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AI and IOT based Solar Power Monitoring with Street Light

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ABSTRACT
Artificial intelligence (AI) is a wide-ranging branch of computer science concerned with building smart machines capable of performing tasks that typically require human intelligence. AI is interdisciplinary (more than one branch of self-decision making and application controlling) science with multiple approaches, advancements. The main aim of the project is to process the real time data acquisition under supervisory control and monitor for large scale of street light with solar power with IOT application like things peak or blynk.
The main aim of the project is to process the real time data acquisition under supervisory control and monitor for large scale of street light and solar power with IOT application like things peak or blynk
Keywords – ATmega328 microcontroller**,** IOT [Internet of Things], Sensor, Solar panel, Wi-Fi module

I. INTRODUCTION

The street lighting is one of the largest energy expenses for a city. An intelligent street lighting system cans cut municipal street lighting costs as much as 50% - 70%. An intelligent street lighting system is a system that adjusts light output based on usage and occupancy, i.e., automating classification of pedestrian versus cyclist, versus automotive. An intelligent street light management proposes the installation of the wireless based system to remotely track and control the actual energy consumption of the street lights and takes appropriate energy consumption reduction measures through power conditioning and control [1].

The street light controller should be installed on the pole lights which consist of microcontroller along with various sensor and wireless module. The street light controller installed on the street light pole will control LED street lighting depending on traffic flow, communicate data between each street light. The data from the street light controller can be transferred to base station using wireless technology to monitor the system [2]. The mode of operation of the system can be conducted using auto mode and manual mode. The control system will switch on-off the lights at required timings and can also vary the intensity of the street light according to requirement.

In this project IOT based solar power Monitoring and control system is a very innovative system which will help to keep the power regulation as we need. This system monitors the voltage, current and power and informs about the level via a things speak server. For this the system uses voltage sensor, current sensors. Also this system can operate automatic street light with time control using RTC module. The system makes use of atmega328 microcontrollers, LCD display, wifi module to send data over thing speak server. The system is powered by a 12V solar panel with 12V, 1.2A battery backup. The LCD screen is used to display the status of the voltage, current, power of respective sensor collected information.

The data on things speak in graphical/ bar graph format consists with reading, related to all sensor information. The LCD screen shows the status of the sensor values. The system puts on LCD screen continuously monitoring of sensor with microcontroller atmegs328. Thus this system helps to keep the power maintain by informing about the sensor levels of the boiler by thing speak server.

The rest of the paper is organized as follows. Section II presents a review of related literature. Section III System Architecture this Section describes the main components used in the system, and explains their operation. Section IV

which also explains the operation of the system in general and the outlines results of the project. V.concludes the paper.

II RELATED WORKS

In [1] this project is designed to detect the vehicle movement on the highways to switch ON only a block of the streetlight ahead of it and switch OFF the trailing light to save energy. During the night all the lights on the highways remain ON for the vehicle, but lot of energy is wasted when there is no vehicle movement on the highways. In this paper two kind of sensors has been used which are light sensor, photo electric sensor.

In [3] the paper describes about the circuit that switches the street light ON detecting the vehicle movement and remains OFF after the fixed time. In this system the street light automatically ON/OFF during the night and the day time. In this system the GSM technology has been used in which the manual switching OFF/ON of the street light using GSM. Here the system controls the intensity of the street light by dimming and brightness the intensity on the detection of any object using PIR sensor.

In [2] this system the system with LDR sensor, PIR sensor, Zigbee is used to intimate the status of humans use, light intensity and street light ON/OFF status to the EB section to avoid wastage of energy by glowing street lights in unwanted areas. The whole system is operated by using artificial energy source called solar and with battery backup. The PIR and LDR sensors sense the persons and light intensity of a particular place and transmits the data in wireless to the EB section with Zigbee. Depend upon the data received the controller will turn ON/OFF the street light in wireless communication. This system is appropriate for street lighting in remote urban and rural areas where the traffic is low at times.

