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Solar Street Light with Dusk and Dawn Facilities

Ajit Divakaran Mini
Department of Electronics Engineering
Shah and Anchor Kutchhi Engineering College
Mumbai 400088, India

Gupta Satyam Ramdayal Asha
Department of Electronics Engineering
Shah and Anchor Kutchhi Engineering College
Mumbai 400088, India

Kamble Ansh Suresh Anuradha
Department of Electronics Engineering
Shah and Anchor Kutchhi Engineering College
Mumbai 400088, India

Jagdale Satyam Suyog Rekha
Department of Electronics Engineering
Shah and Anchor Kutchhi Engineering College
Mumbai 400088, India

***Abstract*—This paper demonstrates the working of a street lighting system without any sensor required, any manual input or external source of power supply in the form of electricity. This system tries to become the ideal self-sufficient, inexpensive and a device that works off a cleaner source of energy while falling in line with then energy conservation trend. Use of custom PCB layout makes the system space efficient along with energy efficiency. The Solar Street Lighting System is a modern take on the existing Street Lighting systems, with the introduction of Solar Panels in order to make them self-sufficient, while also promoting the use of clean and renewable source of energy. This system, turns the lights ON and OFF based on the amount of voltage that is being generated by the solar panel and comparing it with the set values thus eliminating the use of any sensors making this system inexpensive while also eliminating the needs of any sort of manual input like ON time and OFF time setting. In this way the authors of this paper have tried to build the system energy and cost efficient.**

Keywords*— *Solar panel, solar street light system, energy efficient, automatic operation, rechargeable battery

I. INTRODUCTION

In this age of energy conservation, about 25-30% of the total energy spent in the city is consumed by its street lighting system. The problem with this system lies within its design, it is obsolete so as to speak. The fact that it depends upon external source of power supply in form of electricity is concerning.[1]

simple and cost-effective solution for this problem would be replacing this system with a more modern and energy conserving design. **Solar Street Lighting System**, a simple yet a powerful and energy efficient system, where in depending up on the amount of voltage produced by the solar panel, the lights can be turned **ON** or **OFF**.

The main goal that is being tried to achieve here is to make the existing lighting system self-sustaining and automatic. The lights are set to turn **ON** once the sun sets down which in turn generates less amount of voltage indicating that it's dark now and lights are to be switched **ON**. The same concept is applied when the lights are to be turned **OFF**, once the sun has risen and enough sunlight is being acquired to the solar panel in order to generate the minimum amount of voltage required to send the system to its charging mode hence switching OFF the lights. Once the system is in its charging mode, the rechargeable battery connected to power the system will keep charging until its fully charged or until it's time to switch on the lights again.

Application of this system brings in two of the most crucial befits of all. The first one being the system becoming self-sufficient. It will not require external power to be supplied to it anymore, instead it will generate all they electricity required from a clean and renewable source of energy, the Sun. Second benefit is the conservation of this generated energy itself. The system will no longer be depended upon human input since it will be turning **ON** and **OFF** on its own, hence saving a significant amount of energy which is something the world sorely needs right now. [2]

II. METHODOLOGY.

This section is divided into three parts. This section discusses about hardware used, software development and the working of the proposed system.

A. Hardware Specifications

1. **Solar panel**: The solar panel is a device which is capable of converting the solar energy freely available during the day into equivalent electrical energy. It is a photovoltaic module which contains an array of solar cell, a tiny device which converts the energy of light source into electricity by the phenomena called photovoltaic effect. Since this kind of energy is more efficient as compared to other sources of energy, the electricity generated through this panel can be stored in a battery and used as a power source.

2. **Battery**: The battery used is a rechargeable type of battery, which basically consists of one or more electrochemical cells. It is also called as 'accumulator' since it accumulates and stores the energy in the form of electrical charges through a reversible electrochemical reaction. Rechargeable batteries can be charged, discharged into systems or loads and recharged again. It has numerous applications in these modern technological worlds ranging from its use in mobile phones which uses very thin and size effective batteries to power electric vehicles like locomotives and ships, even it can be used in stand-alone power systems which uses heavy duty

rechargeable batteries. A 12V-1.3Ah lead-acid rechargeable battery is used in this paper [5].

