A sensor Web Model for Domestic Electric Power Management

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ABSTRACT

There is so much research have taken place in electrical transmission, distribution and consumption from point of view performance and reducing cost of distribution. But the consumption measurement and monitoring leaking, wastage and consumer aware of information in terms usage and online bill payment transparently. But recent studies have highlighted that a significant part of the electrical energy consumption in residential and business buildings is due to an improper use of the electrical appliances. In this context, an automated sensor web based power management system - capable of reducing energy wastes while preserving the perceived comfort level - would be extremely appealing in the context of India particular. Towards this objective, we proposing a (WSN) Sensor web model architecture for domestic power management. A a sensor-based intelligent system that monitors the energy consumption and communicates to a central server to web live. It has been experimenting in a real household scenario. The analysis and model experimental results expected will give more significant benefits such as energy savings, transparency in bill payment and elimination of misuse.

Keywords – sensor web, WSN, energy saving, web model, automated sensor web, domestic power management

I. INTRODUCTION

Residential and business buildings account for approximately 20% of the overall world-wide energy consumption [1], with an increasing trend over time. The major causes of energy consumption in buildings are space heating and conditioning, water heating, lighting, and the use of computers and other electronic devices [2]. A significant part of this energy consumption is due to an improper use of such appliances and devices. Just eliminating energy wastes, without lowering the level of perceived comfort, would reduce the overall energy consumption in buildings by approximately 30% [3]. One of the main sources of energy waste is represented by electrical appliances in standby mode which accounts for approximately 10% of the overall energy consumption in buildings [2].

According to a number of studies, providing appropriate feedbacks to building occupants can significantly reduce the overall energy consumption, in the order of 5-20% [4,5]. However, only relying on people’s awareness and behavior may not be an effective approach. Indeed, a recent experimental study [6] has shown that more than 30% energy saving was achieved immediately after installing a monitoring system in a residential household, but the percentage reduced to less than 4% one month later. An automated energy management system in addition to user cooperation would be certainly a more effective solution. In this paper we propose sensor web system for monitoring and the power consumption of each house or a building.

A single wireless energy monitoring sensor easily clipped to the Main electrical unit. The energy monitoring unit transmits energy data wirelessly to a central server for processing and data and post to web live. It has long term benefits and comprehensive solutions in addition to theft reduction. It is proposed that the latest IT technology in meters, for metering, billing and payment for such remotely scattered large number of retail customers can be done with web interface. This process eliminates the traditional “paper and pen” and the errors associated with manual reading/ recording/ processing of the meter data. The paper is organized as follows. Section II describes the related work. Section III introduces sensor web model architecture, while Section IV describes its implementation benefits. Conclusions are drawn in Section V.

II. RELATED WORK

Wireless sensor networks (WSNs) have been widely used in the past for environmental monitoring applications. Recently, they have also been considered for real-time and fine-grained monitoring of electricity consumption in buildings. A distributed monitoring system - based on a network of AC power meters - that allows users to view their individual energy consumptions through a web interface. Wireless sensor networks have been widely used in the past for environmental monitoring applications. Recently, they have also been considered for real time and fine grained monitoring of electricity measurement. Automatic Meter reading also makes the data recording fast and saves on time and hence complies with the definition of automation [1]. This paper briefly describes the design and implementation of web service for domestic power management –that allows users to view their individual energy consumption for a period of time to pay their bills through the web. The research is to achieve full and detailed visibility of electricity consumption lively through the web. Our paper presents a system that is able to provide a interface between single electricity sensor attached to the main electrical unit. Monitoring
energy consumptions in households as well as industries through this web service works effectively and efficiently. All the previous research works mainly focusing on energy monitoring, while our work also addresses the problem of energy conservation through online power management of electrical appliances. An automated sensor based power management system, just similar to one in this paper proposed [3]. Here however, the emphasis is mainly on architectural and design issues, rather than on an experimental analysis. On the contrary, we implemented our proposed system and deployed it in a real house hold scenario so as to perform an experimental study is going. An automated system for optimizing the energy consumption of the heating, ventilation and cooling (HVAC) system in homes is presented in [4]. Smart home can be very helpful to power management to estimate and control customer power demand in order to optimize energy production and transmission and to avoid costly peaks that usually happens in house hold electricity meter. The goal in this case is to equalize energy demand and to allow a more efficient use of green energy sources regulating energy consumption in real time on the base of availability. The idea of regulating energy demand motivates the research on home automation and communications network systems to control home appliances [6].

