An Automatic Solar Panel Based Street Lighting System: A Systematic Literature Review

R. Santhosh Kumar[*], **M. Prabu**[**], **P. Venkatesh**[***] **and S. Vijaya Rani**[****]

Abstract: Since the first introduction of street lighting control system to the research community in the year 1997, the field has grown enormously. Street lighting system plays vital role in our everyday lives for drivers and pedestrians. Automated street lighting system is used to switch ON/OFF street lights automatically, reduce power consumption and maintenance cost, while the variety of street light control system have been proposed, plenty comparison of these methods, strengths and issues that can lead to prospective street light control system is difficult. To investigate this issue, to review the present role of automated street light control system and survey (30 articles) in this area published during the year of 2008-2014. This report, summarize the observation and identify of common pitfalls among reviewed works.

Keywords: Street Lighting System, Manual Street Lighting System, Automatic Street Lighting System

1. INTRODUCTION

A Street light is a raised wellspring of light on the edge of a road or walkway, which is used to give light when it is required. Street light assumes a critical part in the safety and security of boulevards and open spots. Now-days, street lighting must be smarter to act in accordance with new enactment, ecological difficulties and need use of energy. Energy (power) is an imperative item for developing India, therefore, essential is its proficient use. Currently India is noticeable among energy squandering nations for the absence of any energy products such as street lighting, home lighting and industrial lighting. The most noticeable wastage of energy (power) occurs in street lighting. Because lighting frameworks, are still composed as per the old standards of dependability. The primary extent of street lighting is the expansion of human life quality of the dark period of the day. Street light can be controlled by two methods, namely manual method and automated method. In manual method, the street lights are controlled by the humans and the control switch will be available in the each of the street lights. In automated method, automation is intended to reduce the manpower. Automated street light system considers some factor to provide the safety of road walkers such as lighting.

The primary attention in the present field automation, power utilization and cost effectiveness. Because of expanding crude material costs, furthermore the expanding social affect ability to Co2 emanations are prompting create new technologies which permit major cost saving and larger respect for the environment. Through this literature review, discover three conceivable answers for these issues. The First possible solution, is the utilization of LED because it provides the best result due to long life and energy saving. LED street lamp is compact and shock resistive with energy efficient. The second possibility is the utilization

[*]   PG Scholar, Department of CSE, Adhiyamaan College of Engineering, Hosur-635109, Tamil Nadu, India, *E-mail: Sant061991@gmail.com*

[**]   Professor, Department of CSE, Adhiyamaan College of Engineering, Hosur-635109, Tamil Nadu, India, *E-mail: prabu_pdas@yahoo.co.in*

[***] PG Scholar, Department of CSE, Adhiyamaan College of Engineering, Hosur-635109, Tamil Nadu, India, *E-mail: venkimahalakshmi10@gmail.com*

[****] PG Scholar, Department of CSE, Adhiyamaan College of Engineering, Hosur-635109, Tamil Nadu, India, *E-mail: Vijisethu.Vijisethu918@gmail.com*

of a remote management system based on an intelligent lamp post that sends information to control terminal in order to reduce maintenance issues and the third solution is to utilization of renewable source solar energy [10] [14] [12] [33].

This literature report mainly focuses on the literature review of the street light control system. This literature review helps to know the merits and demerits of all the street light control system, which is taken through the research paper published during the period of 2008-2014.

The structure of the paper as follows; in chapter 2 of this report show the origin of the problem, which is used to state, the statement of the problem. Chapter 3 focuses on the related work (Literature review) of street lighting system and their roles. The exact existing systems were explained in chapter 4. The chapter 5 shows the result of existing system. Finally the chapter 6 and 7 gives for the proposed work and 6 conclusion of survey work.

2.   ORIGIN OF THE PROBLEM

Street lighting systems, particularly within the public sector, are still designed according to the old standards of reliability and they don't exploit the most recent technology. Electricity is the major requirements in the developing countries like India, so the majority of the power is consumed by the street lights. Furthermore, there is wastage of power occurs controlling the street lights manually. In early days there is no controlling technique to control the street lights remotely, so power wastage is more. Through manual working system the street lights cannot monitor dynamically and maintenance expenses will be high.

