

Street Light Energy Conservation System

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Abstract— This paper proposes energy efficient automatic street lighting system based on low cost microcontroller. The main objective is to design energy efficient based controller for controlling the Light Emitting Diode (LED) based street lamp via appropriate lighting levels control. This system consists of a microcontroller, light sensor, PIR sensor and a set of the LED module. The controlling and managing of the system is based on the density of traffic and five different level of street light brightness has been used for lighting up street proportional to the density of traffic. The system was programmed to automatically turn off during the night. Several numbers of tests have been conducted to test and validate the proposed prototype in the different environment. As conclusion, around 77%-85% reduction in power consumption can be achieved through this proposed automatic street lighting system for energy efficiency system design.

Keywords—Street light,Low power consumption,LDR,PIR sensor ,Microcontroller.

I. INTRODUCTION

Basically, street lighting is one of the important parts of a city's infrastructure where the main function is to illuminate the city's streets during dark hours of the day. In early days, the number of streets in the town and city were very less. Therefore, the street lamps are relatively simple but with the development of urbanization, the number of streets increases rapidly with high traffic density which highlighted There are several factors need to be considered in order to design a good street lighting system such as night-time safety for community members and road users, provide public lighting at cost effective, the reduction of crime and minimizing its effect on the environment.

At the beginning, street lamps were controlled by manual control where a control switch was fitted in each of the street lamps. It is called first generation of the original street light. After that, another method that has been used was optical control method. This method is using high pressure sodium lamp in their system. It can be seen that this method is widely used in the country nowadays. This method operates by using optical control circuit, change the resistance by using of light sensitive device to control street lamps light up automatically at dusk and turn off automatically after dawn in the morning. Due to the technological development nowadays, road lighting can be categorized according to the installation area, performance

and their use, for example, lighting for traffic routes, lighting for subsidiary roads and lighting for urban centre and public amenity areas. While, the sensor network helps in improving the network sensing for street lighting as highlighted mean while, street lighting technology can be classified according to the type of lamps used such as incandescent light, mercury vapour light, metal halide light, high pressure sodium light, low pressure sodium light, fluorescent light, compact fluorescent light, induction light and LED light.

LED is considered a promising solution to modern street lighting system due to its behaviour 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. Therefore, this paper highlights the energy efficient street lighting design using LED lamps through intelligent sensor interface for controlling and managing.

II. STREET LIGHT SYSTEM CIRCUIT DESIGN

The system basically consists of a LDR, PIR sensor, Microcontroller, Relays and Power supply.

A. LDR

The theoretical concept of the light sensor lies behind the LDR (Light Dependent Resistor) which is used in this circuit as a darkness detector. The LDR is a resistor and its resistance varies according to the amount of light falling on its surface.

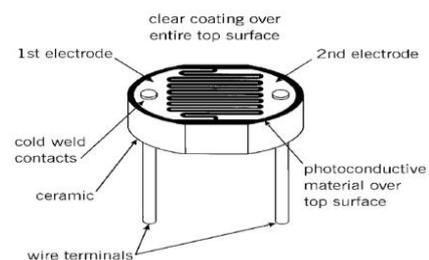


Fig. 1 LDR

When the LDR detect light its resistance will get decreased, thus if it detects darkness its resistance will increase. The LDR is shown in fig.1

B. PIR Sensor

The PIR (Passive Infra-Red) Sensor is a pyroelectric device that detects motion by sensing changes in the infrared (radiant heat) levels emitted by surrounding objects. This motion can be detected by checking for a sudden change in the surrounding IR pattern. When motion is detected the PIR sensor outputs a high signal on its output pin. This logic signal can be read by a microcontroller or used to drive an external load. The PIR sensor is shown in fig.2. Whereas table 1 presents specifications of PIR sensor.

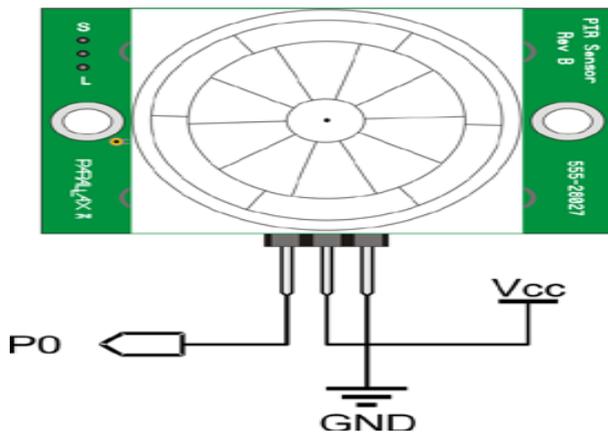


Fig.2 PIR sensor

Table 1: PIR sensor specifications

PIR sensor(#555-28027)	
Sensing range	15-30ft
Sensing object	People ,Animal,Vehical
Supply voltage,current	DC 3-6V,130µA
Communication	Single bit high/low output
Dimensions	35.8*25.4*20.3cm
Operating temperature	0-50C

C. Microcontroller

A microcontroller is a computer control system on a single chip. It has many electronic circuits built into it, which can decode written instructions and convert them to electrical signals. The microcontroller will then step through these instructions and execute them one by one. As an example of this a microcontroller we can use it to control the lighting of a street by using the exact procedures.

Microcontroller are now changing electronic designs. Instead of hard wiring a number of logic gates together to perform some function we now use instructions to wire the gates electronically. The list of these instructions given to the microcontroller is called a

program. There are different types of microcontroller, this project focus only on the AT89C51. The pin diagram of AT89C51 microcontroller is shown in fig.3.

