ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 3, Special Issue 2, March 2016

INDUSTRIAL POWER MANAGEMENT AND CONTROLLING SYSTEM USING WSN

R. Ramya ,P .Sumathi , D . Tharaliga , A . Nandhini, UG Scholars
GUIDED BY
Mrs. S. Sathya Assistant Professor
DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
BHARATHIYAR INSTITUE OF ENGINEERING FOR WOMEN

***Abstract*—The propose and improvement of a stylish monitoring and controlling system for Industrial electrical appliances in real time. The system principally monitors electrical parameters of electrical appliances such as voltage and current and the power is consumed. This system is the implementation of the controlling mechanism of appliances inside different ways. This industrial system is a low-cost and flexible in operation and it can save electricity outflow of the clients. An aim of this paper is, when the circuit is overloaded at that time to reduce the power and maintain the circuit in ON position. Then it is used to intimate low power to the user. And it is also used to control the electrical appliances automatically. The main objective of this improved system is to save an electricity in peak hours.**

***Index Terms*—Energy management, Appliances automation,Iintellectual control system, wireless sensor network, ZigBee.**

I. INTRODUCTION

IT is the service and personal wireless mechanic systems will become more and more useful at industry in future work and will be very useful in healthcare particularly for the disabled people [1]. Wireless mechanic systems consist of numerous spatially disseminated sensors with limited data gathering and dispensation capability to supervise the environmental circumstances. Wireless sensor networks (WSNs) have become increasingly important because of their capability to monitor and manage situational information for various intellectual services. Due to those advantages, WSNs has been applied in many fields, such as the military, industry, environmental monitoring, and healthcare [2]–[4]. standard electrical appliances are monitored and prohibited by WSNs installed in the industry [5].

New technologies include forward-looking advancements in In-progression technology, sensors, metering, communication, allocation, and electricity storage technology, as well as providing new information and elasticity to both consumers and providers of electricity. The ZigBee agreement, wireless statement proposal is presently investigative Japan's new smart industrial wireless system suggestion by having a new initiative with Japan's management that will evaluate use of the cooperative ZigBee, Internet protocol (IP) condition, and the IEEE 802.15.4 usual to help Japan to create smart homes and industry that advance energy management and effectiveness [6].

It is expected that 65 million households will supply with smart meters by 2015 in the United States(US), and it is a practical estimate of the size of the industry energy management promote [7]. There are several proposal to interconnect various domestic appliances by wireless networks to monitor and control the appliances such as provided in [8], [9]. But the prototype are verified using test cradle scenarios. Also, smart meter systems like [9]–[11] have been planned to definite usages particularly related to environmental usages and are limited to specific places. special information and communication technologies integrating with smart meter devices have been projected and experienced at different flats in a industrial area for best power consumption [12], [13], but individual controlling of the devices are limited to industries. There has been design and improvements of smart meters predicting the usage of power consumption [9]–[13]. However, a low-cost, elastic, and forceful system to constantly monitor and control based on consumer necessities is

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 3, Special Issue 2, March 2016

at the early stages of development. In this learn, we have considered and implemented a ZigBee-based intelligent industrial energy management and control service. We used the ZigBee (IEEE 802.15.4 customary) technology for networking and communication, because it has low-power and low-cost character, which enable it to be widely used in residential and construction environments [10]. The paper focuses on human-friendly technical solutions for monitoring and easy control of electrical appliances. It relieve will be increased and best support can be provided. This paper emphasizes the recognition of monitoring and controlling of electrical appliances in many ways. The improved system has the following dissimilar features.

1) Use of Triac with Opto-isolated driver for controlling electrical appliances: The electrical appliances are controlled either tenuously or automatically with the help of fabricated smart sensing unit consisting of triac –BT138 [14].

2) No microprocessor/microcontroller: The design of smart sensing unit does not require a processing unit at the sensing end.

