Design and Implementation of Automatic Street Light Control System using Light Dependent Resistor

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Abstract *—In today's world, streetlights are very much required in populated regions. Due to busy lifestyle of humans, switching operations on streetlights are not carried out on time, and a huge amount of electricity is being wasted. In the present system it is observed that streetlights are not turned OFF even when there is ample amount of light after sun rise and are turned ON even before sunset. Even in timer based street light control systems, the ON and OFF time differ noticeably during sunny and rainy days. To overcome these problems, an automatic streetlight controller is to be designed.*

The project aims to eliminate the manual operations and to design an energy efficient automatic streetlight controller using light dependent resistor and microcontroller. The microcontroller 'ATmega8' is used as brain to control the streetlight system. The programming language used for developing codes to the microcontroller is C-language. This automatic streetlight controlling system requires less maintenance and it is highly reliable. The LCD displays the real time and the variation in voltage across the LDR circuit, due to changes in the illumination of sunlight. The real time, ON time and OFF time setting is done using the keyboard and LCD display. The change in voltage across LDR circuit and the ON and OFF time settings are analyzed by the microcontroller and enables the automatic switching operation when the switching conditions are satisfied. The system is highly economical and reliable and requires very less maintenance.

Keywords - *Light Dependent Resistor (LDR), Street Light, Microcontroller, Illumination.*

I. INTRODUCTION

The Street lights are the major requirements in today's life for safety purposes and avoiding accidents during night. Providing street lighting is one of the most important and expensive responsibilities of a city. Lighting can account for 10-38% of the total energy bill in typical cities worldwide. Street lighting is a particularly critical concern for public authorities in developing countries because of its strategic importance for economic and social stability. The fixtures of street lights indirectly have assisted the public and government in reduction of crime rate and accidents in the area. It also encourages social inclusion by providing an environment in which people feel they can walk in hours of darkness. Despite that in today's busy lifestyle no one bothers to switch it OFF/ON when not required. Inefficient lighting wastes significant financial resources each year, and poor lighting creates unsafe conditions. Energy efficient technologies and design can cut street lighting costs dramatically.

The main consideration in the present field technologies are Automation, Power consumption and cost effectiveness. Automation is intended to reduce man power with the help of intelligent systems. Power saving is the main consideration forever as the sources of the power are getting diminished due to various reasons. Designing a cost-efficient system is very important as the requirement is more. In order to overcome this problem, automatic street light control methods is introduced. The main objective of our project is to provide a better solution to minimize the electrical wastage in operating street lights, in this era of automation humans are restless and are not in a position to regulate the manual operations in any field, a rapid advancement in embedded systems has paved path for the design and development of microcontroller based automatic control systems. Our project presents an automatic street light controller using light dependent resistor(LDR).

By using this system manual works are removed. The street lights are automatically switched ON when the sunlight goes below the visible region of our eyes. It automatically switches OFF the street lights under illumination by sunlight.

It is a simple and powerful concept, to switch ON/OFF the street light system automatically. It automatically switches ON the streetlight when the sunlight goes below the visible region of our eyes and switches OFF the streetlight when ample amount of sunlight is available. The component used for light sensing is a Light Dependent Resistor. By using the LDR we can operate the streetlight automatically, when ample amount of light is available the streetlight will be in the OFF state and when it is dark the light will be in ON state, it means

LDR resistance is inversely proportional to light falling on it. When the light falls on the LDR it sends the commands to the control circuit that it should be in the OFF state and the streetlight turns OFF. This project exploits the working of a transistor in saturation region and cut-off region to switch ON and switch OFF the lights at appropriate time with the help of an electromagnetically operated switch.

This system operates in accordance with the varying sunlight, whenever there is sufficient light falling on the LDR, it exhibits high resistance and acts as an insulator and in darkness the LDR behaves as low resistance path and allows the flow of electricity. The switching operation of streetlight is carried out by ATmega8 microcontroller along with relay driver circuit. The entire control circuit requires a regulated 5V DC for its operation. A step down transformer is used to step down the 230V AC from mains into 12V AC, this 12V AC is converted into 5V DC by using a bridge rectifier, and the controlled output from the voltage regulator is sent to the control circuit.

