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More Efficient Energy Management System Using ZigBee Communication through Comparison of Energy Usage

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Abstract- This paper describes more efficient home energy management system to reduce power consumption in home area. Home Energy Management System (HEMS) is a technology to reduce and manage home energy use. The feedback on energy consumption to energy users is known to be effective to reduce total energy use. A typical HEMS just shows the energy consumption of the whole home and home appliances. Users cannot figure out how efficient a home appliance is, compared to the others. So it is necessary to compare the energy usage of home appliances to that of the same kinds of home appliances. The proposed architecture gives more efficient energy-saving HEMS. In this paper,we propose a green HEMS based on energy comparison .

KeyWord- Home Energy Management, ZigBee, Enegry Usage, Home Appliance

I. INTRODUCTION

Continuous increase in global energy consumption gives rise to the current energy crisis and the environmental problem. As more and more home appliances and consumer electronics are deployed, power consumption in home area tends to grow. Home appliances and consumer electronics account for about 27 % of home energy consumption [1]. Some research showed that the feedback on energy consumption to energy users is effective to reduce total energy use [2]. Another research showed that total energy consumption was reduced by 12 % by setting up the 'energy consumption information system' that displays energy consumption of the whole house and home appliances [3].The current energy crisis and green house effect require more efficient energy management in all areas. Therefore, reducing energy use in homes is a very challenging target to mitigate the energy crisis and the environmental problem. The technology to reduce and manage home energy use is known as home energy management system (HEMS).

Network architecture for home energy management system (HEMS) based on power line communication (PLC) was proposed [4]. A number of HEMS were proposed and developed [5]-[6]. The previous HEMS's monitored and controlled home devices, and showed home energy information.However, the previous works just showed the energy consumption information of homes and home appliances. Users cannot figure out whether a specific home appliance is energy efficient. It is necessary to compare energy usage of a home appliance to that of the same kind of typical home appliances or other's home appliances.In this paper, we propose more efficient green home energy management system through comparison of energy usage between the same kinds of home appliances based on ZigBee communication.

II. GREEN HOME ENERGY MANAGEMENT RELATED WORK

The energy monitoring is necessary to achieve the HEMS.In fig. 1 home section I & II transmits the energy usage through Zigbee communication to the monitoring section fig.2. Electrical outlets are connected to the home section I & II fig.1and it measures energy usage by energy meter..In the proposed green home energy management system home appliances are connected to the electrical outlets. The electrical outlets have a function of energy measurement of home appliances and the capability of ZigBee communication as in[7]. The electrical outlets measure the real-time active power consumption and the accumulated energy consumption of home appliances. The HEMS in the home server gathers the energy information from the electrical outlets and displays hourly, daily, weekly, and monthly energy usage of home appliances with this a user can figure out detailed energy information. Zigbee network is well known as a low power communication method. The electrical outlets also identify whether the connected home appliance is turned on or turned off and whether it is on the standby state or the normal state by measuring the consuming power and comparison of energy usage is done by using reference or typical energy values of home appliances.

The More Efficient green home Energy Management System Using ZigBee Communication through Comparison of Energy Usage is divided into three subsystems home section-I, home secton- II and monitoring setioon.

A. Home section- I

Home section- I transmits the energy usage through Zigbee communication to the monitoring section. fig.3 shows Home Section- I it has atmega 16 microcontroller**,** Zigbee communication ,triac ,optocoupler, Power Supply for AVR 32 Micro controller ,lcd display energy meter,keypad buttons for setting date and time for measurement of energy usage.In the proposed green home energy management system home appliances are connected to the electrical outlets.

