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Intelligent Street Lighting System Using Gsm

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ABSTRACT: *Conventional street lighting systems in areas with a low frequency of passersby are online most of the night without purpose. The consequence is that a large amount of power is wasted meaninglessly. With the broad availability of flexible-lighting technology like light-emitting diode lamps and everywhere available wireless internet connection, fast reacting, reliably operating, and power-conserving street lighting systems become reality. The purpose of this work is to describe the Intelligent Street Lighting (ISL) system, a first approach to accomplish the demand for flexible public lighting systems*.

Keywords: *Energy efficient systems, User-centered design, Location-aware applications, Mobile computing, Wireless sensor systems, Lighting systems, Computing,*

I. INTRODUCTION

Due to the increase of environmental concerns, lighting control systems will play an important role in the reduction of energy consumption of the lighting without impeding comfort goals. As mentioned the energy is the single most important parameter to consider when assessing the impacts of technical systems on the environment. Energy related emissions are responsible for approximately 80% of air emissions and central to the most serious global environmental impacts and hazards, including climate change, acid deposition, smog and particulates. Lighting is often the largest electrical load in offices, but the cost of lighting energy consumption is low when compared to the personnel costs. Thus its energy saving potential is often neglected. According to study global grid based electricity consumption for lighting was about 2650 TW in 2005, which was an equivalent of 19% of total global electricity consumption. European office buildings dedicate about 50% of their electricity for lighting, whereas the share of electricity for lighting is around 20-30% in hospitals, 15% in factories, 10-15% in schools and 10% in residential buildings..Intelligent lighting control and energy management system is a perfect solution for energy saving, especially in public lighting management. It realizes remote on/off and dimming of lights, which can save energy by 40%, save lights maintenance costs by 50%, and prolong lamp life by 25%. The system application in streetlight control for each lamp will reduce in streetlight electricity and maintenance cost, and increase availability of street light

1.1 Main Functions

Remote on/off, Dimming and on-site Status Check.
System Fault Detection/Alarm.
Anti-theft Detection/Alarm.
Date Management (energy consumption report).
24-hours online Monitoring.
Reduce energy use by up to 40%.
Reduce maintenance by up to 50%.
Increase bulb life by up to 25%.
This project consist of spatially using autonomous devices embedded along with sensors which monitor the environmental parameters like sound ,fog ,temperature ,carbon monoxide emission.

1.2 Unique Characteristic

Detecting failures of any node.
Tolerance to communication network.
Dynamic network topology.

The system compromises of server, GUI to display and nodes which are micro controlled processed with embedded sensors measuring different parameters. Each node in the network is linked to the main server via a protocol. The analog data sensed by the sensor is converted in digital form, processed by microcontroller and then sent to the server. The master controls all the slaves .The other nodes sends the data to master and the master collects the data and further sends to concentrator and server where the data is monitored and on necessary alterations process it to switch On/Off the nodes devices. This scenario increases life of streetlights, reduces power consumption, ease of monitoring and controlling and less installation cost are the various advantages achieved.

II. OBJECTIVES

The objective for this project is to design a smart lighting system which targets the energy saving and autonomous operation on economical affordable for the streets.

Build an energy saving smart lighting system with integrated sensors and controllers. Design a smart lighting system with modular approach design, which makes the system scalability and expandability.

Design a smart lighting system which compatibility and scalability with other commercial product and automation system, which might include more than lighting systems.

III. METHODOLOGY

Firstly, Chips would be made to be installed on the lights. These chips will consist of a micro-controller along with various sensors like CO2 sensor, fog sensor, light intensity sensor, noise sensor and GSM modules for wireless data transmission and reception between concentrator and PC. The data from the chips would be received on a remote concentrator (PC) and the PC would also transmit the controlling action to the chip. According to the survey of variation in the intensity of light in the field area, efficient programming would be done to ensure minimum consumption of energy. The emissions in the atmospheres would be detected along with the consumption of energy and any theft of electricity. The research work is divided in the following Phases:

3.1 Research

To do a complete field study of a particular location for the existing consumption of energy, emission levels, cost of set up & maintenance, etc. of that location and design an energy efficient system.

3.2 Software (on PC)

To collect the data (current, power consumption, theft, carbon emissions, etc.).
To monitor lighting control status.
To command the controllers depending upon the light intensity required.

