

Energy Saving Outdoor Light Screening and Management System

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Abstract

Objectives: Energy saving outdoor screening and management system is used to screen and handle open air lamps all the more proficiently when contrasted with the regular systems. The proposed system is to meet this objective with effective manner. **Methods/Statistical Analysis:** Sensors and Peripheral Interface Controller (PIC) microcontrollers are used to sense the lamp performance and control all the lamp unit respectively. Wireless network method is used to monitor the unit which is done by utilizes the ZigBee-supported remote gadgets which permit more effective lights administration. Microcontroller unit used to control each lamp network installed for the project. We propose an energy effective ZigBee-supported outside light observing system. **Findings:** To acknowledge adequacy of the suggested framework, the model has been introduced inside the college, where the trial comes about demonstrating that the proposed framework spares around 70.8% vitality for the open air road condition in light of utilizing sensors, LED lights, and ZigBee supported correspondence organize. From our demonstration we can find that power consumption is greatly reduced from former experiment which is done by using metal halide lamp. This setup uses LED lamp to reduce power usage by nearly 900KW per hour compare to existing setup. **Application/Improvements:** This can be improved by using advanced MC unit and other lighting methods.

Keywords: Energy Efficiency, LED Light Setup, Light Monitoring System, PIC MC Unit, Power Consumption, , ZigBee Network

1. Introduction

Energy proficiency is the main element while outlining interior or open air lighting frameworks. Street light itself utilize almost 40% of total power used in whole city. So that the monitoring system must handle light energy in an efficient manner. For this point, as a result of its plan in view of the ancient lighting benchmarks and inefficient apparatuses and gadgets, the conventional lighting frameworks are not appropriate bringing about energy misfortunes, visit substitution of gadgets. Besides these, conventional systems experience the ill effects of

the absence of unavoidable and viable correspondences, checking, automation, and blame fault detection issues.

Replacement of Metal Halide (MH) with LED lamp is used to reduce consumption of energy. This is one method of saving power utilization¹ But the frameworks in view of these innovations require assisting change to build the vitality proficiently.

To additionally decrease the energy utilizations and minimize wiring configuration, various lighting control frameworks have been suggested to take care of that issue such as: occupancy detecting method, light equal modification², and Power Line Communication (PLC).

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Notwithstanding of diminishing the wiring configuration in PLC based plans displayed in², intermittent drops may happen in PLC systems working on low voltage electrical cables. These declines are caused by noise and attenuation, and can last from a couple of minutes to couple of many minutes. Because of carrier flag lessening, there possibly high idleness or communication disappointment in PLC supported plan. To spare abundant energy and reduce connection problem use less energy standard zig-Bee. ZigBee is a conveying correspondence framework in light of Wireless Sensor Networks (WSNs)

In³⁻⁴ many tantamount structures connected to outside LED module to execute the connectionless monitor arrangement of light. The creator considers energy as a second factor and cost of the system as a primary issue that was done by reducing the number of sensors used in each lamp unit. To reduce the cost of whole system, author try to minimize the number of basic requirements that will cause execution debasement and leads to lower precision and high bundle misfortune⁴. Transfer the information to control centre by using basic wireless technologies such as GPRS and WIMAX in energy productive outdoor light monitoring system. While using the GPRS and WIMAX it must be in authorized range if this is not in authorized range it will affect other user communications in that range, this is the main disadvantage while use GPRS⁵. Hereafter, the lighting framework will likewise necessitate efficient impedance maintaining a strategic distance from calculations to adapt to interference, but this isn't appropriate for the illumination frameworks. In⁵ system does not has the capability to modify the intensity of light based on customer's need, Since they consider only energy conservation and do not take an account of user need that is based on dimming / killing the lamp. Proposed system was not fully tested and verified for season change conditions and client movement, even though that system uses zigBee wireless network for communication⁵.

