A NOVAL APPROACH IN SMART STREET LIGHTING CONTROL SYSTEM

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ABSTRACT

The innovation in smart lighting technology acts as new intelligence to the current network system. Through this automation, the system is not only going to get integrated but also turns into communicable all over the country. The whole system will be monitored by the hub and the usage, malfunction intimation is given to the servers through SMS and mail. Hence it’s time for the consumers and also the suppliers to behave smart or else they will become eventually receiving, highly billed statements. This paper extends an idea of having a power hub which has regulated over all lighting system individually. The hub detects the intensity, position control and decrease the load usage by turning off unwanted loads with a priority that is set by the controller. The power hub can also monitor the energy usage and creates an order of significance among the loads, thus providing intelligence to the current grid system. This paper also enable utilities to integrate, interface with smart governing system and intelligently control the lighting and also detect the malware functioning which enable communication between street lights and servers to provide professional services in affordable way-machine to machine communication.

Keywords: power hub, smart lighting technology, position control, intensity detection, machine to machine communication

I. INTRODUCTION

Street lighting is one of the most important, expensive responsibilities of a city and it is important part of the city’s infrastructure. Lighting is often the largest electrical load in offices, but the cost of lighting energy consumption is less when compared to the personnel cost. About 30% of the total electric power of any country is consumed in lighting [1]. So it is necessary to manage the power in street light in order to save energy. Lighting control system will play an important role in reduction of energy consumption without impeding comfort goals[11, 13, 24]. During olden days the street lights were controlled by manual method then it is controlled by set up an optical control unit which turn on and turn off using light sensing devices, But with recent technologies it is possible to turn on and turn off lights whenever it is necessary [17,19]. Use of recent technology, LED provide better efficiency. Remote management system using sensors [20]-[23] will simplify the management and maintenance cost. Intelligent street lighting is a centralized network that is capable of controlling and monitoring the functioning of the street light remotely. Effective result of this technology [2,3]:

• Energy saving: LED lamps intensity varies in night according to rate of passerby, thus saves energy.
• Maintenance cost: Maintenance cost of LED is less since its lifetime is thrice the existing street lamps.
• Reduction in CO₂ emission: CO₂ emitted by LED lamp is one-third the existing lamp as it consumes less power
• Light lamp has toxic such as mercury, where LED doesn’t contain toxic mercury

The rest of the session will discussed as follows. Challenges to the system is provided in section 2. Related works in section 3, Proposed work in section 4, algorithm and flow chart in section 5, estimation of price and savings in section 6, future scope in section 7, and its applications in section 8.

CHALLENGES TO THE SYSTEM

Necessity of the system Irregular power supply is the most difficult problem faced by people, rather than the commercial people industrial people suffered a lot. India endures from a keen shortage of electricity and power, even after being the fourth largest consumer of power and electricity in the world, ensuing USA, China and Russia. According to the International Energy Agency (IEA), India lacks a further US $ 135 billion in investment for the power sector. Wherein countries like China and U.S.A, the per capita energy consumption stands at 11,919 KWh and 2559 KWh respectively, in India, with a population density of 900 million (1.2 billion minus 300 million without power), the per capita power consumption stands at 778.71 KWh [4]. By implementing good convenient street lighting system we are able to save energy since 30% of total energy is consumed by street lighting.

A. Aspiration of the system

Inorder to meet the system necessity the following three aspects are used. The effective way to reduce the power consumption is to use the recent effective low power consumption lamp such as LED

To provide proper illumination and to utilize the LED technology in an adaptive way the light intensity variation is done depend on pedestrian movements.

The last rebellion idea is to use wireless communication system for controlling, monitoring and malfunction detection.

B. Scope of the system

Our work targets to develop an optimistic system based on the above defined three available solutions by developing a wise lamp-post managed by wireless control system.

This paper we implies recent technologies to enable the system prior to intelligent management and monitor, control the power to street lamp.

