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WSN Based Smart Power Monitoring and Controlling System for Home Automation

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ABSTRACT: In this paper, we have developed wireless sensor networks based smart power management system to control and monitor the power consumption of electrical appliances in a home. System is developed for helping users to operate home appliances with their own smartphones .The aim of my project is to help handicapped or elderly people to live independent life as long as possible. The focus of our system is to operate and to take care of several domestic appliances that may normally be difficult for handicap or elderly live. sensor is placed at electrical loads to sense the current and voltage for calculating the power consumption of electrical appliances. This measured data is transmitted wirelessly using Zigbee module to the Ethernet shield. The transmitted data is monitored and controlled remotely using router. User can control this system remotely, manually, automatically using smartphones. This system is very flexible, efficient and cheaper thus can save electricity expense of the constomer.

KEYWORDS: wireless sensor network, Power management, home automation, Ethernet Shield, Zigbee module

I. INTRODUCTION

It is observed in future that personal care wireless mechatronic systems will become more and more ubiquitous at home and will be very useful in health care particularly for the elderly and handicapped people . To monitor the environmental situation WSN is very useful. Wireless mechatronic systems consist of various ssensors with limited data collection and processing capability to observe the environmental situation. Wireless sensor network have become very important because of their ability to monitor and manage situational information in number of intelligent services. Due to those advantages, WSNs has been used in many fields, such as the military, industry, environmental monitoring. Electric power is the important source for the advancement and development in todays technological world . The technology develops the power requirement and hence day by day power demand is increasing . According to the recent Annual Energy report it is observed that domastic electricity demand is forecasted to increase by 24% within these several decade and the global electricity consumption trend is also reported to be increasing continuously . Power demand is increasing day by day and the fossil fules are vanishing due to rising consumption of energy. The gap between demand and supply is increased. Residential energy consumption tends to grow very fast because more and more home appliances and consumer electronics are installed.

In this technological world internet technologies and WSN are expanding rapidly. Thus home environment has seen a rapid introduction of network enabled digital technology ,which offers various newly introduced opportunities for the connectivity of devices within the home for purpose of home automation. For reducing the energy consumption wireless sensor networks (WSNs) is recommended everywhere.WSN is widely used for environmental monitoring, health monitoring, home automation and industrial monitoring . Wireless sensor network uses Web services and middleware technologies for power management and power monitoring.. This system is designed by the integration of WSNs with aurduino compatable expansion board called as Ethernet shield. This Ethernet shield gives your aurduino board the ability to communicate as server or client on Ethernet network. Energy information is collected from various wireless devices which operates with different communication standards. Household appliances are monitored and controlled using WSN in the home, offices, hospitals, and various institution.

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II. RELATED WORK

Guangming Song and Aiguo Song presents the design and implementation of a home monitoring system based on hybrid sensor networks. The system follows a three-layer architecture which combines hybrid-node networking with web access. An enhanced sensor node has been designed and fabricated to add controlled mobility to wireless sensor networks. The mobile node is capable of simple planar motions and is easy to be controlled through different user interfaces. A test bed including the static nodes as well as the mobile node has also been created for validating the basic functions of the proposed hybrid sensor network system. Network repair and event tracking capabilities of the mobile sensor node were tested. Stability of the proposed system in longtime home monitoring tasks was also verified. Pedro Cheong and Ka-Fai Chang describes a ZigBee-based wireless sensor network node for the ultraviolet (UV) detection of flame. The sensor node is composed of a ZnSSe UV photodetector, a current-sensitive front end including a high-gain current-to-voltage amplifier with 120 dB and a logarithm converter, and a transceiver operated at a 2.4-GHz industrial, scientific, and medical band. A passive photodetector is designed to have a cutoff at 360 nm and convert the UV emission of flame into picoamperes. Including mixed signal processing and ZigBee transmission, the speed of flame detection is as fast as 70 ms. The sensor node consumes only an average of 2.3 mW from a 3.3-V
supply. The performance of a prototype sensor node was verified when the luminous flame was imaged onto the sensor node with different angles ranging from −30◦to 30◦and distances of 0.1, 0.2, and 0.3 m enabling effectivefire safety applications.

