Application of Raspberry PI and Communication Technique for Efficient Power Management for the Street Light System

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Abstract - Outdoor lighting in the majority of the country and urban ranges in India are not energy proficient. As it is the fundamental area of the country and urban base. Thus there is an immense potential for the change and legitimate maintenance without modifying present outdoor lighting framework. This work focuses on the problems like power saving, power theft, security, and immediate response to problems. Here we propose a system which can monitor and control energy consumption regularly. A preliminary arrangement of remote sensor system can be designed to analyze the utility for outdoor monitor and control system. It also plans a very secured and proficient system which can reduce power, similar to the prime request to meet the present expanding power needs. The essential aspect of the work is to consider the prime things while developing new system, that can read, rectifies and in addition control use of energy effectively. This application comprises of a base station (additionally called as control node) and a sensor hub at each of the remote station (likewise called as feeder enable box). The base station monitors and controls every single street light. This work displays a cutting edge and secured road lighting control application. The project ensures power savings because of light dimming choices to maintain strategic power consumption from glowing of lights amid night hours. The goal of the application is to provide programmed automatic control and monitoring on road lights. The project manages outlining a lighting system which focuses on the power saving and autonomous execution on efficiently low cost for the roads and quick countermeasure on complaint. The Energy Consumption of light of a predetermined region can be recorded and accounted on Energy Saving Lighting System with coordinated sensors and controllers. Moreover, errors which occur due to manual operation can also be eliminated. With these facilities the performance and life of the lamps will be increased.

I. INTRODUCTION

Energy substitution has now been in an essential position in the Energy Security Strategy of our nation where control restriction is getting to be noticeably common as of late because of the lack of domestic power supply and the upward value pattern of worldwide fossil fuels. It seems to be the trend of times that the solar energy, which is infinite and renewable, will be gradually replacing the conventional source of energy in some part of our everyday life and production activities. Along with the increasing size of urban areas and the rising standard of construction, the total number of street light of our country has been raising at an average rate of 20% per year, of which the energy conservation is giving the government a cause for concern. Despite the fact that the solar based street light has many favorable circumstances, for example, ecological assurance, low power utilization, and is required to be the future standard of city enlightenment, its local application is at a halt at present due to the current bottleneck in its innovation and cost. Street lights are the key factor of any city to influence it to make the city smarter. Be that as it may, we have seen such circumstance where our street lights are ON in the availability of sunlight. So we need to design such a framework which will run road lights of the city at the appropriate conditions. The inspiration of this task is to outline a keen lighting system which focuses on the energy saving and independent operation which is conservative and reasonable for the avenues. An intelligent lighting system is developed with measured approach outline, which makes the framework versatile and effective. Design a smart lighting system which is compatible and scalable with other commercial product and automation systems, which might include more than one lighting systems [1].

Smart lighting contributes major of electrical energy consumption worldwide [2]. Energy productivity is the key factor while outlining indoor or outside lighting systems. To proficiently use the restricted power resources, energy productive lighting system is required which can deal with the energy intelligently. However, the traditional lighting systems are not reliable because of its design based on the old lighting standards and inefficient instruments and devices. New technologies used on streetlight plants aim to give important benefits both for environment and for economic saving [3-10]. In this way, it brings about power losses, periodic substitution of devices, experiences the absence of inescapable and compelling communications, observing, automation, and defect diagnostics issues. To get the maximum efficiency, the lamp posts use LED (Light Emitting Diode) technology which, together with an intelligent lighting policy based on local sensors information, allows a targeted sizing of photovoltaic panels and batteries used to supply the lamp posts [11]. Additionally, enhancements in lighting quality and extension in administrations can enhance standard conditions for both vehicle activity and people on foot. Lately there has been an expanded measure of consideration

