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An Exclusive Review on IoT Based Solar Photovoltaic Remote Monitoring and Controlling Unit

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Abstract - *Power predicament is a major upcoming problem in the society. Some of the non-renewable energy sources like thermal, nuclear energy are expensive and hazardous to the mankind. The conventional energy sources are limited and cause pollution to the environment also. To overcome these problems, eco friendly system will be a better solution. This paper deals with the monitoring and controlling the output voltage of a solar panel kept at distant location and observing the output in the server with the help of Internet of Things (IOT). Each and every server page consists of a unique IP address which allows the user to access the output page. Furthermore the controlling of solar panel outputs are enabled using relay circuits and boards. Monitoring and controlling process is made easy and efficient, with the aid of this IoT system.*

Key Words: Photo-voltaic (PV), Remote monitoring, Internet of things (IoT), Maximum power point tracking (MPPT), Cloud.

1. INTRODUCTION

In this modern world, Electricity is also added to the most basic needs in everyone's life. The graph of energy consumption is getting increased day by day where as the energy resources are diminishing parallel. In order to balance the scarcity for electricity, various sources are used to generate electricity. For the generation of electricity, there are two ways: one is by conventional method and other one is nonconventional method. Some of the energy carriers like fossil fuels and nuclear fuels are also used, but they are not renewable resources (i.e., they are not 'refilled' by nature) and it is said to be non-conventional. In its broadest sense, sustainable power source can be achieved by using the solar power as source. The wide availability of solar energy has throughout the world. Even The sun has produced energy for billions of years. The sun's rays may cat as an important source for the generation of electricity by converting it into a electric power. Such application is called as solar thermal energy, which is conventional.

Even though various sustainable sources are available such as wind, rain, tides and geothermal, natural based bio fuels and conventional biomass, solar power have huge benefits.

Nowadays in India, frequent power cut is very common. For that it is primary to use the renewable energy and monitoring it secondarily. The rapid growth in renewable energy applications have been empowered by a critical drop in cost over the earlier decades and specialized change in their productivity, unwavering quality and lifetime. And by means that of monitoring the energy prediction, households and communities, the productivity gets increased.

In case of India's development and economic growth, electricity plays a vital role. In energy consumption, India is the fourth biggest country after China, USA and Russia. The electrification rate in India is 64.5%, while 35.5% of the population still lives without access to electricity. Internet of things means that merely the network of Physical objects. This provides the connection of each and every object in the world by means of wireless sensor network. Some devices, buildings, vehicles and other objects embedded with software, network connectivity and sensors can enables these objects to collect and exchange data.

This IoT (Internet of Things) is achieved by wireless sensor networks, sensor networks, 2G/3G/4G, GSM, GPRS, RFID, WI-FI, GPS, microcontroller, microprocessor, etc. Empowering advancements for the Internet of Things are considered and gathered into 3 classifications. They are,

- Advance that empower "things" to accept contextual information or Data.
- To process the relevant data, and
- Innovation to enhance security and protection.

Accepting the information and processing the relevant data can provide an understanding which is needed to build the "intelligence" into "things". This is the highlighted feature that differentiates IoT from standard internet. The need for using IoT concept in this solar tracing system is to overcome the major disadvantages of electricity generation from the solar energy. The range of sun's radiation that reaches the ground surface is not in a fixed value. Because the range may varies according to location, time and climatic conditions. For that the solar

panel can be completely exposed to the sun's radiation always. And hence the solar panel can be monitored by using Internet of Things. Among all techniques which have been studied for the solar panel tracking system by using IoT, only few techniques are delivered as follows.

This paper uncovers four more sections. Section 2 presents the literature review; Section 3 gives detailed explanation about the various related works in this area. Finally, Section 4 outlines the conclusion.

2. LITERATURE REVIEW

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 system using IoT[1]. It provides information related to survey on 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 [2].In this paper they had defined problems related to management of solar panels and fields issues during power generation process so in order to overcome above issues they developed a model by using tiny OS. It also includes gateways, host computers and so on [3].They based on timely manner and also includes data logging based on WSN (Wireless Sensor Nodes).The limit it can accept is 146V and 15.5A Systems, it can be further enhanced [4]. It uses ZigBee wireless communication for multi modal power converters between solar PV cells .It combines as a single host and perform monitoring process. According to MPPT (Maximum Power Point Tracking) algorithm each module collects its details and stores in an reference parameters accordingly. Hence the overall system is centralized [5].
In this paper they will analyze and study a solar power plant of a linear parabolic type after introducing it. They discuss the quality and effectiveness of each internet parameter in order to explain the Internet behavior. They studied delayed behavior by using previous results. Once studied delay behavior, dynamics related to the delay in the Internet are modeled by using system recognition Technique and they used Wave Variable method is chosen as the best monitoring Method on remote monitoring methods. Finally solar power plants monitoring system via the Internet is finally designed [6]. 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 this information, preventive maintenance can be carried out to improve the life of the system, thus overall operating cost also reduced [7]. 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) [8]. In this paper they present performance results of middle scale grid-connected Photovoltaic (PV) system for monitoring periods. The performance of PV system is quantitatively estimated and examined using calculation model with data which are monitored, So that various PV system technologies are development. Their aim is to develop reliable and valid evaluation method of Photovoltaic (PV) system performance such that maximum output is achieved over the system lifetime with performance improvement [9].