3.   RELATED WORK

In this literature review, the issue of the street light control system has been considered broadly in the background of power consumption, maintenances, cost, etc., extensive survey work has been accounted with respect to the street light control system. Some vital overview work identified with this topic as follows.

R. Caponetto (2008) [4] have depicts a remote control system for managing and checking status of street light. It is developed by ALBATROS device, master board and slave board. Master board is situated inside electrical panels and slave board is situated every street light. The communication achieved between master and slave board by using GPRS-GSM and power line. ALBATOROS device fused inside the slave board. This system allows turn ON/OFF the street light, monitoring the street light, checking current status on the street light and reducing power consumption by utilizing a device ALBATROS.

Chen (2008) [6] proposed advanced energy efficient street lighting driving system based on various performance metrics like power consumption, street light automatically modifies their working condition according to the environments by utilizing LED lamps, Ether-based communication interfaces, a digitally-controlled multi-phase driving system for LED light.

Jun Liu [19] (2008) presented an automated reliable and efficient street light remote control system. The system is planned by AT89C2051 and (SC1128) microchip. The system is used to monitor the street lamp, reduce the human power, power consumption. Marco A.D. cost (2009) [7] examined a solar panel based LED street lighting system. Here the lighting system comprises a solar panel as a primary source, battery as a secondary source and LED consider as a lighting source. Using (DC) converter, batteries are charged during day time through solar panel. DC converter is controlled by Maximum Power Point Tracker (MPPT) algorithm; through this the system can attain reducing power consumption.

Chen. Yu and Zhaoyu liu (2009) [5] have presented wireless street light control system, the system focused around (SCM MSP430F149), electric power carrier communication and wireless communication technology (nRF401 chip). In this system the lamp will shut down when communication network failure.

Controlling the street light wirelessly, so maintenances cost and power consumption is reduced. Lin Jianyi (2009) [18] analyzed a new application on a remote monitoring system for the street lamp, based on ZIGBEE technology. This system provides a solution about node deployment. The maximum distance between the street lamps is 40M for transmitting information about lamp to the controller.

Wang yongqing (2009) [34] discussed controlling solar LED street lights utilizing programmed control circuit. This system consists of three working modes such as light control delay, delay quenching and delay plus low power. Light control delay is used to turn OFF lights in daytime and turn ON light after sunset. Delay quenching mode is used to turn ON/OFF lights automatically based on setting time. Delay plus low power is used to changing the pulsed lighting power based on setting time. The above three working modes can be used in different situations flexibly and conveniently. This system can be used for the place such as streets, shops and so on.

WU Yue (2010) [35] presented intelligent street light control system based on timing control and photo electric control. It allows street lights automatically turn ON/OFF. If there are no vehicles passage or pedestrians the street light will turn OFF automatically. The LED Street light turns ON automatically, when the human passed within the distance 10M, through this the system can reduce power consumption. Hemalatha. M (2011) [12] proposed street light control system utilizing PIC microcontroller and GSM technology. The street lights turn ON/OFF automatically based on the RTC (Real Time Clock). Information about the street lights and street light maintenances are informed through GSM.

Anila Devi (2012) [1] have discussed about controlling street light remotely using ZIGBEE and sensors. The system uses various sensors like motion sensors, light sensor to ensure reduction of power consumption, maintenance cost and human power.

In the year of 2012 Rajeev Ray [25], reviewed energy conservation in lighting system based on various lighting technologies such as incandescent light, compact fluorescent lamp and Light Emitting Diode (LED). In the year of 2012 Vijayakumar [33], proposed an energy efficient street lighting system based on ZIGBEE wireless technology, GSM modem, LDR sensor interface with (ATMEGA16) microcontroller. The street lights can be controlled by using mobile phones, the option in the mobile phones is ON/OFF/DIMMING. Utilizing ZIGBEE technology the power consumption is reduced.

In the year of 2012 Deepak kapgate [8], have developed wireless street light controlling system based on wireless sensor network interfaced with (JN5139) microcontroller. Street lights should be switched ON/OFF remotely by an admin. The system provides an optimal cost saving for maintaining the street lights.

