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Automatic Streetlight Controller for Power Reduction and Fault Detection

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ABSTRACT

Power consumption of street lights plays a major role in electrification. Even though the present street light system works automatically, it has many disadvantages like faults, durability of bulbs, light intensity and glows when not needed. The aim of this project is to overcome the problems of power consumption by introducing the light intensity factor, vehicle and pedestrian movement and fault detection, burning hours calculation. PIC16F887 microcontroller processes the information and GSM technology monitors the status of the street lamp. The three sensors used here are PIR (Passive Infrared) sensor, Light Dependent sensor and Ambient light sensor. The major advantages of the proposed system lie in the simplicity of the circuit, low cost, high reliability and increased safety

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1. Introduction

Streetlight is a source of light which is mainly found in the street light system, at the edge of the road or walkway prevents accident and reduces thefts during night time. The modern streetlight system can automatically switched ON during night time and switched OFF during day time [1]. This leads to waste of energy. We require large number of man power to monitor the status of each and every streetlight which leads to wastage of money and time. Maintenance is poor, since the authorities are careless. If there is any fault in a streetlight it is difficult to identify which pole has a problem and it is left as such until the problem is identified. Nowadays most of the streetlight system is performing with the aid of a solar dial. Solar streetlight consist of photovoltaic panels which consumes energy from sun light and makes the streetlight to glow during dark. This system reduces the use of electricity and maintenance is less compared to conventional streetlights..

Fig.1 Solar Panel in street light

But the main drawbacks of solar street light is cost of solar panels and theft is higher since equipment cost is high. Dust in the solar panel may reduce the energy production. The tilt and direction of solar panels needs to be optimised[12].All these major issues are still alive though there are new technologies available. And these drawbacks are not considered as a big problem in our day today life as peoples are in a busy schedule.

Various studies have been made related to the development of advanced street lightning system. Most of the studies have focused four main topics: Automatic ON and OFF, energy efficiency, wireless sensor system, low cost [1][2][4]. Researchers have tried to provide automatic ON and OFF technology which reduces man power but they failed to provide with low level of power consumption. Automatic system will work based upon the intensity, with the help of light sensor. Here LDR is placed beneath the street light in every poles. When the intensity of sunlight is high it will be detected by LDR sensor and it makes streetlight OFF automatically. On the other hand when intensity of sunlight is less sensor makes the street lights to glow. This is the present technology which is implemented in road or walkways. Even though it is an automatic system the lights turn ON or OFF based on the time setup of the system. This doesn't suites in different seasons. And also most of the street light found in areas are not based on vehicle or pedestrian movement. So in night time light glows constantly when there is no movement.

In the present street light system data's are calculated manually every time. Data calculations like burning hours, power consumed etc. This may cause inaccurate result and also increases the man power. Authorities may also forget to take readings. So we cannot monitor the status of the lights regularly. This reduces the effects of message loss, effect of weather and general performance characteristics, and increases cost. Most urban and semi-urban areas and towns are still using fluorescent, CFL, High pressure sodium lamps

or metal halide bulbs, which are not designed to meet area-wise lighting needs. This may increase the cost and consume high power when compared to LED'S. And it also increases the light pollution.

Power consumption is an electrical energy to operate an electrical appliance. The equipment uses more energy than the energy required. These drawbacks are overcome by placing light sensors in all the street light circuit, which is responsible to switch ON and OFF automatically. When the light is switched ON current sensor placed in street light circuits identifies the fault and reports the status to the authority with the help of GSM module[10]. The system collects the useful information from each street light like total number of burning hours, total number of interruptions, tally the actual power consumption and fault detection[13].

Global System for Mobile communication is a digital mobile telephony system which plays important role in this project. GSM modem is a specialized type of modem which accept a SIM card, and operates over a subscription to a mobile operator, just like a mobile phone, GSM modem is used to communicate over the mobile network. While these GSM modem are most frequently used to provide mobile internet connectivity, many of them can also be used for sending and receiving SMS and MMS messages [3] [6] [9] [11]. Here, LED is used mainly to increase the lifespan [7][8]. The lifespan of an LED street light is determined by its light output compared to its original design specification. Most LED street lights have a lens on the LED panel, which is designed to cast its light in a rectangular pattern, an advantage compared to traditional street lights, which typically have a reflector on the back side of a high-pressure sodium lamp. PIC16F887 is the brain for our proposed system. And the programming language which is used to develop the software is C – Language [3].

