International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-8 Issue-12, October 2019

Street-lights with Automated Weather Updating System and IOT Control

J.Jean Justus, S. Mannish, S. Madhumithaa

Abstract— ***Street lights are very essential towards the development of a city and are unknowingly one of the most crucial factors in our day-to-day life. The street lights largely used today are based on providing lighting to citizens but, over looks on environmental issues such as heat dissipation or the amount of electricity consumed. As energy-saving and cost reduction has become crucial right now, it is necessary that we improve standards of the street lights with upcoming technologies to make it efficient. The street lights that focus on saving electricity and providing environmentally friendly lights are based on solar energy. But this implementation does not manage the solar energy used by the street lights nor supervise the power stored in the solar cell to extend the same capacity of power being used in a longer period. This results in street light wasting power in unwanted situations such as being turned on during daytime and most times not working when required such as in times of rain and during days when fog collects hindering visibility. Also, manual work is required to manage the street lights along with repairs and maintenance. Therefore, human error cannot be avoided. To overcome these situations, our solution is to automate streetlights that turn on during night and poor visibility also automatically turn off when there is sufficient light in that particular region. Battery management and street light control as a backup in case of failure or equipment damage via the network are also essential for complete automation in our implementation. Thus, this implementation accepts weather patterns via network and manages the power stored in the solar bank used to provide longer battery life in case of rain or storm in a region. Finally, it reduces the watts consumed and by extension the running cost which from the working prototype gives a power savings of 50 – 60% in terms of cost.***

Keywords : Battery Management , Energy Conservation, IoT, Solar Energy, Weather Updation

I. INTRODUCTION

The street lights have become a very essential part of cities. It is essential to promote security in installed areas and to increase the quality of life by artificially extending the hours in which it is light so that we can live our lives as we do during the daytime. Street lighting is also essential for the safety of the citizens to avoid accidents after sunset. But on the contrary, it is the costliest implementation for a country in terms of electricity measured in watts and by extension running cost.

Revised Manuscript Received on October 30, 2019.

* Correspondence Author

Dr.J. Jean Justus*, Associate Professor in the Department of CSE, St.Joseph's College of Engineering, Chennai.

Mannish, pursuing his B.E degree in Computer Science and Engineering at St Joseph's College of Engineering, Chennai.

S. Madhumithaa, pursuing her B.E degree in Computer Science and Engineering at St Joseph's College of Engineering Chennai.

In India, the demand for street lights are 18 percent of the total electricity production against a global average of 13 percent. This demand of 18 percent in terms of watts is 3400MW and to put it in terms of cost is 0.2 million or 1,41,92,200 rupees per month and 17 crores per annum.

Most commonly implemented street lights in India based on renewable energy are solar energy-based street lights. These street light models are implemented at least in a building or in a community. It consists of the following components.

- Solar panel – Typically 24-Watt panel will generate 2200 lumens output
- Storage battery to save electricity via the solar panel. Back-Up -2-3 Days High-Quality lithium batteries (LiFePO4).
- LED bulbs that use the least power consumption compared to other light bulbs

Table 1 proves that the usage of LED is better than other traditional light bulbs based on calculated metrics from the same table.

Table - I : Comparison of Light Bulbs

Metrics	Led	Incandescent	Sodium vapor	Mercury
Watts per hour	40 W	60 W	250W	400W
Efficiency	90%	10 %	90%	30%
Life Expectancy (in hours)	10000	1000	24000	24000
Intensity in Lumens	800	800	120	35- 65

Most of the street lights follow only these said features or technology stack and since energy is not consumed directly from the electricity board, bill will be reduced for at least 10 years. But using only solar-powered streetlight does not address the following:

- **Further power management within the solar battery**

This should ensure proper utilization of power stored within the battery to increase the battery lasting time as well lifetime, decrease it's recharge-time.

- **Automation based on day and night**

This automation refers to turning on the street lights when the environment does not have ambient light and off when there is sufficient lighting. This does not require human or manual operation which causes error thereby not turning off the light during day time.

- **Unmanned error detection and correction using IoT**

Since the street light is going to be automated there will always be a chance of malfunction or an error rectification that will be required immediately. If it is not rectified immediately then there will be further loss in terms of electricity and thereby cost in rupees.

Therefore, our proposed solution is be to change the intensity of light from minimum to maximum brightness with battery management and control using IoT to detect and control errors. Since the lights at night are used by very few people it will be cost-reducing if it is intensified when someone is using the road at night.