Light Dependent Resistor

LDRs or Light Dependent Resistors are very useful especially in light/dark sensor circuits. Normally the resistance of an LDR is very high, sometimes as high as 1000000 ohms, but when they are illuminated with light resistance drops dramatically. Photo sensors are the devices that alter their electrical characteristics, in the presences of visible or invisible light. The best-known devices of this type are the light dependent resistor, the photo diode and the phototransistors. Light dependent resistor as the name suggests depends on light for the variation of resistance.

LDR are made by depositing a film of cadmium sulphide or cadmium selenide on a substrate of ceramic containing no or very few free electrons when not illuminated. The longer the strip the more the value of resistance.

When light falls on the strip, the resistance decreases. In the absence of light the resistance can be in the order of 10kΩ to 15kΩ and is called the dark resistance. Depending on the exposure of light the resistance can fall down to value of 500 Ω. Light dependent resistors are available as discs 0.5cm to 2.5cm. The resistance rises to several Mega ohms under dark conditions. The figure-1 shows that when the torch is turned on, the resistance of the LDR decreases, and allows the current to pass through it.

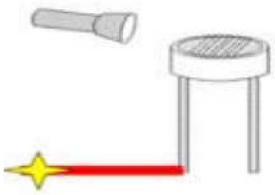

Figure-1 Light dependent resistor

The LDR are made of High resistance semiconductor, when light fall on such a semiconductor; the bound electrons gets the light energy from incident photons. Due to this additional energy these electron become free and jump into conduction band. The electron hole pairs are generated. Due to these charge carries the conductivity of LDR increases, increasing its resistivity.

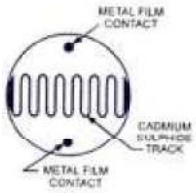

Figure-2 Construction of LDR

The construction and symbol for LDR are shown in above Figure-2 and Figure-3 respectively. The device consists of a pair of metal film contacts separated by a snakelike track of cadmium sulphide film, designed to provide the maximum possible contact area with the two metal films. The structure is housed in a clear plastic or resin case, to provide free access to external light.

Figure-3 Symbol of LDR

Practical LDRs are the light dependent resistors available in the market which are used for practical implications in various electronic circuits. Practical LDRs are available in variety of sizes and package styles, the most popular size is having a face diameter of roughly 10mm. The practical LDR is shown in the Figure-4.

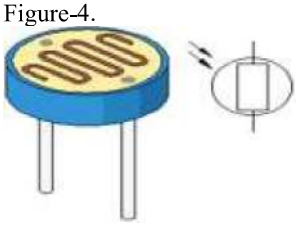

Figure-4 LDR

Features of LDR are as follows:

1. High reliability.
2. Light weight.
3. Wide spectral response.
4. Wide ambient temperature range.

Regulated Power Supply

The basic building blocks of a regulated dc power supply are as follows:

- A step down transformer
- A rectifier
- A DC filter
- A regulator
- Step down Transformer

The step down transformer, converts the AC input 230V,50Hz to 5V. The alternating voltage from secondary terminal of the transformer is given to a bridge rectifier. The bridge rectifier converts alternating voltage to unidirectional voltage with the switching action of diodes. This voltage is finally fed to a 5V regulator IC through a 470uF, electrolytic capacitor, which eliminates the ripples and make the output stable. After regulation we get a 5V DC voltage at the output of 7805 IC.

