Advance Solar Power LED Street Lighting With Auto Intensity Control

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ABSTRACT

The project research is designed based on advance light emitting diodes (LED) street lighting with an auto-intensity control uses solar power due to photovoltaic effect that convert light energy to electrical energy. A charge controller circuit is applied to control the charging of the battery, and light dependent resistor (LDR) is used to sense the ambient light on daytime. We have also attempted to measure the solar cell limitation, which defines the scope of a particular process through multiple sensor data acquisition. In this system, different parameters of the solar panel such as voltage, current, light intensity and temperature are surveilled using a microcontroller. The streetlights intensity required to be always high during the peak hours [1]. The streetlights are switched on at night when the day is getting darker and then switched off at the day automatically by using a sensing device LDR lights are the advance application system device of lighting, because of their stunted energy consumption and prolong life they are fast replacing conventional lights all over the world . Light emitting diode (LED) replaces the HID lamps where intensity control is attainable by pulse width modulation (PWM). A programmable microcontroller of the 8051 family is engaged to control different intensities at different times of the night using PWM technique, for energy storing for solar-based system, also using a charge controller for protecting the battery from overload, over charging and huge discharge protection [1]. A voltage regulator (VR) is automatically used to maintain a constant voltage level, that generate fixed output voltage that remain constant for any changed in input voltage load condition of the system. A Mosfet is used as an advance-switching device to control the current and voltage flow between the source and drain; it works as a switch, “No” and “Off” device. The ability to turn the power Mosfet “No” and “Off” allows the device to be used as a very efficient switch with switching speeds, much faster and adjustable.

Keyword: LCD, LDR, RTC, High Pressure Sodium (HPS), 8051 Microcontroller Family.

1. INTRODUCTION

The project research is designed base on advance light emitting diode (LED) street lighting with auto intensity control using solar power from photovoltaic cells. The main purposed of this research project is to provide an advance application solution to minimize the electrical wastage in operating streetlights, in this electronic Technology era human restless [1]. Manual control is liable to errors and leads to energy wastages and manually dimming during mid night is impracticable. The main function of the streetlight is to illuminate the street at dark hour. In designing a proper streetlight, various factors are to be considered which includes its efficiency to provide appropriate lighting on the street, its harmful environmental effect, installation, commissioning and running cost etc. Therefore, before designing a streetlight all these factors should be

considered appropriately and efforts should be made to incorporate technologies, which are more cost effective base on the research project, discussed [2]. Photovoltaic cells are used for charging batteries, which convert sunlight energy into electrical energy that generate the electricity. A charge controller or (charge regulator) circuit is used to control the rate limits at which the electric current is added to or drawn from the electric batteries. It prevent the battery from overcharging and protect it against overvoltage, which can reduced battery performance or lifespan from the solar panel. Battery charger should have short circuit protection, reversed polarity protection and over voltage protection. At late night, intensity of light should be maximize, during the daytime the intensity of the light can be reduced simultaneously till morning to save energy consumption. The microcontroller contains programmable instructions, which controls the intensity of streetlights based on the PWM (Pulse width Modulation) signals generated. To generate pulse width modulation (PWM) signal at different time we used RTC. Real-time clock (RTC) will consume power from microcontroller. Automatic intensity control is a simple and advance application concept in which streetlight controls its intensity according to the brightness of the surrounding [3]. Streetlight is automatically switched ON when the sunlight goes down and is automatically switched OFF when there is sufficient sunlight. This function is done by a sensor called Light Dependent Resistor (LDR).

1.1 Project Objective

The main project objective of this research is to provide a greater solution to reduce the electrical wastage in operating streetlights, in this electronic technology era human disturbed, the streetlight uses the light energy by photovoltaic effect to electrical energy in order to reduce the cost of power consumption. Manually control is liable to misconception and leads to energy wastages and manually dimming during mid night is unachievable [4]. A rapid advancement of combining of computer software and hardware, which is fixed in either capability or programmable systems, had paved path for the virtual mechanisms based on microcontrollers. The research paper presents an advance automatic street light controller using (LDR) light dependent resistor which is also known as photo resistor made cadmium sulfide, a 8051 microcontroller which is programmed using C language to act as a pulse width modulator. The circuit also consists of a solar cell measurement and a charging circuit is done by the use of a microcontroller 8051 family [5]. The streetlight intensity is monitored using an LDR sensor, the temperature-by-temperature, the current-by-current sensor and the sensor voltage-by-voltage divider principle. All these data are programmed base on the instruction of the 8051 family microcontroller.

