Smart Sensors and Actuator for Power Management in Intelligent Buildings (IB) Using WSN

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Abstract – The wide range discipline of mechatronics can be technically combining mechanical and electronics engineering, it associates the integration of mechanical, electrical, control and computing to create real time functional products. The design and analysis to develop a smart monitoring and controlling system for household electrical and electronics appliances in real time has been studied. The system mainly monitors electrical parameters of household electrical and electronics appliances such as voltage and current; thereafter it observes and calculates the units of power consumed. The proposed system is the implementation of the controlling mechanism of electrical and electronics appliances in different ways like by server or by user. The user can control the home appliances by sending message to GSM module using Wireless Sensor Networks (WSN). The Power Management in Intelligent Building (IB) system is a low cost and flexible in operation and thus can save electricity expense of the consumers using WSN. The prototype has been thoroughly tested in real time and an experimental result shows the better performance in power consumption.

***Index Terms*: Power Management, Home Automation, Intelligent and Control System, Wireless Sensor Networks (WSN).**

1. INTRODUCTION

It is predict that service and personal care wireless mechatronic systems will become more and more all over at home in the near future and will be very useful in adaptive technology health care particularly for the elderly and disabled people. Wireless mechatronic systems consist of various contiguous distributed sensors with limited data collection and processing ability to monitor the environmental situation periodically. Wireless Sensor Networks (WSNs) have become increasingly important because of their capability to monitor and manage situational information for various intelligent building services. Due to those advantages, WSNs has been applied in many fields, such as the military, industry, environmental monitoring, and healthcare [2].

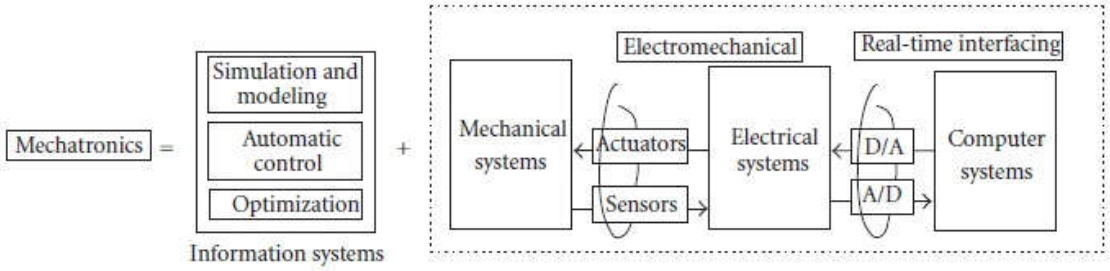

Fig.1 Process of Mechatronics

Mechatronics is a theoretical analysis used for the optimal design of electro-mechanical products. The term was coined arround 40 years ago, in 1969, when the engineer Tetsuro Mori combined the words "mechanical" and "electronic" to view the electronic control systems that Yaskawa Electric Corporation was building for the mechanical factory equipment.

Mechatronics is a design principle, which is an integrating approach to an engineering design process as shown in Fig.1. The primary factor in mechatronics is the involvement of these areas throughout the design. Through a mechanism of simulating interdisciplinary ideas and techniques, mechatronics provides ideal conditions to raise the synergy, thereby providing a catalytic effect for the new solutions to technically complex situations. An important characteristic of the mechatronic devices and systems is their built-in intelligence that results through a combination of precision mechanical and electrical engineering and real time programming integrated to the design process [1].

The WSNs are increasingly being used in the home for energy controlling services. Regular household appliances are monitored and controlled by WSNs installed in the home. New technologies include cutting-edge advancements in information technology, sensors, metering, transmission, distribution, and electricity storage technology, as well as providing new information and flexibility to both consumers and providers of electricity [14]. The GSM and GPRS wireless communication platform is presently examining Japan's new smart home wireless system implication by having a new initiative with Japan's Government that will evaluate use of the forthcoming GSM, Internet Protocol (IP) specification, GSM and GPRS help Japan to create smart homes that improve energy management and efficiency [16]. It is expected that 65 million households will equip with smart meters by 2015 in the United States, and it is a realistic estimate of the size of the home energy management market [17].