ATmega8 Microcontroller

Figure-5 ATmega8 Microcontroller

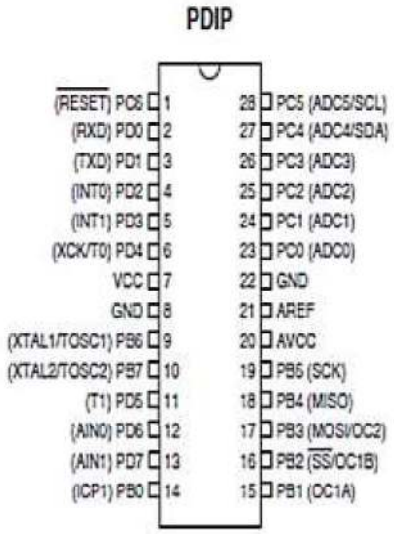

Figure-6 Pin Diagram of ATmega8

The ATmega8 provides the following features: 8 Kbytes of In-System Programmable Flash with Read-While-Write capabilities, 512 bytes of EEPROM, 1 Kbyte of SRAM, 23 general purpose I/O modes, internal and external interrupts, a serial programmable USART, a byte oriented Two wire Serial Interface, a 6 channel ADC with 10 bit accuracy, a programmable watchdog timer with internal oscillator, an SPI serial port, and five software selectable power saving modes. The idle mode stops the CPU while allowing the SRAM, Timer/Counters, SPI port, and interrupt system to continue functioning. The Power down mode saves the register contents but freezes the oscillator, disabling all the other chip functions until the next interrupt.

The device is manufactured using high density non-volatile memory technology. The Flash Program Memory can be reprogrammed In system through an SPI serial interface or by an on chip boot program running on the core. The ATmega8 is supported with a full site of program and system development tools including C compilers, macro assemblers, program simulators and evaluation kits.

Advantages of using Atmega8 Microcontroller

- Both changing of the input level can generate an interrupt.
- There is an added EEPROM to store data over a power off time.
- An internal oscillator and an internal power on reset make the AVR working without any other components.
- Atmega8 has ADC inbuilt, 8051 needs external ADC IC.
- AVR is easy to program, 8051 is old & need to create library for every functions.
- AVR is easy to program (IDEs), 8051 is old & has OK level IDEs, need to create library for every functions.
- AVR having specific function pins and easy to configure, 8051 is having less (no) specific function pins.
- A watchdog to handle hanging software states is added. This is not usable for electrical influence, since it must enabled after reset and can be disabled.
- The instruction time is many times faster than the 8051.
- They are built using two different architectures. 8051 uses CISC instruction sets while the AVR
- Atmega8 uses RISC instruction sets.

Block diagram of complete assembly

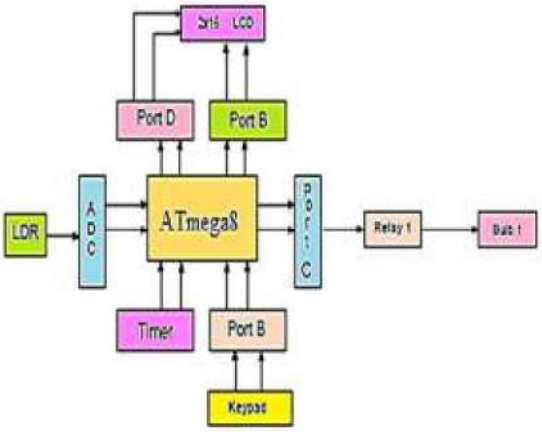

Figure-7 Block diagram

The complete block diagram of automatic street light control is as shown in Figure-7. The Real time and ON and OFF time is set using keypad and LCD display. A tolerance time of one hour or so is preset in the microcontroller. The Light Dependent Resistor senses sunlight and sends analog signals to the switching circuit which includes microcontroller acting as the brain of the circuit and relays operating as a switch. The analog signals of the LDR and On/Off Time when within the set tolerance value triggers the relay switch and street lights are operated automatically.

II. LITERATURE REVIEW

Lighting can account for 10-38% of the total energy bill in typical cities worldwide [1]. Street lighting is a particularly critical concern for public authorities in developing countries because of its strategic importance for economic and social stability. Inefficient lighting wastes significant financial resources each year, and poor lighting creates unsafe conditions. Energy efficient technologies and design can cut street lighting costs dramatically (often by 25-60%). The main consideration in the present field technologies are Automation, Power consumption and cost effectiveness. Automation is intended to reduce man power with the help of intelligent systems. Power saving is the main consideration forever as the sources of the power are getting diminished due to various reasons. The busy lifestyle of humans has led to untimely switching of street lights. As a result lot of power is being wasted. The advanced development in embedded system has set a platform for designing energy efficient systems. Electrical Power wastage can be reduced by using two light dependent resistors as light sensing devices or light sensors to indicate day or night time. A photoelectric sensor has been used to detect the movement of humans and vehicles on the streets [2].

