Simulation Effectiveness on Electric Power Reliability Analysis Based on the Internet of Think (IoT)

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ABSTRACT
Along with the rapid development of technology in the current era of globalization. It is the main instrument in the progress of various social and life aspects. In this study, technology is used to help solve several problems in life. Network smart electricity or better known as Smart Grid is one form of transformation and technological reform in the electricity industry. Smart Grid is a modern electrical energy network that can intelligently integrate the electricity network with communication devices that support power plants and electricity distribution transmission networks to be more attractive, communicative and quality. Smart Grid is also able to prevent and isolate disturbances quickly and present electricity data information in real time. While the Internet of Thing (IoT) is a method that aims to maximize the benefits of internet connectivity to transfer and process data or information through an internet network wirelessly, virtually and autonomously. Almost every activity carried out by humans always uses technology. The use of automatic security instruments has become the choice today. In modern times like now there are many kinds of technology, and therefore I will develop technology with better security instruments.

Keywords: Technological developments, IoT applications, and electricity

Introduction

In the digital era, the demand for reliable and uninterrupted electric power has become increasingly critical due to the growing dependence on technology and automation in both industrial and residential sectors. One of the major challenges in power system management is maintaining the reliability of electric power distribution**,** especially in areas prone to faults, overloads, or operational inefficiencies.

The Internet of Things (IoT) has emerged as a transformative solution in the field of electric power systems, enabling real-time monitoring, data acquisition, and remote control of electrical infrastructure. By embedding sensors and smart devices throughout the grid, IoT provides continuous visibility into system performance, allowing for predictive maintenance, early fault detection, and faster decision-making processes.

Simulation plays a vital role in evaluating the effectiveness of IoT-based solutions before they are applied to real-world power systems. Through simulation tools, researchers and engineers can model various electrical scenarios—such as fault events, load fluctuations, and system failures—and observe how IoT technologies respond to these conditions. This approach enables the development of more resilient and adaptive power systems by identifying weaknesses and optimizing system parameters in a risk-free virtual environment.

This study aims to analyze the effectiveness of simulation methods in evaluating and improving the reliability of electric power systems through IoT integration. The research focuses on measuring how well IoT-enhanced systems detect, report, and react to power disturbances under different simulated scenarios. It also explores the potential of simulation as a tool for optimizing the design and deployment of IoT technologies in electric power networks. By combining IoT and simulation technologies, this study seeks to contribute to the development of intelligent and reliable power distribution systems that can meet the demands of modern society.

Several countries in America and Europe have been intensively working to realize this technology. In the United States, the implementation of the smart grid is coordinated by the Department of Energy (DOE) in collaboration with the Electric Power Research Institute (EPRI) through a project called "Intelligent Optimization."

The focus of this research is to develop **a** new design for energy control systems using IoT-based technology, supported by simulation tools and analysis, smart technologies, testing infrastructure and demo plants, as well as appropriate regulatory frameworks and market mechanisms.

According to NIST (National Institute of Standards and Technology), a smart grid is defined as a power system network that utilizes two-way information technology, secure cyber communication technologies, and integrated computing intelligence across the entire electric power system spectrum—from generation to end-users. Meanwhile, the Department of Energy (DOE) defines a smart grid as a power system based on sensing technology, digital communication, control systems, information technology, and other field devices that are used to coordinate processes within the electrical grid in a more dynamic, efficient, and responsive manner.

The feasibility and reliability of electricity supply is one of the most critical parameters in energy distribution, especially for cross-application use and grid operators. Currently, the information available at power generation, transmission, and distribution points is often limited to local networks only, and the data systems are not yet based on real-time information. This presents a major challenge in moving toward a more intelligent and high-quality power grid one that provides greater reliability, real-time monitoring, and resilience against disturbances.

METHOD

The method used in this research is Research and Development (R&D). The primary objective of this method is to produce a specific product and evaluate its level of effectiveness (Sugiyono, 2011). In the design of this solar power generation system, the main components include solar panels, a **s**olar charge controller, a battery, and a load. The integration of supercapacitors in this design is carried out with five variations, using one to four supercapacitors with a capacity of 150,000 μF each. The purpose of this approach is to examinethe comparative performance and impact of each variation tested. It is known that the energy density of supercapacitors is 10 to 100 times higher than that of conventional capacitors, and they offer high efficiency levels, reaching up to 95%. In addition, supercapacitors possess a power density up to 50 times greater than that of traditional batteries. Therefore, the decision to incorporate supercapacitors in this system design is based on these advantageous characteristics.