3) Flexibility in controlling the appliances: Depending on the user requirements, appliances can be monitored and controlled in different ways. The rest of this paper is organized as follows: Section II discusses the associated work and analysis of WSN's constraints for industry energy management systems; Section III provides complete implementation of the developed system; Section IV presents the investigational results and Section V has finished and discussed about the opportunity work. II. ASSOCIATED WORK In this section, we briefly discuss the existing works about smart industrial systems based on the wireless communication technology. Han *et al*. [15] proposed a Industrial Energy Management System (IEMS) using the ZigBee technology to reduce the standby power. The recommended system consists of an automatic standby power cutoff opening, a ZigBee hub and a server. The power outlet with a ZigBee module cuts off the ac power when the energy consumption of the device connected to the power outlet is below a fixed value. The central hub collects information from the power channels and controls these power channels through the ZigBee module. The central hub sends the present state information to a server and then a user can monitor or control the present energy usage using the HEMS user interface. This facility may create some uneasiness for the users. For example, if the users may want low intensity of light ,for some situation but the system will cut the power off leading to darkness .Gill *et al*. [16] projected a ZigBee-based home automation system. This system consists of a home network unit and gateway. The core part of the development is the interoperability of different networks in the home environment. Less importance is given to the home automation. Pan *et al*. [17] recommended aWSN-based intelligent light control system for indoor environments ,such as a home for a reduction in energy consumption. In this paper, wireless sensors are responsible for measuring current illuminations and the lights are controlled by applying the model of user's actions and profiles. Song *et al*. [18] suggested a home monitoring system using hybrid sensor networks. The basic concept of this paper is a roaming sensor that moves the appropriate location and participates in the network when the network is disconnected. Suh and Ko [19] proposed an intelligent home control system based on a wireless sensor/actuator network with a link quality indicator based routing protocol to enhance network reliability. Nguyen *et al*. [20] have proposed a sensing system for Industry-based treatment based on optical linear encoder (OLE); however, it is limited to motion imprison and arm-function estimate for industry based monitoring.

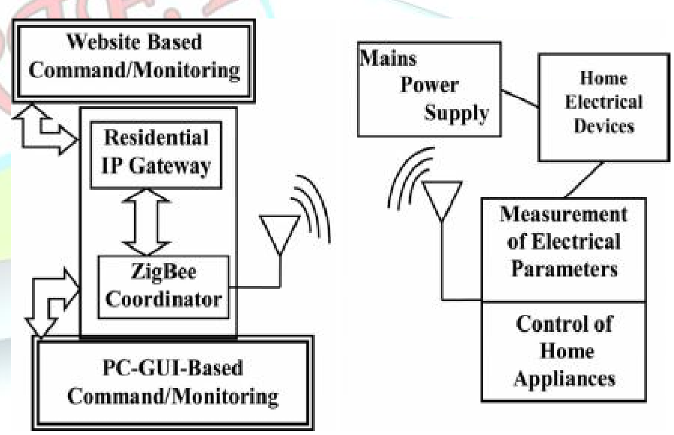


Fig 1 : Functional block diagram of the system

Huiyong *et al*. [21] examined the integration of WSN with service robot for smart home monitoring system. The above mentioned home monitoring and controlling systems have limitations with respect to true home automation such as: 1) energy consumption control mechanism is limited to only certain devices like light illuminations,

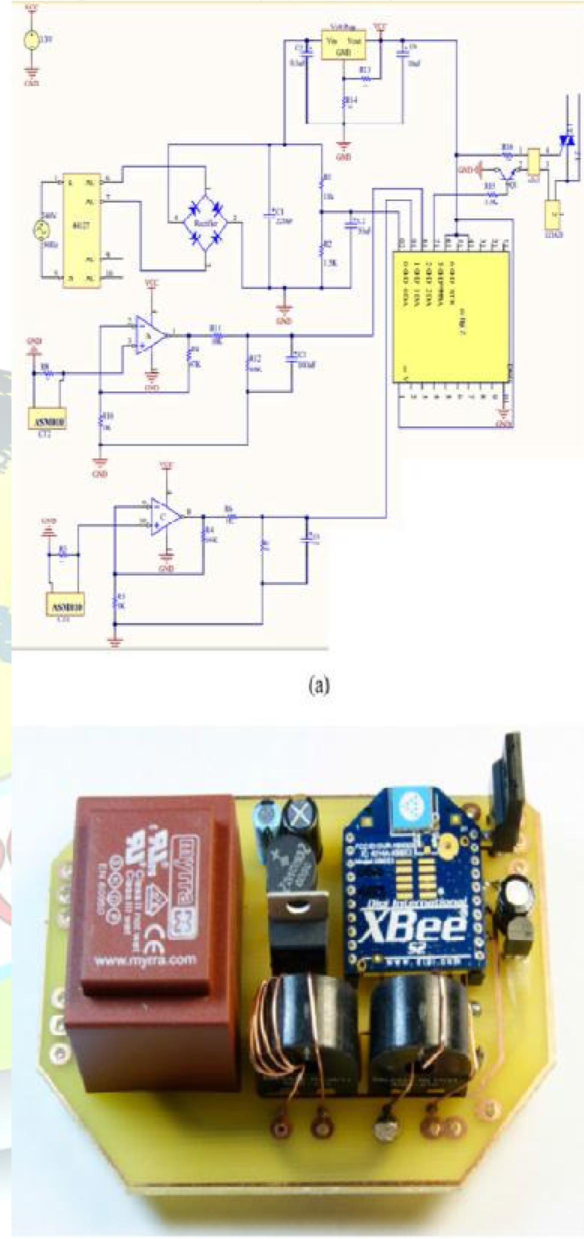
ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 3, Special Issue 2, March 2016