However in this era advancement in Embedded systems, Automatic street light controlling can be achieved using microcontrollers and light dependent resistors [3-4]. The supply to the control unit and to light the street light is being achieved by the implementation of solar panels. Again the LDRs are used to differentiate between day and night light. The discrete analog signals sensed by LDR due to variation in its resistance are converted to digital signals. The Microcontroller is programmed in such a way that during morning and evening as the intensity changes according to which street light intensity is programmed with five intensity levels. This system is basically street light intensity control as well as switching control. A lot more amount of power is conserved as the power is conserved as the power utilization depends on the light in the streets.

As the intensity of Light fall below 10 lux during night time [5] open circuit voltage reaches a certain value and the controller senses the voltage value and the switching operation is carried out and the streetlight glows.

III. OBJECTIVES AND METHODOLOGY

The literature review clearly indicates the gap in literature of conventional method of street light control. This motivated the proposed study wherein, the need for cost efficient and power efficient method of automatic street light control is necessary.

Aim: To design and implement automatic street light control system using light dependent resistor.

Objectives:

1)To study the existing street light control systems.

2)To design energy efficient street light control system.

3)To develop the hardware of control unit.

4)To test and validate the designed system.

Methodology:

Methodology for objective1:

•Literature survey will be made to understand the existing street light control systems and their limitations.

Methodology for objective2:

•The control unit will be designed according to the specifications.

•The designed control circuit will be simulated using MULTISIM and its characteristics will be observed.

•The design will be refined to get the desired characteristics and retested using MULTISIM.

Methodology for objective3:

•The finalized design of control circuit will be fabricated after choosing appropriate components.

Methodology for objective4:

•The fabricated control circuit functioning will be observed and recorded.

•The advantages of new design of control circuit will be validated against the performance of existing systems.

•Conclusions will be drawn based the validation studies.

IV. EXPERIMENTAL WORK

This project basically emphasizes on developing a cost efficient and highly reliable automatic streetlight control system. The main drawback of present conventional switching and timer switching system is wastage of power. Here the prime concern is to design and fabricate a highly reliable automatic streetlight controller.

ATmega8 microcontroller is the brain of the entire controlling circuit. The control circuit requires 5V DC to operate which is obtained from the rectifier circuit which also includes a step-down transformer and a voltage regulator. The light dependent resistor used as a light sensing device senses light intensity and sends analog signals to the microcontroller. The timer concept is employed along with light dependent resistor. The real time, ON time and OFF time settings is done using the four button keyboard and liquid crystal display. A tolerance of one hour is provided for the efficient operation of the streetlight.

In order to turn ON/OFF the streetlight, two conditions have to be satisfied. One of the condition is light intensity sensing of the light dependent resistor and the other being the timers in the microcontroller. Once both of these conditions are satisfied the microcontroller generates control signals to energize and de-energize the relay for the streetlight to turn ON and turn OFF.

The Analog signals from the LDR are processed in Analog to digital converter (ADC) of the ATmega8 Microcontroller. The real time and On/Off time is set, A tolerance of one hour is pre-set using codes written in C language and the program is dumped into the microcontroller. The operation of Relay switch is controlled by the ATmega8 Microcontroller.

The project aims at designing a highly reliable automatic streetlight system, as in the present street lighting system power wastage problems are being encountered due to improper switching operation. The designed control circuit includes a microcontroller used as the main controlling component in the control circuit along with Light Dependent Resistor. The developed system is found to exhibit efficient automatic switching control.

The constructed circuit of automatic street light control. The designed system in the project includes codes written in embedded C which is dumped into the ATMEGA8 microcontroller. The microcontroller analyses the analog signals sent by LDR and the ON/OFF time settings done initially using keyboard LCD display. The streetlight turns ON/OFF, only when both the conditions are satisfied.

