SCADA SYSTEM FOR MONITORING AND CONTROLLING ENERGY IN SMARTHOME WITH HYBRID WIND-SOLAR POWER PLANT

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ABSTRACT: This paper presents the development of a SCADA system to monitor and control the energy in a smarthome. In the system, the renewable energy resources consist of the PV generator and the wind power generator are connected to grid. The Winlog SCADA software is employed to develop the SCADA system. The remote devices consist of the power meter to measure the load power, the charge controller to charge the battery from the PV and the wind power generator, and the load control to switch on/off the load. To connect the master control and the remote devices, the RS-485 serial communication is adopted. While the Modbus protocol is employed to communicate the Winlog SCADA and the remote devices. The experimental results show that the developed system is able to perform the SCADA task properly under the different types of the remote devices.

Keywords: SCADA, smarthome, PV, Wind power, Modbus

1. Introduction

Smart Grid is new modern technology in delivering electrical energy to customer in a smart way by incorporating the information and communication technology. A Smarthome is a part of the Smart Grid system in which the resources are managed smartly. In this paper, we deal with the management of electrical energy for the home.

In the Smart Grid, the availability of renewable energy is very important due to fact that the energy flows in two ways, i.e. from the grid to the Smarthome and vice versa. The energy may flow from the Smarthome to the grid when there are renewable energy resources in the Smarthome, such as the wind generator or the solar panel.

A monitoring and control system is required by the Smart Grid to manage the whole system. The Supervisory Control and Data Acquisition (SCADA) system is many used for controlling the Smart Grid as proposed in (Aghamolki, Miao, Fan, 2015; Bytschkow, Zellner, Duchon, 2015; Dhend, Chile, 2015; Raman, Hanafiah, Ghani, Jusoh, 2012; Soetedjo, Lomi, Nakhoda, 2015).

Implementation of SCADA in the Smarthome was proposed by (Fernandes, Morais, Faria, Vale, Ramos, 2013), where the SCADA House Intelligent Management (SHIM) is employed to reduce the total energy consumption in a house. The combination of SCADA software and high level language was proposed in (Soetedjo, Lomi, Nakhoda, 2017) to solve the optimization problem in order to minimize the electricity cost in a Smarthome.

In this work, we develop a SCADA system to monitor and control the energy in a Smarthome, where the electricity is supplied by the grid, the wind power system and the solar panel. The main objectives are twofold. First, the Graphical User Interface (GUI) is developed using the

Winlog SCADA software to animate the electrical variables of the load (Smarthome) and suppliers. Second, the communication protocol using Modbus RTUS is employed to establish the communication between Winlog SCADA and the peripherals in the Smarthome.

2. Proposed System

2.1 Electrical Configuration

The electrical configuration of proposed system is illustrated in Figure 1. As shown in the figure, there are three energy resources, i.e. the PV, the Wind generator, and the grid. Since the outputs of the PV and the Wind generator are the DC power, then the gridtie inverter is employed to convert to the AC power and connect to the grid directly.

The outputs of the PV generator and the Wind generator are fed to the charge controller for charging and discharging the battery. In the proposed system, four power meters are installed to monitor the power delivered by the energy resources and the power extracted by the Smarthome.