paid to the state of electrical dispersion systems, including those providing street lights. The outcomes of these episodes extend from people on foot revealing a "tingling" sensation to cases which have brought about casualty. The application is developed such that we put light sensors in all the street lights circuit and which are capable to turn on and off naturally. A multi-practical road light control framework, which is greater power monitoring and advantageous, is introduced here as individuals put increasingly consideration regarding energy preservation and natural assurance. In this manner effort has been made to moderate energy conservation. While the most of the street lights have adopted the photosensitive control technology which turns on the street lights when environment is dark and turns off the street lights when environment is bright, the street lights still consumes a lot electricity when there is few vehicles driving around, s the new design is better at all level. Once the lights are made on, current sensors put at each street light pole are mindful to report issue status to the concentrated system with the assistance of GSM module appended with the circuit. With the status accessible in the unified system, the service person now can find the location of the damaged or defective street light for repair thus lessening the time to find it and repair. The project likewise gathers helpful data from every street light toward the finish of every day. The data is put away in the database and in view of this data outlines are determined. The graphs are shown in the street light area which contains data like power utilization, add up to number of consuming hours, add up to number of intrusions, count the actual power utilization with the power provided, points of interest of fault identification i.e. certain area of street light. The proposed system designed to accomplish singular shortcomings repaired inside couple of working hours as opposed to taking days/even months time spent in current framework where a staff really goes on "light watches" six/eight times each year to check for such broken lights. For the most part, they depend on occupants or other metropolitan workers to report dynamic lights (at the end of the day, damaged lights).

II. RELATED STUDY

Road lighting can be categorized according to the installation area, performance and their use as: Lighting for traffic routes, lighting for subsidiary roads and lighting for urban centers and public amenity areas [13]. Street lighting can be classified according to the type of lamp used such as: Low Pressure Sodium (LPS) which produce monochromatic orange-yellow light, High Intensity Discharge (HID) lamps, High Pressure Sodium (SON) lamps that can give golden white light, Metal Halide, Mercury Vapor and Light Emitting Diode (LED) Street lights. Adjustable lamp reflectors and/or holders are usually provided along with the road lighting luminaries in order to optimize the distribution of the light according to road layout. Different types of lamps used in lighting design with their luminous efficiency and lamp service life is given in Table 1 [13].

Type of Lamp	Lumens per watt	Average lamp life in Hours
Incandescent	8-25	1000-2000
Fluorescent	60-600	10000-24000
High Pressure Sodium (HPS)	45-110	12000-24000
Low Pressure Sodium (SON)	80-180	10000-18000
Metal halide	60-100	10000-15000
LED	28-79	25000-100000

Table 1: Lamp efficiency and service life

Public street light control and management system is made up of the computer network systems, communication systems and a number of spot intelligent control terminals. Each terminal control device provide power for one or more of the block street, every control terminal is called a sub-node. Light switches control is carried out by the two-way controlled silicon in control box. Terminal for the control of road blocks is two-disseminated PC control system which is composed of host computer from the sub-node and host computer from central control room (master node) which offering operating of engineers and computer stations (as a central control room).Its main completion is remote control, telemetry, remote hearing, failure analysis, data retrieval, system maintenance, electronic map display and print statements and other functions [6].

III. EXISTING SYSTEM

Street light is ineffectively designed and deficiency kept up, there is huge number of scorched out lights which prompts instability. There is a complaint register in every zonal office street light section. Presently street light management is done through manual process such as a physical activity is required to switch on and off the street lights according to their needs. It is so hard to maintain the activity in physical methodology because once the manual process fails there will be no lightening into the respective streets. As well as the manual process is time consuming for fault finding and corrections hence takes more and more time to manipulate each and every activity such as failures of lamps and either it is on or off. And it is difficult to identify the light in the respective location because of the present system doesn't use any advanced devices such as Global position System [GPS] and internet facilities, so that it is very difficult to identify and inform the control messages to the control room as well as these kind of street light mechanism cannot receive the control messages from the control room. For all the entire manual process will cause poor efficiency and cost & time wastages in both performance wise as well as efficiency wise. At the state level, a large part of the State Electricity Boards are reeling under enormous losses by virtue of a combination of assistance and under-recoveries. The National Tariff Policy of 2006 stipulates that the State Electricity Regulatory Commission (SERC) settle tax inside +/ - 20% of the cost of supply. Unfortunately, most states fail to meet this

guideline. As a result, the power sectors in most states are in a financial mess.

This demonstrates a major impede with regards to putting resources into more energy proficient power dispersion hardware and most recent power metering and observing systems. The one sector that needs urgent attention is street lighting because of poor condition of street lighting system.