II. RELATED WORK

Harshita Gupta et al. [1] have proved the implementation of PIR sensor depending on the range of its detection which is 5 to 12 V. The additional cost and energy in the model requires an additional amount of power depending on the overhead. It can be avoided by using an ultra-sonic sensor which has a requirement of only 3 to 5 V. Furthermore, the LDR sensor does not detect proper light conditions at a distance, it can sense only around it. To overcome this issue, we use a phototransistor (NPN) which produces the required intensity.

M. Priyadarshini et al. [2] have used a PIR sensor which detects an object and Turn on and turn off Lights. However we need to address the fact that during night time, it is advisable to keep the streetlights turned ON since its sole purpose is to make roads and surroundings visible.

K.Y.Rajput et al. [3] have elaborated on implementing and connecting the streetlights over a network along with a focus on energy consumption. However it does not implement renewable energy which has become essential these days as energy conservation is crucial.

Swati Rajesh et al. [4] have implemented power saving with sensors and changing intensity of light automation. It can be improved with separate control for error detection and its rectification. It also can include efficient management of lead-acid battery which is powered by solar energy by using convectional electricity when there is no opportunity to charge the solar bank the next day.

B. Abinaya et al. [5] have designed an adaptive lighting based on Weather conditions for energy savings and wastage. However, the system consists of an LDR sensor which in real-time does not provide proper detection in the variation of sunlight. Also, it can be improved by knowing the status of the street lights in real-time when it is in operation along with that of the CCTV footage.

Gul Shahzad et al. [6] have implemented street light system for energy conservation and traffic adaptive control. This was implemented with a wireless mesh network from which we can remotely read conditions of the street lights. However, the energy conservation efficiency can be improved by implementing street light control with an android or web interface for immediate rectification in case of error and by battery usage management along with the implementation of solar energy.

Fabio Leccese et al. [7] have proposed a system which provides energy saving with a change in intensity of streetlights to conserve energy along with web-based monitoring. Creating a proper android platform will enhance the system along with weather data extraction from the cloud as implemented in this system with battery management will enable to save more energy and thereby the cost.

Yun-gui Zhang et al. [8] have implemented smart server control of street lights with a GIS database and GPRS wireless communication module. This method can be improved by using a solar panel with power bank (Power storage). It can be optimized by fully automating based on the environmental lighting conditions and varying the intensity based on the people using the streets.

III. PROPOSED SYSTEM

Figure 1 represents the Block diagram of the proposed model. Microcontroller has three independent inputs such as power source from the battery, intensity of light in the environment and weather pattern for the next two days. These inputs have driven the system to be implemented in the most optimized method.

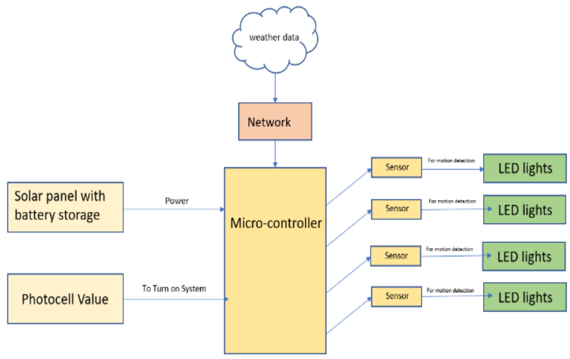

Fig. 1. Functional Block Diagram

Figure 2 represents the implementation of the prototype. Components such as IR sensor and microcontroller NodeMCU are used to implement wireless transmission of data over a sample of five lights. However, these components have to be replaced with the components said in Table II.

Fig. 2. Prototype Connection in Real-time Model

Table II - Scalability Chart

International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-8 Issue-12, October 2019

FEATURES	ULTRASONIC SENSOR	PHOTO TRANSISTOR NPN SENSOR	LED STREET LIGHTS
INSTALLATION COST	₹250.00-₹2000.00	₹55.00	₹700.00
ENERGY CONSUMPTION	3-5 volts.	300mA.	220 volts/30 watts.
EFFICIENCY	More accuracy in detection(up to 600cm)	It can detect upto 24 meters.	Only half of the power consumption than traditional
LIFE EXPECTENCY	20 Years.	Based on maintenance.	15 Years.

The components used in the prototype needs to be modified according to real-world application. The most important components to be replaced include the IR sensor with an Ultrasonic sensor and LDR with a phototransistor, NPN-type. The metrics and requirements given in Table II have guided in the selection of these components.