whereas several household appliances can be controlled; 2) energy control is based on fixed threshold power consumption, which may not be appropriate to different consumers; 3) controlling the home appliances through network management functions, in practice dweller requirements may vary according to their behavior but not distinctiveness. Not a single system has taken into selflessness of variable tariff of electricity, which is consumed throughout day and night. In this paper, a low-cost, flexible, and real-time smart power management system, which can easily integrate and operate with the home monitoring systems such as [22] is presented.

III. SYSTEM DESCRIPTION

The system has been designed for measurement of electrical parameters of domestic 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. 1 shows the practical description of the developed system to monitor electrical parameters and control appliances based on the consumer necessities. The measurement of electrical parameters of home appliances is done by interfacing with fictitious sensing modules. The details of the design and development of the sensing modules are provided in the following sections. The output signals from the sensors are incorporated and connected to ZigBee module

for transmitting electrical parameters data wirelessly. The ZigBee modules are interfaced with various sensing devices and interconnected in the form of mesh topology to have reliable data reception at a centralized ZigBee coordinator. The maximum distance between the adjacent ZigBee nodes is less than 10M, and through hopping technique of the mesh topology, reliable sensor fusion data has been performed. The ZigBee coordinator has been connected through the USB cable of the host computer, which stores the data into a database of computer system. The collected sensor fusion data have been sent to an internet suburban gateway for remote monitoring and controlling the industry environment. By analyzing the power from the system, energy consumption can be controlled. An electricity duty plan has been setup 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 linked to mains 240 V/50 Hz supply. Fig. 2 shows different appliances connected to the developed smart sensing system. Fig. 3(a) and



(a)

(b)

Fig2:(a)Overall schematic of voltage,current sensing circuit integrated with ZigBee module
(b)Designed and developed prototype-electrical appliances power monitoring and control

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 3, Special Issue 2, March 2016

1) ***Voltage Measurement:*** The voltage transformer where P_{act} is the actual power, V_{rms} and I_{rms} are the RMS values of voltage and current, respectively, and P_f is the power factor. The output signal of the current transformer completely depends on the nature of the connected appliances whether the connected load is purely resistive, capacitive, or inductive. In most of the domestic appliances, the output waveforms are not pure sinusoidal as shown in the following graphs Fig. 7(a)–(d)for different loading conditions. From the graphs, it is inferred that zero-crossing determination is difficult to measure for some of the appliances and elimination of noise is not trivial. Moreover, it is not important for this application to measure power with zero error. Hence, in our paper, instead of measuring power factor, we have introduced correction factor to normalize the received power with respect to the actual power based on the scaling factors of the voltage and current measured. The power consumed by the appliances is calculated in the computer system after receiving voltage outputs from corresponding current and voltage sensors by the following equation:

$$P_{cal} = V_{act} \times I_{act} \times C_f \quad (4)$$

where P_{cal} is the calculated power; V_{act} the output voltage as given in (1); I_{act} the current value as given in (2); and C_f is the correction factor. The term correction factor is introduced to calculate power accurately by the system. The correction factor is the ratio of actual power to the measured power. Correction factor is required for the power measurement for some loads. This correction factor can be obtained by plotting graph for calculated power against the actual power. Thus, the power is calculated in computer using C Sharp programming after receiving voltage outputs from corresponding current and voltage sensors. The prototype has been tested and results achieved for many household electrical appliances are shown in the following section. Table I shows the percentage error for all measured parameters with the corresponding references. It is seen that the maximum error is less than 5% for the domestic appliances. From the low percentage error of power, it has been decided that power can be calculated without considering power factor.

