

# Implementation of Integrated Intelligent Power Management System Using Zigbee Protocol

Sagar Santaji<sup>1\*</sup>, Snehal Kangralkar<sup>2</sup>

<sup>1</sup>Electronics and Communication, Gogte Institute of Technology, Belagavi, India

<sup>2</sup>Electrical and Electronics, Gogte Institute of Technology, Belagavi, India

**Abstract – Industry based hindrances and their related solutions are discussed in this paper. One of the major factor for operating machines is voltage, and it plays a vital role in industry on which every machine is operated. In order to workout issues like load shedding major steps need to be taken and we cannot really desist related problems of it. Growth rate of any industry will be taper's due to these kind of issues. Sensors and actuators are deployed in different sections of industry in order to measure various controlling parameters by making use of Zigbee IEEE 802.15.4 standard. This paper demonstrates the priority based selection of the processes, time and process based system by which we can save the amount of voltage to be utilized and it also redeem the timing requirement of the processes and along with it in time based system. Health monitoring of any machine is one of the major application of this paper, which assist in determining the glitch of any machines and also obviates from any jeopardy.**

**Index Terms: Industry, Zigbee, IEEE 802.15.4.**

## I. INTRODUCTION

Industry Scientific and Medical radio band in which zigbee operates and other communication protocols also operate under this ISM band itself. Zigbee is a layered architecture and having IEEE 802.15.4 international standard. It is named as zigbee because it can accommodate many nodes or devices ranging up to 65,535 and these nodes are clustered together like bees and nodes can communicate in zigzag manner hence the name so zigbee. Zigbee layers are divided into Physical layer, Medium access control layer, Network layer, application support sub layer, and application frame work as shown in the figure 1. These layers are combined and assembled one over another hence it's also called as Zigbee protocol stack. The lower layer being the physical layer that contributes for the communication of physical parameters. Like voltage ranges, information in the form of bits, signal level. Both Physical and data link layers are being described by the IEEE 802.15.4. Whereas the layers namely network and application layers are been specified by the Zigbee alliances. Totally 27 communication channels been included in the zigbee which are further subdivided into varying frequency bands which are ranging from 868MHz ,915MHz, to 2.5GHz. Out of 27 channels as discussed above ,the zeroth channel is made to operate at 868MHz frequency band provided data rate would be 20Kbps. When the nodes or devices are in the out of

range or far away from each other then Network layer plays an important role in communicating them. When a communication has to take place between the nodes and if they are found out of range then zigbee protocol networking is been used effectively because of its network layer but the topology of the protocol will remain unchanged. There are different topologies are used in communication like bus topology, But bus topology in which only one path will be available for the communication between two nodes and if this node fails then the entire node communication will be failed. topology the entire band width will be allocated to the specified path. Similarly the different topologies are ring, star, and mesh. These three are very important topologies of zigbee protocol .Zigbee works on the principle of Master and slave. The master zigbee is acts as major node which can also be described as coordinator, and other zigbee node can be slave. Master Zigbee communicates with slave Zigbee. The master zigbee which is named as coordinator helps in maintain the network and also it is also plays an important role to obtain successful communication between the nodes.

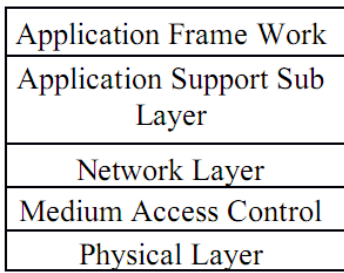


Figure 1. Zigbee protocol stack

II. MOTIVATION

In every field we may come across one or the other issues, similarly when we consider the large production based industries where the daily production will be carried out depending upon the time, manpower and process bases. But now days it has become a problem to run a industries on daily under situations like load shedding. So the industries will give holiday on the day of load shedding, else power is not there for certain hours then workers are set free from their work. These conditions will economically set back the industries. And small scale industries cannot afford these problems .So a better way of solution has to be provided for these kind of problems, hence we have decided to provide a better solution in the form time and process bases system, priority based systems and also by making use of the sensors we can save the amount of power which is been explained in the coming chapters this paper. This project is to provide a better solution for the current issues which are faced by the Industries.

