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Modern LED Street Lighting System with Intensity Control Based on Vehicle Movements and Atmospheric Conditions Using WSN

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Abstract— Street lighting accounts for 53% of outdoor lighting use, and the market is continuously increasing. In the context of rising energy prices and growing environmental awareness, energy efficiency is becoming one of the most important criteria for street lighting systems design. Monitoring of street lights and controlling is of utmost importance in developing country like India to reduce the power consumption. The world is converging towards wireless as a communication channel and at the same time facing energy and environmental problems .The paper presents a remote streetlight monitoring and controlling system based on LED and wireless sensor network. The system can be set to run in automatic mode, which control streetlight. This control can make a reasonable adjustment according to the seasonal variation. Also this system can run in controlled mode. In this mode, we can take the initiative to control streetlights through PC monitor terminal. This street light system also includes a time cut-out function, and an automatic control pattern for even more electricity conserving, namely when vehicles pass by, the light will turn on automatically, later turn off. This design can save a great amount of electricity compared to streetlamps that keep a light during nights. The design implements traffic flow magnitude statistics without adding any hardware, facilitating transportation condition information collecting. Furthermore, this system has auto-alarm function which will set off if any light is damaged and will show the serial number of the damaged light, thus it is easy to be found and repaired the damaged light. The system can be widely applied in all places which need timely control such as streets, stations, mining, schools, and electricity sectors and so on. In addition, the system integrates a digital temperature and humidity sensor, not only monitoring the streetlight but also temperature and humidity.

Keywords— Wireless sensor Network, LED Street light system, Control System, Energy saving.

I. INTRODUCTION

Outdoor lighting is an important functional and decorative component of built environments. Street lighting helps to ensure the safety of people in traffic and to prevent crimes. It even enables the efficient use of street space through informal self-regulation of the crowd. Nowadays, street lighting accounts for 53% of outdoor lighting use worldwide. Furthermore, the outdoor lighting market continues to grow (compound annual growth rate of the outdoor lighting market is estimated to be 42% in the period of 2011–2020).

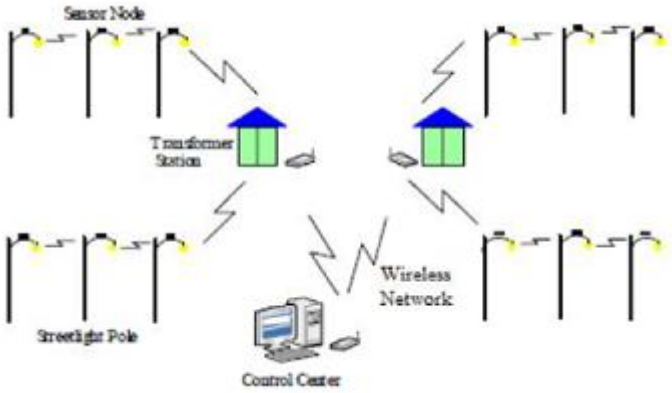

Fig: 1 Structure of Street Light Power Monitoring System using WSN

In recent years, environmental issues have gained widespread international attention, resulting in the development of energy-efficient technologies aimed at reducing energy consumption. One aspect of the situation is an increasing demand for the reduction of the amount of electricity used for illumination. In particular, energy conservation for large scale illumination tasks such as street lighting is gaining considerable importance. The street light system is one of the largest energy expenses for a city, accounting for upwards of 35-45% of a municipality's utility budget.