3.3 Lamp Controller

Power on/off/dim the lamp.
Monitor the status of the lamp.
To collect the data from various sensors.

3.4 Communication Link

To establish an effective communication link between the controller and PC for bidirectional data transfer

IV. LITERATURE REVIEW

4.1 History

In general, this chapter cover the literature review from different sources related to the smart lighting system – invention of other’s project, technology and current industrial product. Observation and findings about their advantages and recommendation from the studies discuss in this chapter too.

A group of student (Prakash, Shankar, Guha, Alam, 2010) from institute Sir M. Visvesvaraya Technology had invented smart street lamp monitoring system using Xbee wireless module. Their aim is to monitor the health of street lamps and forward monitored result to the control station.

Figure 1 shows the simplified block diagram of the complete smart street lamp monitoring system. Inside the lamp module, it consists of light dependent resistors (LDR) module, microcontroller module and transmission module. The lamp module will communicate with the control centre through wireless using Xbee.

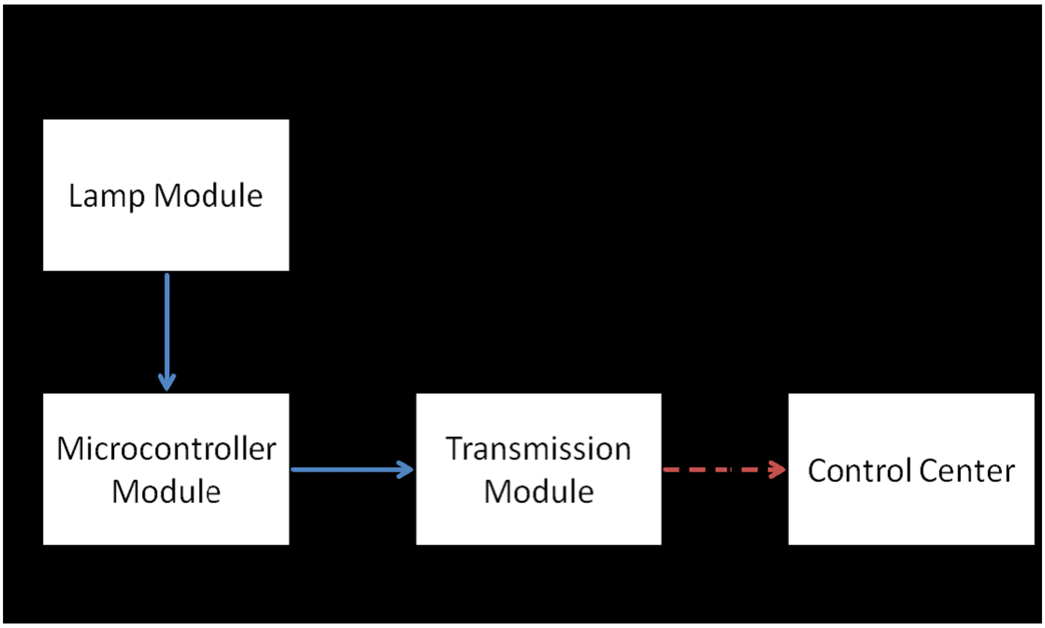

Figure 1: Block Diagram of The Complete Smart Street Lamp Monitoring System.

In the LDR module, it consists of two LDR. One of the LDR is install on top of the street lamp for the checking the day/night status condition. Another LDR is place under the street lamp to monitor and checking the lamp health status. The results of the LDRs send to microcontroller, where the microcontroller will process the data and send the data to the transmission module. In the transmission module, there is wireless Xbee that transmit the data through wireless to the control centre. In the control centre, it will monitors each of the street lamp status, as well as controlling the operation of the street lamps

4.2 Origin of the Research Problem

Due to the increase of environmental concerns, lighting control systems will play an important role in the reduction of energy consumption of the lighting without impeding comfort goals. As mentioned in the IEA Annex 31 (IEA 2001), energy is the single most important parameter to consider when assessing the impacts of technical systems on the environment. Energy related emissions are responsible for approximately 80% of air emissions (IEA 2001), and central to the most serious global environmental impacts and hazards, including climate change, acid deposition, smog and particulates. Lighting is often the largest electrical load in offices, but the cost of lighting energy consumption remains low when compared to the personnel costs. Thus its energy saving potential is often neglected. According to an IEA study (IEA 2006), global grid based electricity consumption for lighting was about 2650 TWh in 2005, which was an equivalent of 19% of total global electricity consumption. European office buildings dedicate about 50% of their electricity for lighting, whereas the share of electricity for lighting is around 20-30% in hospitals, 15% in factories, 10-15% in schools and 10% in residential buildings (EC 2007).