Cadmium Sulphide Track

Fig.2 Ambient sensor

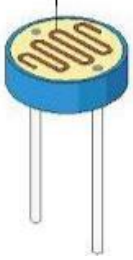

Fig. 3 LDR sensor

In this paper we use three sensors which are PIR (Passive Infrared) sensor, placed between two streetlights which is used to indicate the movement of pedestrian. The Light Dependant sensor is placed beneath the street light that detects whether the light is ON/OFF[3][5]. So faults can be detected. And the Ambient light sensor works for brightness. We use 12V DC power supply. Because of the simplicity of the circuit, the proposed system has low cost, high reliability and increase the feeling of safety.

Fig. 4 PIR sensor

2. Proposed Platform

The project aims to reduce the side effects of the current street lighting system, and find a solution to save power. In this project the first thing to do, is to prepare the inputs and outputs of the system to control the lights of the street. A quick detection of faults is necessary. LED bulbs are used to increase the lifetime and it reduces the pollution. Faults are intimated to the authorities through Short Message Service (SMS) via GSM modem. The burning hours calculation determines the power consumption in streetlights. The streetlights are operated based on light intensity factor which increases the efficiency of the system. The proposed system has low cost, high reliability, increase the feeling of safety and the circuit is simple to design.

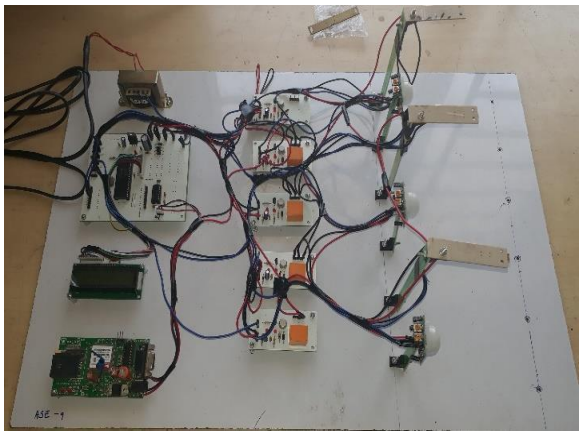

Fig.5 Proposed street light system

3. Block Diagram

The overall block diagram of "Automatic Streetlight controller for power reduction and fault detection" is shown in the Fig 6.

Automatic streetlight system is designed to reduce power consumption and to increase the efficiency by controlling the light intensity factor. This system consist of PIC16F887 microcontroller, GSM modem, Analog-to-digital converter, Level converter, Relay driver, Battery, LCD control circuitry. The PIC microcontroller is used to directly interact through GSM to identify the working and non-working streetlights from any place. It acts as the brain for the entire system. When faults are detected, the information is sent as SMS to the respective authorities. The RB7 is considered as the serial data input output pin and the RB6 as

the serial programming clock. The level converter converts TTL logic into CMOS logic and vice versa.

