International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2014): 5.611

Smart Street Lighting System: An Energy Efficient Approach

Shagun Malhotra[1], Vivek Kumar[2]

[1]ECE Department, Pusa Institute of Technology, New Delhi, India

[2]EEE Department, HMR Institute of Technology & Management, New Delhi, India

Abstract: ***Today electricity is a major concern worldwide and most of the power generation stations are based on conventional fuels like coal but we have limited sources of these non renewable fuels. So as to minimize the dependence on these sources, we have to move on to new and renewable sources like solar and wind, etc. However proper usage of electricity could also be one of the effective tools for saving the conventional fuels. Street lights are one of the most crucial parts for public lighting systems which consume a major part of the generated electricity. The conventional or manual controlled street lighting system has demerits like high power consumption, high cost and absence of effective monitoring system. This paper describes an energy efficient approach of smart street lighting system, which can automatically control the switching and intensity of street lights based on surrounding light intensity. Basically a smart street lighting system is a flexible street lighting system consists of various sensors and a controller which make it an intelligent street lighting system. This system can effectively overcome the demerits of any conventional street lighting system.***

Keywords: Energy efficient system, Light Dependent Resistor (LDR), Light Emitting Diode (LED), Microcontroller, Passive Infra Red (PIR) sensor

1. Introduction

A Smart Street Lighting System is an intelligent street lighting control system that has to light up at the right time and function seamlessly. A city's street lights meant for providing safer traffic conditions, safer pedestrian environment and can represent a great improvement to the city's architectural, touristic and commercial output. By implementing this system individual dimming and ON/OFF switching of the street lights becomes an easy task. We can choose our pre-programmed schedules; plan a schedule of our own to manage every street lamp, automatically according to our needs [1], [2].

When the street lighting needs to decrease in a certain area or within a certain time span, this system helps to dim the lights accordingly. If the pedestrian traffic decreases significantly say between 1:00AM and 5:00AM, then dimming the lights is the right solution. It will reduce the illumination of the street lights to 20% whenever no pedestrian or vehicle was detected. By this we will considerably reduce energy consumption and CO2 emissions, also reducing light pollution and overall environmental impact.

2. System Architecture

The system architecture of a smart street lighting system is shown below (Figure 1) through a simplified block diagram. It consists of a microcontroller module which regulates the entire sensing and controlling activity for the system. This proposed system also having different sensors for sensing various parameters, a voltage regulation circuit which regulates the input voltage for the LED module, an LCD for local display and GSM/GPRS module for wireless communication with the control centre.

