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ZigBee and PLC Based Smart Home Energy Management System

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ABSTRACT

This paper describes smart home energy management system that included both energy consumption and renewable energy generation. ZigBee is used to home appliances to measure and transfer the power and energy of the outlets and the lights. Power line communication is indented to monitor solar panels. By monitoring both energy consumption and generation simultaneously, the proposed HEMS can optimize home energy use and result in energy cost saving.

Keywords: *HEMS, ZigBee*

[1] INTRODUCTION

The current energy crisis requires significant reduction in energy consumption in all areas. Energy saving and renewable energy sources (RES) are considered as methods of solving the problem. In home area, the increasing number of home appliances and consumer electronics causes residential energy use to grow rapidly. Optimized home energy management system (HEMS) is needed to reduce energy use and save money. Optimization of home power consumption based on power line communication (PLC) has been studied [1]. A HEMS that monitors, compares, and controls home appliances has been proposed [2]. In addition, RES such as a photovoltaic energy system and wind energy system are deployed to conserve residential energy use and to reduce energy cost. Energy management systems including renewable energy have been studied to advance smart home [3], [4]. In this paper, we propose smart home energy management system including renewable energies based on ZigBee and PLC networks to optimize home energy use.

2. STRUCTURE AND COMPONENTS OF PROPOSED HOME ENERGY MANAGEMENT SYSTEM

2.1 System Structure

Fig. 1 shows the schematic overview of the proposed smart HEMS. The smart home consists of two parts: energy consumption and energy generation. The energy consumption in home is caused mainly by home appliances and lights. Outlets and lights are equipped with an energy measurement and communication unit (EMCU). The communication capability is based on ZigBee, which is well known as a low power communication method [4]. The EMCU measures the energy consumption of home appliances and the lights.

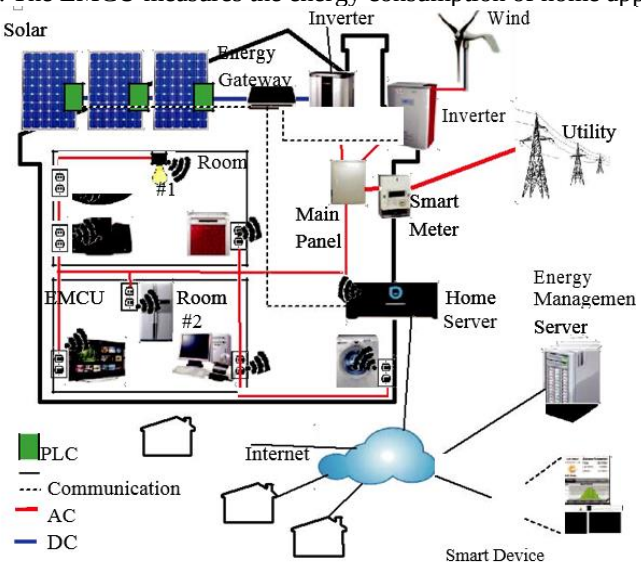

Fig. 1. Schematic overview of smart HEMS

The EMCU in outlets and lights reports the measured values to the home server periodically through ZigBee. The home server acquires and stores the energy information of home appliances and lights. The home server has the mapping information about which home appliance is connected to which outlet and about the location of lights. It then analyzes the energy and power usages of home appliances and lights continuously. Users can

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figure out the energy usage status of home appliances and lights and find out which one is unnecessarily turned on. The outlets and lights in home can be controlled for energy saving either automatically by the home server or manually by the users. Users can also access the information of home energy usage information through a smart mobile device both locally and remotely.

The energy generation part consists of a solar power generator and a wind power one, which are two of the most popular RES. Solar panels on the roof are connected to the inverter, which converts dc power to ac one. Each solar panel is equipped with a PLC modem to monitor the status of all solar panels for maximum power generation. The PLC is considered as a retrofit technology because it needs no additional communication lines. The energy gateway (EG) gathers all the status information from the solar panels based on PLC and from the inverter through a serial communication [5]. The EG monitors the performance and status of all solar panels in real time. The status information of each solar panel enables users to maintain the performance of solar power generator. The EG also gathers the wind power status from the wind inverter. The home server aggregates all the power generation information and utilizes it for home energy management.

From the information of the energy consumption and the energy generation, the home server can manage and control home energy use according to the circumstances in real time. It estimates the renewable energy generation based on the weather information from the weather forecasting web service, which provides solar radiation, cloud amount, wind speed, and so on[6]. The home server provides users with various aspects of analysis and helps them optimize home energy use manually or automatically. Moreover, the energy management server gathers and stores the energy information of client homes, and it provides the energy portal service and helps clients compare the energy information of them with that of others.