III. POWER MANAGEMENT THROUGH WIRELESS SENSORS

1. Automatic Meter Reading (AMR)

It is a process of digitally noting the energy meter readings. Meter readings is the feedback loop for the utility’s efficient operation and besides completing the Revenue cycle, the meter reading provides vital data for the following utility operations.

i. Billing
ii. Energy Audit
iii. Tariff formulation
iv. Electricity regulator
v. Load research
vi. Grouping of feeder

We have switched over to intelligent electronic meters to avail its benefits. Now it is needed to change the meter reading process. The work is motivated by the observation that mature research in the area of appliance load monitoring is as yet not transferred to actual commercial integration. Hart[5] proposed a new approach two decades ago, transitioning from complex hardware with simple software to simple hardware with complex software for measurement analysis. Although Appliance Load Monitoring tool poses to be a powerful and inexpensive tool for disaggregating electrical costs for a domestic setting, its potential is yet to be realized in the commercial sphere.

2. Energy Conservation Strategies

The system architecture has been designed with the aim of allowing a flexible and efficient management of domestic energy management so as to provide the potentials for implementing appropriate energy conservation strategies for (or class of appliances). In the following we provide a (non exhaustive) list of such strategies.

3. User awareness.

If users are aware of the energy consumption of each electric load, they can use electrical energy in a more efficient and convenient way. To this aim, the sensor web is a distributed sensing system provides the users with detailed and real-time information on the instantaneous energy consumption and status (i.e., on/standby/off) of data, even remotely. Further, it can also send periodic reports (e.g., by e-mail) on the use of electrical energy. Finally, it can alert the users by sending a message to a portable device when some specific events occur (e.g., an appliance is active when it is supposed to be inactive), also suggesting possible actions to save energy.

4. Reduction of stand-by consumptions.

For domestic power management sensor web allows the user to specify an appropriate management strategy to reduce (or also eliminate) standby wastes. Indeed, it can recognize when an appliance is in standby mode and take appropriate actions to execute the strategy defined by the user. For example, the system can switch off a certain appliance after a predefined time interval has elapsed from when it entered the standby mode.

5. Scheduling of flexible tasks.

The cost of electrical energy varies during the day and typically is cheaper during the night. Thus, some energy consuming tasks that do not require a user involvement can be scheduled for execution when the energy cost is lower. WSNs allows the user to specify the exact time or time interval (e.g., the slot time when the energy costs are lower) when a certain task is to be executed by a specific appliance (e.g., the washing machine).

The synergy between the strategies for appropriate scheduling of flexible tasks and reduction of standby consumption can actually minimize the energy consumption of electrical appliances. For example, the washing machine can be switched on by the system only at the pre-programmed time. Once the task has been completed.
the appliance enters the standby mode. This is detected by the system and the washing machine is then switched off.


A significant fraction of energy is wasted due to electrical appliances that are unnecessarily active, e.g., lamps switched on when the external light intensity is high, air conditioning system providing a too low ambient temperature, and so on. To eliminate this kind of wastes, sensor domestic power management relies on environmental sensors capable of monitoring ambient conditions (e.g., temperature, light intensity, humidity, presence of persons, etc.). Data acquired by environmental sensors are conveyed to the central server, through base stations located at each floor, and used by the system to adapt the behavior of each single appliance, based on rules specified by the user (e.g., desired light intensity).

III. SENSOR WEB MODEL

The overall system architecture is composed of electrical meter and electricity sensor attached namely the monitoring and the control subsystems. The former Acquires at prefixed time intervals measures of the energy consumption of the analyzed and context information (e.g., temperature, light intensity, presence of persons). The latter exploits the data collected by the monitoring system and some energy conservation strategy to control the behavior of electricity meter. In the following we will analyze the two subsystems in detail. In the AIM architecture, the wireless sensor network (WSN) provides the basic tools for gathering the information on user behavior and its interaction with appliances from the home environment. Moreover, the sensor network provides measurements of some physical parameters like temperature and light that can be used by the system to perform some automatic adjustment of the energy management system.