Public lighting in streets, tunnels, city centers, ports and squares etc. can account for about 30% of the urban energy consumption. And the maintenance costs are very high. India is facing a huge energy crisis which has to be addressed to at the earliest using devices that are energy efficient. Based on environmental and economic factors, cities need smart energy management systems urgently for energy saving, maintenance costs reduction and CO2 emission reduction.

4.3 From IEEE Reference

4.3.1 An Intelligent Driver For Light Emitting Diode Street Lighting

Due to light emitting diode (LED) with better performances , the demand for developing LED Street Lighting is growing continuously. Nowadays, a topic of interest in this context is the search for electronic driver in order to take advantage of LED performances. This work focuses in saving potential pitfalls during intelligent driver design procedure. To meet the LED street lighting application, the intelligent driver is based on our patented LED modules, which derived from the thermal, photometric, power electronics techniques. The intelligent driver includes: 1) an AC/DC converter, designed in a Quasi-Resonant Operation flyback topology to maintain high efficiency and constant current/voltage output of 800 mA/31 V with variable voltage output at wide input voltage range of 100-250 V/AC; 2) Also, the intelligent street lighting controller which performs the function of soft startup, Full ON, Hall ON and OFF is achieved. By setting an example of a 50 W LED pole head design, the suggested driver has been conducted in order to illustrate the complete process and results, which shows 72% more energy savings compared with conventional street lighting after 3 month running.

4.3.2 WSN For Intelligent Street Lighting System

In the paper authors propose to apply Wireless Sensor Network (WSN) to intelligent street lighting system. As a result of such a combination one obtains a system designed to increase functionality of light installations for a wide range of applications and introduce a platform for new additional services, which meets current and future user needs. The system is composed of WSN nodes integrated with light sources based on high power LED diodes, which enable additional services not only directly related to lighting but also new services as telemetry, monitoring of noise, humidity, temperature, as well as services associated with the road information systems, intelligent transportation systems and intelligent roads

4.3.3 Design Of New Intelligent Street Light Control System

In China, the methods of time-control, optical-control and time-optical-control are in common used to control street lamp, particularly in small and medium-sized cities. But due to the backward lighting control and administrative method, the precision is bad, and the result of work is also poor. Through many kinds of sensor combination sense environment's change, the multi-sensor exhibition can combinatory logically control the new intelligent street light controller system. And based on the degree of illumination control fixed time, in the automatic foundation fixed time, according to the multi-sensing exhibition survey data's special combination change, to control the street light nimbly; the system can also realize the automatic timing control, by pre-installing time to control street light switch and ultimately to control the street light time. Simultaneously the system can also realize the automatic sunshine control, which may act according to the actual determination of the sunlight degree of illumination and the degree of illumination control criterion and automatically control street light. On the basis of the merits of the regular control and the optical control, a new street smart controller is designed, with dual functions including timing control and automatic photoelectric control. It allows street lamps automatically lit in the evening, lighting the road for a few hours (adjustable time). After 0:00, when few vehicles or pedestrians go past, it turn off automatically. And terminal controller has wake-up function. After the street light turn out automatically, when the vehicles or pedestrians are going through, street light will be waken up by terminal controller. When the vehicles or pedestrians go past, the lights are off automatically. Design of new intelligent street light control system does not only achieve energy-saving power but also extend the service life of lighting equipment. Moreover, it is controllable, ease of maintenance. At the same t- - ime, it is helpful to highlight the festive and other characteristics, and ultimately make street light network, intelligence, humanity and art. An optimal configuration is reported. Finally, the results of experiment are obtained that: when a motor is closed to 15 meters, LED lights are on automatically. While people passed, the distance is proximity 10 meters

