EasyChair Preprint

№ 2245

Energy efficient : IOT based street lights monitoring system by using solar energy with NodeMCU

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December 25, 2019

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***Abstract*— The street lights are actually consuming huge amounts of electrical energy throughout the world.With the Internet of things gradually entering into our daily lives and solar panels witch convert sun's energy to electrical ,energy consumption becomes more efficiently, The main purpose of the system is to monitor the solar panel and battery status live online and The system also detects fault in the system and indicates it using GSM(Global System for Mobile communication) technology by sending SMS to the maintainer to look the maintenance. The system with the motion sensor to turn on and off the light by motion detection in night time. The system light will be off during the day time. This essay briefly describes the solar led street lighting system. It uses the solar radiation energy to charge the battery with the solar panel during day time, and offer energy to the LED(Light Dependent Resistor) light equipment at night. This system has a double advantage in both utilization of new energy and energy-saving. This project provides an efficient transmission and intelligent synthesis of Internet of Things, the system can obtain real-time information about energy from Battery and solar voltage then be transmitted.**

Keywords*— *IOT, Smart Street Lights, solar panel, GSM, NodeMCU.

I. INTRODUCTION

The Smart Street Lights are an important part of a smart city that we find to be part of the smart transport services. Intelligent lighting can reduce energy consumption and provide dynamic operation and management, Depending on the surrounding environment, the lights can dynamically turn on / off or dim to allow significant cost reduction.

Traditional street lighting has been around for a very long time. The raised source of light on the edge of a road or path is used to help people see at night. Traditional street lights are connected to the electrical power grid and there will be a monthly bill for the electricity that the street lights use. Recent incorporation of LED light bulbs has improved energy efficiency and many cities have switched to LED street bulbs to save on operational costs. [1]

IoT is a modern approach in which barriers between real and digital worlds are slowly removed by constantly changing any physical device into a smart alternative ready to provide smart services[2].All things in the IoT (smart devices, sensors, etc.) have their own identity. They are combined to form the communication network and will become actively participating objects . Such objects include not only everyday accessible electronic device, but also food, clothes, tools, parts and subassemblies; goods and luxury items; monuments and landmarks; and various forms of trade and culture. [2] Therefore, these objects can create requests and alter their status. All IoT devices can therefore be controlled, tracked and counted, which eliminates waste, failure and costs significantly. a Smart Street Lights implementation based on the IoT infrastructure is implemented in [3]. Solar panel, also known as solar modules, photovoltaic modules or photovoltaic panels transform solar energy into electricity. The photovoltaic module is the result of a series or parallel group of PV cells and consists of the system's conversion unit. [4]

[5]provides a robust Internet of Things (IoT) control system for monitoring and handling the energy flow of renewable energy generated by microgrid solar panels. The main goal of smart street light systems is that lights turn on when needed and light turn off when not required. The smart street light system contains of LED lights, The system is programmed to automatically turn off during the hours of daylight and only operate during the night and heavy raining or bad weather. It can be operated free of cost by using automatic controlled, self-powered, efficient solar LED street light. In this paper we also added the solar concept which is use to recharge the battery to produce energy to turn on the street lights.

We suggest powering street lights completely using solar energy by connecting the lights to photovoltaic (PV) panels, which are accompanied by a set of batteries and a charge controller in order to store energy at day time, and provide it back for lighting the streets during night-time. We designed both hardware and software, where the hardware component included a variety of circuits, for example NodeMCU, Voltage sensor and GSM SIM800L and the and the PV panel, while The software used to run this system was Arduino IDE compiler and programmer. The overall goal of this project is to create a prototype for a smart street lighting system that would reduce (or completely eliminate) electricity use.

The rest of the paper is organized as follows. Section II presents a review of related literature. Section III proposed system. Section IV describes the main components used in the system, and explains their operation.Section V which also explains the operation of the system in general and the outlines results of the project. Section with analysis of the system efficiency, and Section VI concludes the paper.