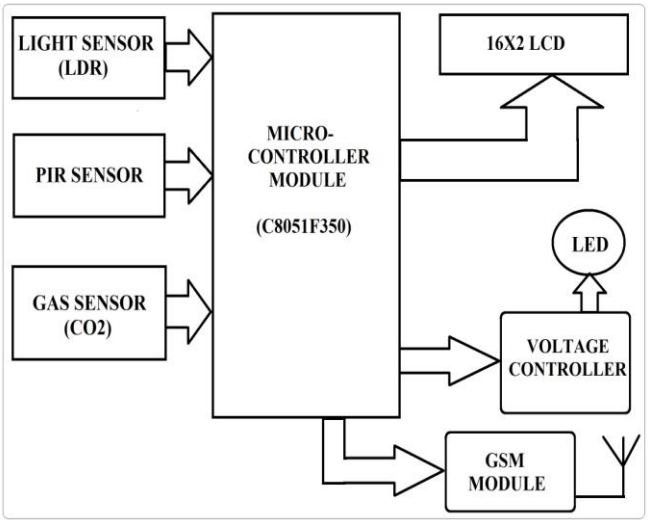

Figure 1: Block diagram of Smart Street Lighting System

a) Microcontroller (MCU) Module

Microcontroller C8051F350/1/2/3 devices are fully integrated mixed-signal System-on-a-Chip MCUs. There highlighted features are listed below. They have a high-speed pipelined 8051-compatible microcontroller core (up to 50 MIPS). In-system, full-speed, non-intrusive debug interface (on-chip). Also having a 24 or 16-bit single-ended / differential ADC with analog multiplexer. Two 8-bit Current Output DACs. A precision programmable 24.5 MHz internal oscillator and 8 kB of on-chip flash memory. On-chip RAM is of 768 bytes. SMBus / I2C, Enhanced UART, and SPI serial interfaces implemented in hardware. Four general-purpose 16-bit timers. Programmable counter / timer array (PCA) with three capture / compare modules and watchdog timer function. On-chip power-on reset, VDD monitor, and temperature sensor. On-chip voltage comparator and 17 I/O ports [6].

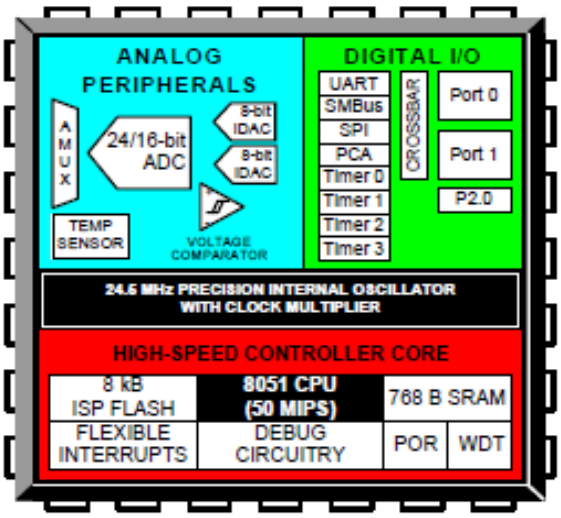

Figure 2: General specifications for C8051F35X family

b) Liquid Crystal Display (LCD)

LCD stands for Liquid Crystal Display. LCD display module here is 16X2 which means it can display 2 lines each of 16 characters. Here this is used to display various parameters locally like intensity of LEDs, level of CO2 emissions, fault detection, etc. Besides supply pins it is having few pins for data connection, while others for control purpose.

Figure 3: Liquid Crystal Display (LCD) 16X2

c) Light Dependent Resistor (LDR) Sensor

LDR stands for Light Dependant Resistor, basically optically variable resistor. In this sensor resistance and light intensity are inversely proportional. When light intensity will increase, resistance decreases and vice versa. A Light Sensor is used to sense devices the illumination level of the street light and surrounding brightness of the sunlight to a microcontroller in order to maintain the constant lighting level of the street light. Here we use two LDRs, first one is used to switch on the street light i.e., when light intensity falls on it, it turns on LDR and then the street light. One more LDR is used for fault detection i.e., if the street light intensity does not fall on LDR then there is change in resistance. This change indicates that there is some fault in the LED panel.

Figure 4: Light Emitting Diode (LDR)

d) Passive Infrared (PIR) sensor

PIR stands for Passive Infrared Sensor. A passive infrared sensor (PIR sensor) is an electronic sensor that measures infrared (IR) light radiating from objects in its field of view. Any object in the world radiates IR rays and these rays are sensed by these sensors. The vehicle/human which passes by the street light is detected by PIR sensor. Here we are using two PIR sensors for bidirectional detection. This sensor is used for dimming purpose and the placement of the sensor is crucial. The sensor should not be placed too low (to avoiding monitoring the small animals) nor too high (can't be sense kids or children).

Figure 5: Passive Infrared (PIR) sensor

e) CO2 Gas Sensor

The CO2 (Carbon Dioxide) Gas Sensor Module is designed to determine when a preset Carbon Dioxide gas level has been reached or exceeded. Microcontroller can be interfaced with the sensor module through a 4-pin SIP header and requires two I/O pins from the host microcontroller. The sensor module is mainly intended to provide an alarm limit when the CO2 emission becomes excessive.

Figure 6: Gas (CO2) sensor

f) Transceiver Module

The SIM300 is an all in one GSM/GPRS solution that comes in a compact plug-in module which is interfaced with the microcontroller through UART (Universal Asynchronous Receiver Transmitter). With an industry-standard interface, the SIM300 offers GSM/GPRS 900/1800/1900 MHz 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.