An intelligent lighting control system can cut municipal street lighting costs as much as 70%. A Street light use HID (High-Intensity Discharge) Lamp as light source. Due to global concerns regarding the amount of power consumed by HID lamps and the amount of atmospheric CO2 released because of power consumption, LED array illumination has received attention recently as an energy reducing light source. LED illumination requires about one third to one half of the electric power needed for HID lighting. The lifecycle of an LED can be more than three times as long as an HID light and LED system would be comparatively maintenance free. In recent years, LED lighting can be expected to fully replace earlier used light sources. An intelligent street lighting system is a system that adjusts light intensity based on usage and occupancy of the traffic as it illuminates a certain number of street lights ahead and fewer behind, depending on movement of vehicles. The system also proposes the wireless based system to remotely track and control the actual energy consumption of the street lights and take appropriate energy consumption reduction measures through power conditioning and control. the street light controller should be installed on the pole lights which consist of microcontroller along with various sensor and wireless module. The street light controller installed on the street light pole will control LED Street lighting depending on traffic flow of the road, and will transmit this data of each street light to control station via wireless technology to monitor the system. The mode of operation of the system can be conducted using auto mode and manual mode. The control system will switch on-off the lights at required timings and can also vary the intensity of the street light according to requirement. From above picture it is seen that need of street light. We know that Street lighting is a key public service provided by public authorities at the local and municipal level. Good lighting is essential for road safety, personal safety and urban ambience. Street lighting ensures visibility in the dark for motorists, cyclists and pedestrians, thereby reducing road accidents. Street lighting also indirectly facilitates crime prevention By increasing the sense of personal safety, as well as the security of adjacent public and private properties. On the other hand Energy savings also utmost importance today. The goal is therefore, the reduction of operating prices of street lighting with the creation of a system characterized by straightforward installation and low power consumption using LED instead of HID lamps.

II. WHY WE ARE USING LED.....

Street lighting is gaining considerable importance. Most outdoor illumination sources, such as street lights, use HID Lamps as light sources. Global concerns have been raised regarding the amount of power consumed by HID lamps and by extension, the amount of atmospheric co2 released due to such power consumption. Because of this LED array illumination has received attention recently as an energy reducing light source. LED road illumination requires about one third to one half of the electric power needed for HID lighting. The lifecycle of an LED can be more than three times as long as an HID light. LED illumination could reduce the amount of time needed to exchange defective fixtures, and it is expected that an LED system would be comparatively maintenance free. This in turn, means that LED system could be considered suitable for use on isolated islands or in high mountainous regions. In such a back ground, and as a result of the significant improvements to luminescent efficiency in recent years, LED lighting can be expected to fully replace previously used light sources within our lifetimes.

They make sense for many reasons, such as their compact size, high efficacy (lumens per watt), longevity, and robustness. LED sources also allow for interesting new design forms, often with slimmer profiles than traditional metal halide arc lamps. LED is considered a promising solution to modern street lighting system due to it is behavior and advantages as emphasized. Apart from that, the advantages of LED are likely to replace the traditional street lamps such as the incandescent lamp, fluorescent lamp and High Pressure Sodium Lamp in future but LED technology is an extremely difficult process that requires a combination of advanced production lines, top quality materials and high-precision manufacturing process. The comparison of the lamps used in the present street lights and the proposed street lights are shown in table 1. It is inferred that LED light provides many advantages over high pressure sodium light.

TABLE.1 : COMPARISON OF LIGHT TECHNOLOGY

Light Technology	Life Time	Lumens per watt	Ignition Time	Remarks
High Pressure sodium Light	12,000 – 24,000	45-130	Up to 15 Min	Low color rendering with yellow light, contains mercury & Lead.
LED Light	50,000-100,000	70-150	Instant	Relatively higher Initial cost.

III.OBJECTIVE

Energy savings are of utmost importance today. The goal is the reduction of operating prices of street lighting with the creation of a system characterized by straightforward installation and low power consumption with intensity control. Another is that if any human or vehicle movement detected, the motion sensor triggers the microcontroller to turn the LEDs to their full brightness and it gets restored back to the dimming brightness.

When the vehicle passing is in the road. The streetlights are switched ON when the vehicles are come closer to the lamp the LEDs are activated and later turn OFF. And the vehicles in certain distance the nearby LED lights are dimmed the half of the level of LED power using the PWM technique, to reduce the power. These control and LED status information are passed through the ZigBee wireless medium. The system can be widely applied in all places which need timely control such as streets, stations, mining, schools, and electricity sectors and so on. In addition, the system integrates a digital temperature and humidity sensor to detect the cloudy weather and atmospheric conditions.