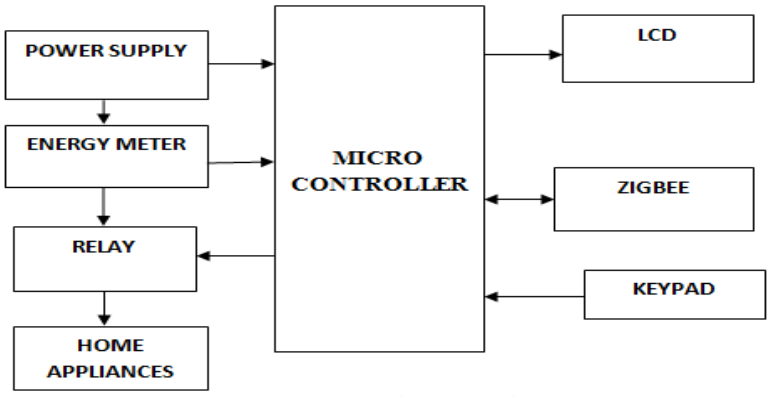

Figure 1 Home Section- I & II

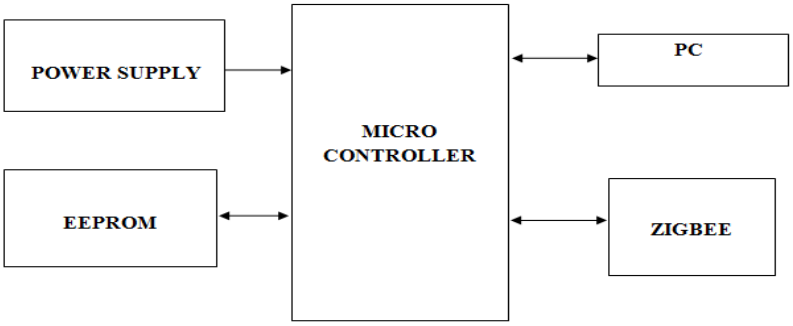

Figure 2 Monitoring Section

B. Home Section- I & II

.Fig. 4 shows home section I & II transmits the energy usage through Zigbee communication to the monitoring section. Home appliances are connected to the electrical outlets. The electrical outlets measure the real-time active power consumption and the accumulated energy consumption of home appliances. The electrical outlets have a function of energy measurement of home appliances and the capability of ZigBee communication . ZigBee network is well known as a low power communication method [8].

C. Monitoring Section and Home Section- I & II

Fig.5 shows monitoring Section and home Section- I & II, in this monitoring section includes pc with Zigbee communication which receives energy usage from home section I & II. To transfer the energy usage of home appliances, it is necessary to measure the exact power and energy of them and to provide the communication network capability. For communication capability, the electrical outlet is equipped with the ZigBee/IEEE 802.15.4 WPAN network and communicates with the ZigBee coordinator of the home server for information transmission and receiving.