In the year of (2012) K. Y. Rajput [27], presented on intelligent street lighting system based on GSM technology and wireless sensor network integrated with (C8051F350) microcontroller. Using GSM technology the location of the street lights can be identified and the information of street lights is gathered by sensors. It is fully based on location aware application and WSN application. The system always needs internet connection for sending street light information to the maintenance team. Automatic street light control systems based on IR sensor, LDR sensor is interfaced with (89S52) microcontroller. The system provides power saving, cost effective and 90%, reduce of manual work. The system does not suitable for long distance communication, discussed by kapse sagar (2013) [15].

Street lights are controlled and monitored by various sensors (LDR, IR, Motion, Humidity and Temperature) with (PIC16F) microcontroller. Based on environments deviation the street lights automatically get adjustable like ON/OFF/DIMMING and also the system consists auto-alarm, if any street light is damaged then the information immediately transfer to the maintenance team. The system provides 50% power is saved, developed by Archana (2013). In the year (2013), Kannadasan [14] stated that the new mechanism to preserve the street lights with automatic ON/OFF by using PIR sensor and GSM technology interface

with (ATME189C51) microcontroller. Controlling and monitoring street lights using GSM via short message service. The system provides 70% power and manual operator is saved.

In the year (2013), Pooya Najafi [26] suggest a new method for monitoring and remotely sensing the street lights by using computer vision and image processing technique. Utilizing the image processing technique the system gives a clear picture of damaged street light to the controller and the system implementation cost is high. In the year of (2013), OmkarNadu [24] introduced a monitoring and controlling the street lights using GSM with (89C51) microcontroller. It is android and IOS based application can be developed for mobile phones for controlling the street lights. This system reduces power consumption up to 50%.

In the year of (2013) Bhaskar Reddy [32] suggests an efficient monitoring system by using ZIGBEE technology at PC end. By this system 60%-70% power is saved by using LDR, IR sensors and LED light. This system is particularly suitable for urban areas and rural areas. In the year of (2014) R. Kavitha [16] developed distributed intelligent street lamp monitoring based on ZIGBEE and sensors. This system uses ZIGBEE transmitter and receiver, the information of the street light is transmitted to controller to know the status of street light. Through this system the power has been saved up to 50% by using solar panel, IR sensor, Air velocity sensor, and Rain sensor.In the year of (2014) Rich Sam Alex, introduced a solar photovoltaic panel based street lighting with (ATMEGA) microcontroller. By using renewable energy source, this system can save power 25%-30%. In the year of (2014) Liaigao [17], proposed solar street lamp control system based on ZIGBEE and sensors. In this system GPRS is used to transfer the collected information of street lights from ZIGBEE node to controller to take corrective action.

An automatic street lighting system was controlled by the combination of sensor and ZIGBEE technology with (Ardunio UNO R3) microcontroller. Thus a system can reduce energy consumption, maintenance cost and crime activities, was stated by Srikanth (2014) [31].

In the year of (2014) Siva Rama Krishna [30], a developed energy efficient system for reduction of power using ZIGBEE network and sensor in the street lighting. The system consists of (PC7618) microcontroller, light sensor and motion sensor in order to reduce power consumption and maintenance cost. A review of lighting technology such as LED lighting, compact fluorescent light, sodium vapor lamp and incandescent lamp based on various performance metrics like power consumption and light lifespan, discussed by Satwinder Singh in (2014) [29].

This report shows a survey of research work in the area of Automated Street lighting control system published during the period of 2008-2014. All research papers indexed by the Google Scholar and the Digital Bibliography and Library Project (DBLP) databases for the reviewed time period. From this set, exclude short papers, extended abstracts, no peer-reviewed research and papers not available in the English language and those containing no evidence of experimental study. To narrow the focus, has further selected research work relevant to automated street lighting control system. Thus, any methods specifically developed for power consumption, monitoring street lights and maintenances cost etc., were excluded. The final set of 150 papers, containing 30 journals and 140 conference/workshop papers, was reviewed manually without any means of automatic search techniques.