II. RELEVANT ENDEAVOR

RELATED IEEE REFERENCE PAPERS

A. An intelligent system for street lighting control and measurement.

The author implement the communication capabilities to already existing system through ZigBee integration, here HPS lamps are ON/OFF by photoelectric relay. It focuses on low cost, low power consumption and demanding low data transmission rates with high
reliability. ZigBee allows topologies ranging from a simple end-to-end connection to a mesh topology Since ZigBee has limited geographic capability a routing modification is proposed, where constraints such as traffic and dead end must be addressed so Global Positioning System (GPS) information in the node installation is approa-ched. The module used was the XBee™ ZNet 2.5, manufactured by Digi Inc., which consists of a 16-bit microcontroller and a ZigBee compatible 2.4 GHz radio transceiver. B. WSN for intelligent street lighting system Wireless Sensor Network (WSN) is applied to intelligent street lighting system inorder to increase functionality of light installations for a wide range of application. The system is composed of WSN nodes unified with light sources based on high power LED diodes, which also enables new services as telemetry, monitoring of noise, humidity, temperature, as well as utilities associated with the road information systems, intelligent transportation systems and intelligent roads. WSN provides a wide range of control signals and actuators which are compatible with different application profiles. Based on sensors reading a constantly working Lamps can be turned on and off. Energy can be saved when full lighting is not required as lamps can switch to a low light level. C. Remote-Control System of High Efficiency and Intelligent Street Lighting Using a ZigBee Network of Devices and Sensors For optimized management and efficiency of street lighting remote control system is used using ZigBee. For significant cost saving and to respect the environment three solutions are proposed which is to use the recent lighting technology in street lamp, remote control system using GPRS or GSM, utilize the renewable energy. System management and maintenance are performed from the information collected from the network of sensors. Base station control receives information from the lamp post. Information is transferred from one lamp post to another as point by point, where each lamp post has a distinct address in the network. Each lamp post can only send the data to the next one, until it reaches the base station. Due to this the transmission power is limited and the signals sent by the lampposts do not interfere with each other. The important elements are the voltage controllers, microcontroller (U2, Microchip PIC 16f688), the XBee module, transistor logic (TTL), analog-to-digital converter (ADC) D. An energy-saving control method based on multi-sensor system for solar street lamp Multi-sensor system is provided to extend the working period of solar street lamp for better energy saving control method. The multi-sensor system is used to collect and recognize the signal of man body, based on the collected information lighting-control method is adjusted. The output power and lighting luminance is dynamically adjusted. This paper optimizes the distribution of storage batteries, and accomplishes the purpose of extending lighting period. Both the sound sensor and infrared sensor includes multi-sensor system module. The output power of system can be adjusted according to the lighting requirement based on multi-sensor output, and the aim of energy saving can also be achieved. At the condition of full charging, the lamp can operate at rated power for 11.3 hours.

Fig. 4.1 Functional block for street light module

OTHER JOURNALS
A. E– Street: LED Powered Intelligent Street Lighting System with Automatic Brightness Adjustment Based on Climatic Conditions and Vehicle Movements
The paper presents remote street light controlling and monitoring system based on wireless sensor network and LED. The traffic flow magnitude statistics is implemented without adding any hardware. If any damage is occurred to the lamp it will be set off using auto alarm function and it displays the serial number of the damaged lamp. It not only monitoring the street light but also it integrates the temperature and humidity sensors. Transmission of signals between streetlight and control unit is provided using Microchip-Wireless (Mi-Wi) protocol. The lights will glow bright if any motion is detected using sensor and back to its dimming state. Lights can also be turn ON/OFF from the control room through wireless medium. The transmitter end consist of power supply, microcontroller PIC16F, photosensitive detection circuit, IR vehicle detector, feedback circuit, fault detection circuit, LCD display and Mi-Wi transmitter module. The receiver end consists of Mi-Wi receiver module, MAX232, RS232 and PC.B. Design and Development of Intelligent Wireless Street Light Control and Monitoring System Along With GUI
It is a solar based lighting system paper. Graphical User Interface (GUI) is used to control street light, ZigBee is used for monitoring and control purpose, LDR and IR sensors are used to provide better efficient in street lighting. It operates in both auto and manual mode. The Control unit can be protracted so that alternative electrical systems, not individual lampposts are connected, and data might be sending regarding power consumptions to the control system. Depending on the atmospheric conditions the transmission of ZigBee alters, since the transmission power is studdedly kept as minimum as possible in order to contribute very low energy utilization the transmission power ranges from ten to hundred meters. With the application of radio frequency modules ZigBee wireless communication network has been.
implemented. They operate at a frequency of 2.4 GHz which is within ISM band. Expen-sive and tedious wiring and connection to external power network can be avoided by implanting this system.