1.2 Problem identification

The purpose of designing an advance new system for the streetlight that do not consume extreme large amount of electricity and illuminate large areas with the highest intensity of light is applicable to most engineers working in this field. Inefficient lighting wastes significant financial amenities and services every year, and poor lighting cause high-risk conditions. Design mechanism and Energy efficient technologies and can provide low cost of the street lighting drastically. The main problem is that the manual controls on the streetlights face, cause a lot time taking during evening times when they are to be switched ON and a significant waste of energy is tender at morning at all could not be turned OFF simultaneously at once. The intensity of the streetlight undergo waste in the midnights lights glow at full intensity although there is not much congestion traffic. Therefore, that is why we come up with an advance system, which overcomes the problems of existing systems. This system will reduces manually control and efficiently save adequate electricity energy for future use. This is done by using low power, robust and efficient components.

2.0 Implementation Method of Street Lighting

This circuit consists of charge controller battery that is charged by the solar panel by photovoltaic effect, which convert sunlight energy into electrical energy. The battery supply to the 8051 family microcontroller, which is programmed with the instruction to work as a pulse width modulator (PWM) connected to the light dependent resistor (LDR), which provide high or low signal, depending on the light intensity. When the 8051family microcontroller gives a high signal to the Mosfet, the light emitting diode (LED) is OFF, and then the MOSFET gets a low signal, which turns ON and the LED glows. The circuit comprises of measurement circuit and protection device for the evaluation of photovoltaic power and the contrast of light for sunlight obtained. The current is sensed by the current sensor, voltage is esteemed by the potential divider circuit and temperature by the temperature sensor [5]. The block diagram is shown below in fig 2.1

2.1 Block Diagram

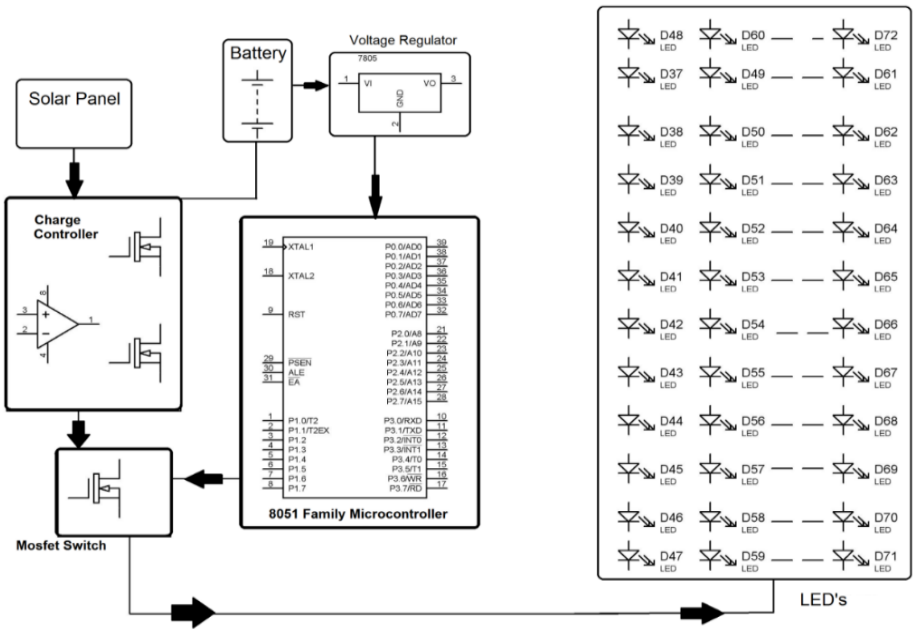

Figure 2.1 Block diagram of the solar powered led streetlight with auto intensity control