The flowchart in Figure 3 depicts the details in the implementation of the real-world model. The first step is to transfer the weather pattern to specific microprocessors via a network based on which it determines its power that is either the solar power bank or direct electricity. Once the power source is determined it scans the environment at regular intervals to check for low life intensity. When the system turns on, it is turned on at minimum intensity which will be at half the highest intensity to reduce power consumption.

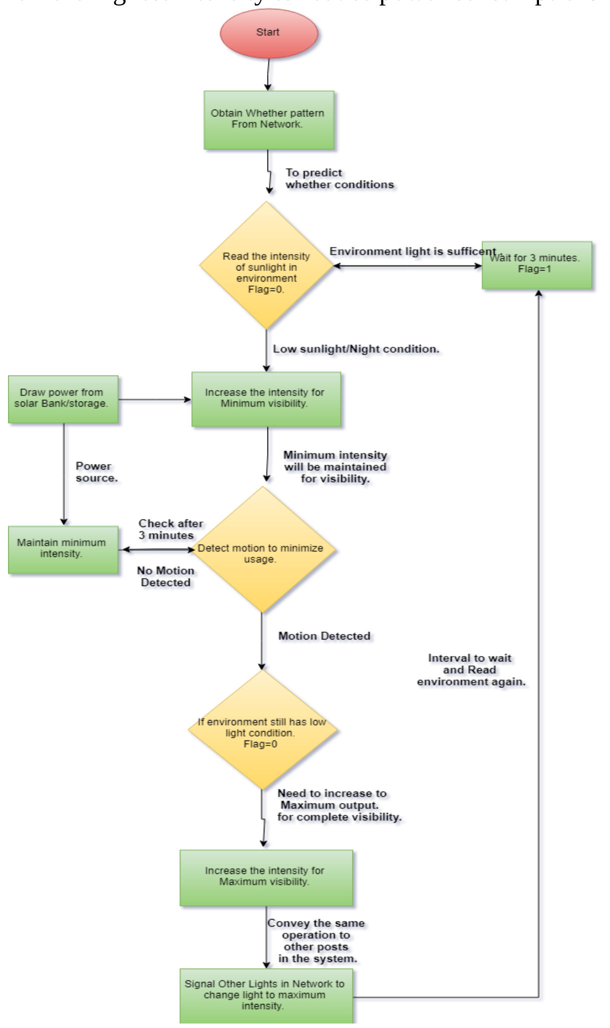

Fig. 3. Flowchart of the Actual Model

The lights will be changed to maximum intensity in the detection of a presence, which is provided by a motion sensor, in this case, being an ultrasonic sensor due to its low power consumption. IoT provides easy error correction and detection as it provides a solution to quick updating and notification of damaged street lights to authorities. This system has, therefore, overcome manual operation of street lights thus working automatically even in times of poor visibility rather than only during night.

IV. AUTOMATION COMPONENTS AND CONTROL

A. LDR Sensor

This sensor is used to judge the sunlight intensity in the environment to decide if the street lights need to be turned on or remain turned off. When switched on, the street lights operate in minimum intensity and maximize intensity only when required to reduce the consumption of electricity. Therefore, it turns on street lights even when there is a storm or heavy rain and there if there is a poor visibility. Cadmium Less LDR can be used since cadmium is banned by the restriction of hazardous substances. (ROHS).

It works on the principle based on increasing the resistance directly proportional to the intensity of light on its surface. It is basically a photocell that works on the principle of photoconductivity. When the light intensity exceeds a specified frequency, the photons absorbed in the semiconductor provides the valance band electrons, the energy required to jump into the conduction band.

The real world application is a phototransitor which performs the same function as that of the LDR with accurate detection for sunlight at any range and longer life-time when maintained in a well placed enclosure.

B. IR Sensor

This sensor is used to detect an object with a range to change the intensity from minimum intensity to maximum intensity when the street lights are turned on due to low light condition in the environment. Once the object is not in the range of the sensor the intensity changes back to minimum. The sensor is designed to detect changes based on colour, temperature, and reflection of light by an object. For the real world application , IR sensor has been replaced with an ultrasonic sensor. The reason is that they have greater range detection and consumes 3 – 5 V of power compared to PIR sensor and have life expectancy of 20 years.

