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A Web-based Automatic Meter Reading for Electric Power Monitoring

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Abstract. Power monitoring of electrical appliances can be an effort for energy efficiency. Automatic Meter Reading (AMR) is a technology that commonly used to automatically read the electrical parameters (current, voltage, phase, etc.), diagnostic and status from the power metering. The on-site monitoring process needs the user to visit the place where the power meter is installed thus making the process less efficient. A web-based monitoring system is proposed in this paper. By TCP/IP communication protocol, the power meter can transmit the data through internet connection making the monitoring and control process is remotely possible. To support wide range of web-enabled devices, a responsive web interface design is implemented.

1. Introduction

Power monitoring of electrical appliances can be an effort for energy efficiency. An effective and efficient measurement system is strictly needed [1]. Automatic Meter Reading (AMR) is a technology that commonly used to automatically read the electrical parameters, diagnostic and status from the power metering. AMR is a key point in smart grid systems including electricity [2]. In smart grid architecture, accurate measurement of electrical parameter (voltage, current, frequency, power factor, etc.) is a basic requirement to be fulfilled [3][4]. The use of AMR can reduce the expanses due to monitoring process, extend the device life-time, avoid the excessive components by integrated device, and improve the measurement reliability [5]. AMR can be also saves a lot of labor cost [6]

For power and energy monitoring, the use of AMR will be significantly required. However, the common AMRs show the parameters being measured through a dedicated built-in display (in-situ monitoring) [3]. This condition becomes more challenging especially for remote measurement. The users should actively visit the place where the power monitors are installed. Alternatively, the drawback of in-situ monitoring can be solved by remote monitoring [7]. To achieve this goal, the communication method for remote monitoring system is mandatory required.

The Ethernet protocol is commonly used for remote monitoring systems. Beside this, the RS-485 communication protocol is more commonly used than Ethernet protocol. However, the Ethernet protocol offers more flexibility. However, the power meters with Ethernet protocol are much more costly than common power meters. Some of them are provided by a built-in web server for web interface purpose. With internet application, many monitoring devices can be developed [8-13].

A web-based monitoring system is proposed in this paper. By TCP/IP communication protocol, the power meter can transmit the data through internet connection making the monitoring and control process is remotely possible. To support wide range of web-enabled devices, a responsive web interface design is implemented.

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2. Methodology

The research schematic is shown on Figure 1. The schematic is based on monitoring and controlling systems installed at the Electrical Power Laboratory, Dept. of Electrical Engineering, Politeknik Negeri Bali (Bali State Polytechnic).

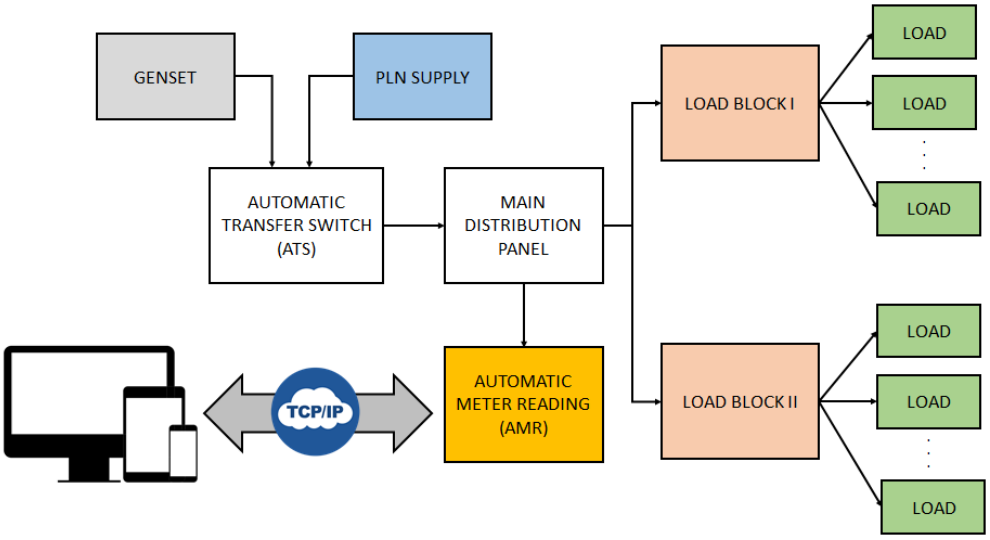

Figure 1. Research schematic.