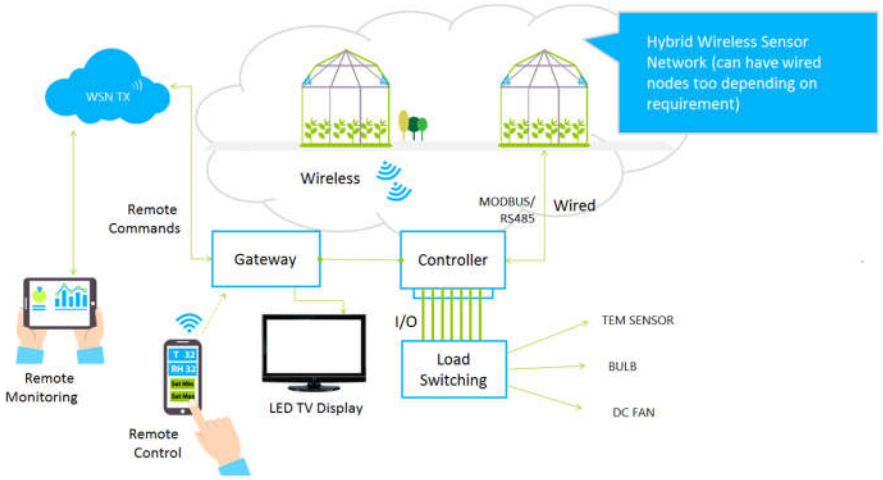

Fig.2 Wireless Sensor Networks Architecture

There are various methods to interconnect more domestic appliances by wireless networks to monitor and control such as provided in [3], [4]. But the prototypes are verified using test bed scenarios. Also, smart meter systems like [4] & [6] have been designed to specific usages particularly related to geographical usages and are limited to specific places. Different information and communication technologies integrating with smart meter devices have been proposed and tested at different flats in a residential area for optimal power utilization [7], [8], but individual controlling of the devices are limited to specific houses. There has been design and developments of smart meters predicting the usage of power consumption [8]. However, a low cost, flexible, and robust system to continuously monitor and control based on consumer user requirements is at the early stages of development. In this proposed system, the design analysis and implemented a GSM and GPRS based intelligent home energy management and control service. The GSM and GPRS technology for networking and communication because it has low power and low cost characteristics which enable it to be widely used in home and building environments. Fig.2 shows the Wireless Sensor Networks Architecture.

The proposed system focuses on human friendly technical solutions for monitoring and easy control of home appliances. The resident user comfort will be increased and better assistance can be provided. This proposed system emphasizes the realization of monitoring and controlling of electrical appliances in many ways.

The developed system has the following noticeable features.

1. Using GSM and GPRS technology, the home appliances are controlled either remotely or locally, this section is fed to microcontroller board to supply automatically with the help of fabricated smart operating voltage sensing unit.
2. Microprocessor/Microcontroller is used to design analysis of smart sensing unit which is used as a processing unit at the sensor end.
3. Accommodation in controlling the home appliances: Depending on the user requirements, home appliances can be monitored and controlled in different ways.

2. SYSTEM DESCRIPTION

The system has been designed for measurement of electrical parameters of household appliances. Important functions to the system are the ease of modeling, setup, and use. From the consumer point of view, electrical power consumption of various appliances in a house along with supply voltage and current is the key parameter. Fig.3 shows the functional block diagram description of the developed system to monitor electrical parameters and control appliances based on the consumer requirements. The measurement of electrical parameters of sensing home appliances is done by interfacing with fabricated sensing modules. The details of the design and development of the modules are provided in the following sections. The output signals from the sensors are integrated and connected to energy meter module for transmitting electrical parameters data.

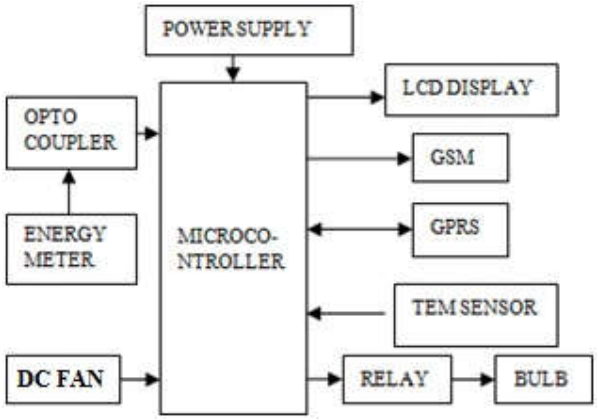

Fig.3 Functional Block Diagram

In this proposed system the controller automatically finds the temperature value. When the temperature value is exceeds the threshold value the fan will automatically ON. Voltage sensing circuit, current sensing circuit will show the voltage & current of BULB. Energy meter will show units consumption of the devices. Through GPRS server we can ON or OFF the loads at any time. And how much of electricity is consumed by the loads that information also posts in to server by using of GPRS module. Through GSM module we can on OFF the load by sending message.

By analyzing the power from the system, energy consumption can be controlled. An electricity tariff plan has been set up to run various appliances at peak and off-peak tariff rates. The appliances are controlled either automatically or manually. The smart power metering circuit is connected to mains 240 V/50 Hz supply.