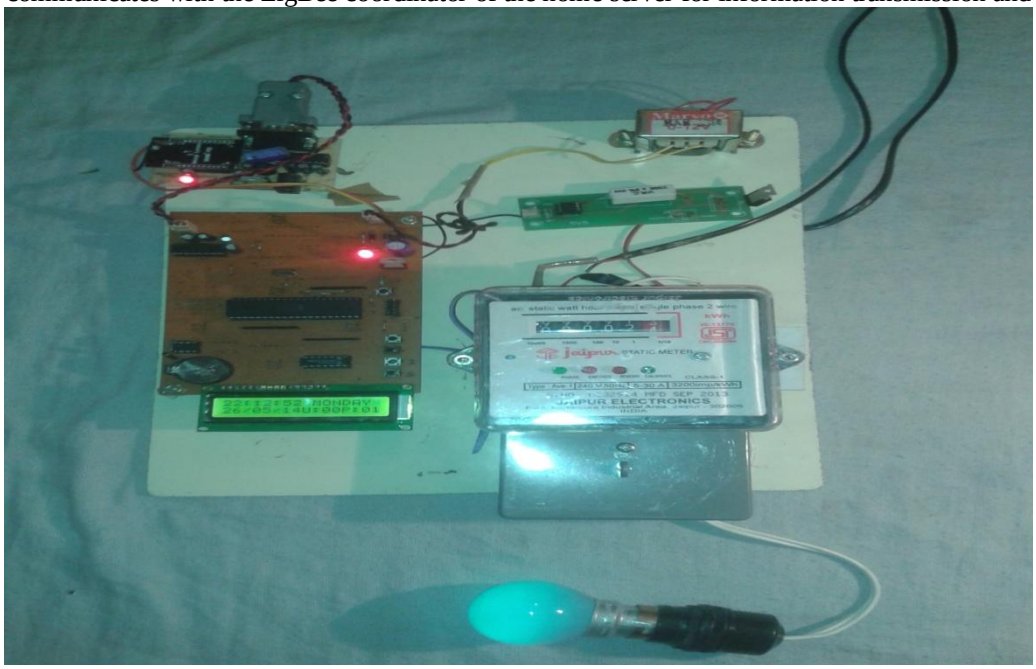

Figure 3 Home Section- I

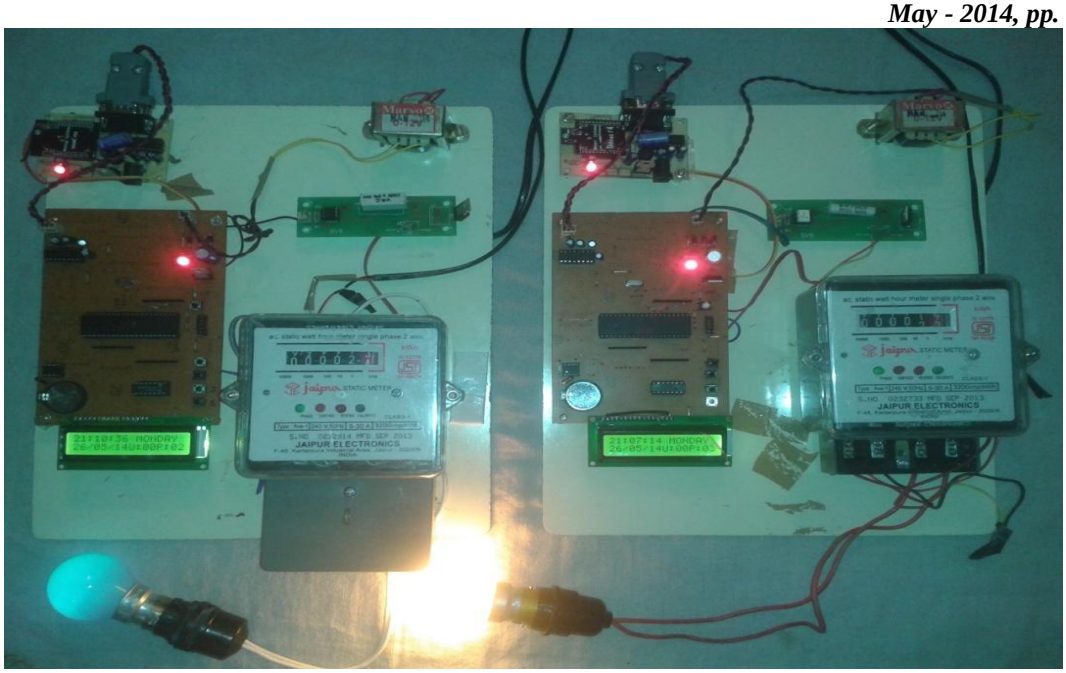

Figure 4 Home Section- I & II

Figure 5 Monitoring Section and Home Section- I & II

D . Power Supply for AVR 32 Micro controller:

This section describes how to generate +5V DC power supply. The power supply section is the important one. It should deliver constant output regulated power supply for successful working of the project. A 0-12V/1 mA transformer is used for this purpose. The primary of this transformer is connected in to main supply through on/off switch& fuse for protecting from overload and short circuit protection. The secondary is connected to the diodes to convert 12V AC to 12V DC voltage. This is filtered by the capacitors, which are further regulated to +5v, by using IC 7805.

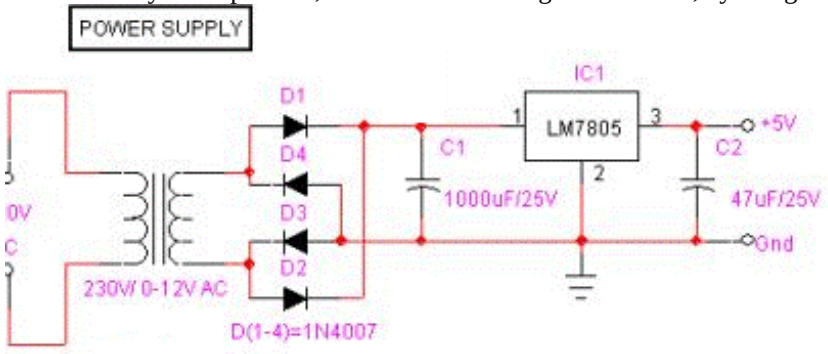

Figure **6** Power Supply

III. PROPOSED HOME ENERGY MANAGEMENT SYSTEM

Fig.7 shows the architecture of the proposed HEMS. The home has two rooms and each room is equipped with two power outlet, and one ZigBee hub. The power outlets include a power measurement function to measure the power consumption and the capability of ZigBee communication.