4.3.4 Integrated System for Intelligent Street Lighting

This reports the study and hardware implementation of a dimmable electronic ballast for high pressure sodium lamps, and a microprocessor-based system for control and energy measurement for this ballast, which uses a power line communications system to send and receive status and commands from another ballasts plugged in the same mains sub circuit. These ballasts are connected in the topology of a logic network, one of them being defined as the master of the sub circuit, and the others as slaves. The master unit distinguishes from the slaves by the additional communications system, which works through a cell phone, and enables the wireless connection to a PC-based central supervisory system. This way, any locale or town becomes able to control its entire main lighting system, in addition to the obtainment of more accurate data about energy billing, which together with the ability to control luminosity and the better power factor, will result in financial and energetic economy

4.4 Company Working On Similar Technology

4.4.1 IoTcomm Technologies, China

IoTcomm Technologies develops communication technologies for the Internet of Things (IoT), including but not limited to Power Line Communication (PLC), GPRS, Zigbee and WIFI. By integrating PLC and wireless communication technologies seamlessly, IoTcomm has developed an intelligent street lighting control and management system, which provides its customers with the least expensive and the most reliable solution to significantly reduce power consumption, operating costs and environmental impacts. IoTcomm also offers power line communication modules and wireless communication modules, which are readily to be integrated into smart automation systems including lighting, heating and cooling, security, fire detection, access control, or energy monitoring equipments for both commercial and residential buildings.

V. PROBLEM FORMULATION

This system resolves the faulty street lamps issue, where people are rarely taking the initiative to report faulty street lamps in their locality. With this device, it able to track whenever there is faulty lamps and sends the data to the control centre. Thus, technician will be able to acknowledge the faulty street lamps at the first moment and head for the repair.

Another benefit of this system is the cost saving in terms of wiring. The Xbee module will allow the streets lamps communicate to the control system via wireless. With the wiring method, the high cost of the construction and material makes the system uneconomical; moreover, the reliability of the system will reduce too.

Although this system monitors the health of the street lamp status, it did not have other smart feature whereby controlling the street lamps by automatically turning ON or OFF the lamps. If this feature is apply to this system, this allow another great energy saving. In addition, any faulty lamp will be automatically turning OFF which avoid more energy wastage causes by the faulty lamps.

With the application of the lamp illumination control on the system, the lamps are able to turn ON the lights with low illumination when the surrounding condition needs the low light illumination of the lamps (e.g. rainy or cloudy day).

There are no data of the return of investment (ROI) of this system, but it may believe that the ROI will be in less than 8 years. One of the main weaknesses of this system is the device are placed at outdoor, thus, precaution steps need to be taken whereby the case of the devices must be designed carefully. It must be sealed or isolated probably to avoid the environmental that could affect the lifespan of the devices.

VI. PROPOSED PROBLEM SOLUTION

6.1 Assumptions And Prerequisites

The user is at Control Station i.e. the Master Node, which is the governing device of wireless sensor network.
The user must be aware of working wireless sensor network based application [4].
User must provide proper network setup parameters for WSN based application.
Environmental Conditions such as rain, snow, storms etc.can affect the System performance.
The Master node must function properly during entire working, i.e. it should not fail in the due procedure.

6.2 Implementation Details

Firstly, microchip would be required to be installed on the pole lights. These chips will consist of a micro-controller along with various sensors like CO2 sensor, smoke sensor, light intensity sensor, noise sensor and GSM modules for wireless data transmission and reception between concentrator and PC. The data from the chips would be received on a remote concentrator (PC) and the PC would also transmit the controlling action to the chip. According to the survey of variation in the intensity of light in the field area, efficient programming would be done to ensure minimum consumption of energy. Separate automatic mode will be provided that will have timing considerations in addition to surrounding light conditions.

6.2.1.High Lightning Features

Multicolor LED.
Light sensor.
Smoke Sensor.
Carbon emission sensor.
Noise Sensor.

6.2.2.The Server Works In Two Modes
-Auto mode.
-Manual mode.

Both the modes can be set from remote machine, if auto mode is set only then intelligent approach is taken.