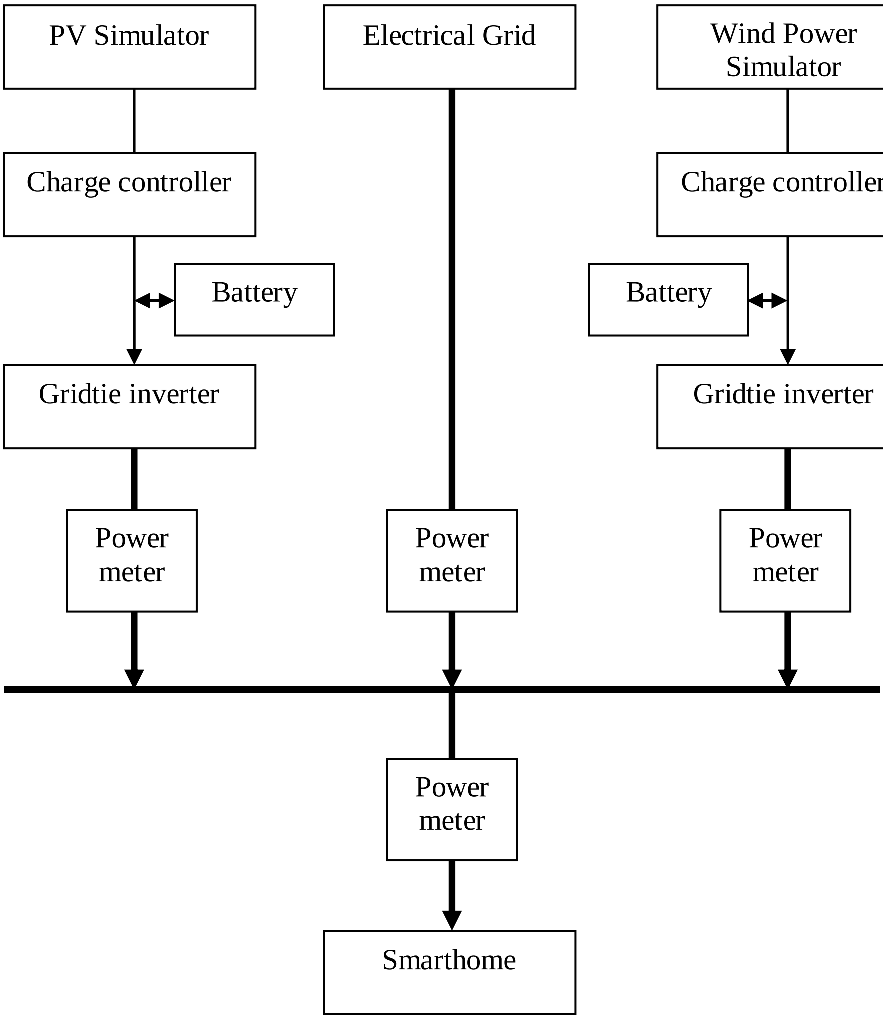

Figure 1 Electrical configuration

2.2 Communication Architecture

The communication architecture of proposed method is depicted in Figure 2. The Modbus protocol is employed in this SCADA system, where the Winlog SCACA acts as the Modbus master, while the devices are the Modbus slave. The serial communication RS-485 is adopted to communicate between the Winlog SCADA and the monitored and controlled devices. In this work, the monitored devices consist of the charge controller of the PV, the charge controller of the Wind generator, the power meter of Smarthone, the power meter of the grid. While the controlled device is an Arduino microcontroller that is used to switch on/off the load.

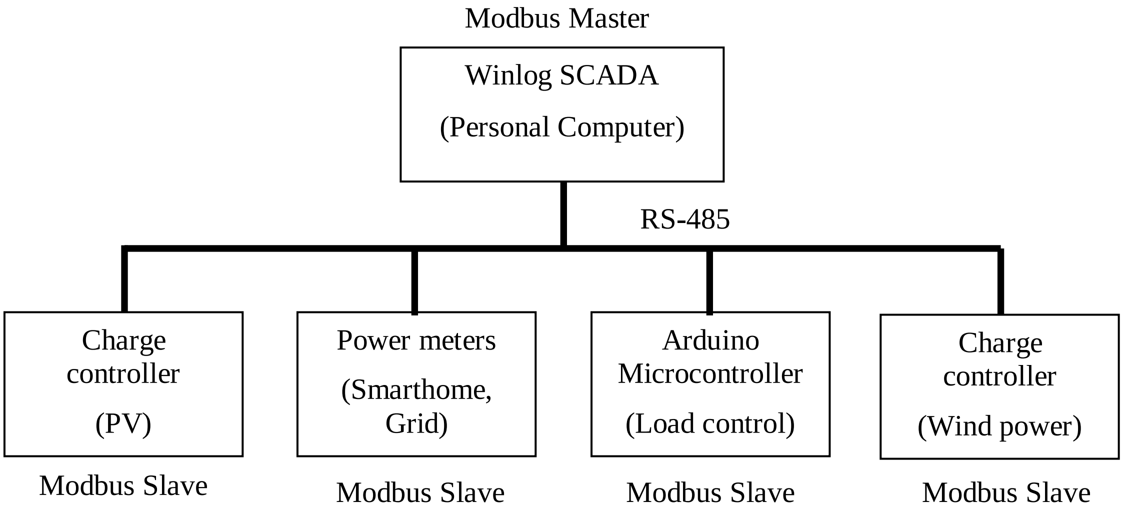

Figure 2 Communication architecture

3. Experimental Results

The devices used in the experiments are depicted in Figure 3 – Figure 5. Figure 3 illustrates the PV simulator, where the halogen lamp is employed to simulate the solar radiation from the sun. Figure 4 illustrates the wind power simulator, where one motor is powered and coupled with another motor that generates the DC power. Figure 5 illustrates the power meter (left side) and the charge controller (right side)