The main supply is provided by two sources, that is an installed diesel generator (genset) or state electricity company (PLN). The PLN supply is the main source whereas the genset is used as a back-up. An Automatic Transfer Switch (ATS) will turn the loads to the genset when the PLN is switched-off. In this case, the genset will be automatically switched-on. For maintenance reason, the genset sometimes replace the PLN sources intentionally. But for daily purposes, the PLN supply is always prioritized as the main source.

Through the Main Distribution Panel (MDP), the loads are divided by two main groups, called Load Block I (LB I) and Load Block II (LB II). The LB I consists of miscellaneous devices for student's experimental purposes like grinding tools, drilling tools, CNC machines, etc. whereas the LB II is dedicated for lab's daily operational loads (like computers, ACs, TVs, etc.).

The AMR is installed on MDP's box. Therefore, both genset and PLN supply are continuously monitored. The AMR will measure many parameters such as current, voltage, power, energy, etc. These parameters are our objects to be transferred. The main purpose of this research is how to deliver these parameters through the communication lines. By doing this, the operators of the Electrical Power Laboratory can regularly monitor the use of the electricity.

Based on many considerations, the use of TCP/IP protocol offers some advantages. By unshielded twisted-pair (UTP) cables, the communications between AMR and computer (or gateway) can be built. The data can be transferred either by Local Area Network (LAN) plan or internet plan. With no internet connections provided, the LAN plan can be applied only for internal purposes. It means that the data to be transferred from AMR to the computers and then to be shown on the monitor is accessed only for authorized lab operators. If an internet connection is available, the data can be accessed anytime and anywhere. The operators or other authorized persons can monitor the electric power data by their own devices (desktops, laptops, mobile phones, etc.). By this monitoring schema, the remote monitoring advantages can be achieved.

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3. Results and Discussions

3.1. Selecting the AMR

There are many types of AMR devices in the market. All of them are classified by their specifications, starting from the simple equipped features to the complex one. Selecting the appropriate AMR is the key to achieve the research purpose. Since our main purpose is transferring the data through the TCP/IP communication protocols, the AMR that support this kind of protocol is needed. Based on the financial support and market availability, the Schneider PowerLogic PM5560 is chosen. This AMR device is featured by Ethernet protocol with RJ-45 port.

3.2. Installed System

The AMR device is installed on Main Distribution Panel (MDP) which is located just after the Automatic Transfer Switch (ATS) panel. The installation consider the user convenience of the users.

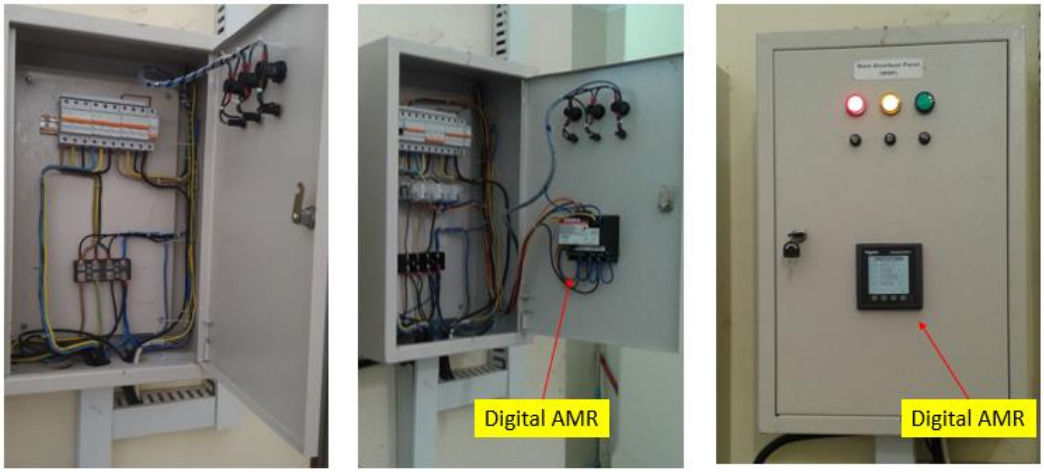

Figure 3. AMR is installed on the MDP Panel. Without AMR installation, the original MDP appearance is shown on the leftmost figure. The inside and outside parts of the MDP after AMR installation are shown in middle and right figure respectively.

3.3. Web-based interface

A web-based interface for the users is developed. By using a web-based technology and broadband connection, it is possible to display various sophisticated contents to desktops, laptops, or mobile devices anywhere in the world. This in an advantages for the operators or authorized persons as the electric parameters of the laboratory's usage can be received and monitored wherever and whenever it is convenient for them.