With a specific end goal and to satisfy above mentioned problems, we have designed a system to satisfy user needs and conditions that is energy saving outdoor light screening and management system based on ZigBee

method. Wireless ZigBee network has many routing algorithms. The suggested energy saving outdoor light screening and management framework likewise actualized the regular work steering calculation that brings about recovering system execution when contrasted with the regular frameworks. The proposed ZB-ESOL framework additionally fills the client fulfilment by utilizing inheritance and light sensors, and gives the door to plan the Advance Metering Infrastructure (AMI). While design the energy saving system we must consider some factors such as ensure the user predefined least fulfilment level and to save more energy.

2. Proposed Energy Efficient Outdoor Lighting System

In this letter, we outline ZigBee-based vitality efficient open air lighting control frameworks as appeared in Figure 1. For open air illumination surroundings, we choose our college hostel as a experiment part and introduced the LED lights joined by ZigBee module, adding with some sensors like light, occupancy, temperature. Through utilizing sensors the lights ceaselessly screen the power of the daylight associated with it, and supported on that power of light of that force AT mega 128 MC (Microcontroller Unit) has the capability to reduce light

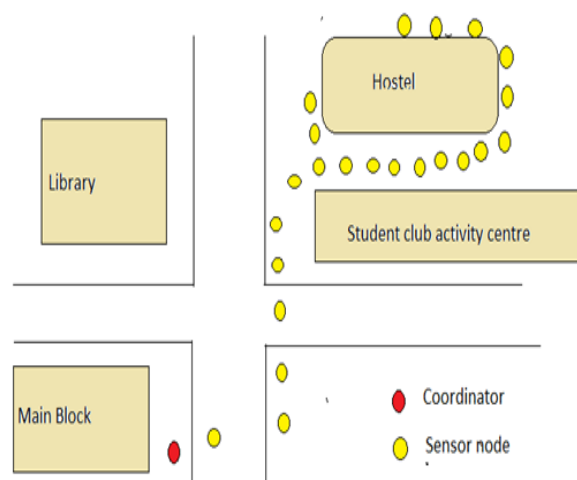


Figure 1. Suggested Energy efficient structure.

intensity as dim or off/on. Data is exchanged bounce by jump starting with one light then onto the next, where every light has a one of a kind address in the system. Each light can just send the data to the closest one till the point where that the data achieves the facilitator.

2.1 Light Supervising System

The light supervising system introduced in every light comprises of a few sections in Figure 2, the temperature sensor, light beams, and inheritance beams, control measuring IC, MCU, weight equators, and wireless network (ZIGBEE). For easy frequent monitoring the level of the lamp, some sensors are joint to the ZigBee RCM (Radio communication module). Light temperature and occupancy sensors utilized for to monitor some following criterions like light status of the plant, usage of power and lamp housing heat. These gadgets cooperate and exchange the greater part of the data to MCU which forms the information and naturally sets the fitting strategy. The point by point discourses identified with the primary segments

associated with the light checking framework is given in sub classifications.

2.2 ATmega 128 MU (Microcontroller Unit)

To control the process of the entire hub in every lamp ATmega 128 MCU is introduced. Based on the circumstance light and temperature beams collect the data and transmit to the MCU where the controlling process done. By complete the early behaviour the inheritance and light beams pedals the framework, which triggers the MC. The MU active either the intensity of light is less than the minimum voltage or to start conduction if few individuals went across the road or building. The detached infrared movement indicator sensor as appeared in Figure 3 is being introduced in every light which is utilized to check the nearness of travellers or autos going in the boulevards.