2.3 Block Diagram Summary:

In this project, we are going to switch off and on the streetlights automatically base either on the day region or during dark hours. The limits of the day varies from season to season, appropriately our module operate based on the light intensity control when to start or stop in order to save energy consumption. For this, we are using Light Dependent Resistor (LDR) is used as the light sensor, which send a signal with the required information to the microcontroller. 8051 MC is connected to control all the necessary instructions given and stored information base on how the light intensity of daytime and night light operate. Light dependent resistor (LDR) and relays is used, by using the LDR we can operate the lights, when the light

is available then it will sent a signal be in the OFF state and when it is dark then the light will be in ON state, which means light dependent resistor (LDR) is inversely proportional to light [6]. When the light enters the light dependent resistor (LDR) it sends the command instructions to the 8051 family microcontroller, that it should execute the instructions sent as OFF state then it switch offs the light meanwhile same instruction applicable to ON state, all these command instruction are sent to the microcontroller to execute and manipulate it, which is already programmed, then according to that the devices operate. We use a Mosfet to act as an ON/OFF switch, which allows the device to be used as a highly efficient switch with switching speeds and adjustable.

3. Working Operation

This research project is mainly designed base on advance light emitting diode (LED) Street Light with Auto Intensity Control and highly steadfast automatic streetlight control system. The main weakness of present conventional switching and timer switching system is wastage of power. Here the major concern is to design and fabricate a highly reliable automatic Streetlight controller. An 8051 microcontroller is the brain of the whole Controlling circuit. The control circuit requires 5V DC to operate, obtained from the rectifier circuit, which also includes a charge controller and a voltage regulator, which maintain a constant voltage level. The light dependent resistor (LDR) used as a light sensing device, its senses light intensity and sends analog signals to the 8051 microcontroller. The concept of timing is engaged along with light dependent resistor (LDR). The real time, ON and OFF settings is done automatically programmed in the microcontroller. A tolerance of one hour is provided for the systematic operation of the streetlight. In order to turn ON/OFF the streetlight; two conditions have to be fulfilled. One of the condition is light intensity sensing of the light dependent resistor (LDR) and the other being the timers in the microcontroller. Once both of these conditions are fulfilled the microcontroller generates control signals to energize and de-energize the relay for the streetlight to turn ON and turn OFF.

3.0 Hardware Implementation

- Charge Controller
- 8051 Microcontroller
- LED (Light emitting diode)
- LDR (Light dependent resistor)
- Solar Panel
- Voltage Regulator
- MOSFET
- Rechargeable Battery

3.1 Charge Controller

Solar charge controllers regulate the energy flowing from the PV array and transfer it directly to the batteries as a DC-coupled system, which is the most efficient and effective manner. Controller is a very significant device in solar streetlight, used to decide the status of the charging and lighting by switch on or switch off. Some recent controllers are preprogrammed and it consists of a battery charger, a Led lamp driver, a driver, a secondary power supply, an MCU and a protection circuit. The battery can be controlled by the controller from the under and over charging conditions. The battery can be charged by

the power received from the solar panels in the sunrise and while in the sunset it charges the battery. Some modern controller are programmable so that user can decide the appropriate chance of charging, lighting and dimming.

3.2 Microcontroller 8051 Family

8051 microcontroller is a single chip microcontroller, which is used for taking input from any device or giving output to any device. It is 8-bit microcontroller, four port, total content 40 pins and 32 input/output pin, means it can read, write and process 8-bit data.

Pin Description of the 8051

Figure 3.2 Pin Description of 8051

Microcontrollers are often referred to as single chip computers that incorporates all the basic components of a personal computer on a much smaller scale. In functional terms, a microcontroller is a programmable single chip that controls a process or system. Microcontrollers are typically used as embedded controllers where they control part of a very larger system such as an appliance, automobile, scientific instrument or a computer peripheral. Microcontrollers are designed to be low cost solutions; therefore using them can drastically reduce part and design costs for a project [6]. Physically, a microcontroller is an integrated circuit with pins along each side. The pins presented by a microcontroller are used for power, ground, oscillator, I/O ports, interrupt request signals, reset and control.

