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# Smart Street Lighting System

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**Abstract:** ***This paper has introduced a intelligent street lighting system based on two type of sensors which are wireless sensor network (WSN) and pyroelectric infrared sensors (PIR). This paper also includes design of intelligent street light system using zigbee device. Here the use of PIR sensor and microcontroller in intelligent street lights with detailed explanation of WSN and Zigbee is given. Main goal of this research paper is to design a power saving street light system and take a step towards making our street smart and intelligent streets.***

**Keywords:** ZigBee, LED, PIR sensors, Networks, WSN

## 1. Introduction

With the development of economy and urbanization, the street lighting system has become one of the crucial concerns of people. However, in street lighting system, the efficient management and energy-saving control of lighting system is very important. In system based on WSN, the information of pedestrians and vehicles on road is sensed and collected by a sensor array, which consists of different sensors. It also provides some other services like telemetry, monitoring of noise, humidity, temperature and services associated with road information systems, intelligent transportation systems and intelligent roads.

All the sensors are placed on the lamp pole and the efficiency of these sensors on the lamp are affected by sensing area, height of lamp pole, angle at which the sensor is kept etc. Second type of sensor (PIR sensor) is used for detecting movement of pedestrians and vehicles.

The paper also presents a study on ZigBee-based wireless devices which allowmore efficient street lamp system management. A scheme for a Zigbee-based street light control is proposed so that we can aim at reducing the human error in the operation of street lights. A lack of automation in the current system leads to large amount of human error in street lighting system. The information is transferred point-by-point using ZigBee transmitters and receivers which are then sent to a control terminal usedto check the state of the street lamps and to take appropriate measures in case of failure. The system allows energy savings with increased performance and maintainability.

Here we are making an intelligent lamp post which is managed by a remote controlled system that uses LED-based lightweight supply and is power is given by renewable energy (solar panel and battery). It is then implemented through a network of sensors to gather the relevant information associated with the management and maintenance of the system. Data is transferred in wireless mode using the ZigBee protocol.

## 2. Working of system using Zigbee

***Measuring Stations and detectors:***
The measuring station is located in every lamppost and consists of many modules: the presence sensor, the sunshine sensor, the failure sensor and an emergency switch. The **presence sensor or PIR sensor** has the task of detecting the passage of a vehicle or pedestrian causing the switching on and off of the lamps. This feature permits to activate the lamps when necessary and avoids waste of energy.

**Light sensor** will measures the external light intensity and provides assurance to a minimum level of illumination of the road, as needed by regulations. The sensor should have high sensitivity which is within the visible spectrum. This provides a photocurrent which is high enough for low-light luminance levels.

**Supervision module:** This sensor improves fault management. A Hall sensor detects when the lamp is switched on. The system recognizes errors which are compared with the stored information. This information is reported by the ZigBee network to the station management unit. Figure 1 shows various sensors.

These devices work along and transfer the information which is collected by them to a Microcontroller that processes the information and chooses the appropriate action.

***Control unit:*** The sensors transfer the collected information to a controller that uses software which is then used to manage the system. If no fault is detected, the microcontroller measures the current by the Hall sensor storing the values in memory. All the operations have predetermined time for management of time. At the stop signal, the lamp is turned off.

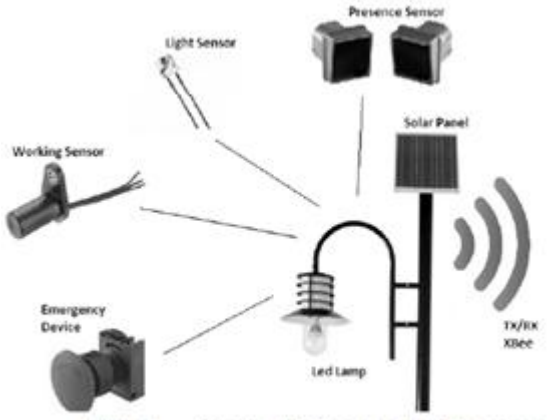


Figure 1. Scheme of the lamppost with sensors.