In many urban communities, the street lights are introduced and preserved by departments. Most urban and semi urban communities and towns are as yet utilizing a combination of fluorescent, CFL, high weight sodium lights or metal halide bulbs, which are not intended to meet range insightful lighting needs.

Almost no examination or arranging has gone into the luminance required in various territories of roads, to address the necessities of walkers and vehicular activity alike. For example, the lighting needs of vehicular activity in fast zones are unique in relation to low-speed high movement zones. In like manner, lighting needs in street intersections are unique in relation to optional streets. On the other hand, the lighting prerequisites of a zone with vehicular activity will shift from that of a territory with high pedestrian traffic. A one-estimate fits-all way to deal with road lighting brings about wasteful arrangement of energy assets and winds up in inefficient utilization of power that could have been exceptional used somewhere else.

Street light arranging is not just about luminosity yet additionally the status of the lighting pole, which in turn fluctuates in light of the necessities of that specific range. Standard tenders are issued on a 'city-wise' premise, prompting high operational cost caused on road lighting. Regularly, one notification that the street lights remain on well past sunrise. This is due to that the lights are turned off in view of a predefined time as opposed to lighting needs, which differ in light of season and area of the city. There is a requirement for contriving a well thoroughly considered approach to anticipate wastage of power. Hence we can say that under present situation maximum numbers of street lighting system are unplanned and without intelligent control system. Perhaps, the administration can consider actualizing Automatic Street Light Control System utilizing LDR (Light Dependent Resistor), which consequently turns off lights when daylight fall on it. Poor support of street lights is another issue looked by most subjects, leaving extensive zones without sufficient lighting. The districts are hard squeezed for assets and the residents need to confront the brunt.

Disadvantages:

- Performance is low because of manual operations and controls.
- Cannot monitor the street light from remote places, physical intervention is required at every point of time.
- Wastage of Power
- Expensive process.
- Time Consuming and there is no advanced/intelligent methodology to operate the street lights without human interventions.

It is being maintained by the line inspector. The public, councilors and corporation officials either over phone is in person being recorded in the complaint register, the complaints received by them (Fig 1). To resolve the complaints, the grumbling along these lines entered is being given over to the hands on service person. Furthermore, the complaints about non consuming and the field staff will have the rounds in the separate territories twice in seven days are likewise being gone to without even a moment's pause. Be that as it may, it has many weaknesses like the repair work takes days/even a very long time as opposed to taking couple of hours which brings about lag, phone line might be occupied, at times no reaction since this isn't the quick cure on complaints.

Fig.1: Existing method

The switches of lights are turned ON/OFF physically by the laborer in every one of the zones (Fig 2). This prompts the ascent of labor and time. As it is human operation it is inclined to faults.

Fig.2: Operating Street light manually

Existing techniques like enlisting the objection, turning on/off the light physically is tedious and requires labor. The new strategy programmed ON/OFF and fault recognition without human intercession is less demanding when contrasted with the current system.

IV. PROPOSED SYSTEM

The proposed system introduces the automation solutions for street light functioning in which the Raspberry Pi acts as the major controlling unit. This ARM 11 based processor containing board which has serial port for communicating with external

serial modules like GPS and GSM. This board is acting like a CPU which plays a major role in the real-time applications. The proposed street mechanism contains many useful features such as automatic ON and OFF, Manual Free Operations, Automatic Reporting and Controlling facility from remote environments. The intelligent Light intensity Sensor is used to control the street light On and OFF conditions without human intervention, because it returns the light intensity at every point of time to street light controller, once the natural intensity of light is low automatically the street light will be getting ON and once the natural light intensity is high (i.e., visible range) it will automatically getting OFF. Global Positioning System [GPS] identifies and tracks the location of the street light if the particular street light in that location is damaged. And by using GSM, we establish facilities over street light such as messaging/alerting scheme which provides the facility such as getting periodic report from the street light and control the street light being anywhere at any time without any interruptions. So when the street light is not working, another LDR sensor measures the light intensity and immediately the data is sent to the Raspberry pi 3 board. Then the controller will send the details of particular street light with location to the department as a message.

Advantages:

- Completely dynamic and automatic process.
- Manual free operations provide failure free services for long time.
- Performance is comparatively faster than the existing process because of its time efficiency and cost advantages.