C. Resistor

A 10K resistor is used to change the intensity. The change in intensity is from 5 v to 3.3 v using resistance. This has changed the watts consumed per second from 0.9 v to 0.5 v. (In the prototype.).

D. Arduino UNO Board

Arduino board is used to store and run the program for demonstrating the prototype. It is a microcontroller capable of doing a particular task with certain input and output. Certain input and output pins are specified for the model.

- A0 - A4 -- IR sensor analog input
- A5 -- LDR input
- Digital pins 3,5,6,9,10 are used to change the intensity of LED based on the LDR sensor and IR sensor values.

V. RESULTS AND DISCUSSION

Street lights are turned OFF when there is sufficient light in the environment . It is detected by the LDR sensor as shown in Figure 4.

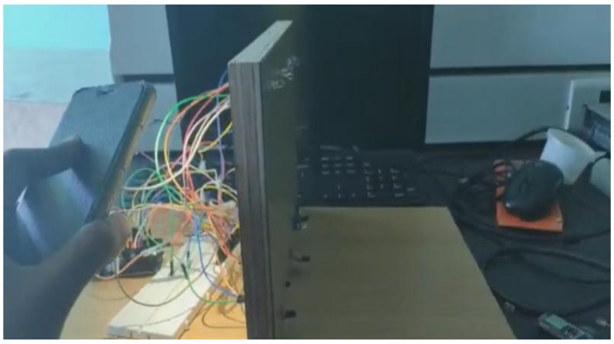

Fig. 4. Turned OFF Stage of Street Light

Street lights are turned ON at minimum intensity when there is no sufficent light. This is depicted in Figure 5.

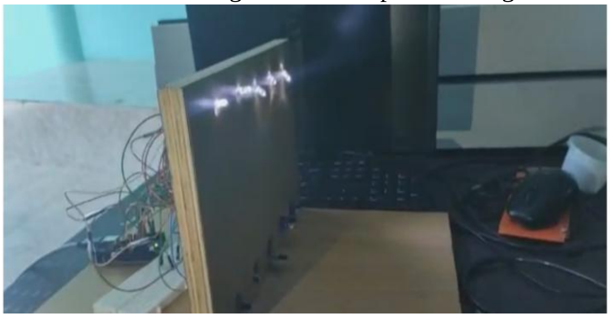

Fig. 5. Circuit Turns ON with Minimum Intensity

The second street light in Figure 6 changes its intensity upon detecting an vehicle. The second street light is being turned ON to its maximum intensiy by detecting an object via IR sensor. It has changed back to minimum intensity once the object is no longer in the detection range of the sensor.

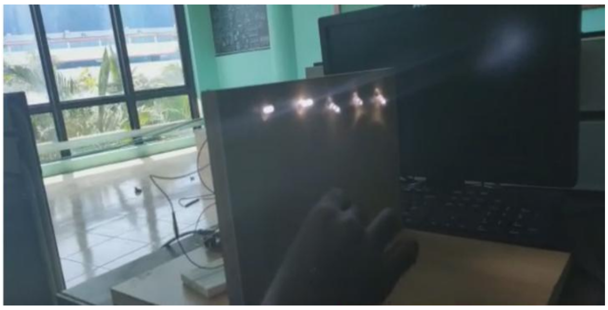

Fig. 6. Intensity Change of Street Light

The fourth street light in Figure 7 changes its intensity upon detecting an vehicle.The fourth streetlight being turned ON to its maximum intensiy by detecting an object via IR sensor. It has changed back to minimum intensity once the object is no longer in the detection range of the sensor.

Fig. 7. Intensity Change of Fourth Light

Figure 8 shows the lights which are at maximum intensity (1) and minimum (0) intensity. Furthermore the electrical consumption is shown with cost saving by this method.

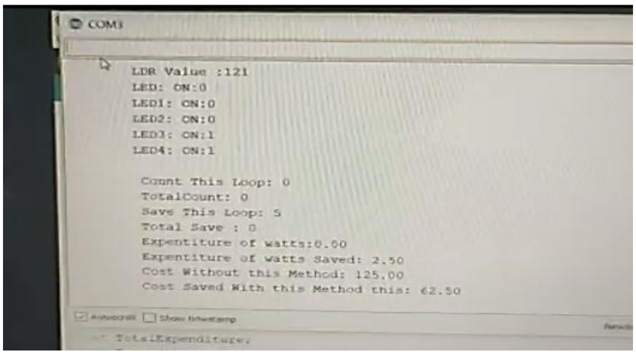

Fig. 8. Real Time Value Generation

VI. RESULT BASED ON IoT

IoT Technology is used to remotely turn ON , OFF and to change the intensity of the street light from a control center or a remote location. This is essential because in the case of a malfunction of a sensor or a photodetector it is mandatory to immediately take action based on the reading from the sensor. This is demonstrated with the help of webpage control and android based control.

