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Solar Power Panel Monitoring and Data Acquisition System

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Abstract: ***As the world now is turning towards renewable energy sources and countries like Iceland have obtained 100% renewable energy status and India has also started to lean towards renewable energy, moreover rooftop solar panels are becoming a trend nowadays but In order to know how efficiently the solar photovoltaic system is working and for performance evaluation there should be some monitoring system.***

Therefore here we propose a system using a microcontroller and internet of things technology using sensors to monitor the parameters of the solar photovoltaic system remotely from anywhere using smart phones and computers using web server. Some solar photovoltaic systems are located in inaccessible locations and it is difficult to monitor it and the solar panels are not utilized to its full efficiency all day ,in order to achieve the solar panel must absorb maximum sunlight every instant , in order to achieve it here we propose a sun tracking technology to control the solar panel and rotate it so it absorbs maximum sunlight every instant .The system is based on a new cost effective technology using a microcontroller and internet of things technology monitors and controls the solar photovoltaic system remotely from anywhere around the world.

Keywords: Solar PV, Internet of Things, ESP32, Adafruit IO, Arduino IDE, Solar Panel Monitoring.

I. INTRODUCTION

The internet of things is a futuristic technology by which an object could be sensed, monitored and controlled remotely using the cloud server network. By using this technology machines can communicate with themselves and be controlled without requiring humans.

In the past decade of years there is increase in demand for reliable and abundant electrical energy derive from renewable energy sources re able energy plays important role in energy crisis of country. One example of renewable energy is Solar power. Solar energy is a very large, inexhaustible source of energy.

Each hour the earth receives 430 quintillion joules of solar energy which is more than enough to power the whole world for a year. But the problem here is it is tough to utilize this much of energy efficiently.

The solar panels nowadays are installed everywhere but they are not monitored so we do not know how much they generate and moreover the solar panels operate at its maximum efficiency for an hour or 2 hours but these can be overcome by monitoring and controlling the solar panel using different devices available in market.

The system will show the power generated by solar panel on the LCD and as well as on a webpage so that it can be monitored very easily.

II. SOLAR ENERGY

In the modern life electricity became the important and essential part of the life. For any work now, a day we require electricity like lighting, heating, refrigeration, cooling, transportation systems what not all the home appliance works on electricity. In day to day life the consumption of electricity is increased but not decreased. To compete with the requirement of the public more and more electricity is to be generated and give to the end users. As the population increases the consumption also increases. The power is generated in three methods generators, electro chemistry, photovoltaic effect.

As the non-renewable energy resources are dwindling, the utilization of renewable resources for producing power is increasing. Solar panels are getting increasing popularly. A solar panel gathers solar energy, then converts it to electrical energy, and stores it in a battery. This energy can be used as needed or as a straight replacement for grid power. The Sun's position with respect to the solar panel changes due to the rotation of the Earth. For solar panels to be most efficient, they need to be continuously oriented toward the Sun. Continuous orientation is the only way to maximize solar energy production. Therefore, the solar panel should always face the direction of the Sun. To get the most out of a solar power plant, it is critical to keep an eye on it.

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In order to keep an eye on the output of these power plants, Solar panel defects can reduce the solar panel's output. Using an IoT-based solar power monitoring system, the system provides solar monitoring and checks if there is a problem in solar panel connection by lowering output. ESP32 is the controller that monitors all the solar panel parameters. Monitor the solar panel and transmit the data to the Internet of Things (IoT). This makes it possible to monitor the solar panel and ensure that it is producing the best amount of electricity possible.

III. LITERATURE REVIEW

A. Paper [1]: - Author Kabalci, Ersan, Alper Gorgun, and Yasin Kabalci

In this paper introduces An instant monitoring infrastructure of a renewable energy generation system that is constituted with a wind turbine and solar panel arrays. The monitoring platform is based on current and voltage measurements of each renewable source. The related values are measured with the developed sensing circuits and processed by an 18F4450 microcontroller of Microchip. The processed parameters are then transmitted to a personal computer (PC) over universal serial bus (USB) to be saved in a database and to observe the system instantly. The coded visual interface of monitoring software can manage the saved data to analyse daily, weekly and monthly values of each measurement separately.