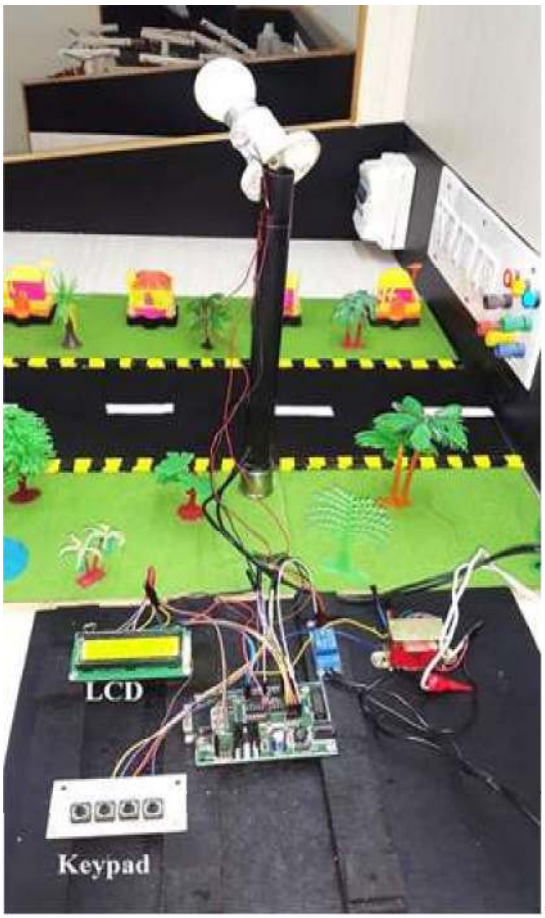

Figure-8 Constructed Circuits

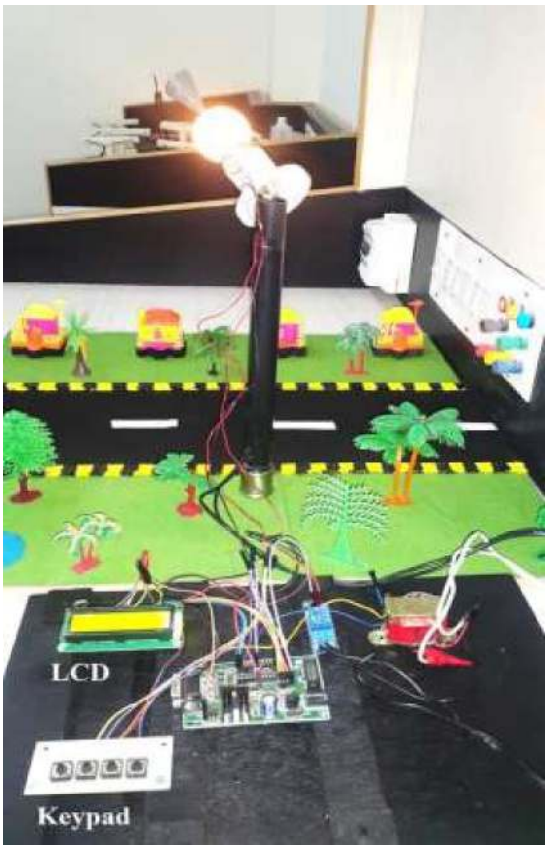

Figure-9 Working model of Automatic Control of Street light system

The working of automatic street light is illustrated in above Figure-9, the bulb glows when the LDR senses the drop in light intensity and when the set ON time is matched, hence both of the above conditions are satisfied.

V. CONCLUSION

Automatic control using LDR helps to save a large amount of electric power which is wasted in conventional street lighting system. The automatic switching operation observed using the developed control circuit is found to be very efficient and the maintenance cost is very less. The circuit controls the turning ON or OFF the street light. The street lights have been successfully controlled by microcontroller. With commands from the controller the lights will be ON when it's dark. Furthermore the drawback of the street light system by just using timer controller has been overcome, where the system depends on both timer and LDR sensor.

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