3. **Microcontroller Atmega328P**: Atmega328P is a low power, high performance microcontroller manufactured by Microchip. It is a CMOS 8-bit microcontroller which is based on AVR enhanced RISC architecture whose features includes execution of powerful instructions in a single clock cycle. It is the most commonly used microcontroller amongst all AVR microcontrollers, as it is considered as heart of ARDUINO boards. This Atmel based 8bit AVR RISC based microcontroller provides features which includes 32Kb flash memory in which reading of data/instructions is possible while it is been written into it, 2Kb SRAM,1Kb EEPROM available to read data ,erase it and also write data to it,23 programmable I/O lines, its operating speed can reach up to 20 million instructions per second(MIPS) with an operating frequency of 20MHz, it has 32 general purpose working registers and two 8-bit,one 16-bit timer/counters with compare modes

. In total it has 28 pins which includes internal and external interrupts, communication interface, I/O lines, PWM channels, ADC channels, SPI serial ports etc. The operating voltage of this device is between 1.8-5.5 volts. Atmega328P is such a powerful and cost-effective microcomputer which provides the user high processing speed approaching 1 MIPS per MHz and balanced power consumption [4].

4. **Power Transistor**: It is a three terminal device specifically designed for handling high current and high power. It can be used in circuits as an amplifier which requires high voltage output. It can also be used to switch electronic signals as it has fast switching speed reducing the delay and lower power consumption. Commonly used power transistors include power BJTs which has features high power handling, advanced process technology and low error voltage.

5. **Voltage regulator**: A voltage regulator is a referred to as a circuit which maintains constant voltage level regardless of the voltage change at the input. The main function of voltage regulator systems is to maintain a constant voltage within the prescribed range that can be tolerated by the system or electrical circuit. A simple feed forward design can be used as a voltage regulator or a simple combination of LEDs and Zener diodes can make a voltage regulation system. In this paper Zener diode as a voltage regulator is used in the charge controlling circuit where the current flow stops if the voltage is beyond the specified value.

6. **Crystal Oscillator**: A Crystal oscillator is an electronic oscillator circuit that uses piezoelectric material and creates an electrical signal equivalent to the frequency provided which works and is based on the property of inverse piezoelectric effect in which the mechanical resonance of the vibrating crystal made of the piezoelectric material produces an equivalent electrical signal. Rochelle Salt, Tourmaline, Quartz is some of the examples of naturally occurring crystals which possess this property. A crystal oscillator provides high frequency stability and has high Q factor. It is mainly used in watches where the quartz crystal inside it provides stable clock signals for digital integrated circuits and it is also used in radio transmitters and receivers for stabilized frequencies [6].

7. **Voltage Divider circuit**: It is a simple circuit which turns the input larger voltage into smaller one which is fraction of its input. It can be used in circuits where there is need of smaller voltage from larger input voltage.

8. **LED**: In the modern era where the world thrives on energy efficiency, LED lamps produces light within the visible light spectrum with extremely high energy efficiency and which consumes up to 90% less than the traditional incandescent bulbs. It is the latest and improved lighting technology from the semiconductor world that produces bright visible light, has long lifespan, environmentally friendly, and moreover there is a dramatic decrease in power consumption which reduces the costs making it affordable. When the electric current passes through the Light Emitting Diode (LED) it emits light with less heat emission making it the new century light source.

B. Software Implementation

In the proposed design of the project mentioned in this paper, uses a microcontroller which requires program for the execution and operation of the integrated circuit. For this purpose, Arduino programming is used to develop a program since it is an easy language to understand and commonly used programming language for the development of microcomputer. The software implementation in the microcontroller helps to control the flow of current according to the level of surrounding light which in turn controls the execution and intensity of LED lights which is interfaced to the microcontroller. The execution of this software starts with analyzing the surround light intensity. During day time when there is enough light from the sun, light directly falls into the solar panel; the microcontroller is programmed in such a way that when the voltage received as an input to the microcontroller has a minimum voltage value up to 50% of its maximum value the LED interfaced with microcontroller will turn off. Anything below this minimum value the intensity of LED lights gradually increases illuminating the streets which happens during night when there is no atmospheric light present. In this way the system can be programmed with automation features effectively and efficiently [3].