The developed web-based interface during this research is shown in Figure 3. The interface is the improvement of the built-in web provided by the manufacturer. To support wide range of web-enabled devices, a responsive web interface design is implemented. Therefore, the web will automatically adjust the wide-size of the user's display. Some parameter such as Load Current, Power, Line-to-Line Voltages, Line-to-Neutral Voltages, Power Factor, Power Quality, etc. can be monitored in real time.

Another advantage of remote monitoring system is its easiness of device configuration. The device setting can be set remotely. By providing a protection password, the authorized operators can set the device parameters remotely without visiting the place where the device is installed. For many devices to be set, this advantage will improve the efficiency.

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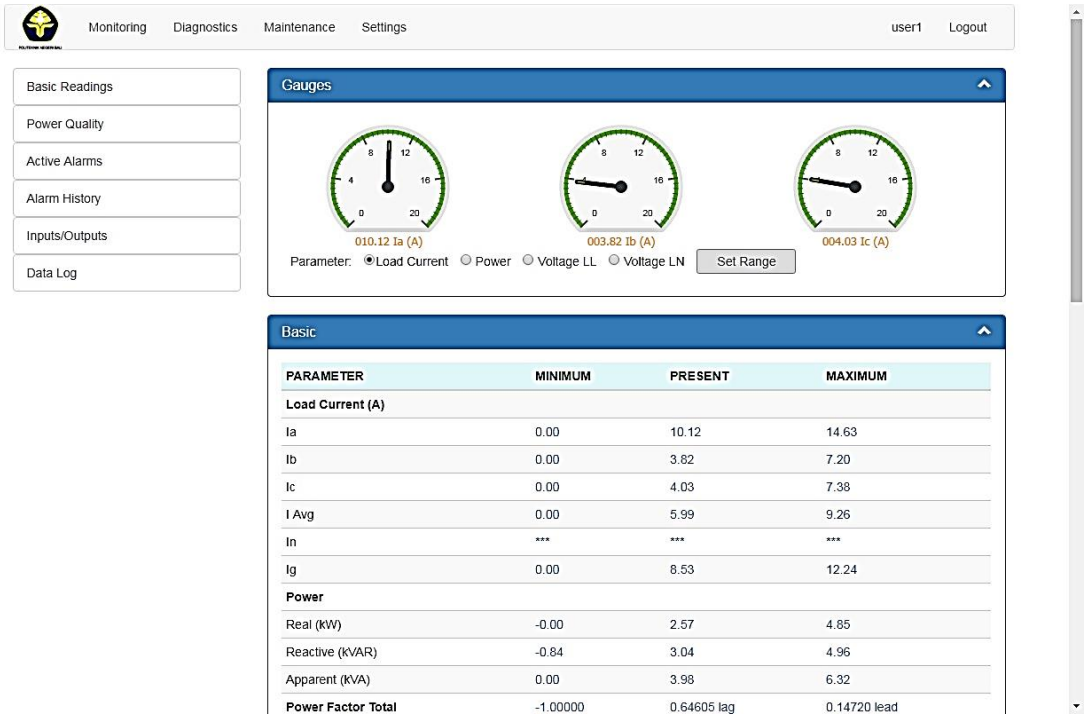

Figure 3. A web-based interface for the AMR

3.4. System Evaluations

The AMR featured by class-0.2 measurement device which means that the device has 0.2% of accuracy. It is very high accuracy for measurement systems. This accuracy can be achieved only by using a digital AMR, not an analog one.

The AMR inputs consists of three-phase voltage and current lines. For measuring the current, a Current Transformer (CT) must be used before connecting the load and AMR channels. In this research, three 100/5A of CTs is utilized. Based on the operator experiences, the device is well installed on the MDP and well accessible for monitoring purposes.

A responsive web interface design is implemented by various types of displays. The web-based interface works accordingly, depends on the display's size. It covers all necessary parameter to be displayed.

4. Conclusion

In this research, a web-based automatic meter reading was developed. The system works accordingly. The user-friendly web interface can be used to monitor the electrical parameters. By using a web-based technology and broadband connection, it is possible to display various sophisticated contents to desktops, laptops, or mobile devices anywhere in the world. Another advantage of remote monitoring system is its easiness of device configuration. The device setting can be set remotely.

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