High-intensity discharge lamps are replaced by LEDs in [4] 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.

In [5] 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.

The work in [6] 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.

In[9] 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.

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[7].

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 [10].

III SYSTEM ARCHITECTURE

In our proposed work, all the energy produced by the solar panel is continuously monitored. The various types of sensors such as voltage and current sensors are attached to the system which senses the conditions and microcontroller calculate the data received from these sensors. By using the Wi-Fi module it connected to the mobile and all these data uploaded to the cloud and the user can have access of these real-time parameters any time [11].

3.1 System Model

The Figure 1 shows the block diagram of the proposed monitoring system which consist of solar panel , Regulator, ATmega328 controller, voltage ,current, light sensors, Wi-Fi ESP8266. In this system the solar panel absorbs the solar energy from sunlight. For this we use 12V solar panel. The output ripples reduced by rectifier and output is stored in battery which is connected with street light with MOSFET driver. This energy is transfer to microcontroller and the sensors with regulator of 5V.

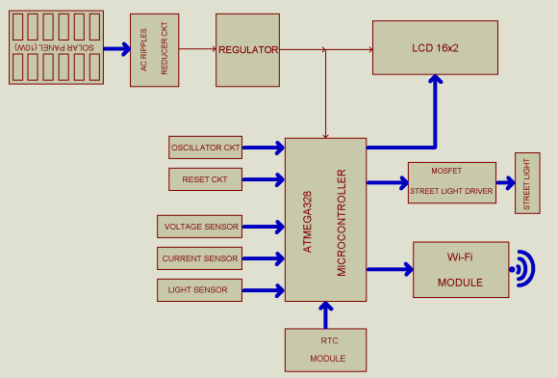


Fig. 1: Block diagram of the system

The obtained energy is sensed by the sensor such as voltage sensor sense the voltage generated by solar panel with help of voltage divider principal and current is obtained by using mathematical formulation. The controller sent that reading to the cloud with the help of IOT.the cloud showing the reading of all quantities on the LCD displays; it can be monitored by time to time with the help of an IOT.The readings are shown in thingspeak server from anywhere and anytime by using internet.

3.2 Hardware Components

3.2.1 ATmega328 microcontroller

In this (atmega328 28 pin microcontroller) works with 16MHz frequency used for (timer configuration), the unwanted frequency produced is bypassed by the capacitor of 27pf capacitor. Reset pin is connected to resistor of 10K whenever reset requires the reset switch (2 lead push to ON switch/ micro push to switch) required pressing. 6 channel 10 bit inbuilt ADC available, 6 PWM pins available, multiple serial communication available, up to 20 programmable pins available.

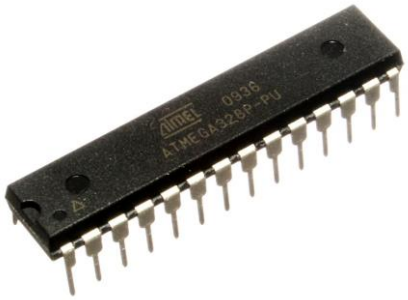


Fig. 2 : ATmega 328 microcontroller

3.2.2 Solar Panel

A solar cell (also called photovoltaic cell or photoelectric cell) is a solid state electrical device that converts the energy of light directly into electricity by the photovoltaic effect.

Fig.3: Solar Panel

3.2.3 Voltage Sensor

A voltage sensor is a sensor used to calculate and monitor the amount of voltage in an object. Voltage sensors can determine the AC voltage or DC voltage level. The input of this sensor is the voltage adjusting with voltage divider.

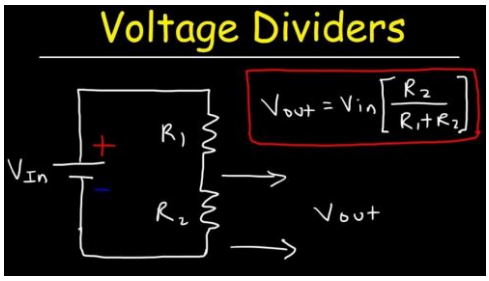


Fig.4: voltage sensor

3.3.3 Current Sensor

Current sensor is used to sense current and given to the microcontroller. Microcontroller takes further action depends on programming conditions.