The Benefits of this Technology are.
I. Energy savings: During night, the intensity of LED lamp varies according to traffic, thus, energy can be saved.
II. Maintenance cost reduction: The lifetime of LEDs is more than the exiting lamps, thus, there can be reduction in maintenance cost.
III. Reduction in CO_2 emissions: As power consumption can be reduced with this technology, therefore, reduction in CO_2 emissions can be observed.
IV. It doesn't contain toxic chemicals, such as, mercury in the light lamp.

IV. ARCHITECTURE OF STREET LIGHT CONTROL SYSTEM

The system consists of a group of measuring stations in the street (one station located in each lamppost) and a base station located on it. The system is designed as a modular system, easily extendable. The measuring stations are used to observe street conditions as the intensity of daylight and, depending on the conditions they activate or off the lamps. Other factors influencing the activation are: climatic conditions, seasons, geographical location, and many possible alternative factors. For these reasons every lamp is designed independent to decide about the activation of light. Automatic Street Light Control System is a simple and powerful concept, which uses transistor as a switch to switch ON and OFF the street light automatically. By using this system manual works are removed. It automatically switches ON lights when the sunlight goes below the visible region of our eyes. It automatically switches OFF lights under illumination by sunlight. This is done by a sensor called which senses the light actually like our eyes. Automatic Streetlight needs no manual operation of switching ON and OFF. The system itself detects whether there is need for light or not. When darkness rises to a certain value then automatically streetlight is switched ON and when there is other source of light, the street light gets OFF. The system consists of a group of measuring stations in the street (one station located in each lamppost) and a base station located near on it.

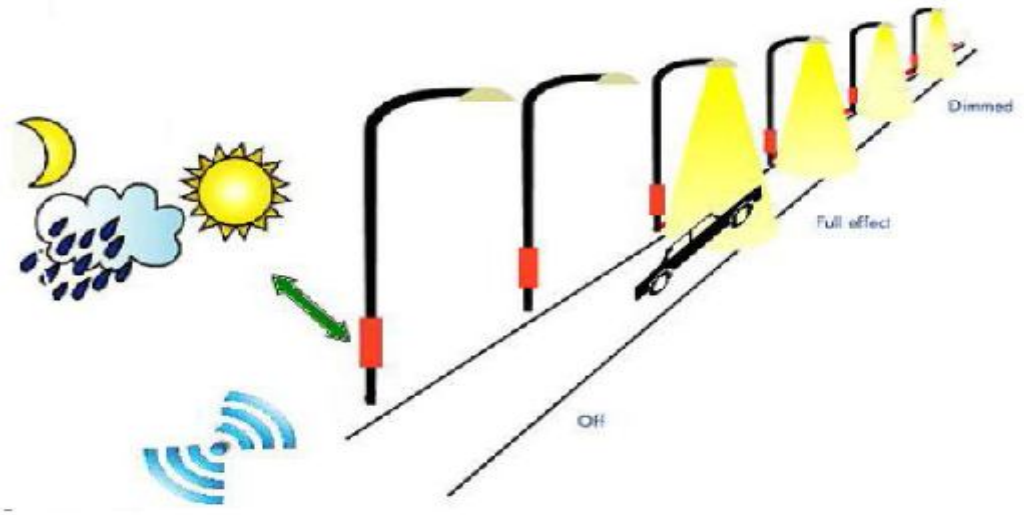

Fig.2: Schematic of street light control system

Fig.2 shows the function, when the vehicle passing is in the road. The streetlights are switched ON when the vehicles are come closer to the lamp the LEDs are activated and later turn OFF. And the vehicles in certain distance the nearby LED lights are dimmed the half of the level of LED power using the PWM technique, to reduce the power. These control and LED status information are passed through the ZigBee wireless medium. In this paper, a simpler, multipurpose, cost-effective design to control the on-off Mechanism of street lights. The terminal has the feature of running on the network and off the network independently, so it ensures the stability of the system. In order to reach a high performance level in a street lighting control system, two important aspects must be taken into account: the selection of the adequate communication protocol, on the one hand, and the selection of the network topology that supports the architecture.