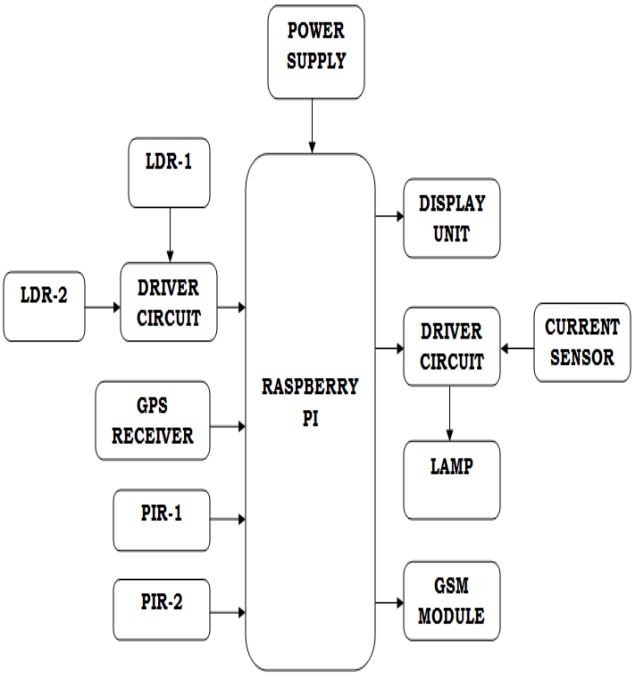

Fig.3: Block diagram of the proposed system

V. WORKING PRINCIPLE

In this application, the street light mechanism is monitored and controlled using the raspberry pi board, GPS receiver, GSM module and sensor circuitry related to the conditions. Initially, the GPS receiver consistently identifies the location which is placed at particular street light poles. The two Light dependent resistors are used for different purpose, one is used to measure light intensity of the environment and other for measuring the light intensity of the street light (LED). When the first sensor has more light intensity, the street light will be in OFF condition i.e., in day mode. When the intensity of light is less i.e., in night mode, the street light will be ON and initially it will be dimmed. Occasionally, when any person moving nearby the street light that can be detected by using PIR sensor, the light will automatically get brighter. So here the dimming can be done by decreasing the supply voltage to the street light which results in power saving. As the second LDR measures the light intensity of the street light, if any damage occurs or lack of power supply to the street light, the light will not work which is immediately measured by the light sensor. Then the particular street light pole information is sent to the department or board as a message using GSM module that is connected to the raspberry pi 3. The information includes the light condition with GPS location and the current transmission. With this message, the department or board will communicate to their service person to recover the particular street light. When the service person approaches the location of street light, he/she will inform the department to off the security box. Here the security box is available for every street light which is used to detect the power theft by PIR sensor when any strange person tries to access the power for other purpose. In case of power theft detected, the message will be sent immediately to the department. So this security box will be in free mode only when the department sends message to the street light pole i.e., GSM module present in the application operates in two way communication. So when the security box is in free mode, the service person can recover or repair the street light which is not working. If the street light is recovered, the light will be ON which is identified by the LDR sensor and sends the information as an acknowledgement to the department. In this application, the complete data will be displayed on a monitor which is connected to the raspberry pi using HDMI-VGA cable.

VI. RESULTS

To verify the functionality, the prototype has been tested with hardware functionality and the collected measurements allowed to evaluate both the energy saving and the correspondent manpower savings. Results of the implemented system are as follows:

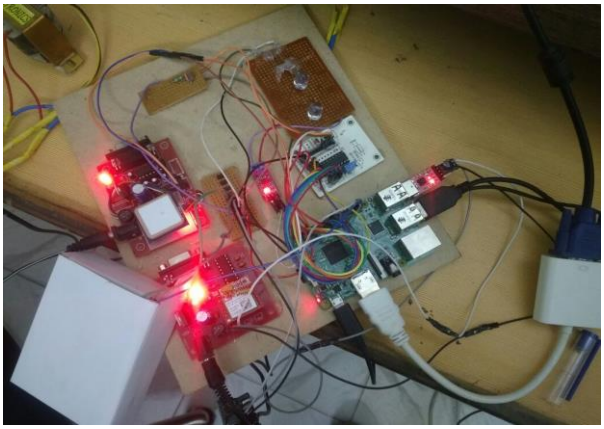

Fig.4: Experimental hardware setup

The application is deployed with some hardware setup in which the raspberry pi board is connected with all other specific boards.