This regulated 9V is generated by stepping down the voltage from 230V to 9V now the step downed ac voltage is being rectified by the Bridge Rectifier using 1N4007 diodes. The rectified AC voltage is now filtered using a C - filter. Now the rectified, filtered D.C. voltage is fed to the Voltage Regulator. This voltage regulator provides/allows us to have a Regulated constant Voltage which is of +9V. The rectified; filtered and regulated voltage is again filtered for ripples using an electrolytic capacitor 100µF. Now the output from by analyzing the power from the system, energy consumption can be controlled. An electricity tariff plan has been set up to run various appliances at peak and off-peak tariff rates. The appliances are controlled either automatically or manually (local/remotely). The smart power metering circuit is connected to mains 240 V/50 Hz supply. Fig.4 shows different appliances connected to the developed smart sensing system.

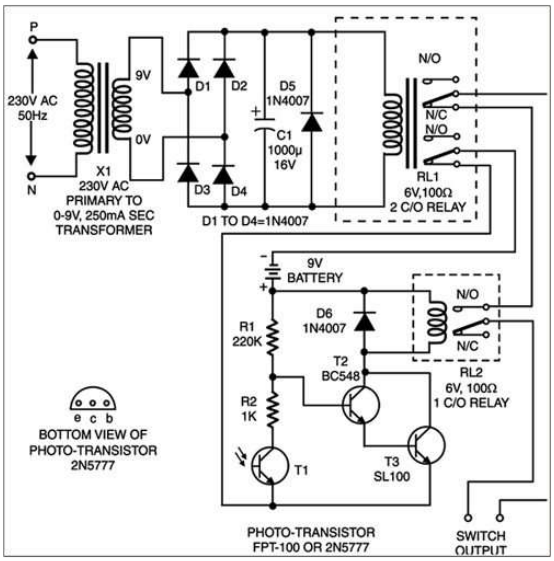

Fig.4 Schematic Diagram

3. RESULT AND DISCUSSION

The proposed system is having the facility of getting the voltage, current and power units reading at any time on the server. The Fig.5 shows the message which is send by the customer to GSM. Similarly Fig.6 and Fig.7 shows Data on Server respectively.

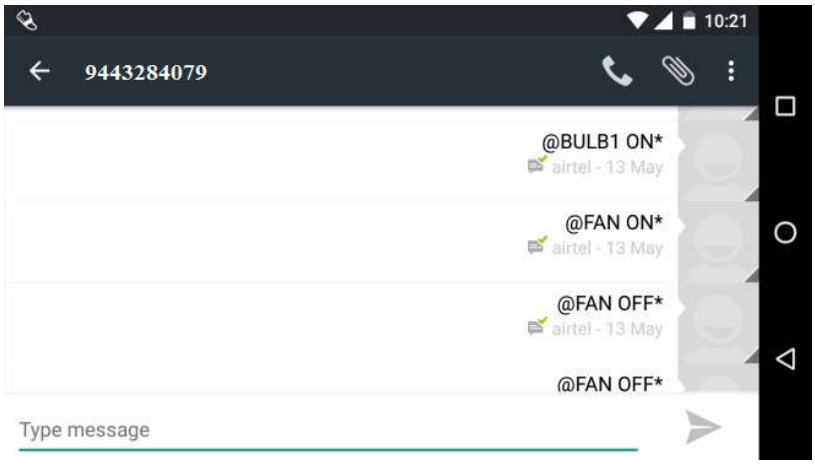

Fig.5 Message which is send by the customer to GSM

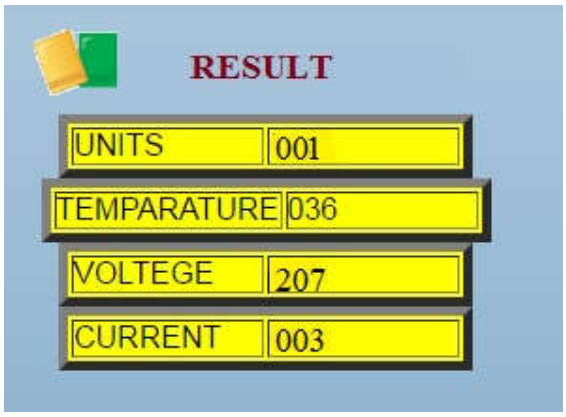

Fig.6 Data shown on server

Fig.7 Server Data

4. CONCLUSION

A smart power monitoring and control system has been design analyzed and developed toward the implementation of an intelligent building. The developed system effectively monitors and controls the electrical appliance usages at an elderly home.

Thus, the real time monitoring of the electrical appliances can be viewed through a online. The system can be extended for monitoring the whole intelligent building. The aim to determine the areas of daily peak hours of electricity usage levels and come with a solution by which lower the consumption and enhance better utilization of already limited resources during peak hours. The sensor networks are programmed with various user interfaces suitable for users of varying ability and for expert users such that the system can be maintained easily and interacted with very simply. This study also aims to assess consumer's response toward perceptions of smart grid technologies, their advantages and disadvantages, possible concerns, and overall perceived utility.

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