Data flow is between sensors and ballast equators and the flow of data is controlled by MCU. And data flow is additionally in charge of creating motion for diminishing the LED lights. Microcontroller unit interfacing with

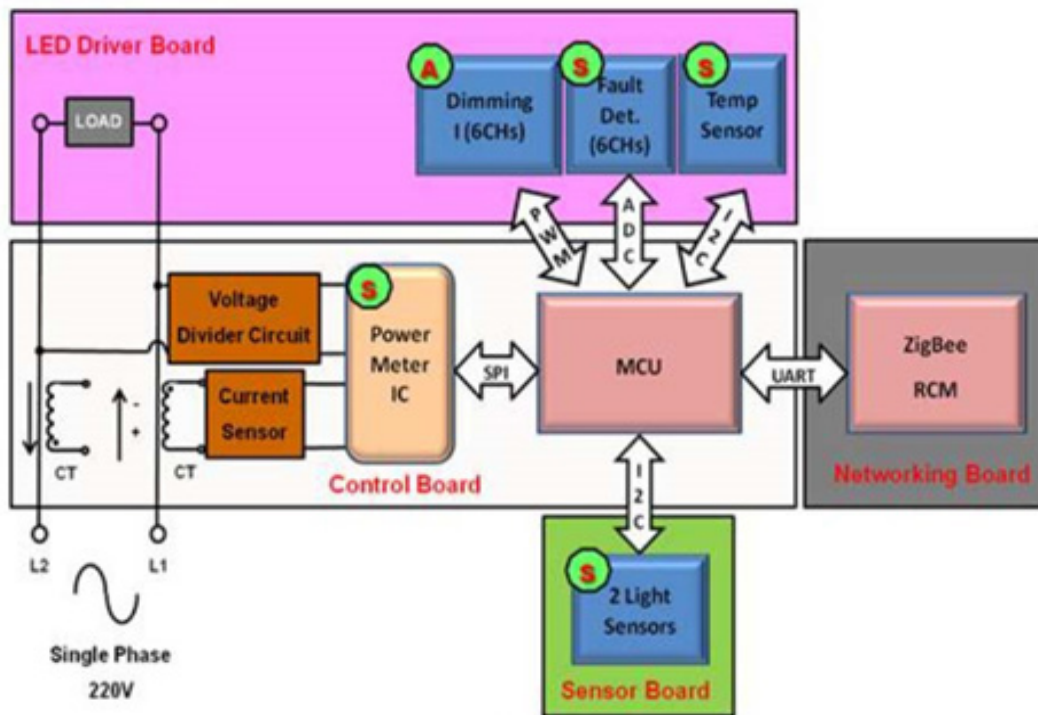


Figure 2. Screening system.

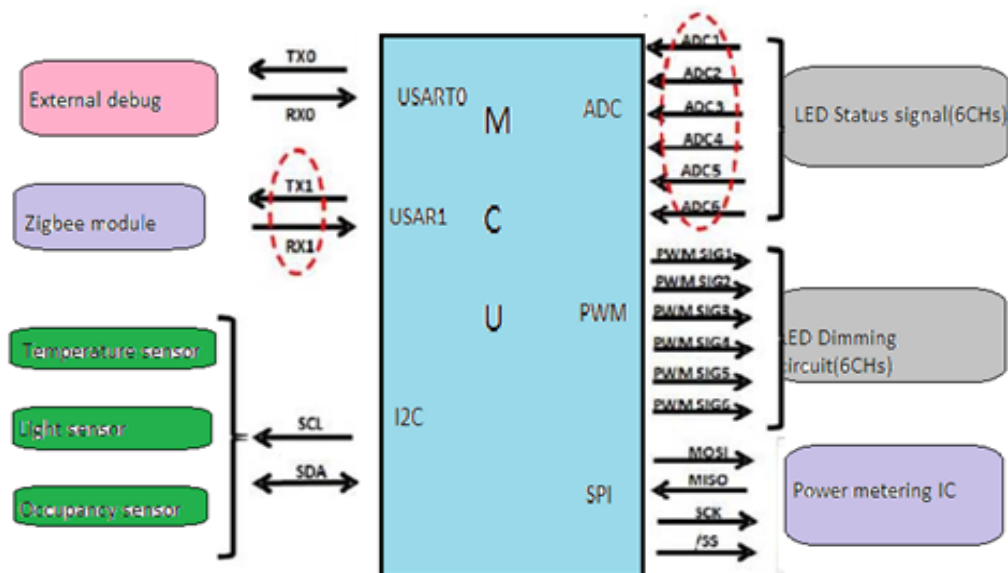


Figure 3. ATmega128 unit interfacing.

peripherals shown in Figure 2 that is used to detail the MCU to speak with other associated gadgets.