Figure 1. Compiling Arduino Program Code

C. Working

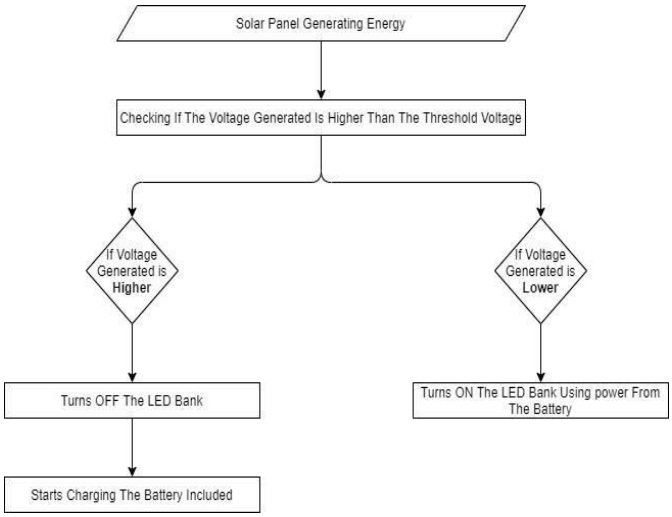
During day time the solar panel produces enough voltage to cross the set value in the code and it put system in its charging mode. Our model works on dusk to down system, which in Layman's terms mean that the lights will turn ON once its dusk and they will turn OFF once it's dawn.

The exact process of this works is, once the sun starts to set, the amount of voltage generated will in turn get lower and once it gets lower than the set voltage in the code, it switches the system to its output mode where the power that was stored in the battery during the day time and use it to power the LED Bank.

On the other hand, once the sun starts to rise in the morning, the amount of voltage generated will automatically start increasing. Once this generated voltage crosses the set value in the program, the system will be sent to its charging mode where in the LED Bank will turn OFF and all the energy generated from the solar panel will be directed to charge the battery.

For our first trials, we used the Arduino Uno to handle our design but once we were confident enough that our circuit works, we manufactured a custom PCB to meet our expectations of a simple and compact circuit.

Flowchart of the System:



III. Circuit Diagram

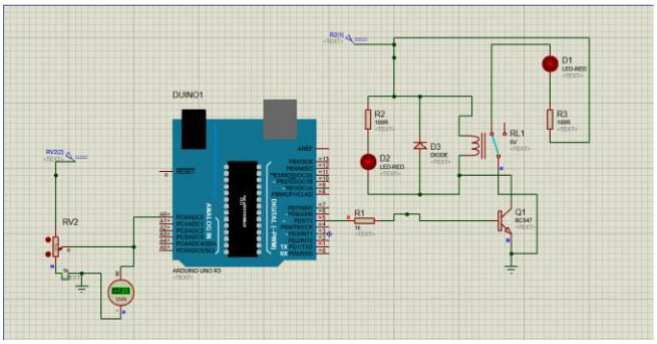


Figure 2. Simulation of Circuit Diagram Using Proteus Software

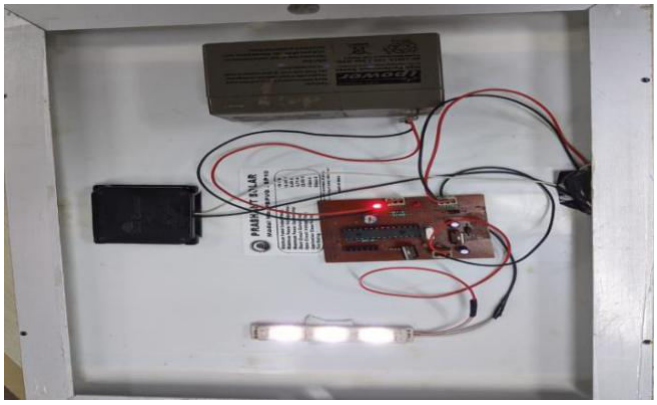


Figure 3. Working of actual system during night conditions.

IV. Conclusion

The Solar Street Light System is solely based on its ability to compare the solar generated voltage with the set values and act accordingly. The current state of already existing street lighting system is complex and tedious to say the least, not to mention expensive. Implementation of Solar Street Lighting System will eliminate this complexity, tediousness and it is relatively cheaper but the main selling point of this system is its ability to self-sustain on a clean and renewable source of energy, the Sun.

This paper elaborates the idea and reasoning for such a system to exist while also elaborating on its design and construction. The circuit successfully turns ON and OFF just by comparing the voltage generated from the solar panel with the set values. This system proves that a system that just needs to recharge its in-built battery and then turn the system ON and OFF, can be manufactured at a very low cost and that too without any sensors. Our system, tries to signify and prove these two major points while also developing a modern street lighting system that can be implemented very easily, at a low cost and also keeping up with the trend of energy conservation.

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