Table 1
Literature review

Year	Publication Title	Method for Street Light Control		Experimental Method
		Approach	Features	
2014	Remote Control System of HIGH EFFICIENCY and Intelligent Street Lighting using a ZIGBEE and Sensor	Led technology, ZIGBEE technology, sensor	Life span, power consumption	Microcontroller (PIC16f877A)

contd. table 1

Year	Publication Title	Method for Street Light Control		Experimental Method
		Approach	*Features*	
2014	Review of an Energy Efficient Smart Street Lighting System	Led technology	Life span, cost, Efficiency and power consumption.	
2014	Distributed Intelligent Street Lamp Monitoring andcontrol system based on ZIGBEE	ZIGBEE wireless technology	More Power Consumption, saving precious time, decrease the huge human power	Mplab Sim, PIC microcontroller (MCU)
2014	Energy Efficient Intelligent Street Lighting Systemusing ZIGBEE and Sensors	ZIGBEE and Sensors	Reduce the Power Consumption	Microcontroller (Atmega 16)
2014	ZIGBEE Based Remote Control Automatic Street Light System	Sensors and ZIGBEE Technology	Reduce energy consumption and maintenance costs, reduce crime activities up to certain limit	(Arduinouno) microcontroller kit.
2014	Efficient System for Reduction of Power Using ZIGBEE Network and Sensors in Street Lighting	ZIGBEE network and sensor	Reduce the energy consumption	Arm controller (cpc7168)
2014	Design of Wireless Framework for Energy Efficient Street Light Automation	ZIGBEE technology	Easy maintenances, reduce energy consumption, flexible, extendable, and fully adaptable to user needs	microcontroller (PIC16f87xa)
2014	Street Lighting System with Fault Detection Using Arm7	Sensors and GSM Technology	Reducing Energy Consumption	(ARM) processor
2014	Power effective wireless street light control	Sensors and ZIGBEE technology	Reduced human power, increasing power saving	(PIC1650) microcontroller
2014	High Efficiency Hybrid in Telligent Street Lighting Using A ZIGBEE Network and Sensors	ZIGBEE Technology and Sensors	Reduced maintenances, increasing power consumption	(PIC16f87a) microcontroller
2014	Design and Implementation of High Efficiency Remote Control System for Intelligent Street Lighting	Sensors, wireless communication technology	Reduce the consumption of the electric and human energy to the maximum	(PIC18F) microcontroller
2014	Gsm Based Remote Control System of High Efficiency Intelligent Street Lighting System Using A Zigbee Network of Devices and Sensor	GSM and ZIGBEE Technology	Increase the Power Consumption	(PIC 16F688) microcontroller
2014	A New Approach for Low Power and Energy Efficient Street Light Management System	ZIGBEE, GSM Technology and Sensors	Low Power Consumption	Microcontroller (C8051f350)
2013	A ZIGBEE Based Wireless Street Lighting System	ZIGBEE Technology	Substantial Energy Saving	PIC microcontroller
2013	An Easy to Deploy Street Light Control System Based on Wireless Communication	Wireless Communication Technology	Increased Energy Efficiency, Communication and in Complex	Sensor board Based on an (Atmega1281)