III. RELATED PAPER WORK

In few of the recent year lot of work is been carried out for determining the noise factor associated with the devices in the industry. Machines which make use of power for their operation need to be handled carefully, all the machines have their own predefined life period. Wrong handling of these machines may lead many dangerous problems. Some of the machines used in industry need a programmed skillful person to operate it [6]. Machines like CNC, Which is used do grinding, roughing, smoothing, finishing, threading almost for the all the operation in the mechanical industry. Similarly lathe machines are also being used for similar like productions. But they are not programmed [3]. They require very less amount power to operate and also it's used for the specific functions. There are few machines which are used to trim the edge component of the material it's called as vibro Benz. In this vibro Benz machine all the small jobs which are designed for that day been put so that if there is sharp edges to be removed it removes it without much of the effort. When we put all the jobs in the vibro benz machine, It is set into vibration, due to this vibration all other jobs which are put into the vibro benz machine start vibrating and without the change of actual shape the sharp edges of the material is cleaned up. Wireless sensor network consisting two or three nodes

can be used for detecting the noise coming from the machines [3]. Few of the research paper it's been mentioned that the wireless sensors can also be deployed to determine the noise out of the vehicles and research work is carried to determine the noise produced by the planes. One of the methods to reach the longer pathway is multi hop technique [3]. These techniques in which noise coming out of the out of the airport base station is collected, But the methodology failed due to the synchronous problems between the nodes by which data could not be received in phase manner means collection of the data by different nodes are collected at different times. When this continues lot of nodes will be out of sync and loses the way of communication. And zigbee protocols which consisting of two slave nodes will collect the data and send to the master in sync [1]. Open and closed instrumentation systems are been formed by making use of the sensors and actuators [7]. The main intention being controlling various parameters and to the system state. Communication is being involved among the various elements in the systems. This requirement in turn helps to understand performance parameters in real time. In order to know the physical state of any machines predictive maintenance is used. Power controlling mechanism is been utilized. [1]. The block diagram is as shown below

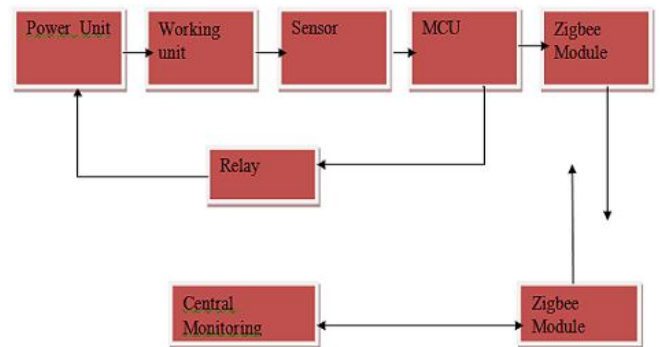


Figure 2. Power monitoring unit

The reason behind using predictive maintenance is the devices are not being kept on all the time. This in turn saves energy. Sensors being periodic devices or non periodic devices. Whenever an event occurs the wake up from the sleep mode, checks for the status performs the function and then again go back to sleep mode. If there is failure or violation there is alarm which will start warning that there is any violation or failure of some tasks. These kind of methods which will actually help in keeping the system into better operation mode and also helps in determining the problem related to the machines. Communication method used among these devices is Wi-Fi, RFID or Bluetooth [7]. But never used a zigbee protocol stack. This design also updates us with various parameters. And while designing the hardware we also need to take care of the electromagnetic interferences occurring in the environment due to the radiations. Several techniques are used when energy management is been discussed for the home automation. Home or industry or any other application

energy conservation and better utilization of the available energy is very much concerned keeping all future aspects in mind. Energy management for the smart homes by the use of renewable energy is been discussed in few of the papers [7]. In this module they considered the generation and consumption of the energy. This module also makes use of the zigbee concepts only in order to save the energy. Home automation being the leading technology in the developing countries. Making the entire home embedded makes it more secure as well as advanced. Here there will be a server which is set up to capture all the controlling parameters related to the energy utilization and generation. In order to collect all the required data into the server remote techniques are been made use where all the data can be sent remotely to the servers [7]. As already been discussed in the above sections it's been told that there is use of home server which manages the micro controller unit which is installed to manage the inlets and outlets of the lights.