V. PROPOSED BLOCK DIAGRAM

The block diagram of proposed street lights control system is shown in Fig..3 and Fig.4 .The transmitter end consists of power supply, ZigBee, Humidity sensor, Motion detector sensor (PIR) , LDR and at the base station side it consist the power supply, ZigBee microcontroller, PWM, Driver circuit, LCD, LED Power, ZigBee wireless module at base station., fault detection circuit,. The block diagram shows the simple working of the ckt.The ckt diagram is present on one pole that is transmitter station and base station. Shown below

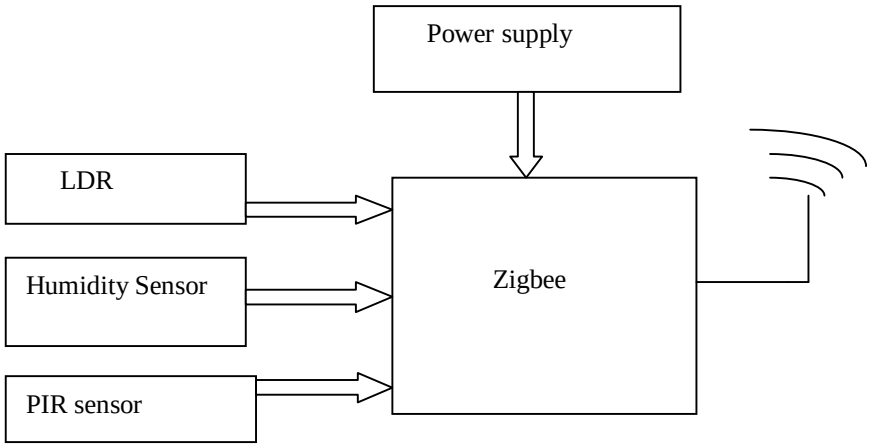

Fig.3: Transmitter Station

The power supply circuit provides the 5V regulated power supply for revitalizing the microcontroller module. The core of the system is a PIC18F45J11 microcontroller. It is preferred because of the following features:- it is a low power, high-performance enhanced flash 8-bit microcontroller with 8K Bytes of in-system programmable Flash memory, 256 bytes of RAM, 32 I/O lines, three 16-bit timer/counters, a full duplex serial port, on-chip oscillator, and supports two software selectable power saving modes: low power Idle and Power- down mode. The photosensitive detection circuit consists of Day & night sensor to determine the external light intensity. The threshold (reference) illumination level is set initially. The photoelectric sensor with set threshold intensity is used to observe street conditions as the intensity of daylight and, depending on the conditions they activate or off the lamps. The street lamps still consume a lot of electricity when merely a few vehicles are driving around the road. Thus, there is a great necessity to develop a control system based on the traffic flow density. Whenever there is no traffic i.e. density of traffic is zero, there is no need of street light to be glow on highways which saves power consumption to a greater extent. The lights of a particular area should glow only when a vehicle enters that area on highways. For this purpose, the infrared detection circuit has been used. It consists of IR sensor (presence sensor) which has the task of identifying the passage of a vehicle or pedestrian causing the switching ON/OFF of street lamps. The load which is street-light lamps is connected to microcontroller. Using power transistors and solid state dual relays, the street-lamps are switched ON/OFF. The solid state relays accept the triggering voltage from power transistors which in turn are triggered by microcontroller on reception of activation signals from the sensors. Pulse width Modulation or PWM is one of the powerful techniques used in control systems today. This PWM technique switches the power supply 5v to 3.3v for dimming purpose. These dimming purposes save the great amount of power consumption.

The fault detection circuit indicates the LED lamp failure as well as wire fault along with lamp and wire number when the lamps are firstly turned on, on sensing the night. Through feedback circuit the malfunctioning message is transmitted to the controller which displays it on the LCD and also transmitted wirelessly through to the ZigBee module control terminal. The LCD display is used to show different conditional messages like day, night, light testing, wire fault, LED failure, etc. The sensors transfer the collected information to a controller that runs the software to manage the system. The Compact and complete, easy to use PIR Sensor Module for human body detection. In addition, the system integrates a digital temperature and humidity sensor, not only monitoring the streetlight but also temperature and humidity. The MCP9800 is a digital temperature sensor capable of reading temperatures from - 55°C to +125°C. Temperature data is measured from an integrated temperature sensor and converted to digital word with a user selectable 9 to 12-bit Sigma Delta Analog to Digital Converter. The MCP9800 notifies the host controller when the ambient temperature exceeds a user programmed set point. The ALERT output is programmable as either a simple comparator. for thermostat operation or as a temperature event interrupt. Communication with the sensor is accomplished via a two-wire bus that is compatible with ZigBee standard protocols. This permits reading the current temperature, programming the set point and hysteresis and configuring the device. Small physical size, low installed cost and ease of use make the MCP9800 an ideal choice for implementing sophisticated temperature system management schemes in a variety of applications. All the operation is regulated by a timing management that permits the system is set for predestined time.