Figure 7: GSM/GPRS Wireless Communication Module

3. Proposed System

Our smart street lighting system is basically an intelligent system which is designed such that the street lights automatically switches OFF and ON based on the sunlight. For this feature we have used a very common and easily available light sensor called as LDR (Light Dependent Resistor). LDR can also be used to detect any faulty light in the system and send the information of the same to the control centre through GSM/GPRS wireless communication. Second specialized feature is the intensity control of the street lights, where dimming and brightening of LEDs has been carried out automatically based on the detection of any moving object. This feature is implemented with the use of motion sensors such as PIR (Passive Infra Red) sensor.

Normally High Pressure Sodium Lamps are used for the public lighting systems which are based on the principle of gas discharge; therefore the intensity of these lamps are not controllable by any voltage regulation. However our proposed system utilizes the latest technology for the light sources as LED (Light Emitting Diode) lamps instead of generally used street lamps such as High Pressure Sodium Lamps, etc. There are several advantages of LED technology over other traditional technologies like energy saving due to high current luminous efficiency, low maintenance cost, high colour rendering index, rapid start up speed, long working life etc.

Installation of camera for security purpose could be another important feature for any intelligent street lighting system. The primary function of camera is automatically capture the image of the object which is moving across the streetlight and saves it in its memory and can be used for reference thus ensures safety at late nights. Thus our proposed system is an alternative to the existing street lighting system where we can control the energy and light intensity and hence the carbon emission.

Some of the features which are likely to be fulfilled by this proposed system are as follows:

- Automatic Switching / Dimming of Street lights.
- Automatic fault detection through sensors.
- Intensity Control of LEDs on Detection of vehicle or human movement.
- Surveillance services through camera.
- Controlling through control centre via Wireless Communication using GSM.

Operation of the Proposed System

As shown in the Flow chart (Figure 8) initially the user will have to set all the required parameters for particular sensors on the Street Light Modules for different areas from the control centre / Server. All the information is sent to the street light modules which are having a microcontroller based circuit using the GSM/GPRS module. Microcontroller then controls the street light based on the sensor parameters and performs the desired action received from the server using GSM/GPRS module. The control centre will monitor and control all streetlight real times through wireless communication module. It compares these values with the preset value and appropriately decides whether to vary intensity of light. The GUI at the control centre gives us a representation of the streetlights i.e. their status (ON/OFF). This proposed model also measures the amount of Carbon Dioxide present in the environment using the gas sensor, Faults through the LDR and shares this information with the control centre.