Figure 1. Research Scheme for Battery-Supercapacitor Control Design

This research scheme is developed as an implementation model for a hybrid electrical energy source**.** Each component—including the battery**,** supercapacitor**,** DC-DC converter, and the Fuzzy Logic Controller (FLC) for the battery-supercapacitor system—is modeled in detail. The block diagram of the system design is shown in Figure 2**.**

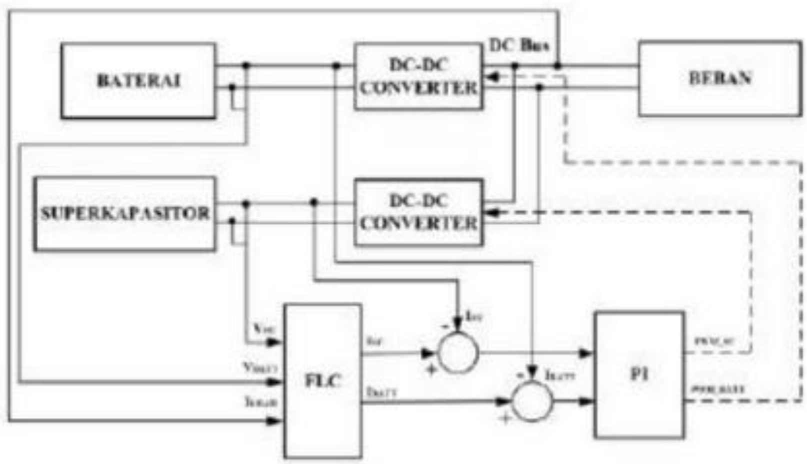

Figure 2. System Block Diagram

After the manufacturing and assembly process is complete, the next step is to test the tool and collect data to evaluate the impact of using Supercapacitors on Solar Power Plants. This study uses a research methodology that starts from a literature study with existing references and the components needed to create an IoT-based electrical power monitoring system. The microcontroller used is Arduino IDE with software for programming and Wemos D1 mini as a module that connects to the internet. The sensors used in the design of this system use current and voltage sensors as sensors to determine the current, voltage and power values from a 220 Volt AC source and the use of a 5v relay module as a sensor to control current and voltage which are quite high. To secure the circuit if there is a higher load in the design stage of the tool by programming using Arduino IDE software. The last stage is testing. Testing is carried out on each subsystem and analyzing the entire system. And can monitor and control so that the electrical power used is more efficient and optimal.

Hardware design is divided into several design stages. The following is a description of each stage of circuit design and components of the design, as shown in Figure 3 and Figure 4.

Figure 3. Kelambir Lima Office

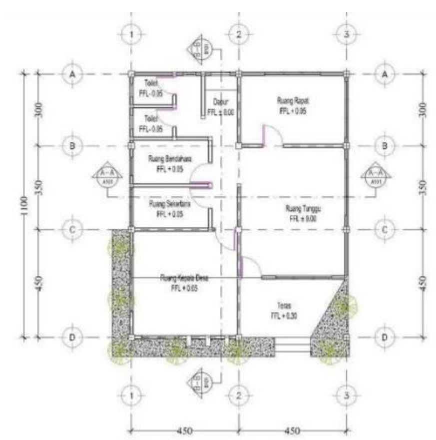

Figure 4. Village Office installation wiring. Design of control and monitoring tools.

This is the process of explaining the internet-based electrical power monitoring system using two microcontrollers as components for processing data. The sensors used will produce data that will later be used to read data that has been processed by the voltage sensor and current sensor. This data will be processed by the Arduino UNO R3 to display data that has been obtained from electrical equipment that is read by the voltage sensor and current sensor. So that it can find out the power that has been used. The Arduino UNO R3 also uses a 5V relay module. The relay functions as an electronic switch that is needed to control high current and voltage.