3.3.4 RTC Module

Fig. 5: RTC module

A real-time clock (**RTC**) is a battery-powered clock that is included in a microchip in a computer motherboard.

This microchip is usually separate from the microprocessor and other chips and is often referred to simply as "the CMOS" (complementary metal-oxide semiconductor).

3.3.5 MOSFET Driver

Microcontroller has very low current output it cannot drive current consuming sources, such like street light hence MOSFET driver circuit requires. We can implement this circuit using transistor or relay driver IC also.

3.3.6 LCD 20 x 4 Displays

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on. A 20x4 LCD means it can display 20 characters per line and there are 4 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data.

Fig. 6: LCD

3.3.7 ESP 8266 Wi-Fi MODULE

We are using Wi-Fi Module ESP8266 in this system which is shown in figure. This is a self-contained SoC microswitch which consists of a TCP/IP protocol stack that permits access to any microcontroller to a Wi-Fi network. It has enough storage capability and on board processing that allows it to interact with the other sensors. This module requires an external logic level converter as it is not capable of 5v-3v shifting.

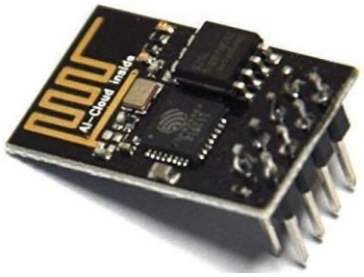


Fig. 7: ESP8266 Wi-Fi Module

3.3.8 Thing Speak Server

Thing Speak allows you to aggregate, visualize and analyze live data streams in the cloud. Some of the key capabilities of Thing Speak include the ability to:

- Easily configure devices to send data to Thing Speak using popular IoT protocols.
- Visualize your sensor data in real-time.
- Aggregate data on-demand from third-party sources.
- Use the power of MATLAB to make sense of your IoT data.
- Prototype and build IoT systems without setting up servers or developing web software.
- Automatically act on your data and communicate using third-party services.

IV. Result

The working model of the proposed system is shown in figure 8.In this project an IoT based solar power monitoring system is designed to obtain the maximum output power from the solar panels & minimum utilization.

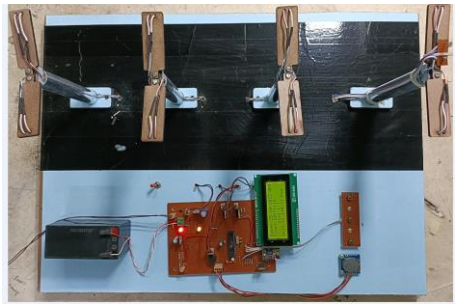
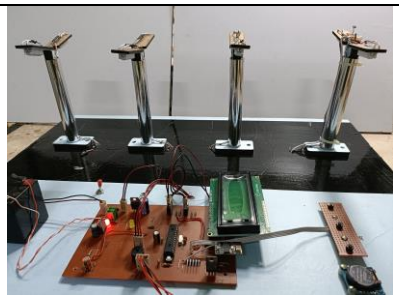
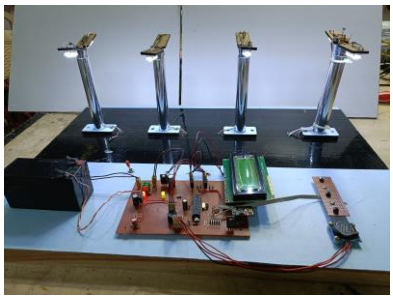
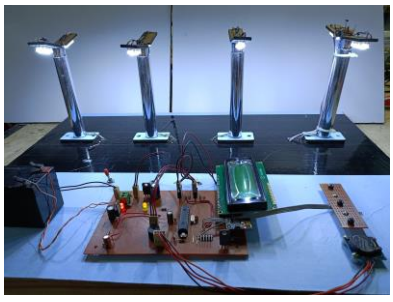
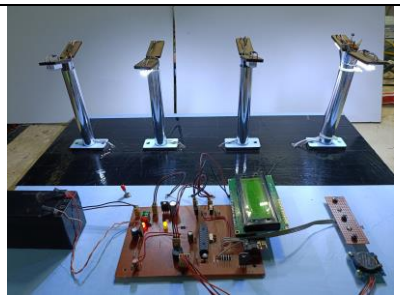
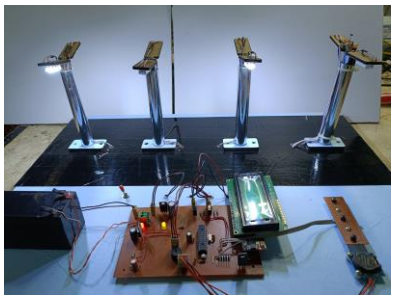