2.3 Light Sensors

I2C crossing point is used to connect the light beam (BH1710FVC) with MCU, that light sensor watch the status of light in luminance flux per unit area (Lux). Sensor used to measure the intensity of sun shine based on that sensor maintains the intensity of the lamp in the range of 200 lux. Reason for the intensity estimation is used to guarantee base enlightenment of the open air lamps. To guarantee a least plane of enlightenment of the open air lamps, estimations have to be made in⁶.

To keep consistent stage of enlightenment, MCU handles the light in view of the daylight power and that will be least flat and perpendicular luminance of 15 lux and 50 lux, individually⁷. If day light intensity falls underneath this illuminance stage lamp will be turned on.

2.3.1 ADE7753 Energy Metering IC

The position of a light is gauged by energy calculating IC ADE7753. Through Serial Peripheral Interface

(SPI) very exact electrical power estimation IC related to Microcontroller Unit. SPI relates current and voltage beams specifically and it requires just 5 V control supply. To screen the evasion current movement in the direction of light done by using current beams. Current level slash beneath the edge of 0.3 A, indicates that light is defective.

2.3.2 Blast Actuator

An extra module to Microcontroller is blast actuator which is used to consolidate dimmable equilibrium. For making a lamp dim, received remote actuation information of activator section interprets of them into the stabilizer control signs. In the proposed framework, a counterbalance actuator can control up to most extreme of four LED modules (units) each of appraised powers with a required current of around for each module. LED modules are fit for multilevel darkening control, i.e., from 0 to 255 of lights utilizing observing and control programming.

2.3.3 Door Node

A portal hub is utilized to fill in as a scaffold between two networks, i.e., ZigBee and web to play out the convention change. Every light controller speaks with the server farm by means of a passage. Door gives the backhaul connect to the server farm and ZigBee module to associate with the road lamp manage incurable. The suggested framework uses Ethernet conventions to connect door node with web, to watch, measure and monitor the LED light properties⁸.

2.3.4 ZigBee Radio Communication Component and System

ZigBee Radio Communication component: To attach and relate to the MCU zigBee RCM utilize Universal Synchronous and Asynchronous serial Receiver and Transmitter (USART). In the view of IEEE 802.15.4 standard zigBee is remote system pattern with less power, minimal effort, high unwavering quality, and nature-recuperating attributes. ZigBee concentrate on less energy, more performance and zigBee RCM is the initial stage of our planned outline framework, which comprises more than one area, which is Ember's EM250 radio chip⁴ and receiving wire for correspondence reason as appeared in Figure 3. Ash's EM250 ZigBee load is a solitary chip arrangement that incorporates a 2.4 GHz IEEE

802.15.4-agreeable handset. To write code for temporary storage of the IC, the EM250 chip is modified with the use of ISP pins.

2.3.5 ZigBee Network

The ZigBee arrange layer has some sorts of topologies titled as star, tree, and mesh topologies. Suggested framework depends on the mesh topology, because it makes them mend foundation and has additional way which can be useful to achieve the facilitator in the event that one neglects to work. ZigBee has less than 1% of bundle misfortune due to the behaviour of zigBee such as more radio affectability. Moreover, it has great practical field for the application achieving thousands of centimetre outside. Besides, the lights introduced in the organization territory utilizing ZigBee arrange has the unmistakable line-of-sight (LOS) circumstances without any trees or different articles hindering the correspondence.