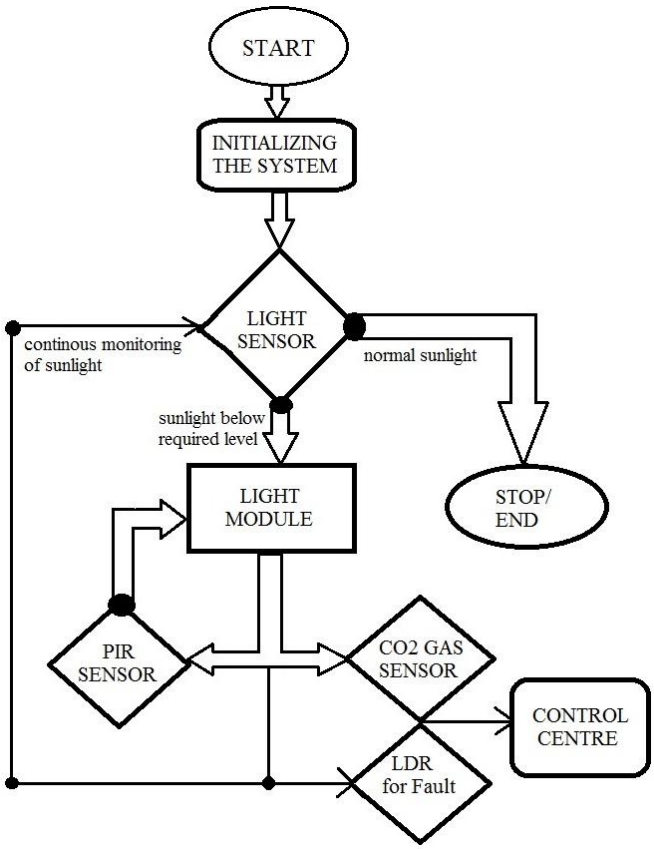

Figure 8: Flow chart for the proposed Street Lighting System

4. Conclusion

The proposed system which is described in the paper can effectively save energy by reducing the power consumption as per requirement. Since this is a sensor based system, so it is self controlled and automated system. Faults could be easily detected using LDR in this system and rectified accordingly, which is usually ignored in the conventional system. However at the same time the system is also flexible for any modification or further expansion such as interfacing of new sensors, connecting surveillance camera for the security purpose, etc. This project of Smart Street Light System is a cost effective, practical, eco-friendly and the safest way to save energy. It efficiently saves the energy by

replacing the conventional bulbs by LEDs and by automatic switching/dimming of LEDs as and when required. Main drawbacks of this system are the initial cost and maintenance. However large scale implementation of this proposed system will definitely reduce the overall cost of the project up to great extent. The project has scope in various other applications like for providing lighting in bus shelters, parks and parking lots of shopping malls or market areas.

5. Future Scope

Moving with the new & renewable energy sources, this system can be upgraded by replacing ordinary LED modules with the solar based LED modules. With utilizing the latest technology and advance sensors, we could serve the same purpose of automatically controlling the street lights much more effectively both by cost and manpower. The main objective of the project is to save the energy, and by doing so we would be able to lighten few more houses. This model could be implemented with few modifications as a source of revenue; as charging station for battery operated vehicles.

6. Acknowledgment

No work, literary or practical can be done without able guidance and support of many people. We take this opportunity to thank all those who inspire us to think innovative and contribute to the development of the country. We also want to thank Government of India's initiatives like Smart city project which motivated us a lot.

References

[1] Prof. K.Y.Rajput, Gargeyee Khatav, Monica Pujari, Priyanka Yadav, "International Journal of Engineering Science Invention ISSN (Online): 2319 – 6734, ISSN (Print): 2319 – 6726 www.ijesi.org Volume 2 Issue 3 March. 2013 PP.60-69".
[2] K. S. Sudhakar, A. A. Anil, K. C. Ashok and S. S. Bhaskar, Automatic Street Light Control System, International Journal of Emerging Technology and Advanced Engineering, Vol. 3, May 2013, PP. 188-189.
[3] Mustafa Saad, Abdalhalim Farij, Ahamed Salah And Abdalroof Abdaljalil "*Automatic Street Light Control System Using Microcontroller*"Department of Control Engineering College of Electronic Technology/ Baniwalid Baniwalid- Libya LIBYA, Mathematical Methods and Optimization Techniques in Engineering.
[4] J. Liu, C. Feng, X. Suo, and A. Yun, "Street lamp control system based on power carrier wave," in Proc. Int. Symp. Intell. Inf. Technol. Appl. Workshops, Dec. 21–22, 2008, pp. 184–188.
[5] 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.
[6] http://www.silabs.com/
[7] https://en.wikipedia.org/

Author Profile

Shagun Malhotra received his B. Tech degree from Guru Gobind Singh Indraprastha University, New Delhi and M.Tech degree from Maharshi Dayanand University, Rohtak. He is having a wide industrial experience of working with private as well as government organization. He has published various papers in International journals. He is now working with reputed Government Technical Educational Institutions.

Vivek Kumar received his B. Tech degree from Guru Gobind Singh Indraprastha University, New Delhi and M.Tech degree from Maharshi Dayanand University, Rohtak. He is having an industrial experience of around two years and teaching experience of more than four years. He is now working as Assistant Professor with a reputed Engineering Institution. His area of interest is New & Renewable Energy and allied fields.