Figure 3 PV simulator

Figure 4 Wind power simulator

Figure 5 Power meter and charge controller

The graphical display of SCADA system is depicted in Figure 6, where the energy resources and the Smarthome are shown. When the button on the energy resources is clicked, then the new window of the power reading is displayed as shown in Figure 7. In Figure 7, the voltage, current and power of the battery and PV that are read from the devices are shown in the Winlog SCADA.

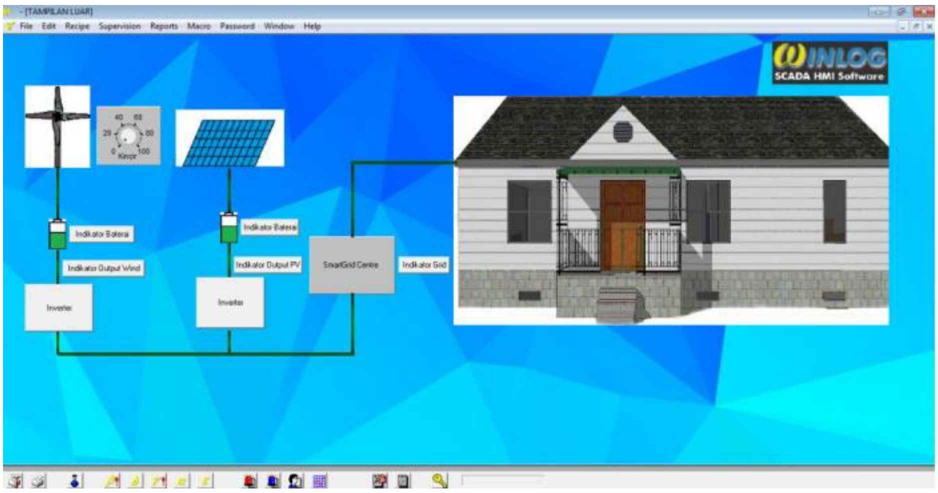

Figure 6 Main display of SCADA system

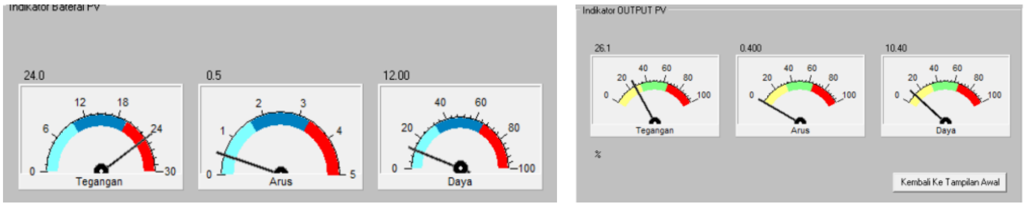

Figure 7 Display of battery power and PV power.

The control function of SCADA is illustrated in Figure 8 and Figure 9. In Figure 8, all loads (lamps) are switched-on, thus the room are appeared on the display. While in Figure 9, the lamp in the kitchen is switched-off, thus the display of the kitchen is dark and showed with the black color.