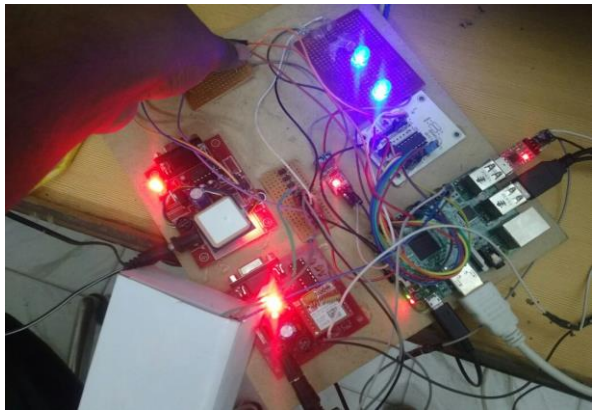

Fig.5: Street light (LED) glowing when the light intensity is less

The street light in this application is considered as the LEDs which glow when the light intensity is very less near the pole as shown in the figure 5.

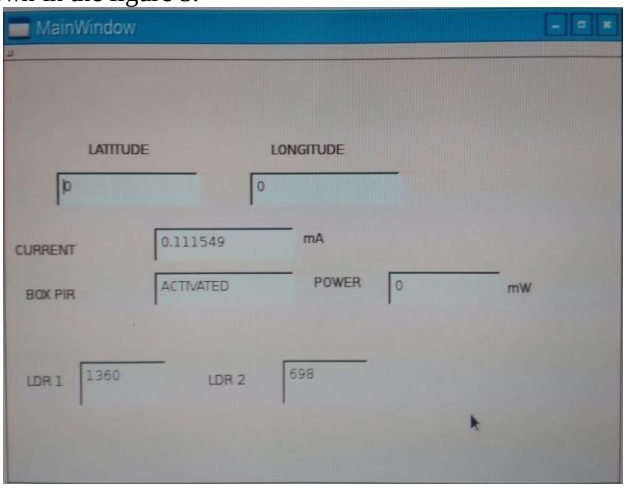

Fig.6: Application window which shows the parameter details used in hardware circuitry

An application page is created in the raspberry pi system to display the parameter details such as GPS locations, current value, and total power consumption by LEDs, security box status, and light intensity at surroundings and from the street light.

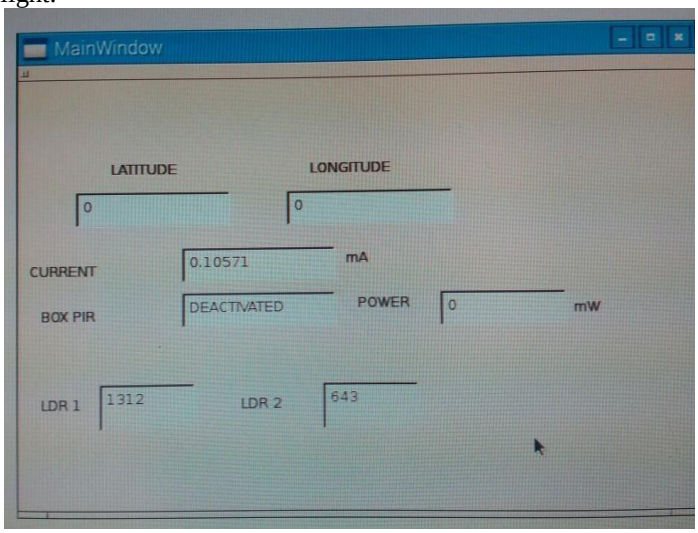

Fig.7: Zero Power (mW) when the street light in day time

In this application, the street light is operated at 5V, 0.12mA supply so that the total power consumed will be in mW as shown in the figure 7. As there is zero power drawn at the time of day i.e., the light intensity is more which is indicated with LDR 1 in the above figure.