6.3 Architecture

6.3.1 Block Diagram Transmission Side

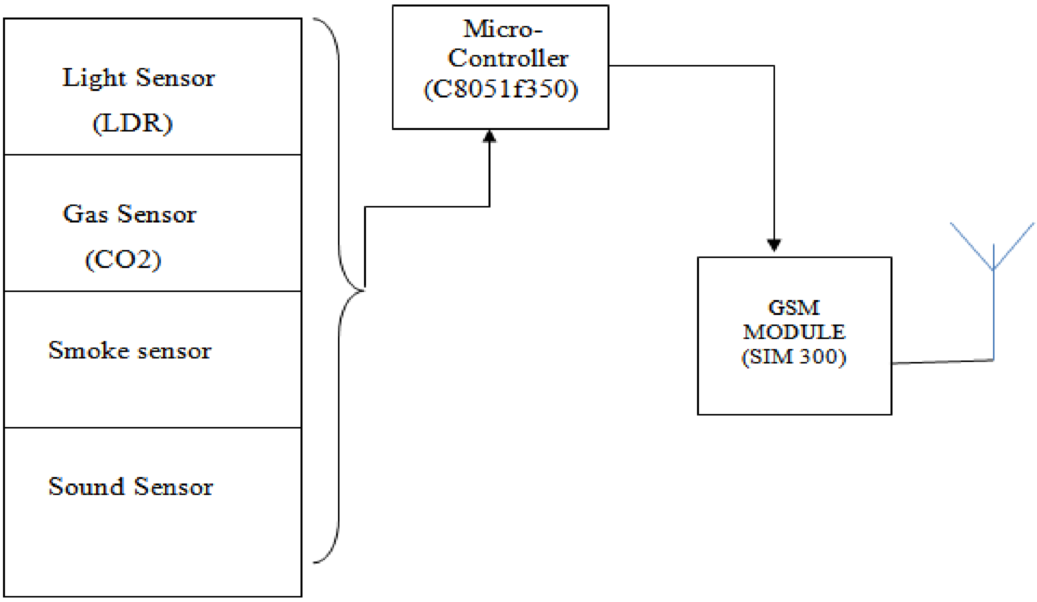

Figure 2: Block Diagram Transmission Side

6.3.2 Block Diagram Reception Side

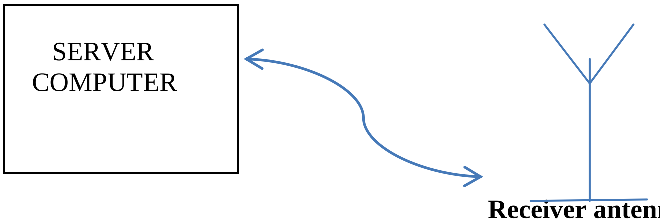

Figure 3: Block Diagram Reception Side

6.4 Basic Model

User Sets all the required parameters for a particular Sensors on a Street Light Modules for different Areas on the Server.

All the information is sent to the Street Light Modules using the GSM / GPRS Module.

Microcontroller then controls the street light based on the Sensor parameters and performs the required action received from the server using GSM / GPRS MODULE.

The control center will monitor and control all streetlight real times [10].

It compares these values with the threshold value and appropriately decides whether to vary intensity of light. The GUI gives us a representation of the streetlights i.e. their status (ON/OFF).

Street Light Module can operate in Manual or Automatic Mode as configured from the server by the user.

Street Light Module also measures the amount of visibility and Carbon Dioxide present in the environment using the respective FOG and Gas Sensor and controls the Fog Lights if Necessary.

All This information is sent to the server on request.

It takes account of environment and safety standards needed in all traffic conditions

6.5 Requirements

6.5.1 Software Requirements

Microsoft visual studio for user interface.

Embedded C for microcontroller chip.

Eagle software for circuit layout.

6.5.2 Hardware Requirement

Use GSM SIM300 module for wireless communication.

Microcontroller C8051F350 for controlling various sensors.
PLC module.
Power line for street light topology.
A PC for observation and running of controlling software.
Various sensors for sensing external parameters.
Beta-LED fixtures.
Camera for street surveillance.

6.5.3 OTHER REQUIREMENTS
Thermacol for visualization of streets and street light vicinity.
small rods as a street light poles.
LED’s as street-light lamp.

6.6 Specification Of Hardware Used
6.6.1 GSM SIM300 module for wireless communication.
The SIM300 is a all in one GSM/GPRS solution that comes in a compact plug-in module. With an industry-standard interface, the sim300 offers GSM/GPRS 900/1800/1900MHz performance for voice, SMS, data, and Fax all in a small sized module that is perfect for integration in any handheld device.
This module can be easily interfaced with it AT commands over TTL serial interface, which makes it easy to connect it to microcontrollers, computers, and other devices.