#### **IV. PREVIOUS EXISTING SYSTEM**

Smart grid systems are the methodology being used in one of the process in which energy management was the attainable target issues. Energy management system is being key issue which is tried to resolve from this method. In this two main components are being used, one being the energy management unit, for measuring the energy which is in need for the operation. A following point which is second variable being the sensor nodes. Sensor nodes which are been deployed in the various sections of the industry are used to capture the data coming from the various sections. In order to communicate with the sensor nodes we are making use of Zigbee from the XBee manufactures. An intelligent power management systems are been defined which are used to capture the data from the sensor nodes. Sensor nodes perform various functions like sensing, controlling, processing etc. In this section each sensor is being deployed in various loads sections. And every 3 minutes it will be monitoring the loads. But where as in our methods we are reducing this time delay.

From the literature survey of various other research work it shows that there have been many proposed system on the factories and industry zones for measuring various parameters. The results based on this method is been carried out and by making use of the Fast Fourier transform approach is used to analyze the power requirements. But this application was carried out in a restricted area. Even though they make use of the zigbee protocol, its range is being up to 200meters and data rate being 250Kbps. The point of preference being despite the fact that they completed in the littler are there is less odds of losing the information, in light of the fact that the information

goes at fast when we make utilization of the littler information. The range of communication may be less but when we consider the frequency of operation is very high. Due to which the antenna heights can be reduced very drastically. This system may not break down because these kind of application be used in personal area networks [12]. This proposed module make use of the processors from the Texas instruments. These processors are really designed for the low power application and are used for various applications. More amount of the information can be fetched from the forums. Texas instruments have their own forums, which will really help in resolving any issues related to the schematics and software related issues. This being the good support forum till now, where our lot of queries are asked, and the respected person in that field comes to the guidance which helps ant developer to solve any problems related to the task immediately. There are different support systems like, Wireless connectivity, Low power modules etc. If any new user wants to put his queries he has to register himself into the forum first and then login with an appropriate login.

#### **V. PROPOSED SYSTEM**

From all above discussions and surveying the papers we can see that in many of the cases it's been found that during the power conservation and energy management situations lot of methods been implemented but all those methods have one or the other drawbacks due to which the methods have been implemented with few setbacks. In few methods large delay is used where as in few of the applications the cost was more, in few if the collision technique was not been taken care where as in few cases the organization was very small. Where as in few cases the power conservation was very small and some cases they did not consider. So these all above issues have been resolved and came with new methodology in which we have been come up with new solution where our main focus was on overcoming the above all setbacks and provide a unique solutions. Our organization always into the research work of this solution, and thinking how to overcome these quandaries .When we have been approached with one of the mechanical industry which was facing these kinds of issues. The mechanical industry was well known industry which is known for its mass production and their outcome was very high. The number of people who were working in this organization was also more in number. The main issues are listed in this paper and they have been provided with new solutions keeping all other aspects in the considerations. This organization is situated in one of the known cities .They have more than 50+ workers in their organization and this organization is known for the mass production of various valves , couplers, various tools, and small components by