3. Experiment Implementation and Discussions

The energy saving outdoor light screening system is intended to update the conventional energetic open air illuminate framework, with the use of zigBee for saving the energy. To confirm its legitimacy, usefulness

Table 1. LED Vs metal halide

Properties	LED lights	Metal Halide Lights
Efficiency [lm/W]	55	80
Lifespan[× 1000 hours]	10-50	6
Directionality	180 °	360 °
Cold tolerance	-40° C	-40° C
Loss	Extremely less	Confined light, unfavourable working temperature, ineffective ballasts.
Power rating	70 W	150 W

and execute in genuine circumstance designed system is tested below the outside situation in Figure 3. We outline energy saving outdoor light monitoring system using LED lamp and wireless zigBee network for communication with internet, this design will diminish to take care and discomfort of upkeep the road light systems.

Traditional metal halide MH lamp road lighting system uses 150 W and 250 W lamps that are replaced in energy saving outdoor light screening system as 70 W and 140 W respectively, 70 W LED bulbs in 22 units and 140 W LED bulbs in 16 Units⁹.

The separating between the lights are around 40 m. The short correlation has been done between the LED and the MH lights in Table 1. From, the we can see that despite the fact that the MH lights has more efficiency when contrasted with LED lights, however this competence is remunerated by the misfortunes happened in MH

lights, for example, caught light, troublesome working temperature, high influence prerequisite, and incompetent weights. Moreover, LED lights the vitality utilization is less than MH lights and furthermore have durability expectancy which thusly successfully lessens the cost of LED lights. LED's has more advantages than MH lamp which is used in traditional road lighting system.

Microcontroller unit consists control centre that is utilized for the purpose of ensuring the ongoing light status and if any deficiency is there it is also identified. Every road side lighting system has unique address for identification, control centre uses that address.

To precisely examine and think about the execution of the planned ZB-ESOL vitality competent road light framework and the traditional illumination control system, the energy saving framework was tested at two outrageous long stretches of winter (September, December) and sum-

Table 2. Conventional system

Duration	Conventional system				
	Lamps Units connected	Evaluation of Lamps Units(W)(Metal Halide lamp)	Working hours/day	Energy consumption per month(/day*30)(KWH)[From eq(1)]	
June	22	150	9	(a)29.7	Total (a+b): 65.7*30=1971
	16	250	9	(b)36	
July	22	150	9.5	(a)31.35	Total (a+b): 69.35*30=2081
	16	250	9.5	(b)38	
September	22	150	12	(a)39.6	Total (a+b): 87.6*30=2628
	16	250	12	(b)48	
December	22	150	11	(a)36.3	Total (a+b): 80.3*30=2409
	16	250	11	(b)44	

Table 3. Suggested energy efficient system

	Suggested energy efficient system				
	Lamps Units connected	Evaluation of Lamps Units(W) (LED lamp)	Working hours/day (Time Average)	Energy consumption per month (/day*30)(KWH)[From eq (1)]	
June	22	70	6	(a)9.24	22.68*30=680.4
	16	140	6	(b)13.44	
July	22	70	6.5	(a)10.01	Total (a+b): 24.57*30=737.1
	16	140	6.5	(b)14.56	
September	22	70	5	(a)7.7	Total (a+b): 18.9*30=567
	16	140	5	(b)11.2	
December	22	70	7	(a)10.78	Total (a+b): 26.46*30=793.8
	16	140	7	(b)15.68	

mer (June, July). Condition (1) is used to figure out the vitality utilization at every period of the introduced lights units.

$$E_{\text{consume}} (\text{KWH})/\text{month} = P \times \text{TL} \times h/\text{day} \times \text{days month} / 1000 \quad (1)$$

Where P is the power in watts, TL is the number of introduced lights, and h/day is the working hours every day. In Table 2 contains outcome of the summer and winter months. From the table we clearly know that the traditional framework, i.e., in the long stretch of winter, system does not use any sensors like occupancy and temperature at 12 hours in a day [7.00 Am to 7.00 PM] and also doesn't have any power saving technique that is based on sunlight dim or ON/OFF of the light in road. Along these lines the vitality utilization for this situation will be around 2628 KWH/month. On the opposite crosswise, by utilizing the proposed vitality predominant framework

this vitality utilization is decreased drastically from 2628 to 765 KWH, i.e., around 70.8% of the vitality is spared every month observed from Table 3. This vitality lessening is because of the use of LED lights rather than regular MH lights, dimming highlight of LED lights, and by utilizing the inhabitancy sensors.