6.6.2 Microcontroller C8051F350
6.6.2.1 Analog Peripherals
24-Bit ADC
-0.0015% nonlinearity
-Programmable throughput up to 1 ksps
-8 external inputs; programmable as single-ended or differential
-Programmable amplifier gain: 128, 64, 32, 16, 8, 4, 2, 1
-Data-dependent windowed interrupt generator
-Built-in temperature sensor (±3 °C)

Two 8-Bit Current DACs Comparator
-16 Programmable hysteresis values and response time
-Configurable to generate interrupts or reset
-Low current (0.4 µA)

Internal Voltage Reference:
-VDD Monitor/Brown-out Detector

6.6.2.2 On-Chip Debug
-On-chip debug circuitry facilitates full speed, non-intrusive in-system debug (no emulator required)
-Provides breakpoints, single stepping, watchpoints
-Inspect/modify memory, registers, and stack
-Superior performance to emulation systems using ICE-chips, target pods, and sockets

6.6.2.3 Supply Voltage: 2.7 to 3.6 V
-Typical operating current:17 mA at 50 MHz 16 µA at 32 kHz
-Typical stop mode current: <0.1 µA

6.6.2.4 Temperature Range: –40 to +85 °C

6.6.2.5 High-Speed 8051 µC Core
-Pipelined instruction architecture; executes 70% of instructions in 1 or 2 system clocks
-Up to 50 MIPS throughput with 50 MHz clock
-Expanded interrupt handler

6.6.2.6 Memory
-768 bytes data RAM
-8 kB Flash; in-system programmable in 512 byte sectors (512 bytes are reserved)

6.6.2.7 Digital Peripherals
-17 port I/O; all 5 V tolerant
-Hardware SMBus™ (I2C™ compatible), SPI™, and UART serial ports available concurrently
-16-bit programmable counter array with three capture/compare modules, WDT
-4 general-purpose 16-bit counter/timers
-Real time clock mode using PCA or timer and external clock source

6.6.2.8 Clock Sources
-Internal oscillator: 24.5 MHz, 2% accuracy supports UART operation
-External oscillator: Crystal, RC, C, or clock (1 or 2 pin modes)
-2x clock multiplier to achieve 50 MHz internal clock
-Can switch between clock sources on-the-fly

6.6.3 Sensor Nodes
The main challenge of Hardware is to produce low cost and tiny sensor nodes. With respect to these objectives, current sensor nodes are mainly prototypes. It includes different sensors for various parameters and a LED light fixtures i.e. LDR, CO_2 gas sensor, Sound sensor(microphone). The envisaged size of a single sensor node can vary from shoebox-sized nodes down to devices the size of grain of dust .
6.6.3.1 LDR sensor
LDRs or Light Dependent Resistors are very useful especially in light/dark sensor circuits. Normally the resistance of an LDR is very high, sometimes as high as 1000 000 ohms, but when they are illuminated with light resistance drops dramatically. When the light level is low the resistance of the LDR is high.

Figure 4: Light Dependent Resistor

6.6.3.2 CO_2 gas sensor

The CO_2 Gas Sensor Module is designed to allow a microcontroller to determine when a preset Carbon Dioxide gas level has been reached or exceeded. Interfacing with this sensor is done through a 4-pin SIP header and requires two I/O pins from the host microcontroller. The sensor module is intended to provide a means of comparing gas sources and being able to set an alarm limit when the source becomes excessive.

Figure 5: Co2 Sensor Mg811

6.6.3.3 Sound sensor

The Sound sensor module is a simple microphone. Based on the power amplifier LM386 and the electronic microphone, it can be used to detect the sound strength of the environment. The value of output can be adjusted by the potentiometer.

Figure 6: Model: Sen12 sound sensor

VII. SYSTEM STATEMENT

To create near to real time environment for working of WSN based Street Light Control System and test performance and working of that application.
To sense real time light intensity by the Ambient lights sensor and depending upon the sensed light intensity take appropriate control action on the Street Light(End Device).
To create library of several modules to simulate the network condition parameters.
To provide graphical user interface to control and monitor the status of street lights.
To give graphical simulation of light intensity to the user.