Khusvinder Gill and Shuang-Hua proposed A ZigBee
Based Home Automation System This technology offers new and exciting opportunities to increase the connectivity of devices within the home for the purpose of home automation. Moreover, with the rapid expansion of the Internet, there is the added potential for the remote control and monitoring of such network enabled devices. However, the adoption of home automation systems has been slow. This paper identifies the reasons for this slow adoption and Evaluates the potential of ZigBee for addressing these problems through the design and implementation of a flexible home automation architecture. A ZigBee based home automation system and Wi-Fi network are integrated through a common home gateway. The home gateway provides network interoperability, a simple and flexible user interface, and remote access to the system. A dedicated virtual home is implemented to cater for the system's security and safety needs. To demonstrate the feasibility and effectiveness of the proposed system, four devices, a light switch, radiator valve, safety sensor and ZigBee remote control have been developed and evaluated with the home automation system.

Dae-Man Han and Jae-Hyun Lim introduced the home energy control system design that provides intelligent services for users and demonstrate its implementation using a real testbed. This paper designs smart home device descriptions and standard practices for demand response and load management "Smart Energy" applications needed in a smart energy based residential or light commercial environment. The control application domains included in this initial version are sensing device control, pricing and demand response and load control applications. This paper introduces smart home interfaces and device definitions to allow interoperability among ZigBee devices produced by various manufacturers of electrical equipment, meters, and smart energy enabling products.

Francesco Benzi and Lucia Frosini reported electricity Smart Meters Interfacing the Households. They addresses this topic by proposing the definition of a local interface for smart meters, by looking at the actual European Union and international regulations, at the technological solutions available on the market, and at those implemented in different countries, and, finally, by proposing specific architectures for a proper consumer-oriented implementation of a smart meter network.

Meng-Shiuan Pan and Lun-Wu Yeh proposed a WSN-based intelligent light control system for indoor environments. Wireless sensors are responsible for measuring current illuminations. Two kinds of lighting devices, namely, whole lighting and local lighting devices, are used to provide background and concentrated illuminations, respectively. Users may have various illumination requirements according to their activities and profiles. An illumination requirement is as the combination of background and concentrated illumination demands and users locations. We consider two requirement models, namely, binary satisfaction and continuous satisfaction models, and propose two decision algorithms to determine the proper illuminations of devices and to achieve the desired optimization goals. Then, a closed-loop device control algorithm is applied to adjust the illumination levels of lighting devices. The prototyping results verify that our ideas are practical and feasible.

Melike Erol-Kantarci and Hussein T. Mouftah reported Wireless Sensor Networks for Cost-EfficientResidential Energy Management in the Smart Grid. The performance of in home energy management (iHEM)is compared with an

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optimization-based residential energy management (OREM) scheme whose objective is to minimize the energy expenses of the consumers. It shows that iHEM decreases energy expenses, reduces the contribution of the consumers to the peak load, reduces the carbon emissions of the household, and its savings are close to OREM. On the other hand, iHEM application is more flexible as it allows communication between the controller and the consumer utilizing the wireless sensor home area network (WSHAN). This paper evaluate the performance of iHEM under the presence of local energy generation capability, prioritized appliances, and for real-time pricing. We show that iHEM reduces the expenses of the consumers for each case. Furthermore, we show that packet delivery ratio, delay, and jitter of the WSHAN improve as the packet size of the monitoring applications, that also utilize the WSHAN, decreases.

Sean Dieter Tebje Kelly, Nagender Kumar Suryadevara, and Subhas Chandra Mukhopadhyay reported an effective implementation for Internet of Things used for monitoring regular domestic conditions by means of low cost ubiquitous sensing system. The description about the integrated network architecture and the interconnecting mechanisms for the reliable measurement of parameters by smart sensors and transmission of data via internet is being presented. The longitudinal learning system was able to provide a self-control mechanism for better operation of the devices in monitoring stage. The framework of the monitoring system is based on a combination of pervasive distributed sensing units, information system for data aggregation, and reasoning and context awareness. Results are encouraging as the reliability of sensing information transmission through the proposed integrated network architecture is 97%.