II. REVIEW OF RELATED LITERATURE

A number of studies were presented in the literature that targeted various aspects of smart street lighting systems.

In[6] the authors Propose a street light monitoring and control system based on IOT to ensure low power consumption, instant identification of defective light and light dimming as per external lighting conditions.

In [3] another study, The main focus is on saving energy and reducing the loss of resources. The energy can be used more effectively in the smart street lighting network by enabling this process.

High-intensity discharge lamps are replaced by LEDs in [7] the proposed system that can adjust their energy depending on the need. Use LDR ,traffic movement is sensed and street light intensity is decreased when not in use.The system also identifies system failure by transmitting SMS to the base station using GSM technology.

The work in [8] provides an intelligent system for efficient monitoring of street light intensity. A light intensity control circuit based on TRIAC is used by the system. The TRIAC monitors the voltage applied to the circuit in accordance to the strength of the light. The light intensity is monitored based on the traffic measured by sensors and based on the sunrise / sunset information available from reliable internet sources, the device is automatically switched on / off. Combined with Internet of Things (IoT) sensors and software, the power electronics circuit produces a fully autonomous network that reduces excessive street light power consumption.

Smart Street Light System based on Image Processing, This system detects movement of vehicles / human presence on highways to turn ON only a chunk of street lights ahead of it and switch off the trailing lights to reduce energy consumption. This is done by processing the object image and then sending control message to the block of street light as presented in[9].

Intelligent Street light control system can fairly switch lights, regulate voltage by degree of brightness and operate at lower voltage at night it essentially saves electricity costs, increases the service life of street lamps and appliances, and significantly reduces the labor costs of maintenance and materials. Street light control and management system consists of network systems to monitor the status of the device as depicted in [10].

A newly designed controller has been created, which continuously tracks the energy state of the battery and therefore regulates the illumination level of the LED light to satisfy the lighting requirements and/or keeps the light "on" for as long as possible. Smart management prevents over-discharge of the system battery and therefore guarantees a longer life of the system battery [11].

In another study, the authors present a smart street lighting system, in which a conventional street light is modified to obtain its power from solar energy. Additional features were added that improve the operation of the system either by reducing the overall power consumption, which was achieved by using a motion sensor, or by using a dust cleaning circuit, which constantly keeps the efficiency of the panel at a certain maximum value [12].

In [13], The aim of an automated streetlight management system using IOT is to conserve energy by reducing waste of electricity and the the workforce. Streetlights are the basic part of any city because they facilitate better night visions, secure roads and exposure to public areas, but they consume a fairly large proportion of electricity. An external DHT11 temperature-humidity sensor is included in this system. It includes a given region's precise temperature and humidity. DHT11 is a composite sensor that contains temperature and humidity calibrated digital signal output. It offers high reliability and excellent long-term stability.

III. PROPOSED SYSTEM

In this paper, it is proposed that street lights be entirely powered by solar energy by connecting the lights to PhotoVoltaic (PV) panels, which are supported by a battery with a charge controller to store energy during the day and provide it back for street lighting at night

The street lights ' power consumption is about thousands of Kwh. But electricity consumption is reduced to few Kwh by using smart streets, which is incomparable with traditional electricity bills.

The system consist of NodeMCU Wifi ESP12 programmable microcontroller. Solar panel use to charge the battery. The DHT11 sensor use to send the atmospheric temperature & humidity to the server.

The motion sensor use to detect the motion and turn the light ON. The system is programmed by the timer to turn ON the light. Also the light will turn ON only in night time by sensing the solar panel voltage. In night the voltage of panel is 0 and so the LED light will ON.

Fig. 1 Smart Street Light System

IV. COMPONENTS OF PROPOSED SYSTEM

TABLE I.