A. IoT based on Webpage

The webpage displays the street light intensity in a region and the status of the street light as to whether it is ON or OFF. With this data, error can be determined and appropriate action can be taken accordingly. This makes certain that the street lights work with saving power.

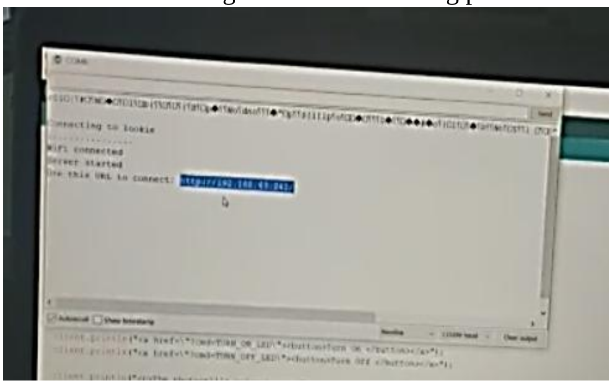

Fig. 9. Street Light Control using Web-page

In Figure 9, link is generated to control the street light via a webpage. From this link, lights in the network is operated remotely. This is done using a wireless microcontroller (NodeMCU) in the prototype. The LED is being turned OFF from the webpage as shown in Figure 10. This is essential during malfunction in the sensor. This prevents unwanted wastage of electricity.

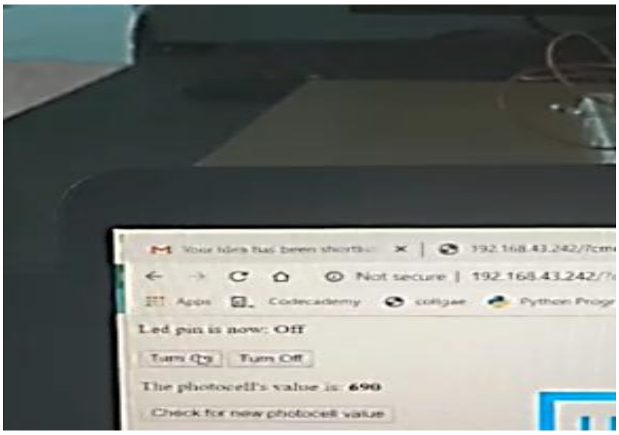

Fig. 10. LED Turn-OFF using WebPage

Control of street lights via a webpage is displayed in Figure 11.This presents the street light intensity in the environment along with the status of the street lights as it is ON or OFF. In this case the LED is being turned on from the webpage.

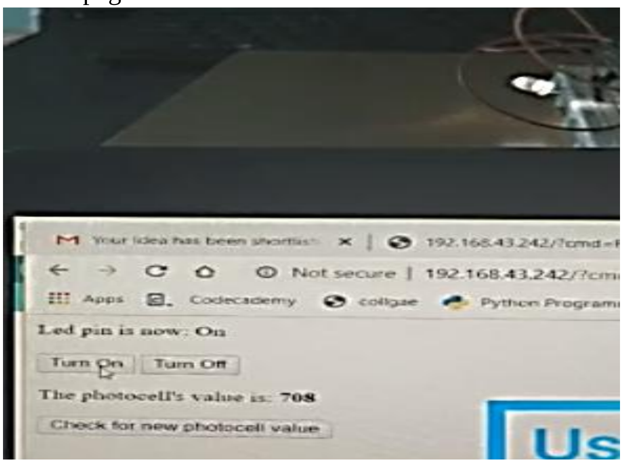

Fig. 11. LED Turn-ON using WebPage

B. IoT based on Android

Android is just another platform to monitor the street lights. Its function is similar to that of the webpage and it is used to monitor a single street or a set of street since webpage based control is better in handling lot of data and controlling a large region. This further ensures as a backup to web-based control with easier access and user-friendly interface. Figure 12 shows the IoT connection and control via android application to eliminate error detection and correction.