III. PROPOSED SYSTEM

A. *Design Considerations:*

The system has been designed for power controlling and power management of household appliances. Important features of the system are the ease of modeling, setup, and use. Electrical power consumption of various appliances in a house is the key parameter from consumer point of view. In the proposed system current sensor and voltage sensor are interfaced to the home appliances for measuring electrical parameters ie. current and voltage of the appliances. Measured current and voltage are used to calculate power consumed by each device . The details of the design and development of the Power management system is provided in the following sections. Fig1 and Fig 2 describes the functional description and designing of developed system. Zigbee module is used for transmition of the measured voltage and current data wirelessly, which is collected from the sensor modules. The zigbee transmitter are interfaced with microcontroller and microcontroller is interfaced with voltage sensor and current sensor . Reliable data transmission takes place between transmitter zigbee and receiver zigbee module .The zigbee receiver has been interfaced through the Serial port of the Ethernet Shield for reliable data transmission to the LAN. With the help of WI-FI router collected data from Ethernet shield has been sent to LAN . Thus home appliances can be monitored and controlled remotely with the help of smartphones. The data controlling operation and data monitoring is performed in three ways. Those are manual controlling, automatic controlling and Remote controlling.

B. *Control Of Home Appliances:*

Smart power monitoring system is integrated with traic. For switching on off the electrical appliances. we used BT136 in this system for controlling the devices. User can operate the devices in three ways.

1) **Automatic control**: In automatic control appliances can be controlled with the help of smart software based on the software programming .By auto switch of the appliances user can save electricity after predefined usage of electricity. We can set limit on electricity consumption for particular home or workplace. In this system user can not use power beyond predefined limit.
2) **Manual control**: In this mode seprate switches are provided directly to the devices. Thus user can manually operates the appliances without following automatic control .Manual control is easiest way to control the devices. This feature has higher priority than automatic control. User can control the devices for appropriate use .
3) **Remote Control:** WSN based smart power monitoring and controlling system has the feature of interacting with the appliances remotely with the help of wifi router. In this mode user can interact with the appliances remotely with smart phone or personal computer. User can operates devices when he is away from devices.

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This feature also reduces manual efforts and time by controlling and monitoring all devices from one place. This is very useful way to operate devices for the elderly and handicapped people. User can monitor the condition of all appliances and do the needful without moving from his/her place. Thus user have flexibility in controlling and monitoring the system through developed prototype.

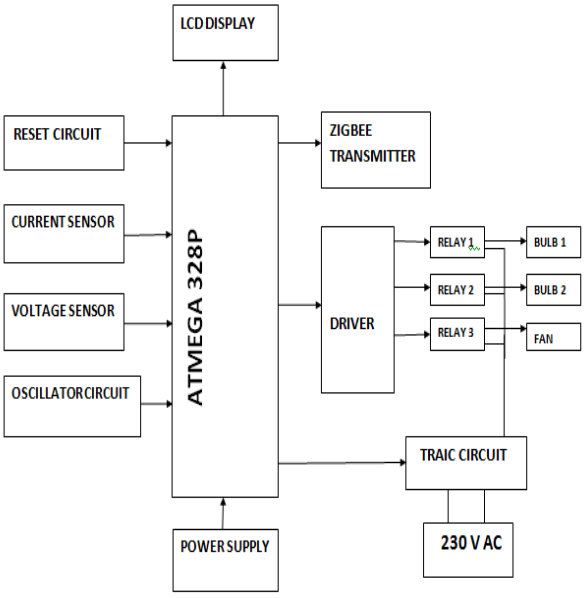

Fig 1 Transmitter Section of Smart Power Management System

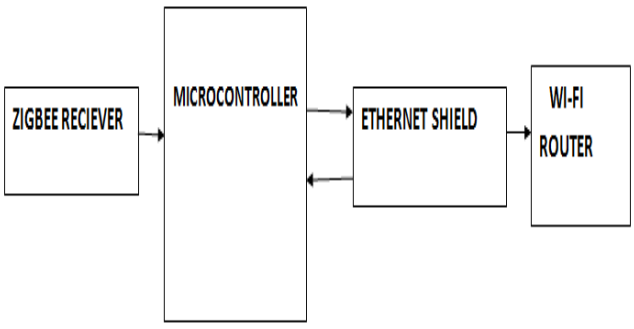

Fig 2 Reciever Section of Smart Power Management System

IV. SIMULATION RESULTS

The system is designed with three relays interfaced with three loads viz D1,D2,D3 which consist of 60 W bulb , 100W bulb and 60 W table fan respectively. Toasters, battery chargers, water kettle, audio devices are successfully tested. Total 3 devices are used for experimental setup. By sensing current and voltage ,power consumption of the appliances are calculated and power usage is displayed on LCD display. These parameters will be analyzed in automatic control. It causes autoswitch off of the appliances when power usage goes beyond specified limit. This enables user to have more cost saving . In manual control method on/off switch is provided directly to the system. User can control the device for its appropriate use whenever required. In remote control user can interact with the appliances remotely with smart phone or personal computer. User can operates all loads D1,D2,D3 when he is away from devices .Graphical user interface of smart power management system is shown in fig3

The transmitter section and receiver section of smart power monitoring and controlling system is developed as shown in fig 4 and fig 5 respectively.