B. Paper[2]:- Jiju, K

In this Paper describes the development of an online monitoring and control system for distributed Renewable Energy Sources (RES) based on Android platform. This method utilizes the Bluetooth interface of Android Tablet or Mobile phone, as a communication link for data exchange with digital hardware of Power Conditioning Unit (PCU).

C. Paper [3]:- Goto, Yoshihiro

In this paper explained about an integrated system that manages and remotely monitors telecommunications power plants has been developed and has started operations. The system is used to operate and maintain more than 200,000 telecommunication power Plants, which including devices such as rectifiers, inverters, and UPSs, and air conditioning plants installed in about 8,000 telecommunication buildings. Features of the system are the integrate the management and remote monitoring functions, into one system and improved user interfaces, which use information and communication technology such as web technology.

D. Paper[4]:- Ali Hosein Arianfar , M. Hosein Mehraban Jahromi, Mohsen Mosalanejad and Bahram Dehghan

In this paper they overcome the drawbacks by monitoring health of solar PV systems for their better performance and maintenance. Remote monitoring capabilities provide the information in advance when performance likely to fail. By using information, preventive maintenance can be carried out to improve the life of the system, thus overall operating cost also reduced. In this paper they will study and analyse and study a solar power plant of a linear parabolic type after introducing it. They discuss the quality and effectiveness of each internet behaviour.

They studied delay behaviour by using previous results. Once studied delayed delay behaviour, dynamics related to the delay in the internet are modelled by using system recognition Technique and they used Wave variable method is chosen as the best monitoring Method on remote monitoring system via the internet is finally designed.

E. Paper[5]:-Purushothaman, SSR Dhiwaakar

In this paper the system propose about the focus is on the DG agents, grid agent and Mu agents. DG agents like distributed energy resource (DERs), load, storage and the grid agents. The Mu agent acts as the communication channel between the DG agents to the higher level agents such as the control agent. The implementation of the system has been done using an Arduino microcontroller.

F. Paper[6]:-Subarna Shakya

In this paper they have defined certain problems in solar panel related to following factors mean time to repair, inflexibility, poor manageability and difficulty in maintenance. So they proposed an system model where gateway is embedded in solar panel with GPRS internet connection to update everything in a smart using IOT.

G. Paper[7]:- Charith Perera, Chi Harold Liu, Srimal Jayawardena

It provides information related to survey an IOT in various fields such as home, city, environment and enterprise and also conveyed the existing level to Iot system. However to proposed it in some other efficient way.

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H. Paper[8]:-Martin Andreoni, Francisco J Galdeano Mantinan

This paper deals with the implementation of the control system of a solar photovoltaic distributed generator (PVDG) and wireless remote monitoring for micro grids applications. The wireless communication technology utilizes a full duplex digital system using the ZigBee protocol, based on the IEEE 802.15.4 standard for Wireless Personal Area Network (WPAN). The supervisory control system is implemented by them on a digital signal processor (DSP) and human-machine interface (HMI) software is developed for interacting with and managing remote sensor systems (RSSs).

I. Paper[9]:- Maisagalla Gopal1, T Chandra Prakash2

In this paper an IoT based Solar power monitoring system is designed to obtain the maximum output power from the solar panels. After the conversion of light energy into electricity through solar panels, the current and voltage parameters are recorded using sensors. The amount of voltage and current received are shown on the LCD display with the help of IoT technology. As there is a Wi-Fi module connected to the sensors, we can view the readings in our mobile device by connecting to the Wi-Fi network. Whenever the readings or data changes it is automatically updated in our mobile. By using IoT technology we can monitor the working of solar panels and there may be a chance to detect the problem when anything goes wrong.