The 5V relay module can also connect and disconnect the electric current indirectly connecting and disconnecting the electric current simultaneously to secure the circuit if there is an overload from the electrical equipment used. Data is received by the Arduino UNO R3 which is obtained from the voltage sensor and current sensor. The value will be displayed via the 16X2 LCD where the data has previously been processed by the Arduino UNO R3.

After getting the value from the ACS712 voltage sensor and current sensor. data from this sensor will then be sent by the Arduino UNO R3 to the Wemos D1 mini via serial communication. The Z voltage sensor data and the current sensor will be used as input which will later be processed by the Wemos D1 mini.

The processed data is in the form of current, voltage, and power values which will later be used by the electrical power monitoring system and read by the Arduino and sent via serial communication to the Wemos D1 mini. In conducting this research, the type of research used is a qualitative method by collecting data

The location of this research was conducted in Kelambir Lima Village, Deli Serdang Regency with the instrument of the situation and its running mechanism. For the reliability of a tool, testing and discussion of the tool itself is needed. So that in the use of this tool, it can produce a circuit that can work well and can be operated well too. In this test, measurements were made of the parameters of the components contained in the system that has been designed.

RESULT

So that it produces a test that is in accordance with the design and can perform measurements on this tool. Testing on this tool includes several parts including:

3.1. Voltage Sensor Testing

Voltage sensor testing is done by measuring the changing voltage. This voltage sensor is a voltage sensor that uses a step down transformer as a medium to convert the actual voltage parameters to the voltage parameters that will be read by the Arduino which will then be processed further. Until getting a comparison of the right value to the measuring instrument that is more precise. The sensor used in this test is a sensor from the results of a multimeter.

In this test, several experiments were carried out which aimed to collect data that was directly connected to the PLN 220V AC voltage. Where the sensor used uses only 1 voltage sensor. After testing the voltage sensor, the test results data were obtained which are displayed in Table 1.

Table 1. Voltage measurement results Measurement Results (Volts)

No	Sensor iot	Multimeter manual	Value Error (%)
1	232	230	0.02
2	233	230	0.02
3	230	229	0.02
4	232	229	0.02
5	230	229	0.03

So the measurement results from the voltage sensor test with the calculation then obtained the average error value of 0.02%.

3.2. Current Sensor Testing.

This time the current sensor will be tested, but the voltage sensor is also used so that the power value can be calculated through the program created. Furthermore, the calculated values will be compared with the results of the current sensor reading. A program for reading current, voltage and power values will be uploaded to the wemos D1 mini to read the values generated by the current sensor.

Table 2. Current measurement results

No	Load	Sensor	Multimeter	Error (%)
1	Lamp LED 3W	0.01	0.01	0,47%
2	Solder 35 W	0.10	0.92	0,08 %
3	Lamp 80 W	0,38	0,367	0,03 %
4	iron 240W	1,55	1,308	0,42 %

Based on the measurement data above, calculations are carried out to determine the average error value on the current sensor. Using the equation formula 5, the average error value is obtained at 0.19%. The results of the calculation will be sent by Wemos D1 Mini to thingspeak.com as data to be displayed on the internet page. The data is displayed in the form of a graph of the values that have been processed and sent. After that, the data is received by thingspeak.com, so that power monitoring in the boarding room can be accessed via the internet. The graph displayed can be seen in the image below. From the data obtained from the tests carried out, the voltage, current, and power values produced have almost the same values. But the accuracy of the sensor used is that the old sensor is still less accurate. However, from the calculations produced, the values obtained are not too far from direct measurements with a multimeter, so the test carried out can be said to be good.

CONCLUSION.

In this study, there are two sensors used, namely the ACS712 current sensor and the ZMPT101b voltage sensor. These sensors function as current and voltage detectors, then the read data will be sent to Wemos via serial communication. Furthermore, the data will be sent to the thingspeak.com server via the Wi-Fi network available on the Wemos D1 Mini, allowing online monitoring. The test results show that this tool has an average error value in the voltage sensor test of 0.02%, the results can be seen in Table 1. While the current sensor has an error value of 0.01%, the results can be seen in Table 2. In addition, the error value on power is 0.22%, the results can be seen in Table 3. Although there are small differences and errors

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