These highlights decrease the normal working time of the planned framework to 7h/day in low traffic region to 8h/day if there should arise an occurrence of occupied streets. The outcomes plainly demonstrates that the vitality utilization of the proposed ZB-OLC framework diminishes discernibly contrary to the traditional frameworks.

Moreover, the energy utilization achieves its pinnacle, an incentive in the long stretch of December for both the frameworks. In addition, the vitality utilization for the proposed ZB-OLC framework diminishes more in radiant months and achieves the base an incentive in June for both the frameworks. If there should be an occurrence of the

proposed framework, because of its savvy climate adjusting ability its working h/day lessens more, and henceforth brings about more vitality decreases when contrasted with the customary framework. In this manner, the proposed vitality efficient framework is exceptionally useful for the administrators and also for the clients because of its high-lights of brilliant climate adjusting capacity. Subsequently, the sole cost to consider is that of the establishment and usage of the framework with sparing on account of lower support and vitality costs¹⁰.

4. Conclusion

The brought together and sagaciously checking of open air lights is the savvy and vitality efficient method for sparing valuable vitality. Our proposed systems have to modify the LED lamp intensity based on the conditions of the sunlight; so that this is called ZigBee based outdoor light monitoring system. It will give some other facilities like screen the status of lamp, energy utilization level by using wireless system. Even though it can monitors each light cost as like as whole system. Advantages of using suggested system is, it can reduce the number of labours who will be used to detect defect in lamp and this can be done with less time. Based on time and whether status it can accompany. Outdoor lighting in rural and some urban sites our proposed system is suggested along with little changes based on that different intervals has less or more movements. It can be flexible and based on the customer requirements it more adjustable and extendable.

5. References

1. Changhong S, Xianghong Z, Wei Y. Design of new intelligent street light control system. *Proceedings IEEE International Congress and Convention Association*. 2010; p.1423–7.
2. Chun C, Hung C, Kun L, Kuan C, Chun Y. A digitally wireless dimmable lighting system for two-area fluorescent lamps. *Proceedings TENCON 2010-IEEE Region 10 Conference*. 2010; p.2173–8.
3. Elejosteetal P. An easy to deploy street light control system based on wireless communication and LED technology. *Sensors (Basel)*. 2013; 13(5):6492–523. Crossref. PMID:23681092 PMCID:PMC3690067
4. Leccese F, Cagnett M, Trinca D. A smart city application: a fully controlled street lighting is le based on raspberry pi card, a zigbee sensor network and WiMAX. *Sensors (Basel)*. 2014; 14(12):24408–424. Crossref. PMID:25529206 PMCID:PMC4299117
5. Ember Corporation. EM250 Single-Chip zigbee/802.15.4 Solution. 120-0082-000 V datasheet. 2013.
6. Siddiqui A, Ahmad AW, Yang HK, Lee C. ZigBee based energy efficient outdoor lighting control system. *Proceedings ICACT*. 2012; 4(5):916–9.
7. Wang Y. Residue-to-binary converters based on New Chinese Remainder Theorem. *IEEE Transactions on Circuits and Systems II: Analog and Digital Signal Processing*. 2000; 47(3):197–205. Crossref.
8. Kaleem Z, Ahmad I, Lee C. Smart and energy efficient LED Street light control system using zigbee network. *12th International Conference on Frontiers of Information Technology*. 2014; p.31–365. Crossref.
9. Arthireena S, Shanmugavadivel G. Efficient sign detection using parallel prefix adder. *IEEE International Conference on Electrical, Instrumentation and Communication Engineering (ICEICE)*. 2017; p.1–5. Crossref.
10. Ozcelebi C, Lukkien J. Exploring user-centered intelligent road lighting design: A road map and future research directions. *IEEE Transactions on Consumer Electronics*. 2011; 57(2):788–93. Crossref.