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DESIGN AND DEVELOPMENT OF SOLAR MONITORING AND POWER GENERATING GRID USING IOT

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Abstract : This review presents an IoT-based solar monitoring and generating system designed for efficient energy management and real-time data visualization. The system harnesses solar energy, stores it in a battery unit, and uses an inverter to power AC devices while also providing DC power for mobile charging. Voltage and current sensors monitor the system's performance, and an ESP8266 WIFI module transmits the data to the Blynk cloud for remote access via a mobile application. An LCD display provides local monitoring of sensor data. This solution offers scalable and efficient solar energy utilization with enhanced monitoring capabilities for various applications.

Keywords: Internet of Things

INTRODUCTION

The increasing global demand for renewable energy sources has driven significant advancements in solar power technology. Solar energy, being abundant and sustainable, has emerged as a critical component in addressing energy security and reducing carbon emissions [1]. The integration of Internet of Things (IoT) technology with solar energy systems has further enhanced the efficiency and accessibility of solar power. This paper discusses the development of an IoT-based solar monitoring and generating system that combines solar energy harvesting, storage, and utilization with real-time data monitoring and visualization [2]. The core objective of this project is to create a comprehensive system that not only generates and stores solar energy but also provides a seamless user interface for monitoring and managing the energy usage. By leveraging IoT capabilities [3], the system enables remote access to performance data, thereby allowing users to optimize energy consumption and ensure the efficient functioning of the solar power setup. This integration addresses the need for smarter energy solutions in both residential and commercial applications [4]. IoT technology plays a crucial role in modernizing solar energy systems by providing real-time insights into energy generation and consumption patterns [5].

Food adulteration has always been a concern in the market domain especially in hotel industries. It is a persistent problem that is prevailing since ages. The quality of food products has been deteriorating and involves the addition of foreign contaminants and the harmful substances added as food additives [1]. Prevention is better than cure is a phrase that is always used prevalently so prevention of food safety and public health is very important. In Gen-z, people have come up with newer innovations and ideas related to image processing to maintain the quality of food and maintain consumer trust [2].

In recent coming years, image processing has turned out to be a vital source for DSP applications and it is combined with Convolutional Neural Networking models which is a main algorithm also used in deep machine learning techniques which becomes easier.

The cumulative integration of IOT, imageprocessing and convolutional neural network shall be discussed in this review. These have several advantages which enables to extract the right amount of adulterants or the poisonous sweeteners/materials that are added to enhance or garnish the food. Image process techniques enable preprocessing, filtering the food images and amplifying it eliminating the discriminative capabilities in a system analysis. These deep machine learning algorithms comes up with enhancing knowledge towards learning complex and rigid patterns from large scale datasets such as VGGnet making it easier to classify and separate out adulterated products [4]. In addition to this this paper also dives into the challenges and certain prerequisite limitations related to image based food adulteration detection system. Involving IOT and cloud data for uploading all the parameters such as appearance, smell, texture, taste of food are displayed. Web development is done through HTML, CSS and JavaScript with all the parameters being monitored real time.

LITERATURE REVIEW

1. Solar power generation system with IOT based monitoring and controlling by Rajeshwar ReddyK, RajeshwarRaoArabelli, Durgam Rajababu and Kommabatla Mahender in 2020:

The developed system can be divided into three main parts: they are power supply unit, sensing unit and the last one is communication unit. The first unit power supply is very necessary for any system to supply continuous power to the operating device. The temperature sensor, the voltage sensor and the current sensor are used for detecting the signals from various sensors. The next unit is the communication component, which receives the signal from other devices after it is transmitted to the appropriate devices. In This stage we use micro controllers and wireless modules to transfer data to server systems and this section is sophisticated to web-based applications built with data collection, data storage and processing elements. Using monitoring and controlling systems are very important for construction and maintains of the system performance is in easy mode.

2. Solar Power Monitoring System Using IOT by Nehali Datar, Sakshi Bhoyar, Ashar Khan, Saurabh Dekapurwar, Harshada Wankhede, Shraddha Sonone, Viraj Bapat, Nitin K. Dhote in 2023:

In this paper we use the application Internet of thing (IOT) to control and monitor the solar power (renewable energy). This system is designed to solve the problem occur in solar power generation like management problem, maintenance and to reduce the time of repair. Using this technology, the cost of solar energy (renewable energy) generation reduces. This also provides real time information to the user help to monitor the system. The main purpose of this paper is that the solar panel can collect or capture maximum solar radiation and maintain the system more reliably and efficiently.