***Management center:*** The transmission system consists of ZigBee devices that receive data which has information about the state of the lamps and sends it to a terminal. The processing unit consists of a terminal with a serial UART interface that receives data provided by a ZigBee device. The management can be extended so that other electrical systems might send data regarding power consumptions to a central system for adjusting energy consumption to and for remote switching and management.

## 3. Wireless Sensor Network

Wireless Sensor Network (WSN) is a set of small electronicdevices which comprises of a microcontroller, an RF transceiver and sensors. The WSN consists of 3 types of nodes which are coordinator, routerand terminal nodes. Routers and terminal nodes are placed on the lamp pole, and coordinator nodes are kept on the lamp pole or are kept in the nearby community with the monitoring center. These WSN nodes can communicate with each other using dedicated protocols. WSN uses linear topology. The whole topology of the WSN is divided into many strip type sensor networks due to large no. of street lamps present near the roads.

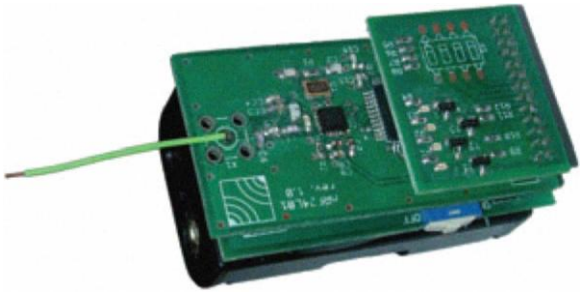

**Figure 2:** Example of WSNmodule

Each strip type sensors are provided with different channels in order to avoid interference. Each node will work as a router and retransmits the messages from one node to destination node. Each message is acknowledged. Thus these networks are used to indicate data from the environment.WSN helps in exchanging data in the street lighting system. A periodic check of the system and nodes should be done. In case of a broken link between nodes an error message should be sent to lamp commissioner. Then a new path must be traced in order to keep network integrity.

## 4. Wireless ZigBee Network

ZigBee is wireless communication technology for communication among multiple devices in a WPAN (Wireless Personal space Network). Zigbee is used in devices where a low data rate, long battery life, and secure networking are needed. The maximum data transfer rate of Zigbee devices is 250 Kbps with a 2.4 GHz oscillator. The approximate power consumption is of 60mW. Zigbee devices employ the technique of Direct Sequence Spread Spectrum (DSSS), which ensures the reliability of signaltransmission, avoiding interference from other signals and thus extending the maximum operating range of up to 100m. Zigbee network can have up to 65336 devices, and each node can interact with every other node, which ultimately results in a very big network.

Zigbee devices are of two types, which are Full Function Devices (FFD) and Reduced Function Devices (RFD). FFDs are devices that help in further propagation of signals into the network. The RFDs do not have the ability to route the signal further in the network and are usually used as network end
points.

**Types of ZigBee networks**

ZigBee is used in 3 modes of operation namely Star structured, Mesh-structured and Cluster Tree network. In star network, in Figure (a), there is a server point i.e. ZigBee Router (FFD) and other ZigBee End Devices (RFD) are operated using this router. All these routers and end devices are in turn controlled by a Network Coordinator (FFD). End Devices can interact only with the coordinator. It is suitable for point-to-point, point-to-multipoint communication.

In Mesh network, shown in Figure (b) there is a Network Coordinator (FFD), which directly interact with very few Router cum End Devices. This network uses “multi-hop" routing to reach far distance. This network is more complex but it is also more robust and tolerant to faults.

A Cluster Tree network shown in Figure (c) is similar to the Star network but has more nodes that can interact with each other; as a result more RFD/FFD can be coordinated with other FFDs.

