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Energy Controlling System Using Wireless Sensor Network

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Abstract: Energy controlling system using wireless sensor network plays a crucial role in realizing residential Demand Response (DR) pro-grams in the smart grid environment. In many part of the world there is a persistent problem is inefficient use of electric power generation and transmission assets. This problem been tackled by demand side management with the introduction of the smart grid, it is now possible to perform demand response at customer premises to get a finer control of the available resources. The objective of Energy controlling system using wireless sensor network is to design and implement efficient Home Energy Management System (HEM and evaluate the HEM operation performance, in particular how each load performs when being controlled by the HEM unit. It provides a homeowner the ability to automatically perform smart load controls based on Utility signals, customer's preference and load priority by using ARM processor. The HEM's communication time delay to perform load control is analyzed, along with its residual energy consumption.

Keywords: Energy controlling, load priority, smartgrid, home automation.

I. Introduction

In many parts of the world, there is a persistent problem of inefficient use of electric power generation and transmission assets. This problem been tackled by demand side management, which was introduced in the early 1980s. Intelligent management of the power grid, aiming at promoting more even utilization of electricity and minimize energy loss during power transmission and consumption is currently highlighted at the global level by utilities, academic organizations as well as public administrations. To protect the interest of both utilities and customers to the full extent, the idea of smart grid coming with enabling technologies has been put forward over recent years and attracts great attention from the power industry and academy engaged in such explorations.

With the introduction of the smart grid, it is now possible to perform demand response at customer premises to get a finer control of the available resources. It provides a homeowner the ability to automatically perform smart load controls based on utility signals, customer's preference and load priority. This project presents the hardware demonstration of the proposed HEM system for managing end-use appliances. The HEM's communication to perform load control is analyzed, along with its residual energy consumption.

With the deployment of smart grids, it is feasible to integrate renewable power generation technologies originated from different sources into the power grid for the purpose of coordination of energy utilization in the event of a power crunch. In this way, the smart grid technology manages to meet the ever-increasing demand of minimizing the negative impact upon the environment while achieving high performance.

Demand-Response program, as one of the most common services in smart grid technology, has been introduced into the power grid. In this way, utilities are capable of achieving load balance in the power grid through the DR procedure by encouraging customers to reduce their electricity consumption during peak load periods with special bonus/incentives in return. Meanwhile, residents could benefit from the DR services in terms of the electricity bill reduction when adjusting their electricity usage of home appliances in houses in response to dynamic pricing and other events associated with the reliability of the power grid issued by utilities.

In order to realize the proposed DR feature, it is necessary to deploy a fully automated DR solution, or auto-DR which can be made possible through the use of a Home Energy Management (HEM) system. Today, interests in HEM systems have grown significantly. Various HEM systems are designed based on different communication schemes, such as Zigbee and power-line carriers. Here we implement and partially been tackled by demand side management, which was HEM system using a task-scheduling approach. With the introduction of this propose an HEM system that can display energy usage the smart grid, it is now possible to perform demand response information of individual appliances.

In addition to the AMI (Advanced Metering Infrastructure)-enabled DR program advocated by utilities, effective energy management within smart homes also has to be taken into account in the context of underlying infrastructures in smart grids.

II. Methodology

The concept of Energy Controlling System Using Wireless Sensor Network is to provide monitoring and control functionalities for a homeowner, and load controllers that gather electrical consumption data from selected appliances and perform local control based on command signals from the HEM system. A gateway, such as a smart meter, can be used to provide an interface between a utility and a homeowner in a real-life HEM deployment. In such a scenario, the gateway receives a DR signal from a utility, which is used as an input for our HEM unit.

HEM unit comprises:

A) An embedded PC running a GUI software application, which includes a DR algorithm that serves as the brain of the HEM system. It makes a decision to switch ON/OFF selected end-use appliances based on the utility signal received, as well as homeowner's load priority and preference settings. It is also responsible for collecting electrical consumption data from all load controllers and providing an interface for homeowners to retrieve appliances' status and review their power consumption;

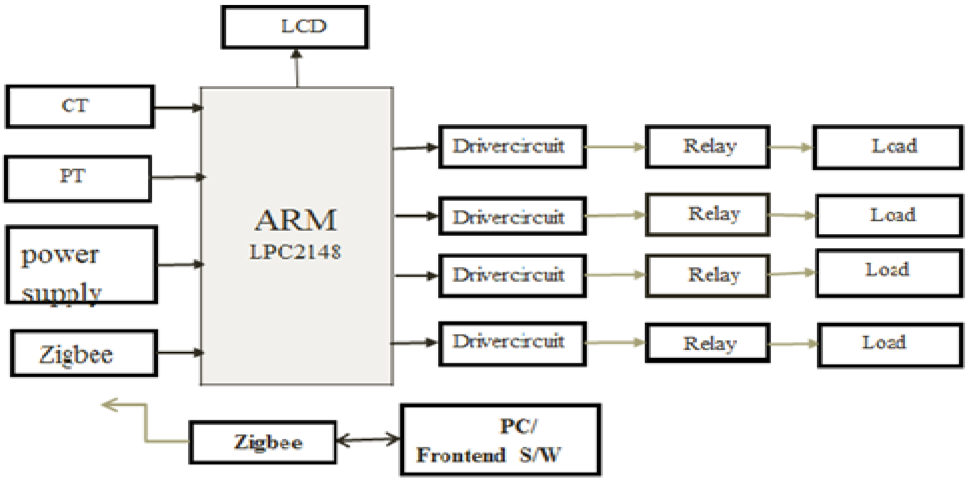
B) An HEM communication module, which provides communication paths between the HEM unit and its load controllers. This module is attached to the HEM unit and enables the HEM unit to send load control commands to all load controllers, and receive responses back. A PC with a Zigbee enabled communication module is used as the HEM unit for this demonstration.