B. Control of Home Appliances

The current paper is novel in terms of other reported literature due to its control features.

1) Smart Power Metering System integrated With Triac: For switching on/off of the electrical appliances, we have used atriac-BT138 [14]. This enables the purchaser for flexibility in controlling the devices: The users (inhabitants) have the options of switching the device on/off in three different ways.

1) **Automatic control**: Based on the electricity tariff conditions, the appliance can be regulated with the help of smart software. This enables the user to have more cost saving by auto switch off the appliances during the electricity peak hours. The electricity tariff is procured from the website of the electricity supply company and is updated at regular intervals.

It is used in our paper is the 44 127 voltage step-down transformer manufactured by MYRRA [23]. The striking features include two bobbins compartments including self-extinguishing plastics and very light weight (100 g). The step-down voltage transformer is used to convert input supply of 230–240 V to 10 VRMS ac signal. The secondary voltage is rectified and passed through the filter capacitor to get a dc voltage. The details are shown in Fig. 3(a). The available dc voltage is reduced by a potential divider to bring it within the measured level of 3.3 V of the ZigBee. This output signal is then fed to analog input channel of ZigBee end device. The acquired voltage signal is directly proportional to the input supply voltage. A voltage regulator is connected to the rectified output of voltage transformer to obtain the precise voltage supply of 3.3 V for the operation of ZigBee and operational amplifier. The scaling of the signal is obtained from the input versus output voltage graph as shown in Fig. 4. The actual voltage is thus obtained as follows:

$$V_{act} = m_1 \times V_{measured\ voltage} \quad (1)$$

where m_1 is the scaling factor obtained from Fig. 4, V_{act} is the actual voltage, and $V_{measured\ voltage}$ is the measured sensing voltage.

2) ***Current Measurement:*** For sensing current, we used ASM010 current transformer manufactured by Talema [24]. The main features of this sensor include fully encapsulated PCB mounting and compact size. The circuit design layout for current measurement is shown in Fig. 3(a). In this current sensor, the voltage is measured across the trouble resistor of 50 Ω. The necessary filtering and magnification is required to bring the voltage with the necessary measurement level of ZigBee. The scaling factors for current measurement for two different ranges of currents are shown in Fig. 5. Two different current transformers are used for two different ranges: 0–1 A and 1–10 A, respectively. The actual current is thus obtained from (2). The line wire is connected to the

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 3, Special Issue 2, March 2016

load, which is passing through the current transformer. With the use of current transformer, the switching on/off of the electrical appliances, we have used a triac-BT138 [14]. This enables the consumer

TABLE 1
PERCENTAGE ERROR RECEIVED VOLTAGE , CURRENT AND MEASURED POWER

Appliance	Ref. Load (W)	V ref (V)	I. Ref (amps)	Mea. Vol (V)	%Error-Voltage	Mea. Cur (amps)	%Error-Current	Cal. Power (W)	%Error-Power
Bulb	25	229	0.11	229	0	0.11	0.00	25.19	0.76
Bulb	39	229	0.16	230	0.22	0.17	4.25	38.1	4.61
Bulb	59	229	0.26	229	0	0.27	3.85	61.83	4.80
Bulb	73	229	0.32	229	0	0.32	0.00	73.28	0.38
Bulb	96	228	0.43	229	0.44	0.42	2.33	96.18	1.86
Heater	401	226	1.73	225	0.44	1.82	5.20	409.5	2.12
Heater	755	223	3.41	222	0.44	3.45	5.86	781.91	3.56
Heater	1155	224	5.15	223	0.44	5.16	6.43	1145.23	0.85
Toaster	811	226	3.49	226	0	3.56	1.17	808.97	0.25
Toaster	665	234	2.90	235	0.43	2.73	2.01	658.72	0.94
Heater	733	236	3.11	237	0.42	2.91	0.19	703.1	4.08
Heater	1217	235	5.19	236	0.43	5.05	2.70	1192	2.05
Heater	1902	233	8.17	234	0.43	7.83	4.16	1869	1.74
Kettle	1995	233	8.72	233	0	8.18	6.20	1917.2	3.90

C. Residential IP Gateway: Transmission Over IP

In order to transmit real-time sensed data over the internet from the collected computer system, the ZigBee packet information is to be transformed to the Internet Protocol Version 6(IPv6). The key element in the data transformation from Zig-Bee packet is the address translation. This was implemented at the application gateway, a program for determining the source or destination address of a packet that encapsulates a ZigBee packets' payload.