3.3 LED (Light Emitting Diode)

Light emitting diodes are semiconductor devices like transistors and other diodes. Light emitting diodes are made out of silicon. The small amount of chemical impurities that are add to the silicon such as gallium, arsenide, indium, and nitride makes an LED lightened. When current passes through the LED, It emits photons as a byproduct. LEDs produce photons directly; not via heat. The color of the emitted light depends on the composition and condition of the semiconducting materials. LEDs have a dynamic resistance that depend on how much current passes through them. LEDs consume a certain voltage, known as the "forward voltage drop". A voltage source and a resistor are connected in to drive an LED.

3.4 LDR (Light Dependent Resistor)

A photo resistor or light dependent resistor (LDR) is a light-controlled variable resistor. The resistance of a photo resistor decreases with increasing incident light intensity; in other words, it exhibits photoconductivity. A photo resistor can be applied in light-sensitive detector circuits, and light- and dark-activated switching circuits. Normally the resistance of a light dependent resistor is very high, sometimes as high as 1000000 ohms, but when they are illuminated with light resistance drops adequately to the base of the transistors. However, when light shines onto the light dependent resistor its

resistance falls and current flows into the base of the first transistor and then the second transistor [7]. The resistor can be turned up or down to increase or decrease resistance, in this way it can make the circuit more or less sensitive. That means light must shine into the LDR for the circuit to be activated.

3.5 Solar Panel

A solar panel is a collection of solar cells. The solar panel converts the solar energy into electrical energy. Solar panels are those devices, which are used to absorb the sun's rays and convert them into electricity or heat. A solar panel is actually a collection of solar (or photovoltaic) cells, which can be used to generate electricity through photovoltaic effect. These cells are arranged in a grid-like pattern on the surface of solar panels. Output of the solar panel is its power, which is measured in terms of Watts or Kilowatts [8]. The performance of the solar panel depends on a number of factors like climate, conditions of the sky, orientation of the panel, intensity and duration of sunlight and its wiring connections.

3.6 Voltage Regulator

A voltage regulator is designed to automatically maintain a constant voltage level. A voltage regulator may be simple "feed-forward" design or may include negative feedback control loop. It may use an electromechanical mechanism, or electronic component. It generates a fixed output voltage that remains constant for any changes in an input voltage or load conditions. The purpose of a voltage regulator is to keep the voltage in a circuit relatively close to a desired value. Voltage regulators are one of the most common electronic components, since a power supply frequently produces raw current that would otherwise damage one of the components in the circuit.

3.7 Mosfet

Metal-oxide-semiconductor field-effect transistor (MOSFET) is a field-effect transistor (FET with an insulated gate) been used where the voltage determines the conductivity of the device. It is used for switching or amplifying signals. The ability to change conductivity with the amount of applied voltage can be used for amplifying or switching electronic signals. MOSFETs are now even more common in digital and analog circuits. A MOSET is by far the most common transistor in digital circuits, as hundreds of thousands or millions of them may be included in a memory chip or microprocessor. A complementary pairs of MOS transistors can be used to make switching circuits with very low power consumption, in the form of CMOS logic [9].

3.8 Rechargeable Battery

A rechargeable battery, storage, secondary battery or accumulator is a type of electrical battery which can be charged, discharged into a load, and recharged many times, while a non-rechargeable or primary battery is supplied fully charged, and discarded once discharged. Several different combinations of electrode materials and electrolytes are used, including lead-acid, nickel cadmium (NiCad), nickel metal hydride (Ni-MH), lithium ion (Li-ion), and lithium ion polymer (Li-ion polymer). During charging, the battery functions as an electrolytic cell. When the cell is connected to an outside energy source, the electrons in the cathode are forced to flow back to the anode.