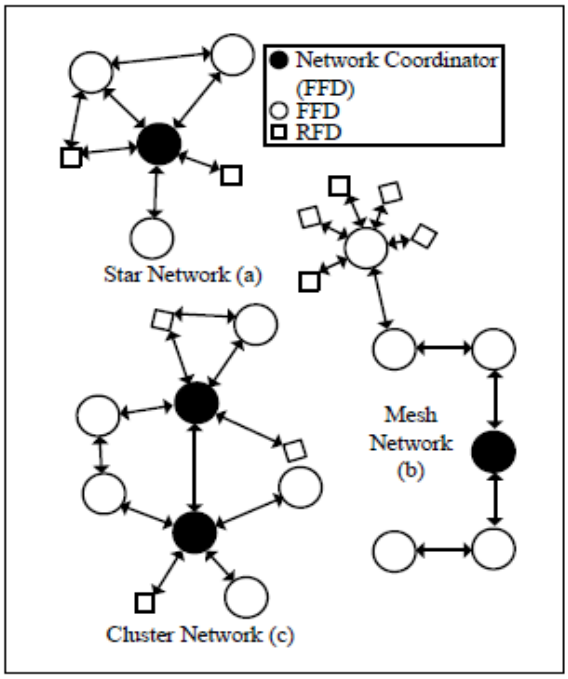


**Figure 3:** Various Topologies

**Advantages of ZigBee Technology:**

1) Less Power Rating
2) Small in size
3) Low cost
4) Long Battery life
5) Supports large number of nodes
6) Open standard protocol with no licensing fees
7) Available from number of source
8) Low maintenance
9) Standard based security (AES 128)

## 5. System Model using WSN and PIR sensor

This system model consists of monitoring center and WSNs. The basic work of Monitoring center is that it communicates with sensor networks with the help of wire or wireless approaches. By monitoring this, the parameters of every street lamp, the information about pedestrian and vehicular movement can be obtained.The activities like detecting and controlling are performed by illumination sensors, PIR and other sensors.

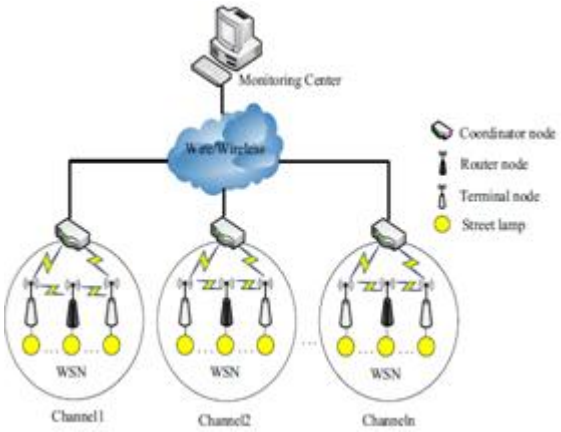


**Figure 4:** Intelligent Street lightening system based on WSN

Let us consider an example for better understanding. Take 3 lamp posts (n,n+1,n+2) , each lamp have there individual sensing area .The LED light sources can be used in the lamps as they are more power efficient and level of light intensity by lamps can be adjusted very smoothly. The lamps can also very easily be adapted to different weather Conditions.These Street lamps can be set up in different models according to the practical requirements. But we will consider only two of the models that are bright and less bright.

1) If there are no pedestrians or vehicles in thesensing area, street light will remain less bright as PIR will not get triggered.
2) If there are any pedestrians or vehicles in the sensing area then the $n^{th}$ lamp will glow bright as the PIR sensor on the lamp will be triggered. Simultaneously a message is also sent to the next street lamp through WSN in order to inform the pedestrians and vehicles coming.