VIII. WORKING

8.1 Auto Mode

In auto mode, according to the traffic intensity and time of slots and also monitoring the weather conditions the nodes are being switched on/off .It monitors the need and thus saving power.
It has following four cases:
Preset control on Timer & Preset on Sensor with combination. Description of a prototype of 5 poles.

Case 1: pole2,4-Whenever there is not much demand for intensity the alternate node provides lights. These settings can be predefined by analyzing the traffic congestion in a particular area and also according to sunset conditions differing geographically.
Case 2: 1,3,5- Similar reason as above.
Case 3: All the poles are working with 50% intensity.
Case 4: All the nodes are working with full power intensity, during the most traffic congestion or as per the urgent calls.

8.2 Manual Mode

In Manual mode, system stores the parameters in computer about changes in environmental conditions continuously like heavy rain visibility, faults ,more or less traffic congestion or during foggy conditions.
User can manually define each node with specific intensity factor as per requirement.

IX. CONCLUSION

In this paper Intelligent street lighting system is described that integrates new technologies offering ease of maintenance and energy savings. The proposed system is appropriate for street lighting in remote as well as urban areas where traffic is low at times. Along with energy saving it also tackles with the problem of power theft .It is capable of taking corrective actions in case of unprecedented events of climatic changes

Results Expected Current System

Energy utilization **:** Works on profile basis i.e. all street lights are ON from 6:30pm to 6:30 am, in other words street lights are functioning completely for 12 hrs a day. Assuming 20 nodes to be working power consumed by them will be given as,
Bulb used =150 W=0.150 Kw,
Number of nodes = 20 nodes,
Number of working hrs per day = 12 hrs
Power Consumed per day = 20 * 12 * 0.150 = 36 Kwhr
i.e. 36 * 30 = 1080 Kwhr/month
Monthly Bill for 20 nodes (Rs 3/kwhr) = 1080 * 3 = 3240 Rs per month

Intelligent system

Expected power saving in various ways.

- 0% consumption say from 7am to 7pm.
-97% saving at the time of dusk say from 7pm to 8pm.
-7% energy saving because of voltage correction say from 8pm to 11pm .
-55% consumption because of dimming technique used say from 11pm to 1am.
-34% consumption because of dimming as well as staggering technique say from 1am to 2am.
- 55% consumption because of dimming technique used say from 2am to 6am.
- 96% saving at the time of dusk say from 6am to 7am .

REFERENCES

[1]. Reza Mohamaddoust , Abolfazl Toroghi Haghighat, Mohamad Javad Motahari Sharif and Niccolo Capanni, “A Novel Design of an Automatic Lighting Control System for a Wireless Sensor Network with Increased Sensor Lifetime and Reduced Sensor Numbers”, Sensors (2011) ,Volume No.- 11(9), pp. 8933-8952.

[2]. De Dominicis, C.M.; Flammini, A.; Sisinni, E.; Fasanotti, L.; Floreani, F.; “On the development of a wireless self localizing streetlight monitoring system “, Sensors Applications Symposium IEEE, pp. 233 - 238 ,2011.

[3]. Gustavo W. Denardin, Carlos H. Barriquello, Alexandre Campos, Rafael A. Pinto, “Control Network for Modern Street Lighting Systems”, IEEE symposium on Industrial Electronics (ISIE), (2011), pp. 1282 – 1289.

[4]. Jing Chunguo, Wang Yan Sun, Wenyi Song, “Design of Street Light Pole Controller Based on WSN”, The Tenth International Conference on Electronic Measurement & Instruments, ICEMI (2011), pp. 147 – 150.

[5]. Shentu, Xudan; Li, Wenjun; Sun, Lingling; Gong, Siliang, “A new streetlight monitoring system based on wireless sensor networks”, International Conference on Information Science and Engineering, pp. 6394 – 6397,

[6]. Wu Yue; Shi Changhong; Zhang Xianghong; Yang Wei; “Design of new intelligent street light control system “,, 8th IEEE international Conferences on Control and Automation (ICCA), (2010) , Page(s): 1423 – 1427.

[7]. Hengyu Wu; Minli Tang; Guo Huang, “Design of multifunctional street light control system based on AT89S52 single-chip microcomputer”, , IEEE 2nd International Conferences on Industrial Mechatronics and Automation (ICIMA), (2010), Page(s): 134 – 137