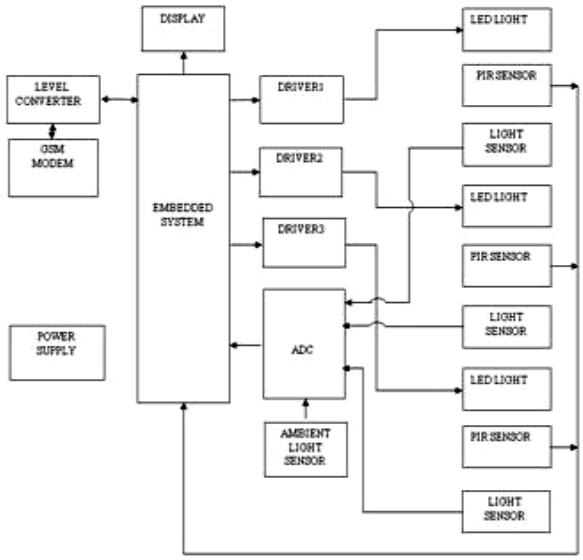

Fig. 6 Block Diagram

Three sensors are used in this system, PIR, Ambient light sensor and Light Dependant sensor. The Ambient light sensor works for brightness, depending on voltage and varies the signal sent to driver. The LDR is used in the system to detect whether the light switches ON/OFF. And the PIR sensor is placed between the streetlights which works for pedestrian movement. The entire streetlight lamps are connected to relay driver. Once the faults are detected by LDR sensor, they are fed to the PIC microcontroller in the form of Transistor Transistor Logic (TTL), from where it is transmitted to level converter which converts it into CMOS logic, which then transmitted to GSM modem, later which is sent as SMS. The GSM modem contains a SIM which is always connected to the authorised person's mobile. The LCD is used to display the burning hours calculation and details of each street light. The LED lamps are used to increase the lifetime of the bulbs which reduces the maintenance cost. Frequent inspection is not required for this system.

4. Working Principle

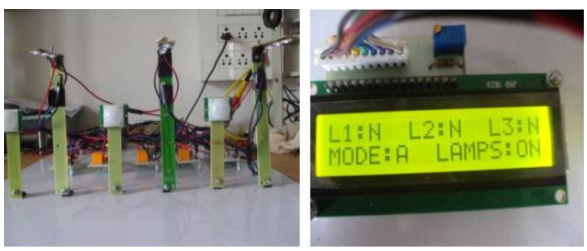

Fig. 7 Status of Lamps

The application is designed in such a way that the street light switch ON and OFF automatically as the light sensor is placed in all the street light circuits. After the lights are switched ON the LDR which is placed in every poles of the light reports the problem status to the higher officials through GSM module. The system also works based on pedestrian and vehicle movement, this is done by ambient sensor which is placed between the lights. When a person or vehicle passes the ambient light sensor detects and makes the light to glow brightly. The use of LED bulbs increases the life time of the system and reduces the light pollution. The LCD present in the system displays the status of the lights. The LDR detects the fault in the system and sends it as a SMS to the higher officials. If lamps L1, L2, L3 works normally then the status displayed is LED will be normal. If any light is not working it will be indicated in the display. And different modes are used here based on intensity.

Burning hours calculation in our proposed system is done by calculating the number of hours the LED bulbs are ON and amount of power consumed. But as per the Demonstration shown voltage given to the LED is less (5V) when compared to the real time application. Street lights used in real time will work with voltage supply of 230V were power consumption is calculated. Total burning hours of street lamp can be calculated every day and at the end of the month readings can be verified. Information can be stored for a long time using GSM modem which contains simcard and used whenever necessary. The manufacturer of LED light sources in our fixture provides an indication of the source life of its light sources.

5. Scope of the Research

[1] Switch ON and OFF automatically.

[2] Works based on light intensity during night time for power reduction.

[3] Streetlights faults detection.

[4] For abnormal working of streetlight, notification is sent to the authorities.

[5] Information of each day is collected and stored in the database.

[6] Wireless Communication.

[7] Reduces power consumption and man power.

[8] Life time of the streetlight is increased.

[9] Can be deployed on any streetlight circuit.

[10] Reducing light pollution and CO2 emissions.

6. Results

During daytime LDR switches off and turn ON the streetlight when the intensity of sunlight decreases. Streetlights are required during the peak hours, say from 6pm to 12am where pedestrian movements are high at that time. The intensity of streetlight increases at this time. After 12am the intensity of streetlight decreases and increases only during vehicular movement. During daytime the LDR switches ON and streetlight turns OFF.

7. Conclusion and Future Work

The Automatic street light controller for power reduction and fault detection will be advantageous in todays up growing countries as it is based on light intensity. This system will be more effective in case of cost, manpower and safety compared to the present system. The automatic street light controller creates a user-friendly approach and promotes power saving. Further improvement can made from this paper by introducing concept of power theft, Raspberry Pi or IOT can be used instead of GSM module.

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