Figure	The main COMPONENTS OF PROPOSED SYSTEM	
	Hardware	***Purpose***
Fig. 2	NodeMCU ESP8266 ESP-12E	NodeMCU board which is cheap IoT developing platform. based on the ESP8266
Fig. 3	. Solar panel 5 V 100MA	convert sun's energy to electrical energy
Fig. 4	Voltage sensor	measure PV output current and voltage
Fig. 5	. 3-7V-2000mAh–Battery	storing energy produced by solar panels
Fig. 6	. DHT11–Temperature and HumiditySensor	measure temperature and humidity values
Fig. 7	Fig. 6. GSM SIM 800L	For mobile communication s

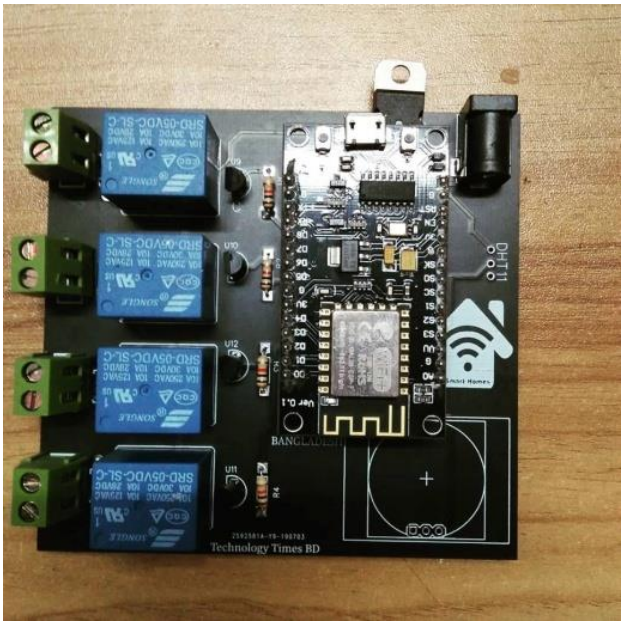

Fig. 2 *Nodemcu Esp12E*

Fig. 3 *Solar panel 5 V 100MA*

Fig. 4 *Voltage sensor*

Fig. 5 *3-7V-2000mAh–Battery*

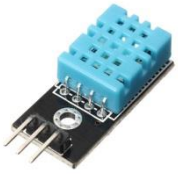

Fig. 6 *DHT11–Temperature and HumiditySensor*

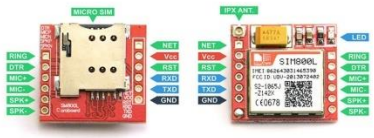

Fig. 7 *GSM SIM 800L*

V. WORKING METHODOLOGY

The basic work of the solar street lights can be known by the following flow diagram which depicts the work of sunlight recharging the battery :

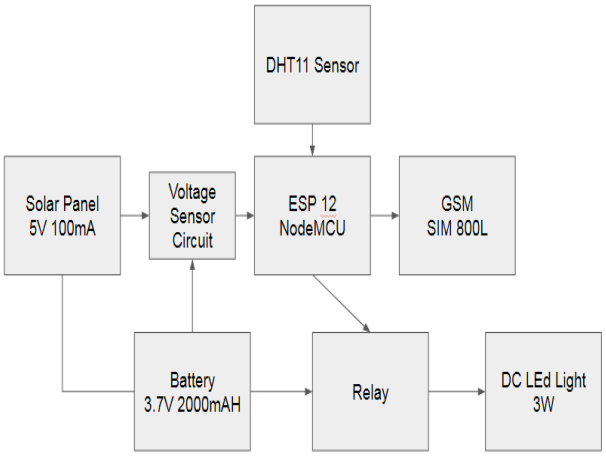

Fig.8 Block diagram of Smart Street Light System

The battery get charged from solar panel and battery gives power supply to the system. The Wemos is programmed to get the data from Battery and solar voltage and compare it periodically. The data from temperature sensor is also programmed in wemos.