The corresponding application gateway program performs the address transformation mechanism for ZigBee to address non-ZigBee nodes. ZigBee is based upon the IEEE 802.14.5 protocol, which uses a 64-bit address for each node on a personal area network (PAN) and 16 bits to recognize the PAN ID.

IPv6 uses 128 bits to address a node on the network, of which 48 bits correspond to the network, 16 bits represent the local network(PAN ID), and 64 bits represent the host id (sensor node). Therefore, the node address for the IEEE 802.15.4 can be placed in an IPv6 address, and the PAN ID can be used to identify thefor flexibility in controlling the devices:

The users (inhabitants) have the options of switching the device on/off in three different ways.

1) **Automatic control**: Based on the electricity excise conditions, the appliance can be regulated with the help of smart software. This enables the user to have more cost saving by auto switch off the appliances during the electricity peak hours. The electricity tariff is procured from the website electrical isolation is achieved which is important in

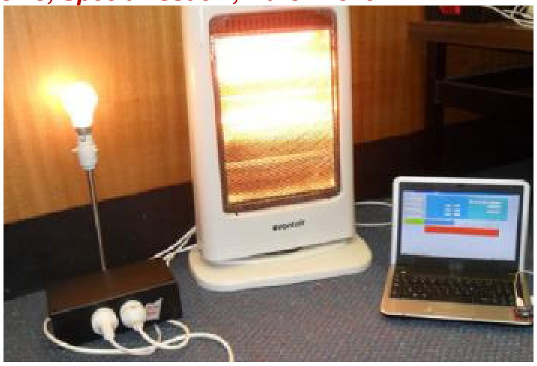
2) **Manual control:** An on/off switch is provided to directly intervene with the device. This feature enables the user to have more flexibility by having manual control on the appliance usage without following automatic control. Also, with the help of the software developed for monitoring and controlling user interface, user can control the device for its appropriate use. This feature has the higher priority to bypass the automatic control.

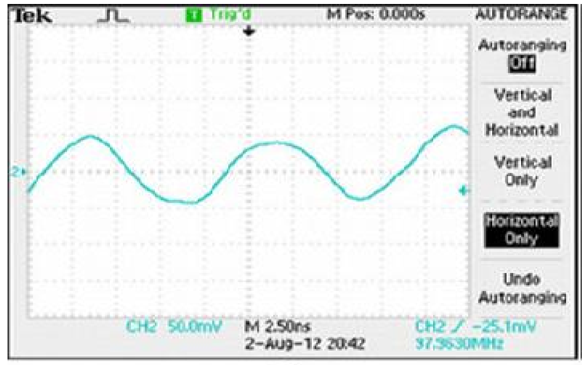
3) Remote control: The smart power monitoring and controlling software system has the feature of interacting with the appliances remotely through internet (website). This enables user to have flexible control mechanism remotely through a secured internet web connection. This sometimes is a huge help to the user who has the habit of keeping the appliances ON while away from house. The user can monitor the condition of all appliances and do the needful. Thus, the user has the flexibility in controlling the electrical appliances through the developed prototype.

D. Storage of Data

The ZigBee packets produced at the gateway encapsulate sample data to be sent to windows based internet server. An application on the server receives packets on an arbitrary port and stores the relevant information in the background of My SQL database in the computer. The database table store information such as source address, time, source channel, and sense data. Rows are added to this table for each packet received. This allows samples to be sorted by time, sensor node, and sensor channel. In the present system, programs for address, packet transformations, and data transmission are written using "C" programming verbal communication, programs for packet reception and data storage are written using "C#," and Web interface is developed using PHP Script and Java Scripts.