2.2 Architecture and Components of Energy Gateway, Home Server, and Energy Management Server

The EG has a PLC interface for solar panels and an RS-485 for inverters. It transfers monitored data to the home server via Ethernet. The home server has a ZigBee interface for home appliances, an Ethernet for the EG and the energy management server, and a Wi-Fi for local access through smart devices. End devices such as home appliances and solar panels are managed in the device table block. ZigBee nodes are controlled by the node control block. Energy consumption manager (ECM) and energy generation manager (EGM) analyze the energy consumption and generation, respectively [5]. The home energy information is shared with the remote energy management server through web service block. The energy management server has numerous client homes for HEMS. The comparison and analysis block compares one set of home energy information to another, analyzes them, and make various energy statistic in the database. The server provides an energy portal service for clients through the home server or the smart device. Fig. 2 shows the architecture of an energy gateway, a home server, and an energy management server.

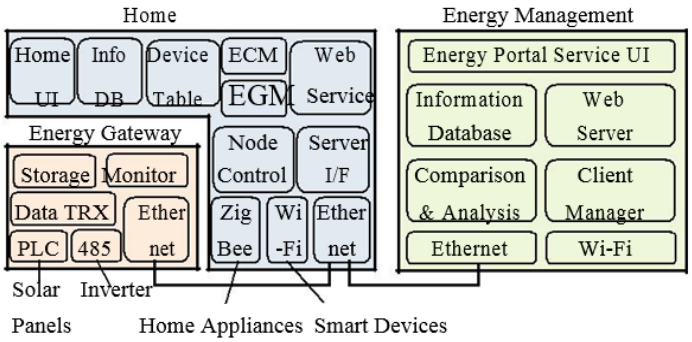

Fig. 2. Architecture of energy gateway, home server, and energy management server

3. IMPLEMENTATIONS

To show the feasibility of our proposed system, we implemented a prototype HEMS with a home server. Fig. 3 shows several implemented results. The EMCU for home appliances in Fig. 3 (a) has a ZigBee wireless personal area network interface and a measurement capability based on an electric metering chipset. It is installed into the outlets and lights to measure the power and energy of home appliances and lights. The PLC modem in Fig. 3 (b) includes both a PLC function and a sensing capability of voltage, current, and temperature to monitor the status of each solar panel. It is compliant with home plug green PHY specification and interoperable with IEEE 1901 standard. Fig. 3 (c) shows the prototype HEMS miniature that includes three outlets, a smart device, and a solar power monitoring display [6]. The user interface of a remote energy management server for home energy information is shown in Fig. 3 (d). It shows various statistic data in several aspects. The smart device application in Fig. 3 (e) is developed to monitor the status of each solar panel. It accesses the home server, fetches the solar panel information, and displays the status of solar panels.

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(a) (b) (c) (d) (e)

Fig. 3. Implemented results (a) EMCU (b) PLC modem (c) Prototype HEMS miniature (d) Energy management server UI (e) Solar panel monitoring UI

4. CONCLUSIONS

We propose a smart HEMS including energy generation based on wireless and wired heterogeneous network. The present paper describes the system architecture and implementation results. We use a low-power ZigBee is used to home appliances to measure and transfer the power and energy of the outlets and the lights**.** Through the EMCU, all energy information of home appliances and lights is aggregated for analysis in the home server. A standard PLC technology is adopted to monitor the status of each solar panel. Solar system's power line channel for PLC is more stable compared to the indoor power line characteristics with respect to time-varying impedance. The home server provides various aspects of data analysis that is helpful to optimize home energy use. By considering the information of energy consumption and generation simultaneously, the home server can achieve home energy conservation and save the energy cost.

REFERENCES

[1] Young-Sung Son and Kyeong-Deok Moon, "Home energy management system based on power line communication," Proceedings of the IEEE International Conference on Consumer Electronics, Jan. 2010.
[2] Jinsoo Han, Chang-Sic Choi, Wan-Ki Park, Ilwoo Lee, "Green home energy management system through comparison of energy usage between the same kinds of home appliances," Proceedings of 15thinternational symposium on consumer electronics (ISCE), June. 2011.
[3] SaeedJahdi and Loi Lei Lai, "Grid integration of wind-solar hybrid renewable using AC/DC converters as DG power sources," Proceedings of world congress sustainable technologies (WCST), 2011.
[4] Hayato Yamauchi, Kosuke Uchida, and TomonobuSenjyu, "Advanced Smart Home," Proceedings of IEEE 15thinternational conference onHarmonics and quality of power (ICHQP), 2012.
[5] Alphy John, I.Bildass Santhosam, "Home Energy Management System Based On Zigbee," International Journal of Inventive Engineering and Sciences (IJIES), Volume 2, Issue-4, March 2014.
[6] G.Ramachandran,N.ManikandaDevarajan,T.MuthuManickam, S.kannan, C. ArunKumar Madhuvappan PM Murali "Comparative Study and implementation Mixed Level & Mixed Signal Simulation using PSpice and VHDL International Journal Of Computational Engineering Research Vol. 2 Issue. 8 2012.