3. IoT-based Solar Energy Monitoring by Preethi Sekar, Priya Sabde, Ganesh Patil in 2022:

The primary goal of this task is to layout solar monitoring devices and shares the information through the IoT. In which the main object of work is the energy of the device can be monitored using the voltage, and the contemporary sensed using the ESP32, and the monitor of the solar power machine suggests power and energy usage. The device is for designing the monitoring of solar energy, in which the solar Strength enables the storage of the power in a battery. The Battery is the power which we can use as electrical home equipment.

4. A SMART SOLAR PV MONITORING SYSTEM USING IOT by V.Kavitha and V.Malathi in 2019:

The IoT based solar energy monitoring system is proposed to collect and analyzes the solar energy parameters to predict the performance for ensuring stable power generation. The main advantage of the system is to determine optimal performance for better maintenance of solar PV (photovoltaic). The prime target of PV monitoring system is to offer a cost-effective solution, which incessantly displays remote energy yields and its performance either on the computer or through smart phones. The proposed system is tested with a solar module of 125- watts to monitor string voltage, string current, temperature, and irradiance. This PV monitoring system is developed by a smart Wi-Fi enabled CC3200 microcontroller with latest embedded ARM processor that communicates and uploads the data in cloud platform with the Blynk application. Also the Wireless monitoring system maximizes the operational reliability of a PV system with minimum system cost.

5. Solar Power Monitaring System Using IOT Syatem by Gaurav Khambalkar, Atharva Wasurkar, Ritesh Jibhakate, Suraj Dongare, Vijay Chikhalonde in 2023:

The IoT-based solar power monitoring system is designed to continuously monitor and display the electrical power generated, temperature, and light intensity of a solar panel. The system works by measuring the current, voltage, and temperature of the solar panel using sensors and transmitting the data wirelessly to data visualization interfaces such as an LCD display, a mobile application, and a computer screen. The working of the system can be divided into three parts: sensing, processing, and visualization.

6. Solar power inverters by Regine Mallwitz in 2016:

This paper reviews the history of solar power inverters and highlights aspects of power electronic packaging concerning functional and packaging integration in solar inverter technology. The most important indicators to characterize the advances in inverter technology are efficiency and losses respectively, mean time between failure and inverter costs. A high integration level is bounded up with high reliability and life time and less costs. The paper presents the state of the art and trends in the inverter design towards higher functional and packaging integration.

Several generations of medium power inverter are analyzed concerning integration level which will be described by different indicators.

7. IoT Based Smart Solar Inverter for Solar Power Generation by P. Prakash, S. Nandha Kumar, K. Sathish Kumar, S. Sreejith in 2023:

The proposed system consists of a solar panel, a smart inverter, and a battery bank. The smart inverter is equipped with sensors and communication modules that allow it to monitor the solar panel's output and communicate with the battery bank. The system's performance is controlled by an IoT platform that uses algorithms to optimize energy generation and storage. The proposed system is designed to improve energy efficiency, reduce energy costs, and increase the reliability of solar power systems. The experimental results demonstrate that the proposed system can efficiently generate and manage solar power, making it a promising solution for renewable energy generation.

8. SOLAR POWER INVERTER WITH DUAL AC OUTPUT by Ayush Singh, Satyam Shukla, Ajitesh shukla, Abhay shukla, Devesh Jaiswal in 2022:

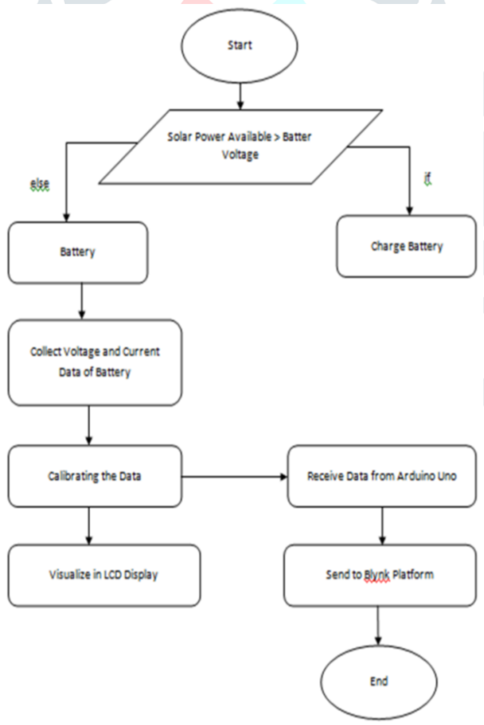
We have developed a Solar Power Inverter with Dual Ac output using, solar panel, DC battery, Inverter, solar charger circuit and two Ac load. A solar inverter convert variable DC output of photovoltaic solar panel into utility frequency alternating current that can be fed into commercial electrical grid or used by local, off-grid electrical network. So using this system we can reduce the cost of electricity by installing a solar panel.