using the new techniques and advanced machines .When we make use of the advanced machines we need to make sure that our workers are skill full to complete those tasks. Because these tasks are really not so easy to complete without having more knowledge about it. When this industry approached us with their problems our team surveyed their company and we did lot of research work how the entire operation of the industry goes on and also what all things they consider for their operations. From the scratch we started inquiring this organization .We collected more amount information regarding various machines which they are using in their organization and what all their power requirements, how much current they consume, what all the daily products on which they mainly concentrate. These all things are very important in order to provide a better quality of result for any kind of products. By collecting all these above details we came with solution with various protocols to be implemented for this product. Looking at the problem statement which mainly focuses on the power saving ,Timing constraint, standby power, health monitoring issues these all issues are been addressed in our paper. The wireless sensor network (WSN) provides the basic tools for gathering information flow on Industrial process and energy usage patterns with respect to Industrial machines. Moreover, the WSN provides measurements of some physical parameters like temperature also, light that can be utilized by the framework to perform some programmed change of the vitality administration framework. We have the Master PC which has VB software in it. This PC side software which is used to record all the status of controlling units. Here we are utilizing an expert Request and slave reaction convention .In this framework the Master sends the solicitation to the all the slaves. In the solicitation outline the expert says the slave ID. Also, in the slave side every slave speaks to a unit or Sun-unit of industry. Each unit has a specific Job and power requirement.

A. Methodology

Xbee is the leading pro company of manufacturing zigbee components which full the requirement of the Zigbee IEEE802.15.4 it can be deployed in the indoor or outdoor over a range of 30meters in practical actually. It also has good receiver sensitivity. Whereas making use of direct sequence spread spectrum it provides more amount of security. It mainly supports point to point, Multipoint, peer to peer topologies. The main advantage of using the Zigbee is its unique proper which is known as self healing and self routing. If you consider the arrangement of the point to point communication then it is difficult method to implement to make use. Because if anything goes wrong and there is loss then whole connection will breakdown and the entire network breaks down. There also same procedure has been used where if the data packet sent by one node is gone under error then the all the nodes which are inter related to that node will be losing the data. So in these cases we clearly saw that

the data was set into loss if any node is coming into the occurrence of the data loss. Now similarly when we talk about the zigbee nodes we have to be very careful because we cannot afford of losing the data in this environment. Hence the zigbee node is really designed for the application where multi functionalities can be processed and gather the data. And if error occurs or if any data is been lost then nodes have the property called as self healing. This actually solves most of the issues related to the collision. The implementation of this entire paper is explained in the figure 3.

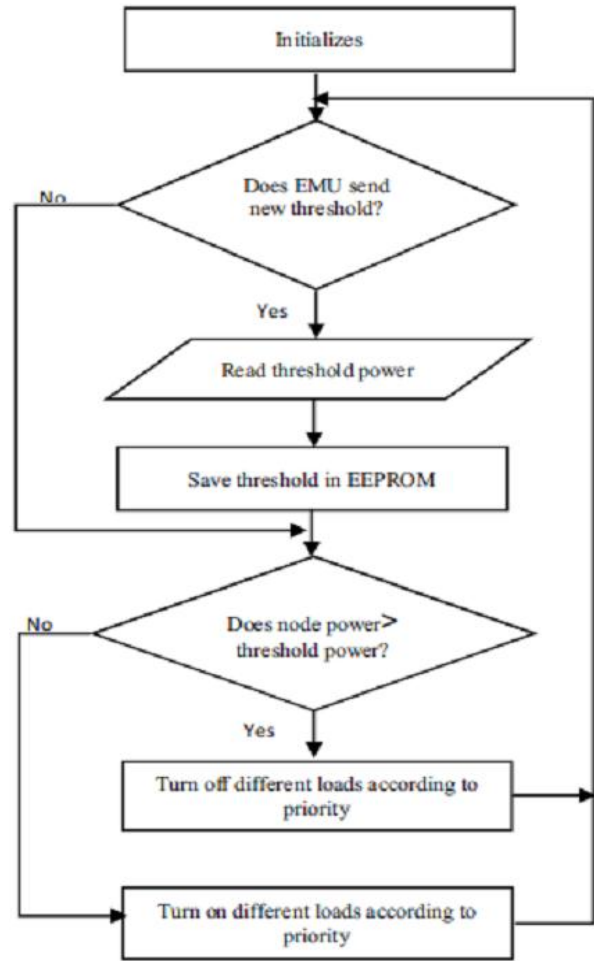


Figure 3.Flowchart of implementation.