J. Paper[10]:-Nor Azlan Othman, Nor Salwa Damanhuri

In this paper it demonstrates the capability and responsibility to all remote monitoring system required by the Raspberry Pi. Data are collected by using raspberry pi and displayed graphically on computer. Node.js software is used to create GUI in computer furthermore, developed system not only can monitor and measure the required data, but also can be remotely analyzed. This monitoring system has the advantage of flexibility in the case of data collection. In addition, this remote monitoring system can be regarded as a low cost monitoring system and also can be used for other application.

K. Paper[11]:- M.Karthickraja, A.Karthik

In this paper the IOT permit appearance to be recognition and controlled remotely over existent reticulation infrastructure, creating opportunities for pure integration of the earth into electronic computer supported system, and resulting in improved efficiency, accuracy and economic benefits in increase to over human interposition. this serves the use to analysis energy manners.

IV. ARCHITECTURE OF SOLAR POWER PANEL

Solar architecture is an architectural approach that takes in account the sun to harness clean and renewable solar power. It is related to the fields of optics, thermic, electronics and materials science. Both active and passive solar housing skills are involved in solar architecture.

The use of flexible thin-film photovoltaic modules provides fluid integration with steel roofing profiles, enhancing the building's design. Orienting a building to the Sun, selecting materials with favorable thermal mass or light dispersing properties, and designing spaces that naturally circulate air also constitute solar architecture.

Initial development of solar architecture has been limited by the rigidity and weight of standard solar power panels. The continued development of photovoltaic (PV) thin film solar has provided a lightweight yet robust vehicle to harness solar energy to reduce a building's impact on the environment.

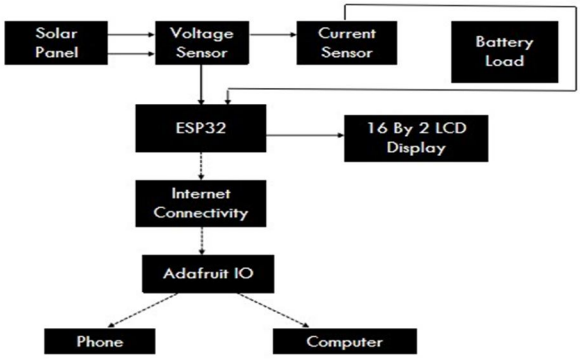


Fig 1: Detailed Architecture of the system

1) The system consists of ESP 32 microcontroller which is the main controlling part of our system this microcontroller have inbuilt Wi-Fi connectivity. We have connected or sensors and display pins in this microcontroller.
2) Voltage sensor for measuring the voltage we have use voltage sensor which is capable to measure the voltage up to 25volt. We have connected positive and negative terminal of solar panel to the input of this sensor. Sensor works with 5volt dc volt and the sensor gives output of 10 bits which means this sensor gives output from 0 to 2^10-1=1023.
3) If voltage sensor measures 0volt then the output value will be 0 and if voltage sensor measures 25volt then the output value will be 1023.
4) current sensors: for measuring current we have use ACS712 current sensor this sensor can measure current from 0Amp to 5Amp.
5) For displaying the output of current and voltage sensor we have use 16by2 LCD display module which will display the value of current voltage power and efficiency value.

V. PROBLEM STATEMENT

A solar monitoring system can help make you more aware of your PV system's performance it offers information about energy consumption and generation, optimizing energy usage, and damage to your solar system, among other topics.

It' s important to monitor your solar setup in some manner – without monitoring, it can be difficult to figure out if your solar panels are operating at their best.

VI. CONCLUSION

The proposed system stores the data from the solar photovoltaic system continuously, so it keeps track of the solar photovoltaic system and daily or monthly analysis becomes easy and efficient.

Using the analysis, it is possible to detect any fault occurring in the system as there would be inconsistency in the data generated by the system.