Fig. 8: Proposed working system

The parameters of the solar panel, as well as the voltage, current, and power, are displayed in real time in different slot shown in table using the LCD.

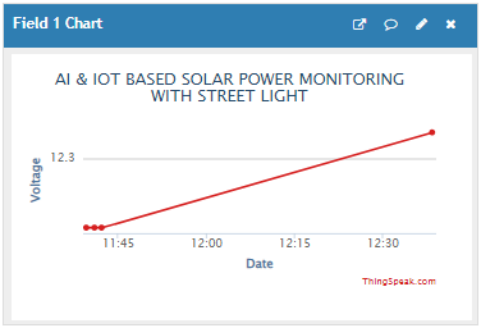
Slot	Display Output
1	
	 Street light OFF 7am to 6pm
2 & 5	  Street light ON intensity mode 6pm to 7pm & 6 am to 7am
3	  Street light ON full intensity 6 pm to 12 pm
4	

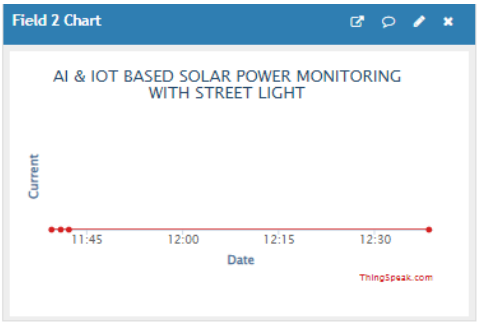




Street light ON alternate 00 am to 6 am

In this project, a solar power monitoring system based on the Internet of Things is created to get the solar panel's reading to monitor and control. With the aid of IoT technology, the received voltage and current are displayed on the LCD screen, IOT thing speak platform.





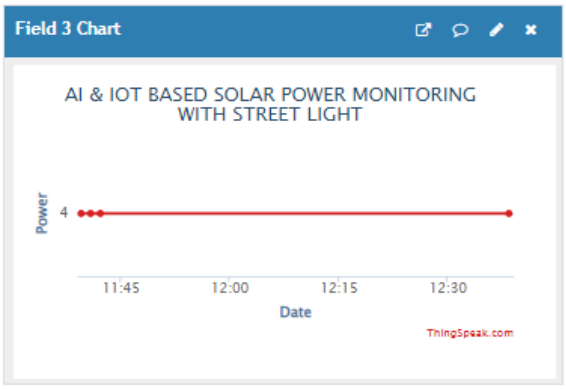


Fig.9: The Graph of Current, Voltage, Power

V Conclusion

The AI and IoT based solar Power Monitoring and Control System is a cost effective, practical, ecofriendly and the safest way to save energy and in this system the light status information can be accessed from anytime and anywhere. In this we monitors the voltage, current and power and informs about the level via a things speak server. . Also this system is operated as automatic street light with time control using RTC module.

In future by using the various Machine Learning algorithms and model it makes possible to make the system smart enough to take right decision about data and performance of the system.

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