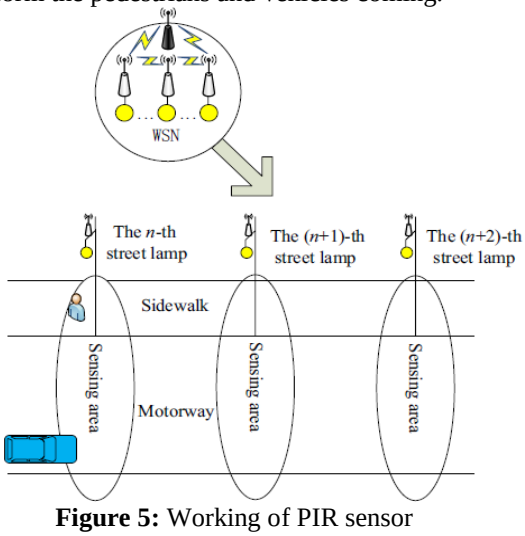


**Figure 5:** Working of PIR sensor

3) The pedestrians as well as vehicles will take some time to leave the sensing area of first street light and enter the sensing area of $(n+1)^{th}$ street light. So as soon as the second lamp receives the message, it adjusts the brightness accordingly after a delay of say x seconds.
4) The same procedure is followed for the $(n+2)^{th}$ street light . This light does not glow after the delay time; this indicates the pedestrians or vehicles have left the sensing area. The $(n+2)^{th}$ one lowers its brightness as no vehicles or pedestrians are sensed by the PIR sensor in the sensing area.
5) Further these street lights can be used to give the information about present and future weather conditions, humidity conditions, noise present on the road and pollution content in the environment.

## 6. Realization of the System

Power is provided by a battery, recharged from a solar panel throughout the daytime. Charge controller manages the processes of the battery charge and power provide. Current generated by photovoltaic panels is handled by the controller to produce an output current for battery charge. Every lamppost being placed at the distance of 25 meters from one another, since modules have a range of 100 m outdoors. The functionality field tests were realized. The system is in a position to transfer data from any chosen lamppost to the management center when passing the info through the remaining lampposts. The transmission rate is 99.98% to 100%depending on the placement of sending unit.

***Power management and consumption***

Power saving is important. These systems avoid the tedious and expensive wiring and connection to external power network, which enables considerable savings and ease of implementation. The system is intended to be low-power, minimizing the battery capacity. Finally, when the system is disabled, all devices (wireless module and Microcontrollers) goes to sleep mode, that permits negligible power consumption.

***Estimation of prices and savings:***

This proposed system may be expensive but higher prices of the lampposts are compensated by lack of costly wiring and the availability of power network and considerably lower prices of maintenance. There is low power consumption, powered by a renewable supply of energy through solar panels with no harmful atmosphere emissions and minimizing light pollution. Prices can be saved by using the highly economical LED technology which is supplied by renewable energy provided by the solar panels. And thus, we have the intelligent management of the lampposts. The system is versatile, extendable and totally adjustable to user needs.

**Figure 6:** View of the system

## 7. Conclusion

Thus by using these two concepts of zigbee and WSN's - PIR sensors we can make highly efficient, low power consuming street light systems. There is ease of maintenance and high transmission rate of information from device to device in the systems explained.

## References

[1] Sagar Deo, Sachin Prakash, Asha Patil, " Zigbee based intelligent street lighting system ", *2014 second international conference on devices, circuits and systems(ICDCS)*

[2] Xinshun Zhang, Jiyujin,HuiminMeng, Zhisen Wang, "A sensing optimal Proposal Based on intelligent Street lighting system", *Proceedings of ICCTA2011.*

[3] Maciej Mendalka, Michal Gadaj, Lukasz Kulas, Krzystof Nyka, "WSN for intelligent street lighting system*", Proceedings of the 2nd International Conference on Information Technology Gdansk, Poland,ICIT 2010* ,on pages 99-100 ,28-30 June 2010.

**[4]** Fabio Leccese, Zbigniew Leonownicz, "Intelligent wireless street lighting system*", co-sponsored by National science center, Poland.*