The ZigBee transmission module (Series S2) connected to microcontroller receives data of the state of the lamps and sends it to a ZigBee receiver module which is connected with control terminal processing unit (base station). The operating voltage required for Zigbee module is 3.3V. It is achieved by using low dropout voltage regulator LM2950 which uses 5V as input from regulated power supply section and provides 3.3V output to energize the Zigbee module. The processing unit consists of a terminal with a serial UART (RS232) interface that receives data regarding the state of the lamps provided by a Zigbee receiver module, connected to the UART interface. The terminal is needed for graphical presentation of the system results. The graphical interface permits to visualize the state of the system with the state of the lights and the power consumption of every lamp.

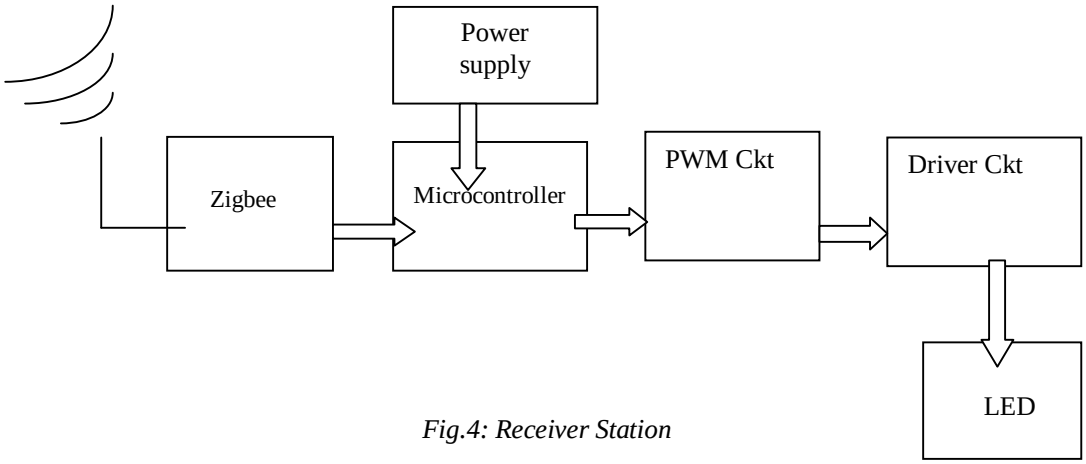

Fig.4: Receiver Station

VI. STREET LIGHT AUTOMATIC CONTROL METHODOLOGY

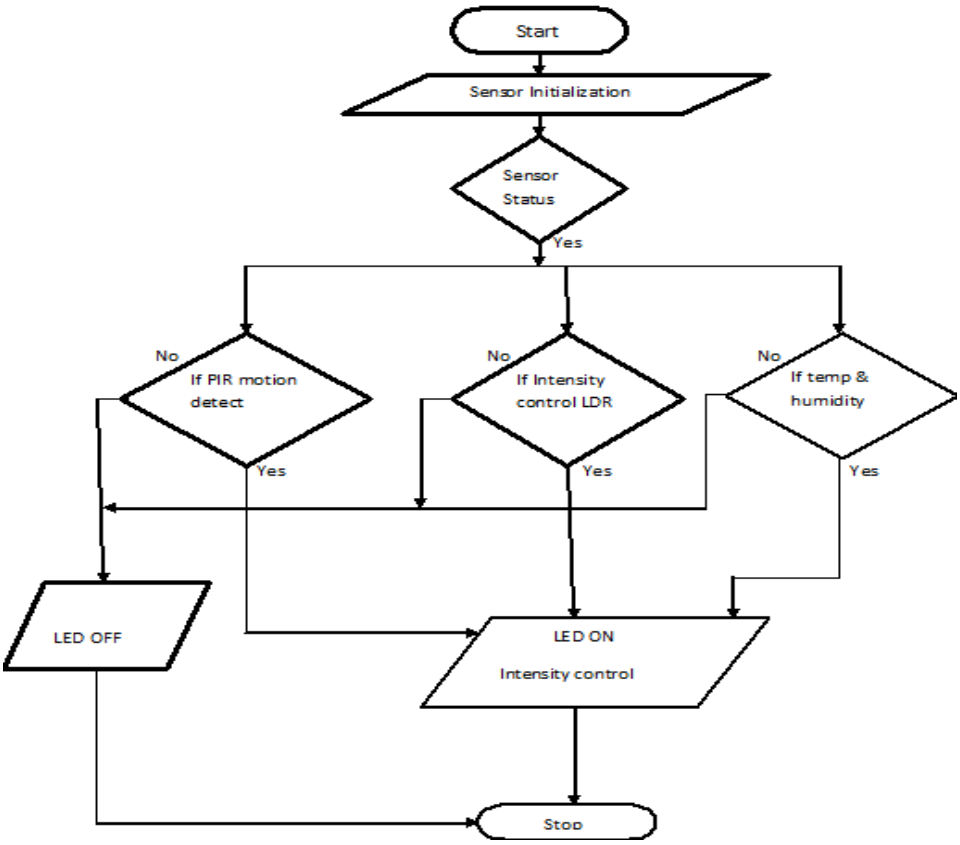

Fig.5: Flow Chart of system

In Fig.5 shown the flow chart of main control, initially in night time all the street lights are activated because of poor ambient light condition. The street lights are operated in two modes. First one if the street lights in automatic mode, if any human or vehicle movement detected, the motion sensor triggers the microcontroller to turn the LEDs to their full brightness and it gets restored back to the dimming brightness. In night time system get started and any motion is detected by PIR sensor ,then this sensor triggers the microcontroller to turn the LED ON with full brightness and after some time it restored back to dimming condition. In rainy season or in winter season sunset occurs early so for that we are using the humidity sensor to detect the environment humidity and temp and triggers the microcontroller to turn the LEDs to full brightness.

VII. ESTIMATION PRICE AND SAVING