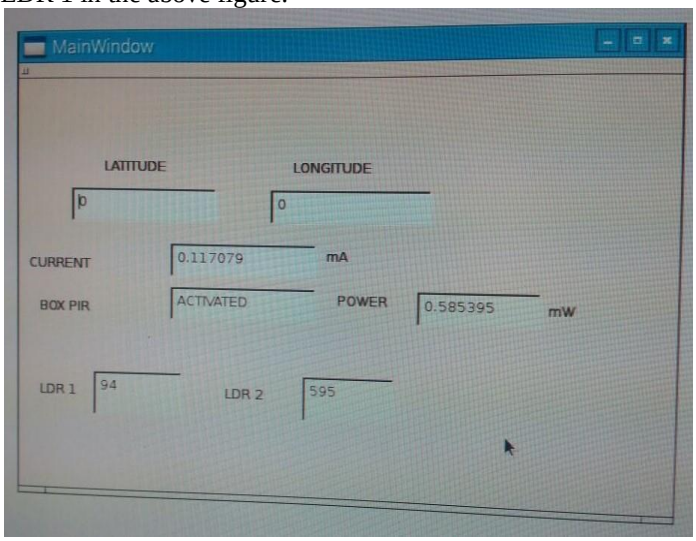

Fig.8: Security box is in active mode

Initially whether it is in day time or night time, the security box is activated to detect unauthorized accessing. PIR sensor is placed in the security box which detects motion of a body. The power rating is indicated (mW) in the above figure 8 as the LDR 1 has less intensity.

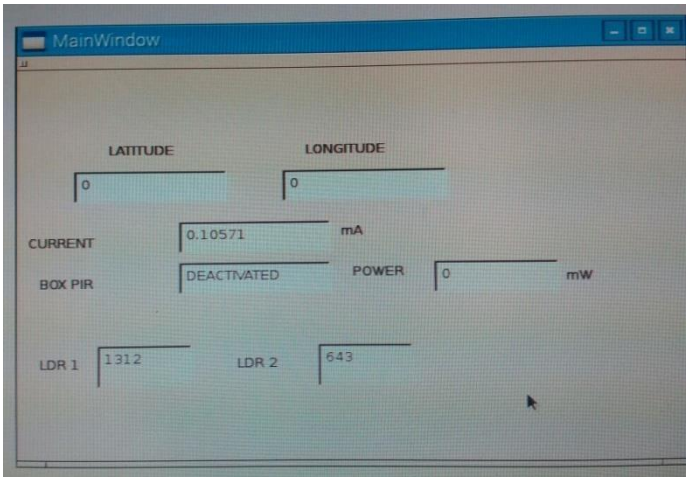

Fig.9: Security box is deactivated by the department

Here the security box is deactivated by the department when the service person informs that he/she has reached the pole with the help of GPS locations.

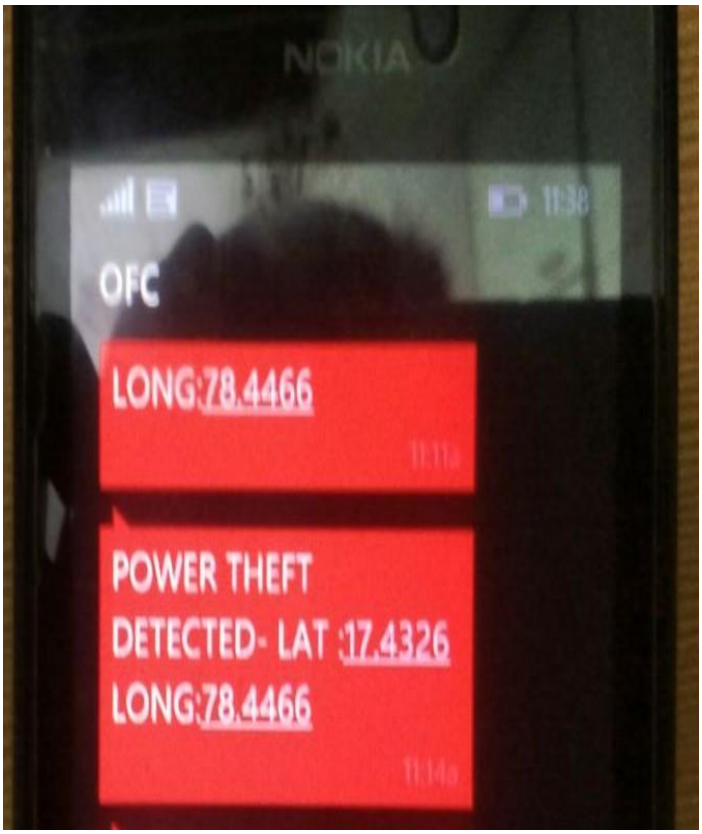

Fig.10: Message at the department showing GPS Location values at the time of power theft

The above figure 10 represents the information of power theft at particular location which consists of latitude and longitude values as a message to the department.