Several researchers have mentioned the real-time application related to machine learning techniques for the detection of food adulterants. Some of the notable types of food adulteration techniques are substitution, contamination, adulterate addition and mislabeling [1].

III. METHODOLOGY

The IoT-based solar monitoring and generating system begins with the harnessing of solar energy using a 50-watt, 12V solar panel. This panel converts sunlight into direct current (DC), which is then stored in a 12V battery unit for continuous power availability. An inverter is employed to convert the 12V DC into 230V alternating current (AC), enabling the system to power devices such as a 9-watt bulb or other AC-powered appliances. Simultaneously, a DC-to-DC regulator manages the conversion of 12V DC from the battery to charge mobile devices efficiently. To monitor the performance and status of the system, several sensors are integrated. These include voltage and current sensors connected to the battery unit to measure respective values accurately. The sensors transmit real-time data to an ESP8266 WiFi module, acting as the central microcontroller. The ESP8266 gathers sensor data and interfaces with an LCD display to provide immediate on-site monitoring of key metrics such as voltage levels, current flow, battery percentage, and power consumption. Additionally, the ESP8266 establishes a connection to the Blynk cloud platform via WiFi, where it uploads collected data for remote visualization and analysis through a mobile application. This setup allows users to monitor and manage their solar energy system's performance in real-time, facilitating proactive maintenance and optimization of energy usage.

IV. FLOW CHART

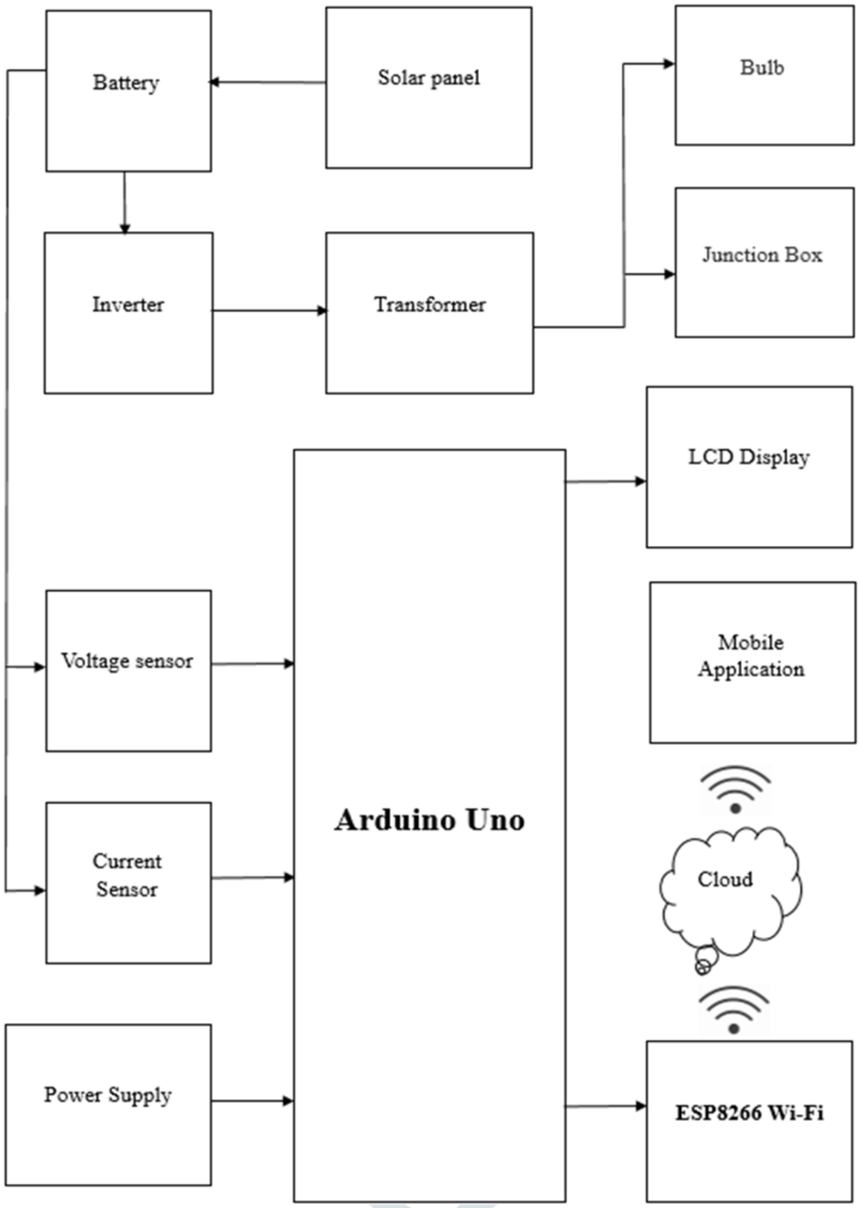


[3]. Fig 2(a) shows the basic block diagram of image processing process.

