REALTIME ELECTRICITY MONITORING AND CONTROL SYSTEM USING WIRELESS SENSOR NETWORK

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Abstract : The energy resource management is a major concern worldwide. Energy management activities minimize environmental impacts of the energy production. The effort to conserve energy made at a grass root level will help harness the existing resources in more rational manner. Therefore, monitoring electric energy consumption has been proposed as an important process which makes immediate reductions in energy use. It is a way to monitor the expense of energy and regulate the usage if it's made in areas deemed unessential. In recent years, advances in electronics have allowed the implementation of many technological solutions that can help to reduce energy consumption but the reforms have a scope of improvement. The system described in this project is the design and prototyping of a home electric energy monitoring system that provides residents with real time information about their electricity usage. The usage can be monitored via their mobiles and can have a better understanding of where the electricity is being used or wasted. The system designed can be used to monitor electrical parameters such as voltage, current and power of household appliances which makes the monitoring aspect useful for the customers. The system consists of a smart sensing unit that detects and controls the home electrical appliances used for daily activities by following different tariff rates. The user can check the usage of various appliances via the mobile application and can also operate various appliances connected to the system through the mobile application. This will make sure that no resources are wasted while there is utility of the appliances in a proper manner as well. The system uses wireless communication and displays the information on android application, along with features such as Smart alert system and Home automation through android app.

IndexTerms - **Electric energy monitoring, energy management, home automation.**

1. INTRODUCTION

The energy resource management is a major concern worldwide. Energy management activities minimize environmental impacts of the energy production. The effort to conserve energy made at a grass root level will help harness the existing resources in more rational manner. Therefore, monitoring electric energy consumption has been proposed as an important process which makes immediate reductions in energy use. It is a way to monitor the expense of energy and regulate the usage if it's made in areas deemed unessential.In recent years, advances in electronics have allowed the implementation of many technological solutions that can help to reduce energy consumption but the reforms have a scope of improvement. The system described in this project is the design and prototyping of a home electric energy monitoring system that provides residents with real time information about their electricity usage. The usage can be monitored via their mobiles and can have a better understanding of where the electricity is being used or wasted. The system designed can be used to monitor electrical parameters such as voltage, current and power of household appliances which makes the monitoring aspect useful for the customers. The system consists of a smart sensing unit that detects and controls the home electrical appliances used for daily activities by following different tariff rates. The user can check the usage of various appliances via the mobile application and can also operate various appliances connected to the system through the mobile application. This will make sure that no resources are wasted while there is utility of the appliances in a proper manner as well. The system uses wireless communication and displays the information on android application, along with features such as Smart alert system and Home automation through android app.

2. RELATED WORK

Discusses related work, definitions and terms, it also reviews the literature with regards to real time power monitoring. A closer look at the components of the built environment can provide insight into integration between the occupants and those engineered systems of the building that are fulfilling the occupants' needs. Demand response and demand side management are a proven method to save energy for commercial and utility applications. However, this control of energy is a global control within the building, i.e. controlling the mechanical systems by adjusting the overall temperature for the building, and installing occupancy sensors to automatically shut-off the lighting system when no one is present. For this occupancy approach, the shut-off must occur within 30 minutes after the detection of vacancy, defeating the potential short term savings when someone leaves the room [1].

However, many of these systems become inactive or improperly calibrated that a lack of interest in operation persists. Furthermore, plug-in loads that remain on even when not in use waste energy by design. At the residential level, active research is moving toward smart homes, home automation, and smart meters with demand response integration to shut-off loads by the utility when peak demand is high. This is an intrusive method that could collide with user comfort. However, when the user is empowered to make that decision, the savings are sustained, with an adaptive controller learning user‘s energy behavior and determining locations and magnitudes of wasted energy and providing this information to the user to take impulse action to save energy and money at the same time, eliminating the guess work of what else needs to be done to save energy.

To address these issues and provide for a greater savings, a local and global control should be envisioned, modeled, simulated, and tested to make a profound change in how we use energy and how we change our behavior to save energy. The following specific topics are relevant to real-time power monitoring and energy saving, namely, plug-in loads and advanced metering initiatives (AMI), the smart grid and residential energy management, Zero-Net Energy Test Home (ZNETH home), and Building Information Modeling (BIM). With a holistic approach to energy, utilizing these concepts, sustained energy saving and sustainable development become a reality.

Plug-in loads and Advanced Initiative Metering (AIM): The electrical distribution system plays a profound role in the built environment as it is an enabling product, an intangible necessity used to power our systems [2]. According to United States Green Building Council, the built environment in the United States accounts for 72% of electricity consumption, 39% of energy use, 38% of all carbon dioxide (CO2) emissions, 40% of raw materials use, 30% of waste output (136 million tons annually), and 14% of potable water consumption [3]. To influence the 72% electricity consumption, energy efficiency programs in the U.S. emphasize the use of energy saving technologies and design practices.

However, a 2010 study by ACEE [4] of 57 energy conservation projects from 1970-2010 found that feedback gadgets alone are unlikely to maximize energy savings. A similar study conducted by research team in the University of Nebraska-Lincoln found that combining real-time information with novel control methodologies and state-of-the-art technology to provide and enable information to empower users to save energy instantaneously is the motivation in adaptive impulse behavior saving approach in this proposed research.