Year	Publication Title	Method for Street Light Control		Experimental Method
		Approach	Features	
	and Led Technology		Scenarios. Size, Morphology, Lamp Technology	
2013	Design and development of intelligent wireless street light control and monitoring system along with gui	ZIGBEE Wireless Technology	More power consumption, saving money	IEEE 802.15.4, Microcontroller
2013	Intelligent Street Lighting System Using GSM	GSM Technology	Reduce energy use by up to 40%. Reduce maintenance by up to 50%. Increase bulb life by up to 25%.	Microcontroller (C8051f350)
2013	Gsm Based Autonomous Street Illumination System for Efficient Power Management	GSM Technology	Increase energy Consumption, Reduce Maintenance	Microcontroller (C8051f350)
2013	Wireless Based Closed Loop Automation of Street Light Control Using Pir	PIR SENSOr, GSM Technology	Low power consumption	Microcontroller ATMEL (89C51)
2013	Automatic Street Light Control System	Ldr, Ir Sensor	Increase the powersaving.	Microcontroller (89S52)
2013	Design of Traffic Flow Based Street Light Control System	ZIGBEE Technology and Sensors	Power can be saved	Microcontroller (AT89S52)
2012	Energy Efficient Street Lighting Control System	ZIGBEE wireless technology	Both remote as well as centralized control. maximum energy efficiency, maintainability	Avr microcontroller (atmega16)
2011	GSM Based Cost Effective Street Lighting Application	GSM, RTC (Real Time Clock)	Power consumption, cost are reduced.	(PIC16F877A) microcontroller
2010	Design of New Intelligent Street Light Control System	LED technology, GPRS	Reduced power consumption and maintenance cost.	(ATmega8) microcontroller
2009	A High Efficiency Autonomous Street Lighting System based on Solar Energy and LEDS	LED Technology	Power Consumption is Reduced	LEDs Driver
2009	Distributed Intelligent City Street Lamp Monitoring and Control System based on Wireless Communication Chip nRF401	SCM Technology and Wireless Communication Technology	Find failure in time and easy to maintenance	(AT89C51) Microcontroller
2009	Wireless Monitoring System of Street Lamps based on ZIGBEE	WSN and ZIGBEE Technology	Save Maintenance Time and Decrease Costs	(ARM7) Microcontroller
2008	Development of an Energy Efficient Street Light Driving System	LED Technology	Power Consumption is reduced	PID Controller
2008	Power Consumption Reduction in a Remote Controlled Street Lighting System	GSM and GPRS Technology	Reduce Power Consumption up to 28-32%	ALBATROS

4.   STREET LIGHTING SYSTEM

In the present world, mostly street lighting system is to fulfill their primary purpose of casting light onto dark roadways, parking areas and public spaces. Street lighting system is increasingly evaluated for how well that reduced power consumption, improve safety for both drivers and pedestrians.

4.1. Manual street light control system

In early days the street lights are operated by manually because each street lamp consists of a control unit. Following that next method has been used such as optical control method and time control method. In optical control method, light sensitive device control used to switch OFF light automatically in the morning and switch ON automatically after the sunset. Time control method used time control to switch ON/OFF light based on timing. The above method has disadvantages such as power loss and high cost.

4.2. Automated street light system

Automated street lighting system avoids power loss and maintenance cost by using latest technologies such as LED Light technology and renewable source of energy (solar panel). It provides cost effective, energy efficient, convenient for maintenance.

5.   RESEARCH METHOD

5.1. Research questions

RQ1. What is Light Control System?

Motivation: The purpose is to get an idea about light control system.

RQ2. Why should Control the Street Light Remotely?

Motivation: Obtain the importance of street lights, controlling the street lights remotely and its usage.

RQ3.What is the necessity to move from Manual Street Light Control System to Automated Street Light Control System?

Motivation: Find issues in manual system and showing the importance of automated system.

RQ4. What are all available devices and methods to Control Street Light?

Motivation: Obtain an overview of existing devices and its function in street lights in order to propose the new devices.

RQ5. What are the similarities, differences between different Light Technologies?

Motivation: Achieve a comparative view of lighting technologies and their features for upcoming researchers.

RQ6. What is the need of an automatic solar panel based LED street lighting system?

Motivation: Obtain the importance of automatic solar panel based LED street lighting system while implementing in real time environment.

5.2. Search process

The search process was a manual search of precise conference proceedings and journal papers from 2008.For the survey purpose, the random manual search technique is used. Research paper related to automated street lighting control system are searched randomly and collected from the year 2008. During a random search of research papers are searched in the search engine by using keywords such as street lighting system, automated street light control system etc.

6. OBSERVATION

This section summarizes the observations, from the table1. In this part answers each research questions listed in section 5.1.

RQ1.What is light control system?

The lighting control system serves to give the perfect measure of light where and when it is required. Controlling street light not only enhances the life span of street lamp; it helps to save energy.

RQ2. Why should control the street light remotely?

Street lights are vital to our everyday lives, lighting the way for drivers and pedestrians. If any failure or malfunction is recognized, the information is transferred to the service engineer through a graphical interface for taking corrective action. In the manual control system the service engineer can't know the street light status dynamically. But controlling the street light remotely the service engineer knows up to date status of the street light.