B. Implementation

The implementation of the project is explained in detail below, We consider Master and slave communication in the existing system. Where the master will be a PC side software, and we have two slaves i.e. slave 1 and slave 2. Slaves mainly process the data and send it to the data base which is PC side software. The processed data will be displayed on the PC by making use of the Visual Basic.

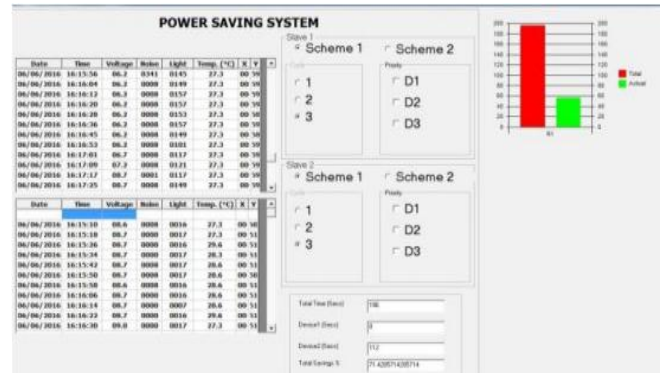
- a) The flow of the working procedure is, whenever I have sufficient amount of voltage, we have considered as 10v.The voltage is 10v the all the relays will be operating. It

means to say that in industry when we talk about it says all the machines are working without any delay. And it's true because we have sufficient amount of voltage so we can keep all the machines in on mode

- b) Now in the second stage we have kept the voltage range between 8-10 volts. Suppose if the voltage goes below 8volts then out 3 only 2 relays will be operating in cyclic manner. Say for example Initially if relay 1 and 2 are on then after certain delay i.e.10sec the next two relays will be operating i.e. relay 2 and 3 . And again after 10 seconds the remaining two relays will be in on mode. Like this all the relays will be performing the operation by being in the on mode such that we meet the daily requirement of the production and there should not be problem in production rate of the products. This method is based on both time and process based because here we are keeping two relays on at a time and making them to operate in a cyclic manner with delay of 10 seconds between two processes.
- c) In third stage the voltage range is kept between 6-8 volts. If the voltage is in the range of 6-8 then two relays will be operating as discussed above, but if voltage goes below six volts say 5 , 4 or till 1 or zero volts then only one relay will be operating . This is the criteria of meeting the requirements of production in the industry when we issues like load shedding problems. In third stage as only one relay will be operating at a time. And after 10 seconds of delay the second relay will be in on mode, this way all three relays will be in on mode after 10 seconds of delay. This actually solves the problem when the actual load shedding occurs.

**VI. RESULTS**

- a) Results obtained in various sectors are listed below, the first stage result explains the power saving mechanism when I select scheme 1 of the Slave1. In scheme 1 when priority three is chosen that time all the three relays will be on and I have sufficient amount of voltage and there is no load shedding problem. This process will take place in scheme1 and scheme2 when priority three is selected and the voltage is considered to be between 8 to 10 volts.



**Figure 4. Scheme 1of slave 1 and 2 selected**

When voltage range is set between 8 to 10 volts all the relays will be operating. This condition is explained in the above figure. The red and green side at the right corner will show the power utilization. So from that graph we can say that if the power consumed by the devices is lesser than the actual power present for operating the devices.

- b) In second stage as we can observe from the above figure 4.2 we have selected scheme 2 of slave 1, and as well as scheme 1 of slave 2 .So when I select Process D2 and D3 in scheme 2 of slave 1 then only on the priority order these two processes will be on rest all the devices will be in the off mode. This process is carried out when we have the problem with other devices or if there is any urgent necessary under certain conditions the priority based operation will be kept in on mode which will play a very important role in saving the power. And in the next section we have also selected process 2 of the slave 2.The voltage range for this process 2 is between the 6 to 8 volts ranging. Only when the voltage is in this range then process two will be selected, then depending upon this process 2 the outcome will be as follows here at a time only two relay will be operating in on mode. And after 10 seconds of delay the next two relays will be in on mode. After 10 seconds of delay the other two relays will be in the on mode and so this process continues in a cyclic mode. With this cyclic mode which depends upon the time we contribute to the power saving mechanism. This is shown at the right corner of the figure. Above figure 4.2 which explains us the both priority based and also the time based systems which will be made to operate to save the power. Likewise the other processes are carried out below depending upon the time and process based systems which will fulfill the requirement conditions.