The Smart Grid and Residential Energy Management: More sophisticated residential energy management is expected to be a key component of the national smart grid power management and control initiative. Recent commentators [5, 6] describe a future in which physical or virtual in-home monitors (so-called "energy dashboards") provide real-time electricity consumption data to residents who will use this data to actively manage their home power consumption. For example, Grid Point and Tendril already offer this and both Google (Google Power meter) [7] and Microsoft (Microsoft Hohm) [8] have announced initiatives to display residential power consumption on personal computers, and many other companies offer a variety of other physical and virtual devices that display aggregate residential electrical power use (at wide ranging prices, from under $100 up to $10,000, others available only through electrical utility pilot projects). These devices are developed and marketed to consumers and electrical utilities with the twin goals of reducing electrical energy consumption (in the case of consumers) and reducing or shifting residential electrical demand (in the case of electrical utilities).

3. PROPOSED ARCHITECTURE

The developed system consists of two electronic devices: data acquisition device which includes the smart switches and a custom micro-controller and data display device which includes the smart phone. The data acquisition device measures power and energy consumed by loads and the data display device displays measured data and sends results to the smart phone/computer.

The main features of this monitoring system are: wireless communication between acquisition and display devices, monitoring capability at the appliance and switchboard circuit's level, average hourly energy use and electricity cost information display, and data recording on the computer. Wireless communication between devices ensures greater flexibility and system's ease of use. The system's ability to monitor both appliance level and switchboard circuit's level informs the consumer about the balance of each appliance or circuit load. The knowledge of average hourly energy use and electricity cost provides important information that motivates changes to consumer's behavior.

General Architecture:

The data acquisition device diagram block is represented in figure 1. This device consists of five major blocks: power integrated circuit (IC), microcontroller, wireless transceiver, signal conditioning and smart switches. The data acquisition device measures line voltage and current signals through appropriate sensors. These analog signals are then conditioned and used by a power IC, which measure voltage, current, power factor and active power. This information is transmitted to a microcontroller that computes the energy consumed by a load and communicates with a wireless transceiver. The transceiver is responsible for sending the measured data to the data display device and for receiving commands from the user.

Data display device receives measured data from the data acquisition device through a wireless transceiver. The transceiver sends the received information to a microcontroller.

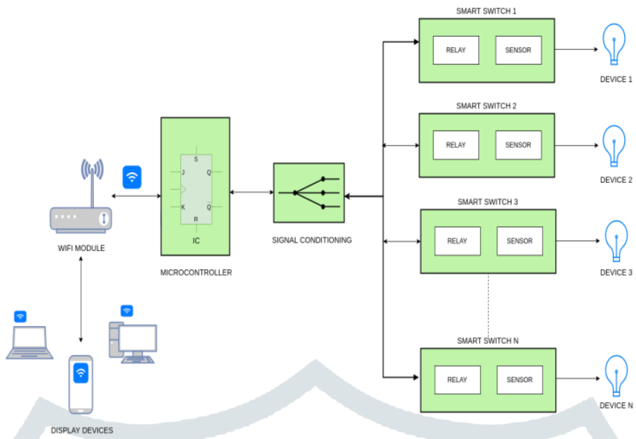

FIGURE 1: FLOW OF PROPOSED SYSTEM

This microcontroller is responsible for several operations, including data driving, communication with different appliances and electricity cost calculation. The device allow the user to select and perform many functions, such as data measurement initialization, power IC calibration, electricity tariff definition, statistics and analytics, alert systems, report generation and home automation.

4.CONCLUSION

Awareness of electricity consumption in the home or building is a first step towards saving energy. The combination of alternative energy and pervasive technologies for monitoring and controlling energy consumption is a powerful vehicle for reducing energy demand. With effective feedback about energy consumption and control of household appliances, users can be motivated and encouraged to change their behavior on energy use such as turning off lights or reducing heat. These small changes in behavior can lead to significant energy savings. This paper presents a smart energy management system for homes and buildings. The proposed system can monitor and measure electricity usage in real-time. With the proposed system, users can remotely control real-time electricity usage through web and other mobile devices such as smart phones or smart pads.

REFERENCES

1. ANSI/ASHRAE/IESNA Standard 90.1-2007: Energy Standard for Buildings Except Low-rise Residential Buildings, American Society of Heating, Refrigeration and Air-conditioning Engineers, Atlanta, GA.
2. Ed Carroll, Eric Hatton, Mark Brown, ―Residential Energy Use Behavior change Pilot,‖ CMFS project code B21383, April 20, 2009 Franklin Energy
3. U.S. Green Building Council, "Green Building Facts." U.S.Green Building Council. www.usgbc.org/ShowFile.aspx?DocumentID=5961, Accessed 7-21-2010.
4. Abrahamse, W., Steg, L., Vlek, C. & Rothengatter, T. (2010). A review of intervention studies aimed at household energy conservation. Journal of Environmental Psychology, 25, 273-291.
5. Grunwald, M. (2009). Wasting our watts: We don‗t need new drilling or new power plants, we need to get efficient. Time, 173 (1), 32-36.
6. Parks, B. (2009). Home energy dashboards. Make: Technology on Your Own Time. 18, 48-51.
7. Google powermeter, http://www.google.com/powermeter/about/, Accessed 7-212010
8. Conserve Energy, Save Money-Microsoft Hohm, http://www.microsoft-hohm.com/, Accessed 7-21-2010.