There are several reasons to controlling the Street Light Remotely:

➢ To obtain the street light consuming energy per day.

➢ To check street light needed any services.

➢ To see the exact street light location.

➢ To check the status of the street light.

RQ3. What is the necessity to move from Manual Street Light Control System to Automated Street Light Control System?

In manual street light control system, light will be switched OFF or ON manually and physically operated street light are not switched OFF properly even the sunlight comes and also switched ON earlier before the sunset, so there is more wastage of energy is occurs, because each street lamp consists control unit to switch ON or OFF the light. So we need huge human power to maintain the street light.

In automated street light control system will reduce the energy consumption, reduce the human power and easy to maintenances the street light because it works automatically based on environment condition using various sensors.

Table 2
Comparison of manual and automated street light control system

Manual street control system	*Automated street light control system*
Wastage of energy	No wastage of energy
Difficult to maintain all the street light	Easy to maintain the all street light
Need huge human power	Need less human power
More cost	Cost effective

RQ4. What are all available devices and methods to Control Street Light?

A sensor is a device that discovers events (or) measures physical quantities and gives a corresponding output. It could be utilized to sense an extensive variety of distinctive energy forms such as movements, electrical signal and radiant energy.

Table 3
Function of Sensors

Device name	Function	Device feature in street light
Presence sensor	It is used to recognize the entry of vehicle.	Switching light ON when it is required, keeping away from wastage of energy.
Light sensor	It is used to monitor the brightness of the sunlight in the surrounding.	It will not require at day time but it is attractive in the early morning and at sunset.
Hall effect sensor	It is valuable to enhance error management and system maintenance.	The system can perceive false positives.
Co2 gas sensor	It is used to focus when a present carbon dioxide gas has been reached or exceeded	The sensor module is proposed to give a mean of comparing gas sources and being able to set caution limit when source gets to be exorbitant
Rain sensor	It is used to measure thickness of the rain.	It is expressed as profundity of water and gather a level surface since rain factor is determined as impact factor of street security
LDR sensor	Light dependent resistors are extremely helpful especially in light sensor circuits.	Automatically switching ON/OFF the street light.

RQ5. What are the similarities, differences between different light technologies?

An electric light is a converter; its prime intention is the change of electrical energy into observable electromagnetic radiation. It is the most common form of synthetic lighting and it is necessary to modern society, giving interior lighting of buildings and exterior light for day and night time activities. Public lighting possesses 10% from the electrical energy consumer categories.

Table 4
Comparison of Light Technology

Light technology	Average of lamp life in days	Efficacy (lumens per Watt)	Consideration
Incandescent	42-208	11-15	Extremely ineffective and short life time.
MercuryVapour	500-1000	13-48	Very ineffective, ultraviolet emission and contains mercury.
Metal halide	417-625	60-100	High maintenance UV emission contains mercury and lead, danger of blasting at the end of life.
High pressure Sodium	500-1000	45-130	Contains mercury and lead.
Low pressure Sodium	417-750	80-180	Contains mercury and lead.
Fluorescent	417-833	60-100	Ultraviolet emission contains mercury, inclined to glass breaking and diffused non directional light.
Compact fluorescent	500-833	50-72	Short life/blaze out, dimmer in cold weather and contains mercury
Induction	2500-4167	70-90	Higher initial cost, limited directionality, contains lead and negatively affected by heat.
LED	2083-4167	70-150	Moderately higher initial cost.

RQ6. What is the need of an automatic solar panel based LED street lighting system?

➢ Reducing street fault such as theft and the panic of the street crime.

➢ It provides security in urban areas.

➢ Reduced maintenance costs

➢ Reduced energy consumption

➢ Performance and energy-consumption data at your fingertips

➢ Reduced greenhouse gas emissions

➢ Street light also enhances wellbeing for drivers, riders and pedestrians

➢ Advertising sustainable transport, public transport and walking.

➢ Identifying the exact location of the street lamp and support the emergency services.