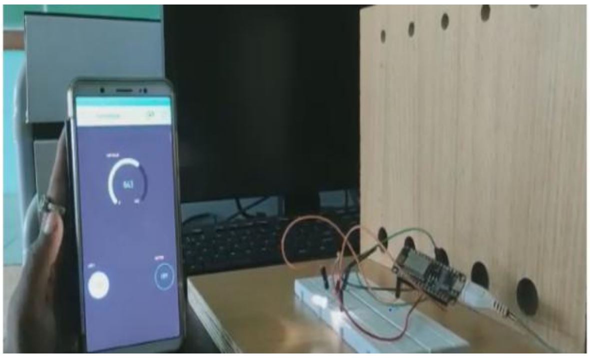

Fig. 12. IOT Connection using Android

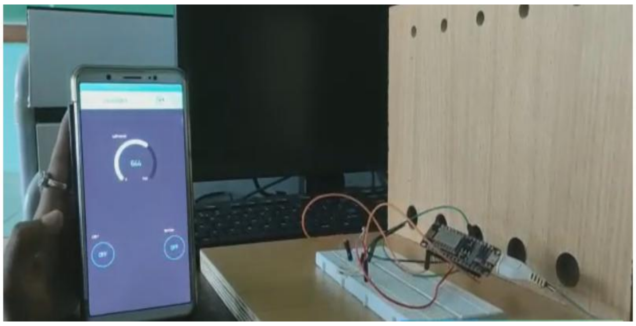

Fig. 13. Remote Location Control

As shown in Figure 13 , lights can be turned off from a remote location. Figure 14 illustrates the Wifi connection used in the prototype.This is carried out by a microcontroller called NodeMCU-ESP8266. This microcontroller has an inbuilt wifi and program processing capabilities.

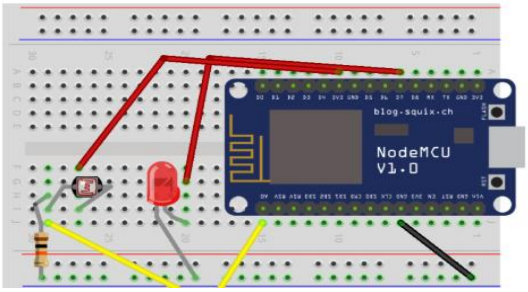

Fig. 14. Wifi Connection Circuit

C. Hybrid Topology for Real-World Application

Hybrid topology displayed in Figure 15 is a type of network topology that uses two or more differing network topologies. These topologies include a mix of bus, mesh, ring, star, and tree topology.

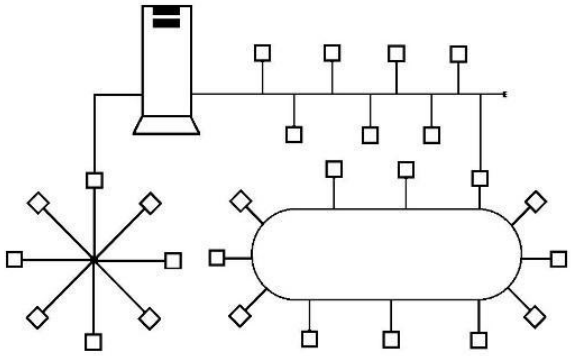

Fig. 15. Hybrid Topology

VII. BATTERY MANAGEMENT USING WEATHER UPDATION

This method sent the weather pattern of a region or an area through a network to the respective microcontrollers . This will not use the power stored in the battery to provide electricity when there is continuous rain or in other words insufficient sunlight. During these days priority is given to the power stored in a solar bank and uses the main electricity generated by the electricity board. Once the main electricity is turned OFF, the solar bank power provides electricity for the street lights as long as it holds power. This concept is similar to that of the inverter used in homes. This model has the potential power for the street lights during rainy days and storms.