C. Smart Street Lighting using a ZigBee & GSM Network for High Efficiency & Reliability

This paper implements both ZigBee and GSM module for collecting and transferring data from one place to another. The use of LED lamp, wireless control system, renewable energy are the best notion to increase energy efficiency, solve problem regarding maintenance and power management, and to maintain green environment. If there is a problem such as low voltage or low current or insufficient light on any Lamp post, the sensor detects and informs to Base unit. GSM module is used for communication between Lamp post and Base Station. At Base station GSM module is interfaces with controller. There is RF (ZigBee) communication between street lamps. UART universal asynchronous receiver-transmitter is used as an interface. If a PIR detects the vehicle the lamp glows and the lamp off if the vehicle leaves. The current and voltage sensor are used to detect the current flow. Microcontroller PIC 16F690 is used. Facility of water supply relay is provided on this pole. We can make this relay ON or OFF as per our requirement. This function is useful for providing the automatic Water Supply for Trees which are present around the Street which reduces the Human effort to give the Water Supply for Tree.

III. PROPOSED MODULE DESCRIPTION

This proposed system is to transform a normal lighting system to a smart street lighting system by boosting the lighting systems efficiency, optimizes the power consumptions using sensor and wireless communication. When the atmospheric brightness is sufficient to provide illumination the

C. STREET MODULE

Street light module consists of Wi-Fi transmitter module and Wi-Fi receiver module. The transmitter module consists of ATmega 328, PIR sensor, LDR sensor. PIR sensor is connected to the digital pin. LDR sensor is connected to the analog pin. The inbuilt analog to digital converter converts the analog input to digital input. Wi-Fi transmitter is used to transfer the information about street lamp to the control unit in a substation. The output of the controller is a PWM signal which makes the LED to turn ON/OFF through led driver by giving pulse to Led driver. Fig [4.1] is the block diagram of street light module. PIR sensor and LDR sensor is connected to ATmega328. The response mode of the sensors can be improved to increase the accuracy of human body identification according to the present environment [5]. From the output obtained from the sensors the LED is turned ON/OFF or dimmed. The status of light is transferred to the control unit through wireless communication.

1) TECHNICAL SPECIFICATIONS:

a) Controller: ATmega328 is used. It is a simplified version of C/C++. The operating voltage is 5 V. It has the memory of 2 Kb RAM, 32 Kb flash memories and 1 Kb EEPROM. Its clock speed 16 MHz (300,000 lines of C source code /sec). It has 14 digital I/O pins out of which 6 is PWM pins, and 6 analog input pins.

b) PIR Sensor: PIR means Passive infrared sensor. It is used to detect the presence of pedestrians. Any object that has the absolute temperature above the zero level emits the IR rays these rays are invisible to naked eyes. It can be detected only using some special semiconductor devices[14,18,25]. This sensor has some crystalline elements that produce electric charge when it subjected to IR radiations. It has a special filter called Fresnel lens which focuses only on IR waves. PIR sensor does not generate or absorb IR rays it only detect the presence of IR rays. Figure [4.2] resembles PIR’s Fresnel lens and its module.

c) LDR Sensor: LDR is a light dependent resistor. Amount of light impinged on the LDR is inversely proportional to its resistance. It has wide ambient temperature and spectral response, low cost. Figure [4.3] resembles LDR, its symbol, construction. Fig 4.4 LDR, symbol and construction. When LDR is placed in dark its resistance is high, current is zero and in light its resistance is low, current is high. LDR is connected to the analog input. It is used to detect the atmospheric brightness [18, 25].