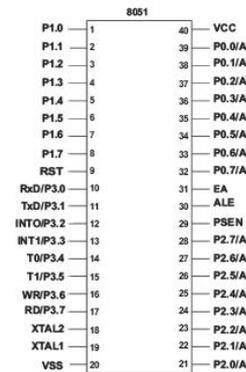


Fig. 3 Pin diagram of AT89C51 microcontroller

III. STREET LIGHT CONTROL CIRCUIT DESIGN

The inputs in the street lighting system are LDR and PIR sensors, after dusk the light sensor will activate the system, to detect any object by PIR sensor, on road to turn ON the streetlights.

In this section each circuit, which has been designed will be discussed. Firstly the LDR circuit as shown in Fig.4, the LDR and RV₁ form one arm of bridge, and R₁-R₂ form the other arm. These arms can actually be regarded as potential dividers, with the R₁-R₂ arm applying a fixed half-supply voltage to the non-inverting input of the op-amp, and with the LDR-RV₁ divider applying a light-dependent variable to the inverting terminal of the op-amp.

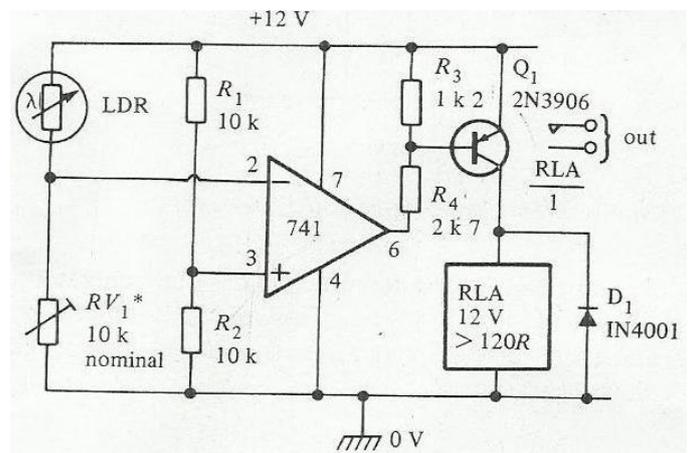


Fig.4 LDR circuit

In use, RV₁ is adjusted so that the LDR-RV₁ voltage rises fractionally above that of R₁-R₂ as the light intensity rises to the desired trigger level, and under this condition the op-amp output switches to negative saturation and thus drives the relay on via Q₁ and biasing resistors R₃-R₄ when the light intensity falls below this level, the op-amp output switches to positive saturation. The circuit is very sensitive, being able to detect light-level changes too small to be seen by the human eye, the circuit can be modified to

act as a precision dark-activated switch by either transposing the inverting and noninverting inputs terminals of the op-amp, or by transposing RV_1 and the LDR.

Further, the Reset circuit is used to put the microcontroller into known state. Normally when a AT89C51 microcontroller is reset, execution starts from address 0 of the program memory. Also, the oscillator circuit has been used to provide a microcontroller with a clock, so that the microcontroller can execute a program.

Two PIR sensors are used in this paper. Their functions to sense the objective that will pass through the street, at the same time give a signal to the microcontroller to turn on the lamp. The idea to save the energy, where the systems have been designed to light ON the lamp in the night only and only if there is any object passes through the street. Except to that the light will be OFF. First PIR sensor is used to turn ON the first lighting column via microcontroller automatically when any object passes in front of it. Mean while the second PIR sensor will turn ON the second lighting column and turn OFF the first one after few delay when the object passes in front of it.

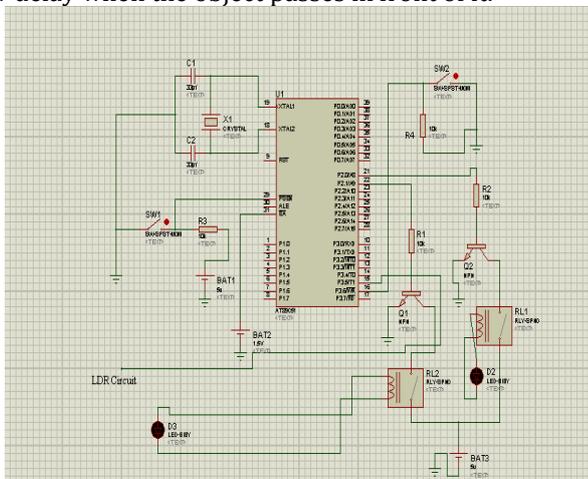


Fig.5 Schematic circuit of street light system

Fig. 5 shows the overall system schematic circuit that has been designed in this paper to control the street lights using AT89C51 microcontroller.

The details of this circuit can be summarized asfollow:

1. Pin 18 to19 of the AT89C51 are connected to the Oscillator circuit and Crystal which consisting of 4 MHz crystal connected to two 33 Pf capacitors.
2. Pin 15 is connected to the LDR circuit.
3. Pins 16 and 17 connected to the PIR sensors through 10KΩ resistor.
4. Pins 21and 22 connected to the lamp1and lamp2 through 2.2KΩ resistance and transistor and Relay.

IV. RESULT AND DISCUSSION

The project aims were 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.

V. CONCLUSION

The automatic street lighting system is developed and successfully implemented presented. As a conclusion, around 77%-85% of power consumption can be reduced by using this system, providing a solution for energy saving. Furthermore, the minimum components including the low cost controller and LED module produce the better saving in term of cost. On top of that, the life time, better illumination and low power consumption of LED are the other criteria for reducing the operational and maintenance cost after installation compared to high pressure sodium lamp.Hence, it helps in further improving the energy efficiency and quality of lighting level

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