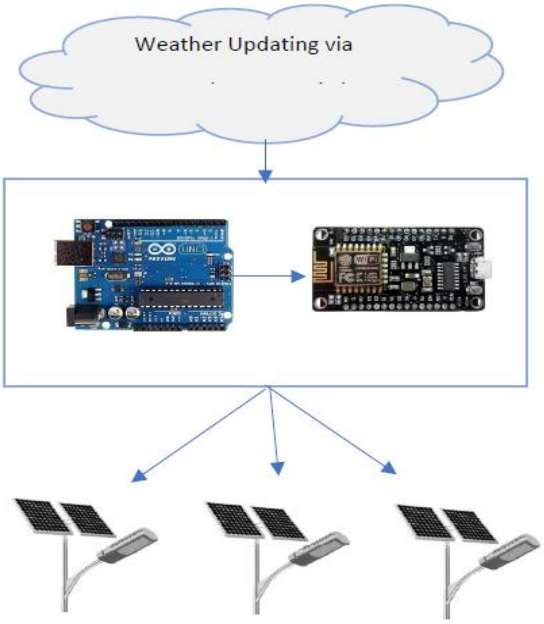

Fig. 16. Automatic Weather Updation Schematic Diagram

VIII. DATA EVIDENCE AND CONCLUSION

Real-time values of running cost between existing system and proposed prototype is compared via a data extraction software TWegde and plotted with Excel.The existing implementation shows a cost of Rs.3800 compared to this model where the cost is of Rs 1600 on highways , main roads and a cost of Rs 1500 on cross streets for similar street light operation time period. Thus, this method saves 50 – 60 percent of running cost depending on the type of road along with automation control to prevent unforeseen wastage of electricity.

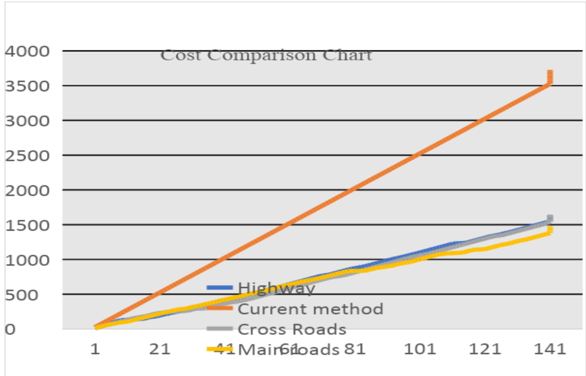

Fig. 17. Cost Comparison Chart

REFERENCES

1. Harshita Gupta, Prasad Thorve,Naman Tripathi, Vina M. Lomte, "Energy-efficient Intelligent Street Lighting System", *International Research Journal of Engineering and Technology* (IRJET),2017.
2. M Priyadarshini M.Keerthana R.Keerthana V.Malarvizhi G.Meena, "SMART STREET LIGHTING", *International Research Journal of Engineering and Technology (IRJET)*,2016.
3. K.Y.Rajput, Gargeyee Khatav, Monica Pujari, Priyanka Yadav. "Intelligent Street Lighting System Using Gsm", *International Journal of Engineering Science Invention*, 2013.
4. Swati Rajesh Parekar, Manoj M. Dongre, "An Intelligent System for Monitoring and Controlling of Street Light using GSM Technology", *International Conference on Information Processing (ICIP)*, 2015.
5. B.Abinaya S.Gurupriya M.Pooja, "IOT BASED SMART AND ADAPTIVE LIGHTING IN STREET LIGHTS"., *Second International Conference On Computing and Communications Technologies(ICCCT'17)* , 2017.
6. Gul Shahzad, Heekwon Yang, Arbab Waheed Ahmad, Chankil Lee, "Energy-Efficient Intelligent Street Lighting System Using Traffic-Adaptive Control", *IEEE SENSORS JOURNAL*,2016.
7. Fabio Leccese Zbigniew Leonowicz, "Intelligent wireless street lighting system", *IEEE*, 2012.
8. Yun-gui Zhang, Li-na Zhao, Li-na Wang, Sheng-yong Zhang, "A Web-based Management System for Urban Road Lighting", *International Conference on Web Information Systems and Mining*, 2010.

AUTHORS PROFILE

Dr.J. Jean Justus obtained her B.E. degree in CSE from Noorul Islam College of Engineering, Manonmaniam Sundaranar University and M.Tech. (CSE) from SASTRA University, Thanjavur. She was awarded Ph.D. degree in Computer Science and Engineering by Anna University, Chennai. Currently, she is an Associate Professor in the Department of CSE, St.Joseph's College of Engineering, Chennai. She is now conducting researches in networking. Her research interests include network security, IoT, bluetooth networking and energy efficient routing in Wireless Sensor Networks.

S. Mannish is currently pursuing his B.E degree in Computer Science and Engineering at St Joseph's College of Engineering, Chennai. His area of interests are Data Analytics and Data Science.

S. Madhumithaa is currently pursuing her B.E degree in Computer Science and Engineering at St Joseph's College of Engineering Chennai. Her area of interests are programming and algorithm development.