3.9 Schematic Circuit Diagram of the Project

Figure 3.9 schematic circuit diagram

3.9 Control of Street Lighting Circuit

Here we used a LDR to sense the daylight, based on that; we switch ON the light emitting diodes. As we made a potential divider with 100K and light dependent resistor. While in the daylight light falls on light depend resistor its resistance will go down, as resistance go down voltage light depend resistor will go to 39th pin of microcontroller as low logic. When night falls there will be no light on LDR so resistance of LDR go increase so voltage drop across will increase, this voltage drop goes to MC as HIGH logic sensing as Night. Based on light intensity falling on LDR decided the duty cycle of output LEDs. The MOSFET switches ON between its drain and source that completes its path of current flow through the LEDs [10]. Therefore, with varying duty cycle from 90% to 10% the current flowing through the LEDs reduces that result in lesser intensity as described earlier. The circuit is shown in fig 3.9

4. Result Analysis

The result comprises the successful operation of the 'Advance Solar Powered Led Street Lighting With Auto Intensity Control' The circuit is stationed in a suitable location that is exposed to sunlight so that immediately it is dark the system automatically switches "ON" the lamps and when the illumination is above 50 lux the lamps are automatically switched "OFF". The values of illumination, voltage, current and temperature is noted from the LCD. The solar energy is one of the important and major renewable sources of energy and has proven it useful in functioning of applications like streetlights. The charge control is necessary in order to achieve safety and increase the capacity of the battery. In cities, currently thousands of streetlights are operated and the yearly electricity maintenance cost is very high. The initial cost and maintenance can be the drawbacks of this project. With the advancements in technology and good resource, planning the cost of the project can be cut down. Thus, this project can be resourceful and a smart alternative for widely used halogen lamp streetlights in our country.

4.1 Observation

The device was observed on Monday, 14/02/2020 at 11:37am in the EEE LAB of Noida International University:

SL no	Current (A)	Voltage (V)	Illumination (Lux)	Temperature (Degree cent.)	Status of LED
1	0.014	0	67.2	15	OFF
2	0.013	0	52.4	15	ON but dim
3	0.03	0	45.2	15	ON but Slightly bright
4	0.012	0	3.2	15	ON but glowing brightly

4.2 Advantages:

- Solar street lights require much less maintenance compared to conventional street Lights.
- Solar street lights are independent of the utility grid. Hence, the operation costs are Minimized.
- Since external wires are eliminated, risk of accidents is minimized.

4.3 Disadvantages:

- Snow or dust, combined with moisture can accumulate on horizontal pv-panels
- Initial investment is higher compared to conventional streetlights.
- Rechargeable batteries will need to be replaced several times over the lifetime of the
- Fixtures adding to the total lifetime cost of the light.

4.4 Applications

This system is designed for outdoor application in un-electrified remote rural areas. This System is an ideal application for campus and village street lighting. Solar Street Lighting System is an ideal lighting system for Roads, Yards, Residential Colonies, Townships, Corporate Offices, Hospitals, Educational Institutions and Rural Electrification.

5. 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 streetlights have been successfully controlled by microcontroller. With commands from the controller, the lights will be ON when it is 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. The solution to energy conservation is to eliminate time slot and introduce a system that could sense brightness environment and act accordingly so that seasonal change would not affect the intensity of streetlights. In addition, LEDs should replace HID lamps due to their dimming feature, another reason are that they are more reliable. The solar energy is one of the important and major renewable sources of energy and has proven it useful in functioning of applications like streetlights.

Solar powered automatic street light controller is one of the applications of electronics to increase the facilities of life. The use of new electronic theories has been put down by expertise to increase the facilities given by the existing appliance. It saves around 40% of electricity from per street light. Therefore, throughout the world if we use this concept then it will eliminate the energy crisis largely extent. It is eco-friendly and utilizes the renewable source of energy very well.

6. Future Scope

The Solar Powered LED Streetlight with Auto Intensity Control can control the electric charge and intensity of lights. This project can be enhanced by using with timer-based products and photo sensor based products. We can use solar tracking system for fast charging. In monsoon season, solar light is more difficult so that we use extra batteries in series to save more power to improve lighting we use LED Panel.

7. Acknowledgement

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