➢ Provides 24 hour use of travel and accessible road transportation

9.   DISCUSSION AND FUTURE ENHANCEMENT

The paper describes a literature review of automated street light control system. This review covers both manual control system and automated control system. This is consummate by detailed analysis of different lighting technologies, devices and methods and experimental method. To best our knowledge, an exhaustive literature survey of automated street lighting system is exhibited to give an extended of researchers.

The future enhancement can be design integrating latest technologies like LED Light, ZIGBEE and using Renewable Source of Energy (Solar Panel) with low cost microcontroller, to make efficient automated street lighting system.

10. CONCLUSION

Summarizing our observations about a systematic rigor of an automated street lighting control system studies, it satisfies the issue faced by common street lighting system. The focus of our survey was mainly on the experimental part of the research; thus, we have not attempted to analyze the quality of the proposed methods. But, the review of the published research along major works of the experimental study: approach, performed experiments, and the evaluation, show that studies from all categories fail to follow basic principles of scientific experimentation. Since our survey work is based on an analysis of published documents, it is possible that many of the identified pitfalls were avoided in the conducted research, but not reported. We hope that these results will help the academic community to overcome common pitfalls discovered in this survey in their future research. In the future, to plan, to repeat this study to see how research in the area of automated street lighting control system is changing and whether any significant trends can be noted.

References

[1] Anil devi, Y & Jaya parkash, V (2014), 'GSM based remote control system of high efficiency intelligent street lighting system using a ZIGBEE network of devices and sensor', *International Journal of Science and Research*, vol.7, pp.2319-7064.

[2] Archana, M (2013), 'E-Street: LED Powered Intelligent street lighting system with automatic brightness adjustment based on climate conditions and vehicle movements, IRAJ.

[3] Brinda, N & Tharmaraimanalan, T (2014),'Designing an Intelligent Street Lighting System using a ZIGBEE Network', *International Journal of Emerging Technologies in Computational and Applied Sciences*, vol. 4, pp. 345-350.

[4] Caponetto, R. & Dongola, L. (2008), 'Power consumption reduction in a remote controlled street lighting system', in *Proc. Int.* Symp. Power Electron*.,* Elect. Drives, Autom. Motion, pp. 428–433.

[5]   Chen .Y & Liu, Z (2009), 'Distributed intelligent city street lamp monitoring and control system based on wireless communication chip nRF401', in Proc. Int. Conf. Network. Security, Wireless Communication andTrusted Computing, pp. 278–281.

[6]   Chen, PY & Liu, YT (2008), 'Development of an energy efficient street light drving system', IEEE int. Conf, pp. 761–764.

[7]   Costa, MD & Costa, GH (2009), 'A high efficiency autonomous street lighting system based on solar energy and LED', Power electron conf, Brazil, pp. 265–273.

[8]   Deepak Kapgate, A. (2012), 'Wireless Streetlight Control System', *International Journal of Computer Application*, vol. 2.

[9]   Dhinakar, P & Pradeepraja, R. (2014), 'Highly efficient and intelligent indoor and outdoor lighting system using a ZIGBEE network of devices and sensors', *International Journal of Innovative Research in Computer and Communication Engineering,* Vol. 1, pp. 2320-9801.

[10] Fabio Leccese, (2013), 'Remote-Control System of High Efficiency and Intelligent Street Lighting using a ZIGBEE Network and Sensors, *IEEE Transaction on Power Delivery*, vol. 28.

[11] Hariharan, A. & Kirubakaran, J. (2014), 'High Efficiency Hybrid Intelligent Street Lighting using a ZIGBEE Network and sensors', *International Journal of Soft Computing and Artificial Intelligences*, vol. 2, pp. 231-404.

[12] Hemalatha, M. (2011), 'GSM based cost Effective Street Lighting Application', International Conference on Communication Technology and System Design, vol. 3.

[13] Imthiazunnisa Begum, R. (2013), 'A ZIGBEE Based Wireless Street Lighting System', *International Journal of Innovative Research and Studies*, Vol. 2, pp. 2319-9725.

[14] Kannadasan, T. (2013), 'Wireless Based Closed Loop Automation of Street Light Control using PIR, vol. 2, pp.2278-1323.