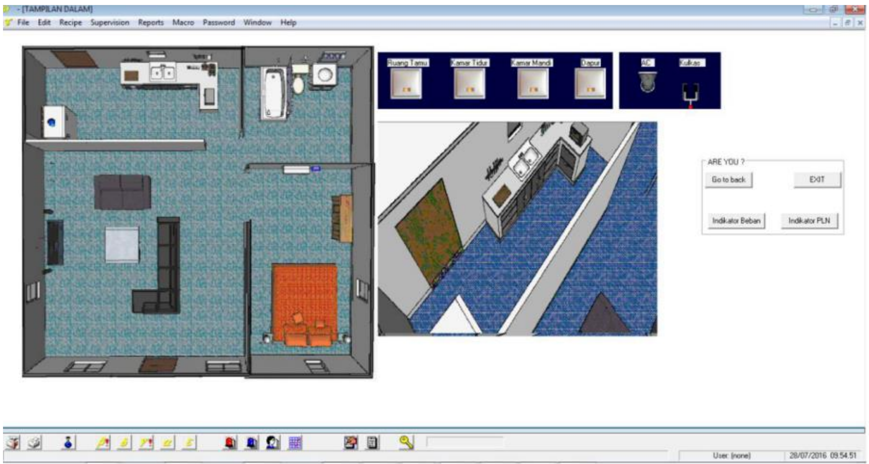

Figure 8 Display of Smarthome when all lamps are switched-on

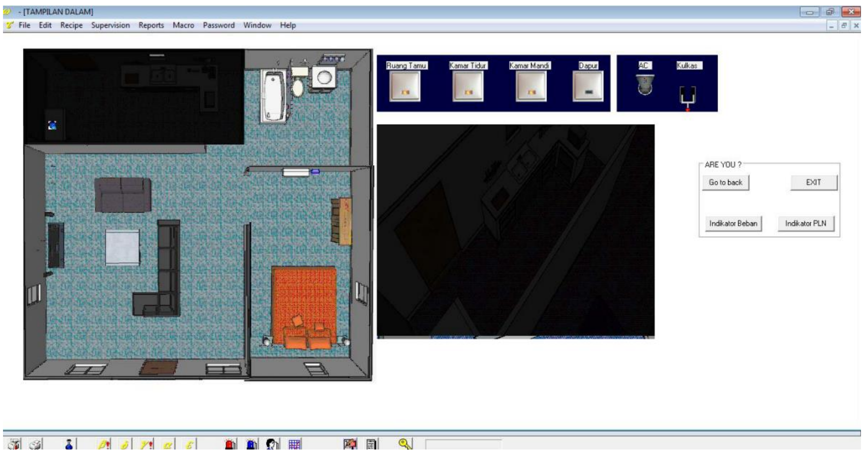

Figure 9 Display of Smarthome when the load is switched-ff

Besides the graphical displays, the Winlog SCADA also provides the real-time data of the communication status and the measured variables. The communication status of each remote device is illustrated in Figure 10, where the status "OK' indicates that the SCADA communicates with the device correctly. While the status "KO" indicates that the SCADA do not communicate with the device. The real-time value of each measured variable is monitored by the Winlog SCADA as illustrated in Figure 11. This real-time information is very useful to monitor the remote devices as well as to debug the system when some errors occur.

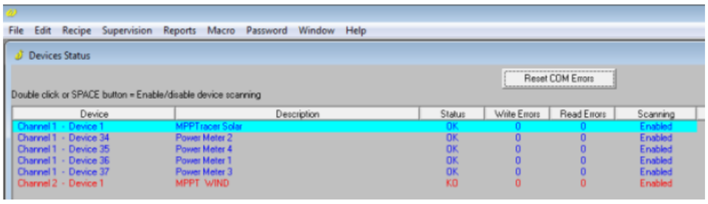

Figure 10 Communication status

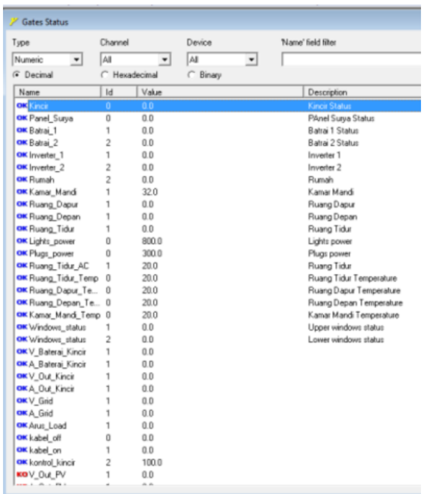

Figure 11 Realtime data of measured variables

4. Conclusion

The Winlog SCADA is employed to monitor and control the electrical parameters (voltage, current, power) of the smarthome powered by the grid-connected system consists of the PV, the wind power generator and the utility grid. The SCADA system provides an efficient approach to monitor and control the plant remotely. The ability of SCADA system to display the parameters graphically helps the operator to supervise the plant easily.

In future, some improvements in the graphical display for the complex plants will be carried out. Further the implementation in an advanced hardware testbed will be developed.

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