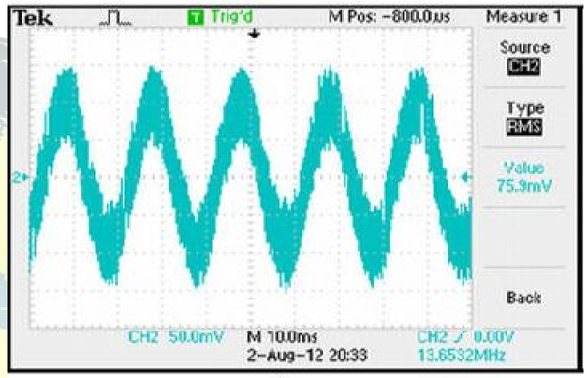
ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 3, Special Issue 2, March 2016



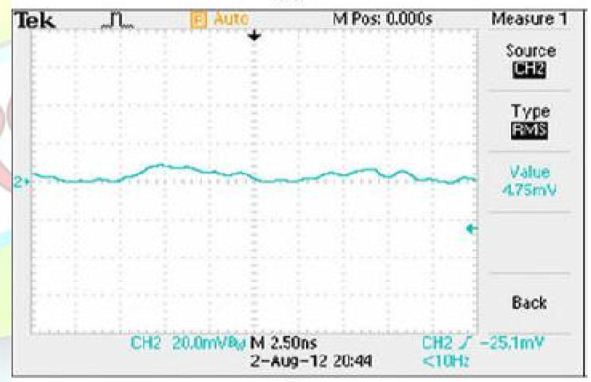


(a)

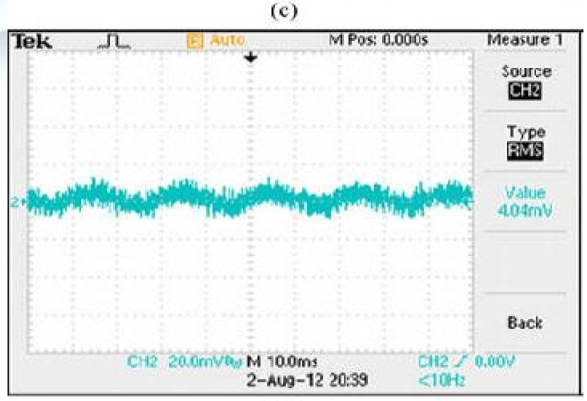
SMART POWER MONITORING AND CONTROLLING SYSTEM OF RESIDENCE



(b)

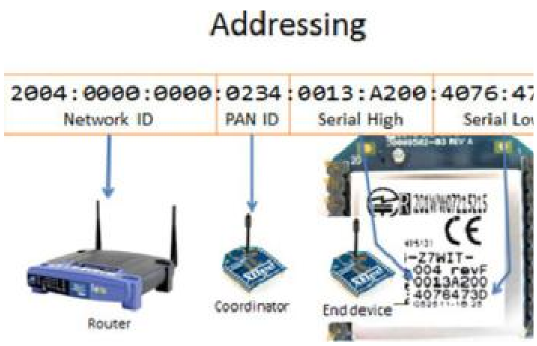


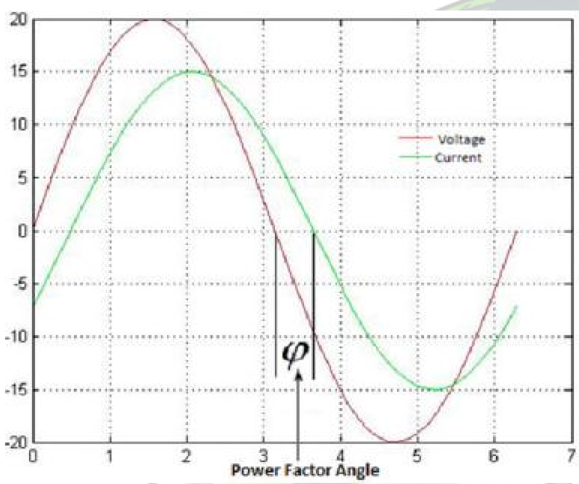
(c)



(d)

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 3, Special Issue 2, March 2016





1.SCALING OF ELECTRICAL APPLIANCES

V. Conclusion and Future Work

A smart power monitoring and control system has been designed and developed toward the completion of an intelligent building. The developed system unproductively monitors and controls the electrical appliance usages at an elderly home.