The wemos initially connected in the wifi network via mobile hotsopt. The IP address is assigned by the hotspot to the nodemcu and we can access it from the wifi network When we type that ip in the web browser then we get the output like below

TABLE II.

IOT ENERGY DATA

Time	Solar Volt	Battery Volt
2019-12-15 09:51:10	2	2
2019-12-15 09:51:27	2	2
2019-12-15 09:58:11	8	6
2019-12-15 09:58:26	7	7
2019-12-15 10:09:59	7	8

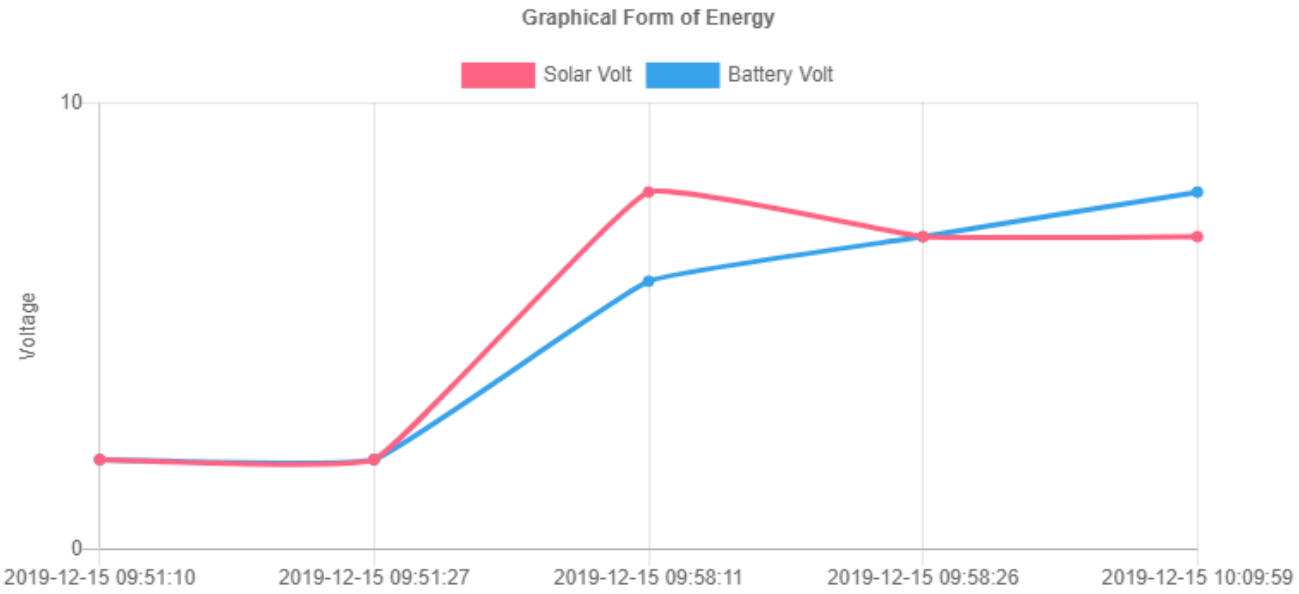

Fig.9 Real-time voltage measurement

The wemos initially connected in the newtok given the output of battery voltage and the current temperature on the website.

If the battery got stolen or if it goes zero volt then SMS will send to the respective maintenance team to look for this matter. Aslo The solar plate is having sensor switch, if someone try to remove it from the pole it gives signal to wemos and SMS will send to the maintenance team or police.

VI. CONCLUSION

Solar panel voltage is one of the best energy production solutions by monitoring and regulating the voltage produced by our proposed system, In this paper, IOT technology was applied for the solar system for a Smart Street Light System aims to reduce the energy consumption of Street Lightings and constructs a controlling of voltage using website. The system can receive real-time energy information from the battery and solar voltage, and also detects device faults and monitors them using GSM.

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