[15] Kapse sagar sudhakar, M. (2013), 'Automated street light control system', *International Journal of Emerging Technology and Advanced Engineering*, vol. 5.

[16] Kavitha, R. & Thiyagarajan, N. (2014), 'Distributed intelligent street lamp monitoring and control system based on ZIGBEE', *International Journal of Science and Research*, vol. 4, pp. 2319-7064.

[17] Liai gao, N. (2014), 'Solar street lamp control system based on ZIGBEE and GPRS', *Journal of Chemical and Pharmaceutical Research*, vol.6, pp.2718-2722.

[18] Lin Jianyi, L & Xiulong , J, 'Wireless monitoring system of street lamps based on zigbee', in Proc. 5th Int. Conf. Wireless Commun., Netw. Mobile Comput, pp. 1–3.

[19] Liu, J. & Suo, X. (2008), 'Street lamp control system based on power carrier wave,' in Proc. Int. Symp. Intell. Inf. Technol. Appl. Workshops, pp. 184–188.

[20] Liu, L & Liu, T (2009), 'The design and realization of communication technology for street lamps control system', in *Proc. 4th Int.* Conf. Comput. Sci. Educ, pp. 259–262.

[21] Manikanda Prabu, S (2014), 'Power Effective Wireless Street Light Control', *International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering*, vol. 3, pp.230-3765.

[22] Mustafa Saad, N (2013), 'Automatic street light control system using microcontroller', *Mathematical Methods and Optimization Techniques in Engineering*, vol. 3.

[23] Nithya, P & Kayalvizhi, N (2014), 'Design of wireless framework for energy efficient street light automation. *International Journal of Innovative Research in Computer and Communication Engineering*', vol. 1, pp. 2320-9801.

[24] Omkar Natu, S (2013), 'GSM based smart street light monitoring and control system', *International Journal on Computer Science and Engineering*, vol. 5.

[25] Pavani, V (2014), 'Street lighting system with fault detection using ARM7', *International Journal of Emerging Engineering Research and Technology*, vol. 4, pp. 440-443.

[26] Pooya Najafi Zanjani, D (2013), 'Montoring and Remote Sensing of the Street Lighting System using Computer Vision and Image Processing Techniques, International Conference on Electricity Distribution, PP. 0954.

[27] Rajput, KY (2013), 'Intelligent street lighting system using GSM', *International Journal of Engineering Science Invention*, vol. 3, pp. 2319-6726.

[28] Richu Sam Alex, N & Narciss starbell, R (2014), 'Energy efficient intelligent street lighting system using ZIGBEE and sensors', *International Journal of Engineering and Advanced Technology*, vol. 4, pp. 2014, 2249-8958.

[29] Satwinder singh, S (2014), 'Review of an Energy Efficient Smart Street Lighting System', *International Journal of Research,* vol.1, pp.2348-6848.

[30] Siva rama Krishna, V (2014), 'Efficient system for reduction of power using ZIGBEE network and sensors in street lighting', *International Journal of Advanced Research*, vol. 7, pp. 1041-1047.

[31] Srikanth, M. (2014), 'ZIGBEE based remote control automatic street light system'. *IJESC*, vol.7, pp. 2247-7898.

[32] Subramanyam, BK & Bhaskar reddy, K. (2013), 'Design and development of intelligent wireless street light control and monitoring along with GUI', *International Journal of Engineering Research and Application* 2013,vol.4, pp.2248-9622.

[33] Vijayakumar, S & Karthik srinivas, S 2012, 'Energy Efficient Street Lighting Control System', International Journal of Engineering & Technology, vol. 1, pp. 2278-0181.

[34] Wang Yongqing, R (2009), 'Design of Solar LED Street Lamp Automatic Control Circuit', Internatinal Conference on Energy and Environment Technology.

[35] WU Yue, W & YANG Wei, Y (2010), 'Design of New Intelligent Street Light Control System', IEEE. Conf. Control Autom, pp.1423-1427.

[36] Yongqing, H & Chuncheng, Z (2009), 'Design of solar LED street lamp automatic control circuit', Int. Conf. Energy environment technology, pp. 90-93.