C) A load controller provides an interface between the HEM unit and a selected appliance. It provides basic power management functions (i.e., monitor, control, communicate) via a standard electrical outlet.

Architecture-wise, it contains: a) A data capturing and processing module, which collects and calculates real-time electrical consumption data, such as voltage, current, apparent power, real power, and power factor from appliances;b) A control module, which is simply an electronic relay circuit that provides the capability to switch a selected appliance ON/OFF, depending on the command sent by the HEM unit; and c) A communication module, which is responsible for providing communication paths between a load controller and the HEM unit. This is to allow the collected electrical consumption data from a load controller to be sent to the HEM unit; commands from the HEM unit to be received by a load controller; and response signals from a load controller to be sent to the HEMunit.

D) Communications With in the HEM System In any HEM systems, two types of communication modules are needed. The type of communication modules selected will impact the overall system's data communication rate, range, cost, and its residual power consumption. Under a typical home area network/smart-device platform, one or a combination of the following communication technologies may be deployed: Wi-Fi (802.11/n), Bluetooth (802.15.1), ZigBee(802.15.4), and Power Line Carrier (PLC).This is because ZigBee is a low-cost, low-power consumption option, and does not require an extensive new infrastructure.

III. BLOCK DIAGRAM



IV. BLOCK DIAGRAM DESCRIPTION

The ARM LPC2148 microcontrollers are based on a 32/16 bit ARM7TDMI-S CPU with real-time emulation and embedded trace support, that combines the microcontroller with embedded high speed flash memory ranging from 32 kB to 512 kB. A 128-bit wide memory interface and unique accelerator architecture enable 32-bit code execution at the maximum clock rate. For critical code size applications the alternative 16-bit Thumb mode reduces code by more than 30 % with minimal performance penalty.

Due to their tiny size and low power consumption, LPC2148 are ideal for applications where miniaturization is a key requirement, such as access control and point-of-sale. A blend of serial communications interfaces ranging from a USB 2.0 Full Speed device, multiple UARTs, SPI, SSP to I2Cs, and on-chip SRAM of 8 kB up to 40 kB, make these devices very well suited for communication gateways and protocol converters, soft modems, voice recognition and low end imaging, providing both large buffer size and high processing power. Various 32-bit timers, single or dual 10-bit ADC(s), 10-bit DAC, PWM channels and 45 fast GPIO lines with up to nine edge or level sensitive external interrupt pins make these microcontrollers particularly suitable for industrial control and medical systems.

A relay is a switch worked by an electromagnet. It is useful if we want a small current in one circuit to control another circuit containing a device such as a lamp or electric motor which requires a large current, or if we wish several different switch contacts to be operated simultaneously.

In electronics, a driver is an electrical circuit or other electronic component used to control another circuit or other component, such as a high-power transistor. They are usually used to regulate current flowing through a circuit or is used to control the other factors such as other components, some devices in the circuit. The term is often used, for example, for a specialized integrated circuit that controls high-power switches in switched-mode power converters. An amplifier can also be considered a driver for loudspeakers, or a constant voltage circuit that keeps an attached component operating within a broad range of input voltages.

The ZigBee specification is a combination of Home RF Lite and the 802.15.4 specification. The spec operates in the 2.4GHz (ISM) radio band - the same band as 802.11b standard, Bluetooth, microwaves and some other devices. It is capable of connecting 255 devices per network. The specification supports data transmission rates of up to 250 Kbps at a range of up to 30 meters. ZigBee's technology is slower than 802.11b (11 Mbps) and Bluetooth (1 Mbps) but it consumes significantly less power.

V. CONCLUSION

The demonstration of the hem system based on zigbee is presented for residential DR applications, along with the analysis of the communication time delay and the evaluation of the overall HEM system's residual power consumption. The objective of this demonstration is to evaluate the HEM operation performance, in particular how each load performs when being controlled by the hem unit. Electrical measurements of the four loads under study are presented, including voltage, current, real power, apparent power and power factor. The real-world implementation of the proposed system will benefit electric power distribution companies by helping to avoid distribution transformer overloads with the presence of new power-intensive loads, like electric vehicles.

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