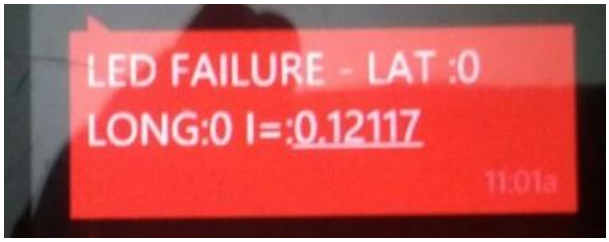

Fig.11: Street light failure detected

If there may not be appropriate power supply (power fluctuations) or lamp damage, then the street light will not work which is measured by LDR 2 and system sends the information accordingly.

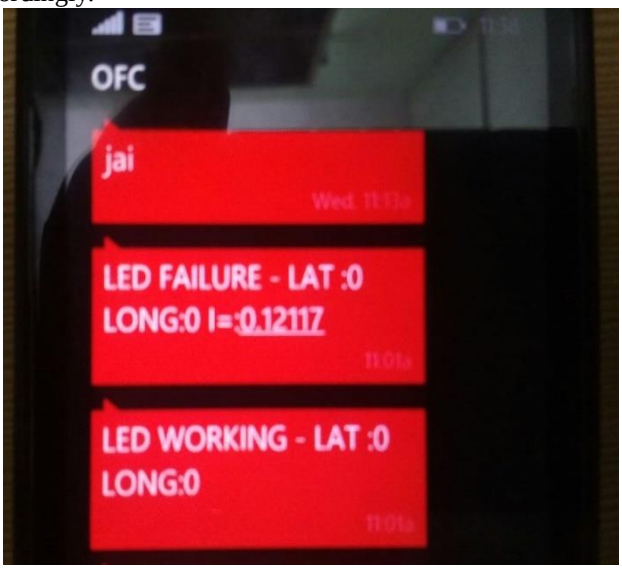

Fig.12: Acknowledgement to the department

Finally, when the service person repairs the light, the street light starts working. This information is again sent to the department as an acknowledgement.

VII. CONCLUSION

Lighting is a vast and quickly developing area of energy management and ozone harming substance outflows. In the meantime the saving capability of lighting power is high even with the present innovation, and there are new energy effective lighting advances going ahead the market. Energy proficient lighting additionally incorporates considerations of the control of light and the utilization of natural light. A supportable lighting arrangement incorporates a perceptive theory, high aspect and energy productive lighting model appropriate for the application. In this paper Smart road lighting system is depicted that combines new advances offering simplicity of maintenance and power is saving. It handles the issue of energy wastage which thus decreases control utilization, builds safety of roads and gives proficient approach to deal with controlling on/off streetlight by utilizing programmed approach. The use of new

technology opens new perspectives toward the developing of high efficiency systems, which allow saving energy and money. For its reliability, simplicity and low cost, the proposed system makes itself a serious candidate to efficiently manage a set of sensors applicable in different fields including monitoring of energy consumption, smart grids and smart cities which need to a sensor network to realize an efficient management of the system under control. A smart remote street light system outlined in this paper, facilitate the application by overcoming the errors and consequently monitoring and controlling which results in power saving. This is achieved by the use of highly economical LED technology. Remote urban and rural areas are the suitable places for implementation of such street lighting system where the traffic is low most of the times. The system can be extended easily, is flexible and also adjustable according to the need of user. Use of GSM technology made the system wireless, less complex. In this proposed paper an automatic street light is designed using Wireless Sensor Network to detect the vehicle, human movements and atmospheric condition. This system also helps to increase and decrease the intensity of LED.

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