SPECIFICATIONS

- ESP8266 NodeMCU
- Current Sensor
- Voltage Sensor
- Arduino Uno
- Transformer
- Junction Box
- Inverter
- Solar Panel

- LCD Display
- Battery
- Blynk Android App
- Arduino IDE
- Porteous



- Fig 2(a): Block-Diagram

FEATURES

Power Supply: It can be powered via the USB connection or with an external power supply (such as a battery or AC-to-DC adapter). The board automatically selects the appropriate power source.

Programming: The Uno is programmed using the Arduino Software (IDE), which is compatible with Windows, Mac OS X, and Linux. It supports the C/C++ programming language.

Resettable Polyfuse: The board includes a resettable polyfuse that protects the USB ports of your computer from shorts and overcurrent.

ICSP Header: The In-Circuit Serial Programming (ICSP) header allows for programming the microcontroller without using the bootloader.

Compatibility: The Uno is compatible with most Arduino shields, which are modular boards that extend its functionality.

Applications

Prototyping: Widely used for creating prototypes of electronic devices.
Educational Projects: Ideal for teaching electronics and programming.
DIY Projects: Suitable for hobbyists creating interactive projects.
Automation and Control: Used in various automation systems, including home automation, robotics, and IoT applications.
ESP8266 Specifications:

Microcontroller:
32-bit RISC CPU: Tensilica L106 running at 80 MHz (can be overclocked to 160 MHz)
Memory: 32 KB instruction RAM, 80 KB user-data RAM, 16 KB ETS system-data RAM
External QSPI flash: typically 512 KB to 4 MB
Connectivity:
Wi-Fi: 2.4 GHz IEEE 802.11 b/g/n
Integrated TR switch, balun, LNA, power amplifier, and matching network
WEP, WPA/WPA2 security
Supports AP (Access Point), STA (Station), and AP+STA modes
I/O:
GPIO pins: Up to 17
ADC: 10-bit ADC (1 channel, up to 1V input)
Interfaces: SPI, I^2C, I^2S, UART (HSUART), PWM
Power Management:
Voltage: 3.0V to 3.6V
Low power consumption:
Standby mode: < 1.0 mW (DTIM3)
Deep sleep mode: ~10 µA
Light sleep mode: ~0.9 mA
Modem-sleep mode: ~15 mA (average, depending on data traffic)
Networking:
TCP/IP protocol stack
DHCP, DNS, HTTP, HTTPS, SSL/TLS, SNTP
Supports Smart-Config for simple Wi-Fi configuration
Development:
SDK: Espressif provides an SDK for easy development
Programming: Can be programmed using the Arduino IDE, NodeMCU, MicroPython, or Espressif's own SDK

APPLICATIONS:

- Prototyping: Widely used for creating prototypes of electronic devices.
- Educational Projects: Ideal for teaching electronics and programming.
- DIY Projects: Suitable for hobbyists creating interactive projects.
- Automation and Control: Used in various automation systems, including home automation, robotics, and IoT applications.

VI. RESULT AND INFERENCE

Result:

The implementation of the IoT-based solar monitoring and generating system is expected to yield several key outcomes. These include enhanced efficiency in solar energy harvesting and utilization, facilitated by real-time monitoring of critical parameters such as voltage, current, and battery status. By leveraging IoT technology, users will have seamless access to performance data through both local LCD displays and remote mobile applications via the Blynk cloud platform.

INFERENCES

1. System performance optimization
2. Energy production forecasting
3. Maintenance scheduling
4. Fault identification and troubleshooting
5. Comparison with similar systems
6. Return on Investment (ROI) evaluation

VII. CONCLUSION

The IoT-based solar power generating and monitoring system represents a significant advancement in renewable energy technology, offering efficient harnessing, storage, and utilization of solar power. By integrating IoT capabilities with traditional solar energy systems, the project has demonstrated enhanced monitoring through real-time data acquisition and remote access via the Blynk cloud platform. This approach not only improves operational efficiency by optimizing energy usage but also provides users with valuable insights into system performance for proactive maintenance and sustainable energy management. Moving forward, further refinement and scalability of this system could lead to broader applications in residential, commercial, and industrial sectors, contributing to a more sustainable energy future.

VIII. References

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