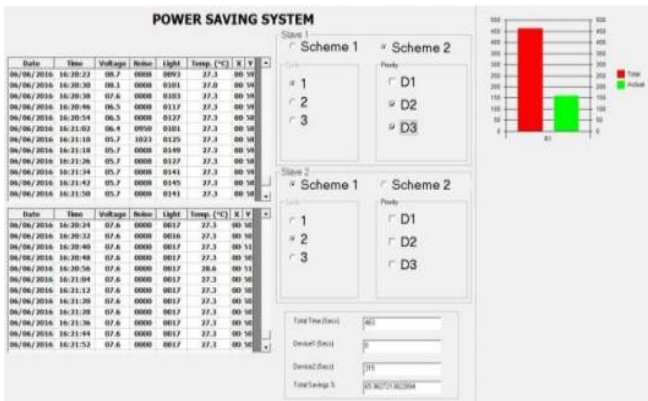


Figure 5. Scheme 2 of slave on1 and scheme one of slave 2 selected

- c) From the above results we can conclude to the point that we cannot select both schemes 1 and 2 at a time. Only one of the schemes will be selected at a time and other will be not selected. In scheme 2 of slave 1 we have selected Process D2 and D3 where as in slave 2 we have selected the scheme 2 and D2 and D3 processes of schemes 2 and the outcome is as shown in the graph at the right corner of the image.
- d) In stage 4 we are selecting the Scheme 1 of the Slave 1 and also Scheme 1 of the slave 2. When we select the Scheme 1 of slave one and process 1 is selected as we can see from the

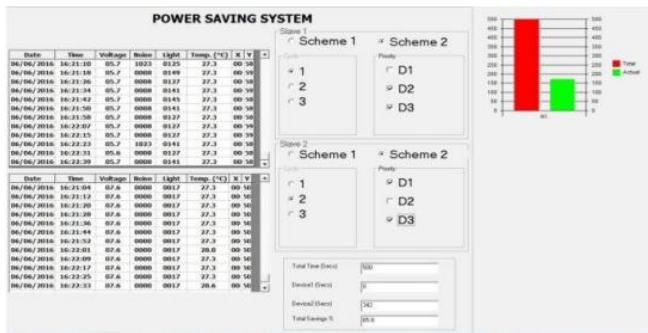
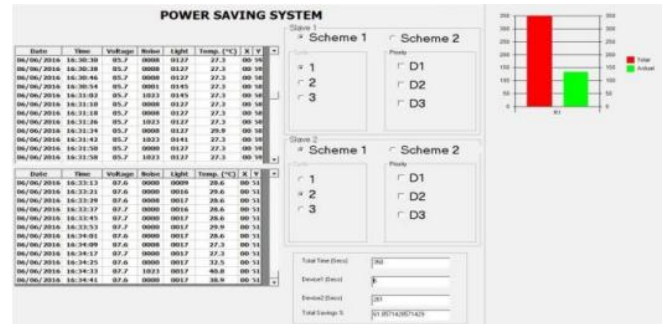