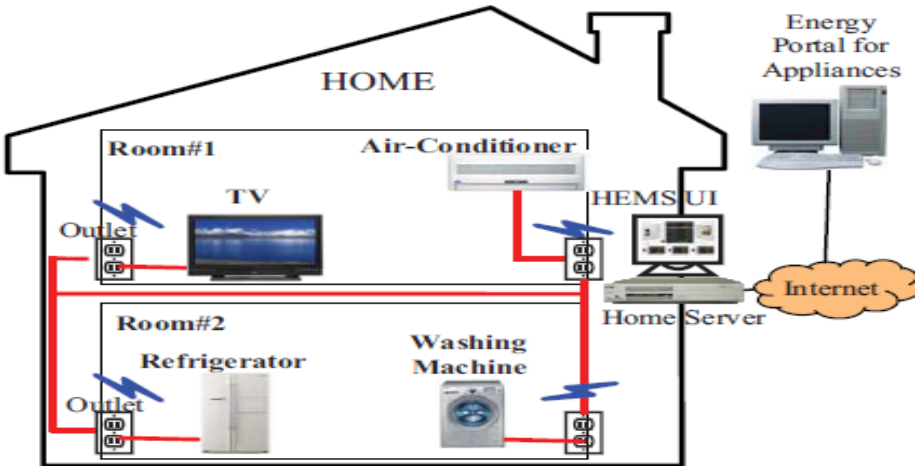

Figure 3 Architecture of the Green HEMS based on Zigbee Communication

The zigbee hub is connected to the power outlet. They measure the power and energy usage of home appliances and transfer the measured power and energy information to the home server through ZigBee network. . The HEMS identifies the home appliances via the corresponding electrical outlet number. The HEMS in the home server gathers the energy information from the electrical outlets and displays hourly, daily, weekly, and monthly energy usage of home appliances. A user can figure out detailed energy usage information in home. He can have exact views of how much energy he is using in each home appliance and what sort of difference he could make by changing his behaviour. This kind of feedback enables users to reduce the home energy use. The electrical outlets also identify whether the connected home appliance is turned on or turned off and whether it is on the standby state or the normal state by measuring the consuming power. A user can get the used time and energy usage of the home appliances. He can figure out the useless energy waste in the standby state and the operation energy usage in the normal state. With this kind of energy information from the HEMS in the home server, it is difficult for a user to know whether the home appliance is energy efficient or not, because there is no reference to compare. So it is necessary to compare the energy usage of home appliances to that of the same kinds of home appliances of others or the reference home appliances.

IV. IMPLEMENTATION RESULTS

Fig.8 shows an example of energy usage of a home appliance. On the normal state, home appliances can consume different levels of power. We implemented the electrical outlet measuring power and energy of home appliances and HEMS on home servers. The power and energy measuring chip communicate with the ZigBee controller through serial interface on the board. The HEMS user interface helps the user figured out the energy usage of the whole home and each home appliances and makes him to try to reduce home energy consumption. It can also stimulate him to replace energy inefficient home appliances with new ones and to properly operate home appliances in a very energy efficient way.

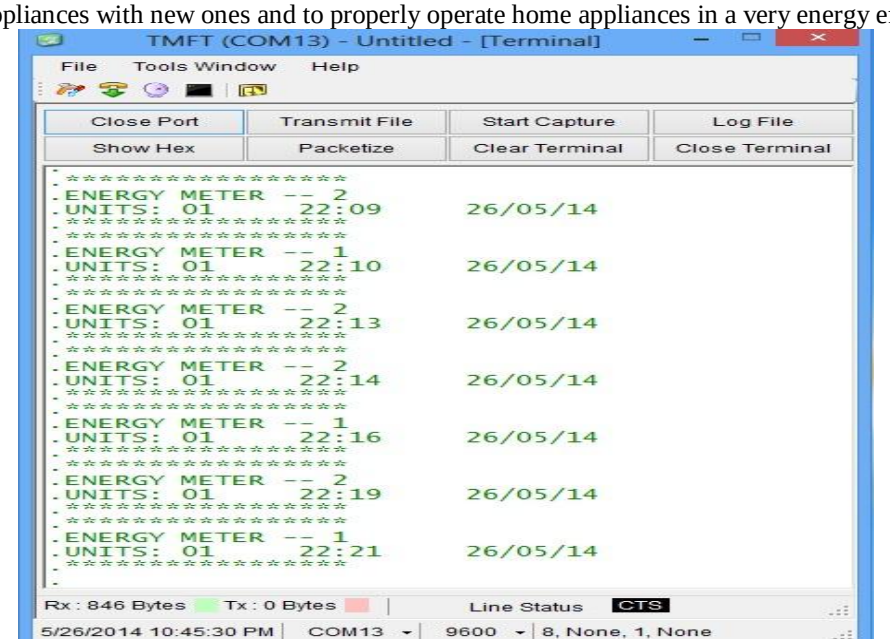

Figure 4 Energy Usage of Home Appliance

V. CONCLUSION

We proposed a green HEMS to change a user's behaviour through comparison of energy usage between the same kinds of home appliances. We implemented the electrical outlet measuring power and energy of home appliances and the HEMS on the home server. The configured ZigBee network is composed of the home server, the ZigBee hub, and the power outlets and light. The home server is a central control unit. The power outlets and the light are the sensor nodes. The home server can manage the power outlets and the light through the ZigBee hub. By comparing the energy usage of his home appliances to that of the reference, a user can check the relative energy efficiency of his home appliances. With the help of the energy usage comparison, a user can change the usage pattern of home appliances into more energy efficient one, or replace an energy inefficient home appliance into an energy efficient one. As a result, our proposed HEMS can contribute to reduce the total home energy use and mitigate the energy crisis and the environmental problem.

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