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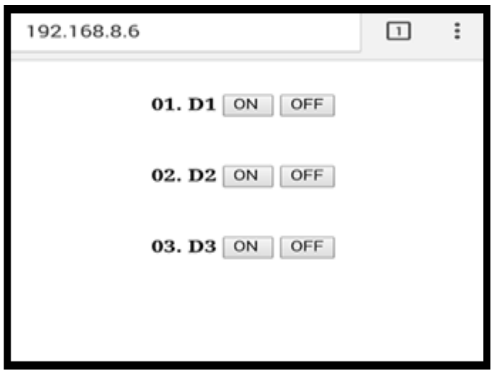

Fig 3.Graphical user interface of smart power management system and controlling system

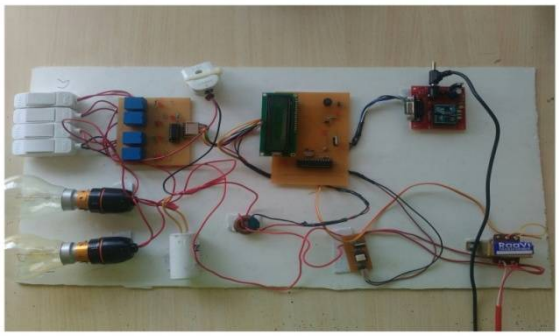

Fig:4.Developed Transmitter Model of smart power monitoring and controlling system

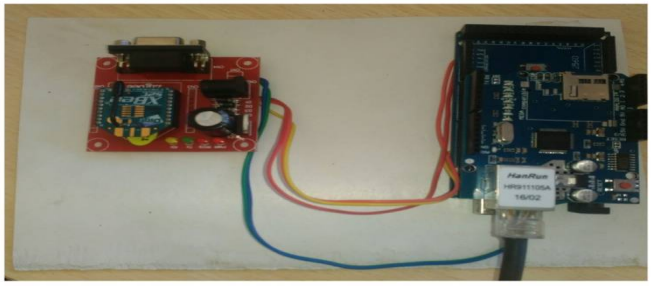

Fig 5 Developed Receiver model of Smart Power Management System

The system has been tested for various appliances and results achieved for the appliances used are shown in the following section. Table 1 shows theoretical and practical values of current ,voltage and power consumption of appliances. Table 2 shows the percentage error for all measured parameters with the corresponding references. It is seen hat maximum error is less than 7% for the domestic appliances. Hence it has been decided that power can be calculated without considering power factor.

Table 1

Theorotical and practical values of current, voltage, power

	Theorotical Values			Practical Values		
Appliances	Current (Amp)	Voltage (V)	Power (W)	Current (Amp)	Voltage (V)	Power (W)
D1- Bulb	0.43	230	100 W	0.45	213.33	96.00
D2-Bulb	0.26	230	60 W	0.26	211.40	56.00
D3- Fan	0.21	230	50 W	0.20	230.00	47.36

Table 2

Percentage error in received current voltage and power

Appliances	% Current Error	% Voltage Error	%Power Error
D1	4.65	7.24	4.00
D2	0.00	8.08	6.66
D3	4.76	0.00	5.28

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V. CONCLUSION AND FUTURE WORK

WSN based smart power monitoring and control system has been designed and developed for home automation. This system monitors and controls the power consumption of home appliances remotely with the help of smartphones. System is developed for handicapped or elderly people to live independent life as long as possible. The entire system is designed on an embedded platform which is easy to design and also consume less power, The system has very low cost and portable size. Thus, the real-time monitoring of the electrical appliances can be viewed through a predefined website. To determine the wellness of inhabitant in the particular area, the system can be developed with cosystems like smart home inhabitant behavior recognitions systems. Appliances should be controlled and monitored from anywhere in the world without any limitation of distance.

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