IOP Conf. Ser. Mater. Sci. Eng., vol. 288, no. 1, 2018.

[9] Alqinsi P, Matheus Edward IJ, Ismail N, and Dharmalaksana W. “IoT-Based UPS Monitoring System Using MQTT Protocol”. *2018 4th International Conference on Wireless and Telematics (ICWT),* Nusa Dua, Bali, Indonesia, 2018. Pp. 1-5, doi: 10.1109/ICWT.2018.8527815.

[10] Rigoursyah et al, 2020 : Muhammad Agung Foury Rigours dan Ekki Kurniawan, S, “Perancangan Ups Berbasis Sumber Energi Listrik Terbarukan Dan PLN Termonitor Perangkat Iot,” *eProceedings of Engineering,* vol. 3, p. 1, 2020.