![Fig 4.2 PIR sensor](image_url)

![Fig 4.3 LDR, symbol and construction](image_url)
d) Wi-Fi/IEEE 802.11b: PHY and MAC are specifies for Wi-Fi standard IEEE 802.11. In the ISM 2.4 GHz frequency band channels it describes 13 overlapping 22 MHz wide frequencies. There are of three non overlapping channels of two group, US uses the channels 1, 6, and 11 as one group. While the channels 1, 7, and 13 is utilized in Europe as another group. IEEE 802.11 has several versions, of which IEEE 802.11b has been widely applied in Wi-Fi. The maximum transmission rate of IEEE 802.11b is 11 Mbps and the CSMA/CA media access method of original IEEE 802.11 standard is used here. The 802.11b PHY layer implements DSSS modulation. The Barker coding and complementary code keying (CCK) are used in 802.11b standard as its modulation technique. Compared to the original standard CCK coding enables data rate to increase dramatically. Specific indoor range is 100 ft at 11 Mbps and 300 ft at 1 Mbps [6].

B. BASE STATION MODULE

Base station is used to monitor, control, and collect the information from individual street lamps. Base station and street lamp communicate via wireless communication. It is also possible to turn ON/OFF/DIMMING the street lamp from remote station. Fig [4.4] depicts the base station module. ATmega328 used at base station is connected to the wireless communication network [15]. It provides two way communications between base station and street lamp. Atmega328 is connected to control unit for monitoring purpose. The data and information are transferred from street lamp to base station. From the information collected it is able detect the malfunctioning, number of hours the individual lamp is in ON condition, total energy consumed. It provides a full control over the remote area.

IV. ALGORITHM AND FLOW CHART

A. ALGORITHM

Step 1: Start the program.
Step 2: Calibrate LDR sensor, PIR sensor and fix threshold value for LDR sensor.
Step 3: Read LDR value
  if LDR value is less than threshold value
  light is in OFF condition
  go to step 3
  else
  light is in ON(dim) condition and read PIR value
  if PIR value is HIGH

B. FLOWCHART

V. PRICES AND SAVINGS

Total energy consumption of street light is about 30% present of the total energy of which 70% of the energy is saved using LED [12, 16]. The initial cost of LED is thrice the high power sodium lamp but the energy consumed is one-third of energy consumed by high power sodium lamp. Even though the initial cost of automatic LED lamp module is high the cost and energy consumption after 3 to 4 years its savings exceeds beyond the initial cost. Effective energy saving is different for different environment. The life time of LED is 50,000 hours so the rapid change of lamp is reduced and cost for maintenance is reduced. The energy consumed by controller is expressed in equation (1)

\[ \text{Energy} = 5v \times \mu A \times 24 \text{ hrs} \quad \ldots \quad (1) \]

The resultant value obtained from equation 1 is comparatively less than light glows on full brightness for nearly 12 hrs (6pm-6am). For example consider 60W lamp is used then the watts consumed are 60W, Kilowatts of electricity used per year will be approximately 110KW/yr and maintenance cost is approximately 660 Rs/yr. But for 60W LED the watts consumed is 6-8W, Kilowatts of electricity used per year is approximately 11KW/yr and maintenance cost is approximately 66 Rs/yr. From this it is clear that the energy consumption is comparatively less when compared to ordinary street lighting method.

VI. FUTURE SCOPE

This system proposes static control unit, in future compact versions of control system can be used for mobile or tab applications. New technologies can be
implemented reduce the consumption moreover. Researchers hopes that there is a risk in LED lighting [-7-10] but mostly upcoming advanced street lighting system uses LED so further development can be established to overcome this risk.

VII. APPLICATION

This project is useful in each and every city that requires street lighting, Industries, ware houses, mines, and public buildings, mostly suitable for rural, suburban sectors where the percentage of passersby is low during night time. The white light is emitting in this proposed street lights that provides high levels of scotopic lumens which allow lights with lower wattages and also reduced photopic lumens to replace existing street lights. This also provides high quality lighting technology that will exceed all other existing technologies in technical parameters.

VIII. CONCLUSION

This system designs autonomous street lighting to save energy, reduce the maintenance cost and also the crime rate is limited up to some extent. To provide better power management LED is used.

Another benefit in this system is communication between lamp post and control system is implemented using wireless communication which enhances better control and monitoring over the street lamp. It is a flexible system where the n number of lamps can be integrated in future.

REFERENCES