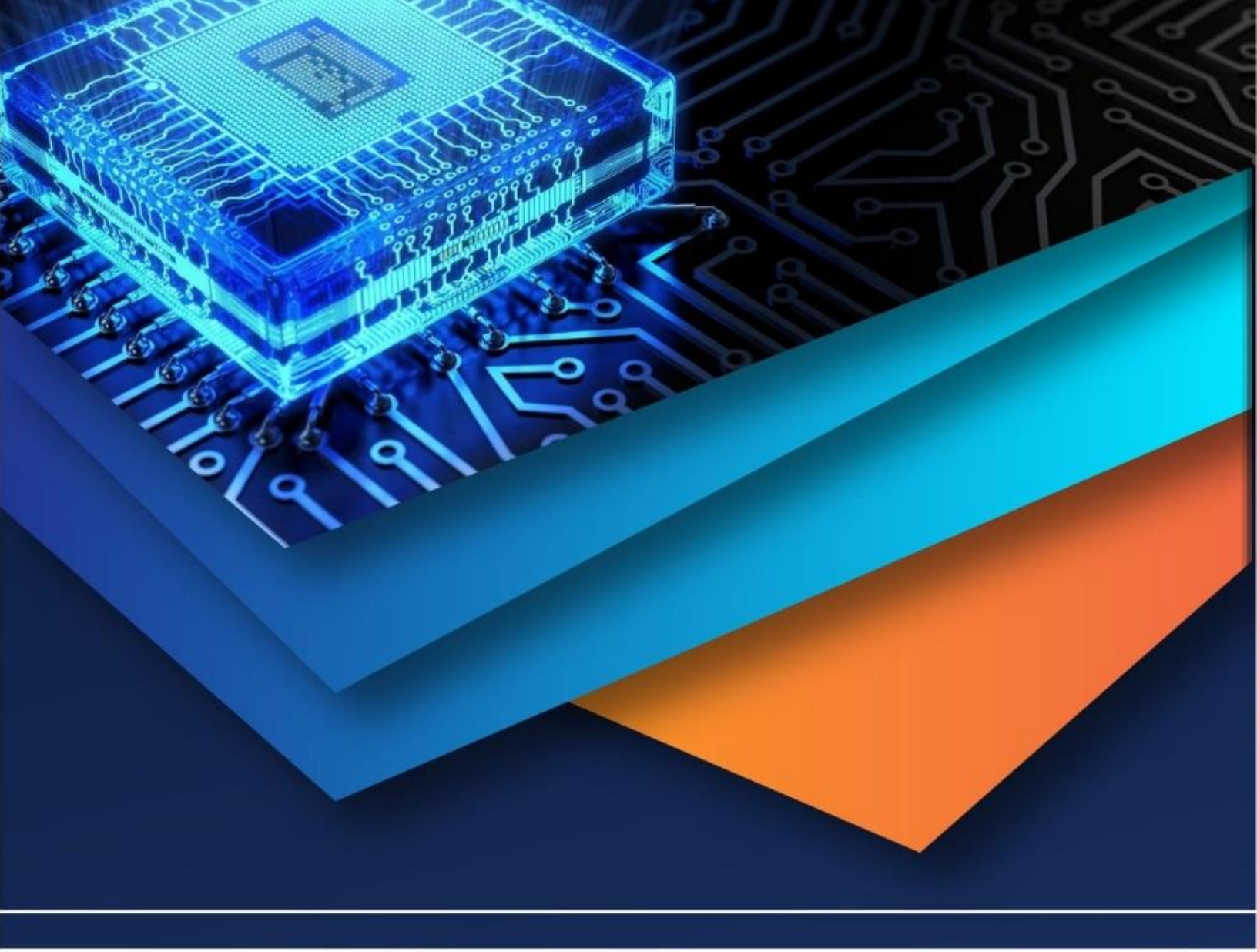
By solar tracking the solar panel is operated at its maximum efficiency all day.

Also, this proposed system will help in maintenance and repairing of solar panels by tracking its output. this system is easy to install and handle.

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