When the circuit is overloaded to reduce the power and maintain an appliances in ON condition. The system can be extended for monitoring the whole intelligent building. We aim to determine the areas of daily peak hours of electricity usage levels and come with a solution by which we can lower the consumption and augment 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 maintain 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 superficial utility. The developed system is robust and flexible in operation

REFERENCES

[1] X. P. Liu, W. Gueaieb, S. C. Mukhopadhyay, W. Warwick, and Z. Yin,
"Guest editorial introduction to the focused section on wireless mechatronics,"
IEEE /ASME Trans. Mechatronics, vol. 17, no. 3, pp. 397–403,
Jun. 2012.
SURYADEVARA *et al.*: WSN-BASED SMART SENSORS AND ACTUATOR FOR POWER MANAGEMENT IN INTELLIGENT BUILDINGS 571
[2] D. S. Ghataoura, J. E. Mitchell, and G. E.Matich, "Networking and application
interface technology for wireless sensor network surveillance and
monitoring," *IEEE Commun. Mag.*, vol. 49, no. 10, pp. 90–97, Oct. 2011.
[3] P. Cheong, K.-F. Chang, Y.-H. Lai, S.-K. Ho, I.-K. Sou, and K.-W. Tam,
"A zigbee-based wireless sensor network node for ultraviolet detection of
flame," *IEEE Trans. Ind. Electron.*, vol. 58, no. 11, pp. 5271–5277, Nov.
2011.
[4] J. Misic and V. B. Misic, "Bridge performance in a multitier wireless
network for healthcare monitoring," *IEEE Wireless Commun.*, vol. 17,
no. 1, pp. 90–95, Feb. 2010.
[5] M. Erol-Kantarci and H. T. Mouftah, "Wireless sensor networks for costefficient
residential energy management in the smart grid," *IEEE Trans.*
Smart Grid, vol. 2, no. 2, pp. 314–325, Jun. 2011.
[6] *ZigBee alliance examining Japan's new smart home recommendations*
(accessed on 8 Aug., 2012). [Online]. Available: http://www.smartmeters.
com/the-news/3449-zigbee-alliance
[7] *The costs and benefits of smart meters for residential customers* (accessed
on 4Apr. 2012). [Online].Available: http://www.edisonfoundation.
net/iee/Documents/IEE_BenefitsofSmartMeters_Final.pdf

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 3, Special Issue 2, March 2016

[8] L. Li, H. Xiaoguang, H. Jian, and H. Ketai, "Design of new architecture of AMR system in Smart Grid," in *Proc. 6th IEEE Conf. Ind. Electron. Appl.*, 2011, pp. 2025–2029.

[9] E. Andrey and J. Morelli, "Design of a smart meter techno-economic model for electric utilities in Ontario," in *Proc. IEEE- Electric Power Energy Conf.*, 2010, pp. 1–7.

[10] D. Man Han and J. Hyun Lim, "Smart home energy management system using IEEE 802.15.4 and zigbee," *IEEE Trans. Consumer Electron.*, vol. 56, no. 3, pp. 1403–1410, Aug. 2010.

[11] V. N. Kamat, "Enabling an electrical revolution using smart apparent energy meters & tariffs," in *Proc. Annu. IEEE India Conf.*, 2011, pp. 1–4.

[12] F. Benzi, N. Anglani, E. Bassi, and L. Frosini, "Electricity smart meters interfacing the households," *IEEE Trans. Ind. Electron.*, vol. 58, no. 10, pp. 4487–4494, Oct. 2011.

[13] I. Kunold, M. Kuller, J. Bauer, and N. Karaoglan, "A system concept of an energy information system in flats using wireless technologies and smart metering devices," in *Proc. IEEE 6th Int. Conf. Intell. Data Acquisition Adv. Comput. Syst.*, 2011, pp. 812–816.

[14] *Triacs-BT 138 Series, Philips Semiconductors* (accessed on 8 Jan. 2012). [Online]. Available: http://docs-asia.electrocomponents.com/webdocs/0b4b/0900766b80b4bf38.pdf

[15] J. Han, C. S. Choi, and I. Lee, "More efficient home energy management system based on zigbee communication and infrared remote controls," *IEEE Trans. Consumer Electron.*, vol. 57, no. 1, pp. 85–89, Feb. 2011.

[16] K. Gill, S. H. Yang, F. Yao, and X. Lu, "A zigbee-based home automation system," *IEEE Trans. Consumer Electron.*, vol. 55, no. 2, pp. 422–430, May 2009.

[17] M. S. Pan, L. W. Yeh, Y. A. Chen, Y. H. Lin, and Y. C. Tseng, "A WSNbased intelligent light control system considering user activities and profiles," *IEEE Sensors J.*, vol. 8, no. 10, pp. 1710–1721, Oct. 2008.

[18] G. Song, Z. Wei, W. Zhang, and A. Song, "A hybrid sensor network system