Figure 6. Scheme 2 of slave 1 and 2 is selected

- e) Diagram shown below this condition actually is considered keeping low voltage into the consideration. This is being the highlight of this project when low voltage is present and if you want to operate all the machines at the same time then it may be a problem but if we can provide power in cyclic order to all the process giving equal time for every process then we can save the power and also we can also fulfill the daily requirements of the products of organization. The stage 3 plays a vital role in saving the required amount of power and also helps in processing the data in cyclic order by giving equal priorities depending upon the timing requirement. Here as we have selected

the process one, the process one is actually carried out when the voltage goes below the threshold level. In this we have considered the threshold is up to 6Volts. If the voltage goes below 6volts then only one process will be operating at first instant and after certain delay the second process will be on and after 10seconds of delay the next relay will be on. So in this case the entire relay will be on. But only one at a time and the next relay will be on only after the first relay becomes off. So this is how all the relays are made on depending upon the cyclic manner and providing equal amount of power to all the processes at a time. And also one of the additional features which is provided over here is the sensors like temperature sensors, or noise sensors, if the value of temperature goes above 40 degree Celsius then sensor will be will capture the data and it will show the message. It's majorly used when temperature of any section increases such that it may lead to any hurdles. This mechanism will explain the process based and time based actions taking place which will contribute to saving the power.



power during load shedding or other power crisis situation.

## VII. REFERENCES

M.Barathi Kannamma, B.Chanthini, D.Manivannan "Controlling and Monitoring Process in Industrial Automation using Zigbee" IEEE International Conference on Advances in Computing, Communications and Informatics (ICACCI), 2013.

N. Javaid, U. Qasim , A. Sharif, A. Mahmood, Z. A. Khan,S. Ahmed "Monitoring and Controlling Power using Zigbee Communications".

Josie Hughes, Jize Yan and Kenichi Soga "Development of wireless sensor network using bluetooth low energy (ble) for construction noise monitoring", International Journal On Smart Sensing And Intelligent Systems Vol. 8, No. 2, June 2015.

Sunghoi Parka, Myeong-in Choia, Sehyun Parka, Byeongkwan Kanga "Design and Implementation of Smart Energy Management System for Reducing Power Consumption using ZigBee Wireless Communication Module", the 3rd International Conference on Sustainable Energy Information Technology (SEIT 2013).

Jinsoo Han, Chang-Sic Choi, Wan-Ki Park, Ilwoo Lee, and Sang-Ha Kim "Smart Home Energy Management System Including Renewable Energy Based on ZigBee and PLC", IEEE Transactions on Consumer Electronics, Vol. 60, No. 2, May 2014.

Roberto Zangróniz Cantabrana, Andrés García Higuera, Jesús Blanco Rodríguez de Guzmán, Javier de las Morenas de la Flor "Low-Cost Wireless System for Measuring Energy Efficiency in Industry" Smart SysTech , June 11-12-2013 in Erlangen/Nuremberg,Germany.

Asad M. Madni "Keynote Speech:Smart Configurable Wireless Sensors and Actuators for Industrial Monitoring and Control" IEEE Sensors Conference,2009.

Jinsoo Han, Chang-Sic Choi, Wan-Ki Park, Ilwoo Lee, and Sang-Ha Kim," Smart Home Energy Management System Including Renewable Energy Based on ZigBee and PLC" IEEE Transactions on Consumer Electronics, Vol. 60, No. 2, May 2014.

Jui-Yu Cheng and Min-Hsiung Hung,Jen-Wei Chang "A ZigBee-Based Power Monitoring System with Direct Load Control Capabilities" Proceedings of the 2007 IEEE International Conference on TucsE04 Networking, Sensing and Control, London, UK, 15-17 April 2007

Gerald P. Duggan, Peter M. Young "A Resource Allocation Model for Energy Management Systems"

Muhammad Bilal Sarwar, Perumal Nallagownden, Zuhairi Baharudin, Mohana Sundaram Muthuvalu "Simulation and Development of ZigBee Based Wireless Stakeout System Controlled by PC" IEEE 2015.

Mohammed Abo-Zahhad, Sabah M. Ahmed, Mohammed Farrag, Mohammed F. A. Ahmed and Abdelhay Ali "Design and Implementation of Building Energy Monitoring and Management System based on Wireless Sensor Networks" IEEE 2015.

---

### Corresponding Author

**Sagar Santaji\***

Electronics and Communication, Gogte Institute of Technology, Belagavi, India

E-Mail – [sssantaji@git.edu](mailto:sssantaji@git.edu)