![Diagram 1](image1.png)

**FIG.1** - Depicting an overview of a system for real time management of electric power consumption activities.

![Diagram 2](image2.png)

**FIG.2** - depicting a sensor clamp coupled to a domestic power digital meter for sensing the number of energy units consumed by the domestic power digital meter.

The sensor network can be implemented using several available communication technologies. Generally speaking, WSNs are today considered the most promising and flexible technologies for creating low cost and easy to deploy sensor networks in many scenarios including home automation. Since in the considered scenario...
the area to be monitored is usually relatively small, it would be possible to consider a single WSN interconnecting all the sensing devices needed for monitoring physical parameters and user activities.

Fig. 3- a flow diagram depicting a method of sensing energy units for real time monitoring of domestic digital meters through the data base.

Fig. 4- a flow diagram depicting a method for online bill payments, real time monitoring and working status of the corresponding domestic power digital meter.

However, in practice this option is not the most convenient one. For cost and commercial reasons heterogeneous technologies (with different transmission mechanisms and/or protocol stacks) may be adopted by appliance
 manufacturers and then integrated together in the home network. Moreover, the features of the sensor network can be tailored on user needs and the specific characteristics of the environment adding new groups of sensing devices even a later stage when the system is already in operation. For these reasons, we propose a hierarchical hybrid network architecture consisting of different islands of sensor nodes (mainly) homogeneous WSNs, but also wired technologies can be included) interconnected through gateways. These are higher layer devices able to communicate via heterogeneous links that can be either wireless (Wi-Fi, ZigBee, etc.) or wired (PLC, ethernet, etc.) and to perform some data aggregation and processing tasks. The network topology created among the gateways is possibly meshed to ensure reliability and resilience to failure.

The above figure 4 describes that the data from electric meter is retrieved by an electric sensor attached to the electrical unit. The retrieved data is sent through a gateway to the base station with some unique parameters. The base station plays a vital role in this domestic power management as it sends the data from the electrical sensor to the central sensor web server. The user can access the data by using the internet to view their energy consumption and bill payment individually through the internet.

IV. IMPLEMENTATION

1. Measurement and Billing
a) The time to access the site and time to read the meter manually will be curtailed.
b) Meter readings will be accurate and human errors while reading, recording and data entry are eliminated.
c) The accessibility obstacles to meter on account of location (Rural/indoor) will be eliminated.
d) Meter reading cost i.e., Number of meter readers and transportation/travel cost will be reduced.
e) Risk/Other wise the insurance cost will be minimized.
f) There will be sealing on seals and stationeries.
g) The cash flow will be improved due to faster meter reading, bill preparation and distribution.
h) There will be quick detection of any defect in the meter.
i) Consumers complaints on A/C of meter reading/billing will be avoided.

2. AMR use to the the consumers
a) Consumers can budget their expenditure on electricity by regularly keeping a watch on it.
b) The reading date for each month can be fixed. The consumption period will neither expand nor shrink on a/c of variation of size of calendar month or due to any reason.
c) Total transparency in meter reading/billing is ensured.
d) The bills through email are available to the consumer through internet.
e) Improved service quality, faster response time will eliminate consumer complaints and result in customer satisfaction.

Fig. 2 A sample test consumption of energy through simulation.
V. CONCLUSION
In this paper we have introduced an automated sensor web based power management system-capable of reducing energy wastes while preserving the perceived comfort level would be fantastic approach in the context. The goal of sensor web model architecture for domestic power management that monitors the energy consumption and communicates to a central server to web live. On the other hand, it allows an improved energy management technique, rules specified by the user. This process is ongoing in our sensor web research lab to show the experimental results through web. Presently the results are optimistic, by eliminating the consumptions and or adapting the behaviour of appliances to the real environment conditions. The main objective of this model is that the experimental results expected will give more significant benefit such as energy savings, transparency in bill payment and elimination of misuse. In addition next – generation electrical appliances will include built in sensors and actuators.

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References

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