This proposed system may be criticized as being expensive however we must consider its advantages: slightly higher prices of the lampposts are compensated by lack of costly wiring and the availability of power network and considerably lower prices of maintenance. Energy savings are of utmost importance today. The goal is, therefore, the reduction of operating prices of street lighting with the creation of a system characterized by straightforward installation and low power consumption, powered by a renewable supply of energy through solar panels with no harmful atmosphere emissions and minimizing light pollution. LED illumination could reduce the amount of time needed to exchange defective fixtures, and it is expected that an LED system would be comparatively maintenance free. This in turn, means that LED system could be considered suitable for use on isolated islands or in high mountainous regions. In such a back ground, and as a result of the significant improvements to luminescent efficiency in recent years, LED lighting can be expected to fully replace previously used light sources within our lifetimes. Making a short comparison with the normal street lighting systems: Supposing that one lamp is switched on for 4,000 hours per year. One streetlight has a median consumption of 200 W yearly. With the system presented in this paper, every lamp uses about 20-25 W (95% of energy consumed by the LEDs).

VIII. CONCLUSION

The proposed modern street light system can detect day/Night time, vehicle movement and atmospheric conditions it vary the intensity of the street light using PWM technique in LED. The dimming and brightening mode of LED saves great amount of energy. Thus if this modern street light system is installed in the cities, then lots of power can be saved. The may be criticized as being expensive however we must consider its advantages: slightly higher prices of the lampposts are compensated by lack of costly wiring and the availability of power network and considerably lower prices of maintenance. The goal is, therefore, reduction of power consumption and harmful atmosphere emission. The modern system is versatile and can be extended according its user needs.

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