3. RELATED WORK

This literature study reveals the elaborate work on various strategies used for monitoring the solar panel position by using Internet of Things (IoT) for effective conversion of solar energy into electrical energy and in solar panel's position tracking automation.

3.1 Using Hybrid PV cells

Design of solar power system for the supply of usable solar power through photovoltaic (PV) the design may comprises of various component, among that there are two major components used. One is the solar panels which can absorbs the radiated solar energy and convert such sunlight into the electricity. The second major component is solar inverter; it is used to alter the direct current into alternating current. Some minor components are used for mounting, cabling and also various electrical accessories as shown in fig.1.

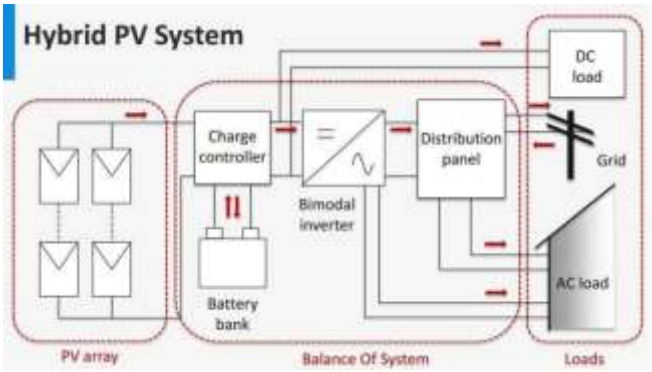

Fig -1: Block diagram of hybrid PV system.

In case of the solar tracking system having two-axis (dual - axis), the panel can be tilted front and to get the maximum

absorbance of sun's rays. However this accurate tracking of the sun rays can be improved by applying MPPT (Maximum Power Point tracing) mechanism.

Even though the panel can be architected as dual-axis, the inverter used along with it will be act much smarter to transmit and receive the information rapidly as well as share the data with user. The framework starts with solid, tough and proficient silicon-driven equipment, which can be controlled by a versatile programming stage fusing a complex execution technique.

Such framework permits installers and administration experts to analyse operational and support issues-including anticipating conceivable inverter or module issues-and remotely update certain parameters in minutes. More or less, the useful stream embraced would be,

- Use in off grid mode: (without network) with the likelihood of connecting to a generator. The inverter must be connected to a battery bank and must have valid off grid capacities- not all Hybrid inverters accepted for off-grid applications.
- Use in on-grid or grid-tie: (connected to the network) with the likelihood of offering validity or abundance vitality. There is a need to have the standard protection and decoupling.
- Use in hybrid mode: the inverter performs with a battery bank, yet in addition associated with the grid. This specialty enables the easy management of energy, which is considered as a highlight of hybrid inverters (smart grid).
- Use in Back-up mode: or storage mode keeps power outages by changing from on-grid to off-grid mode and prevents blackouts by switching from on grid mode to off-grid mode right now of electric blackout, subsequently disposes of network cuts.

3.2 Using Micro grids-Dependable Control

The following module incorporates photovoltaic boards (PV) used for gathering sun's radiation and move systems with two degrees of flexibility used to control the azimuth and height of the boards. The movement can be controlled by either an inherent or a remote controller. The data communication is directed via a gateway which converts signals from Modbus Serial to Modbus TCP protocols. The gathered energy is amended and put away in two 50 kWh stream innovation batteries. By means of inverters and isolators, the AC yield is encouraged onto a isolate building micro grid, utilizing standard 3 Phase 415 VAC, that is associated with specific gadgets and power points set all through the building. The Structure of a dependable control system is shown in fig.2.

For observing and wellbeing, Tigo frameworks are actualized to record the solar panel status. The information is then collected by algorithm implemented in an application server to break down the power use, assess the reaped energy and identify unusual occasions. The aftereffects of this progress, from one viewpoint, give references to ideal and control modules in type of organize based application program interfaces (APIs) and, on the other hand, joined with other building information to make vitality profiles being put away in databases.

At the center of the framework are IoT-based controllers. The introduced tried and true control calculations introduced by controllers which are implanted PC sheets. The sheets are interconnected what's more, when joining with other handling units frame a private cloud system to control and deal with the micro grid.

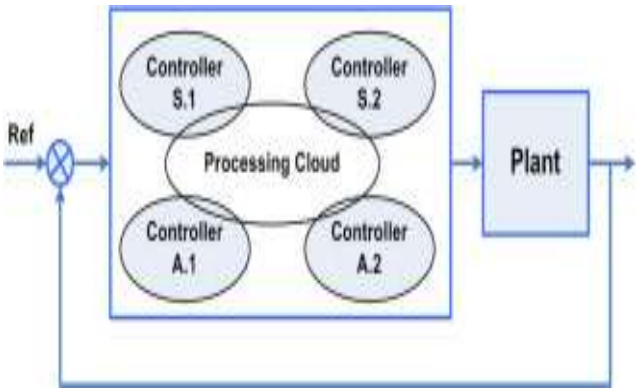

Fig – 2: Structure of a dependable control system.

The term "cloud" here suggests a deliberation of control equipment acquainted with the actuator gadgets, for example, a detachment between the solar tracker and its controller leading through institutionalizing signal arrangements and control conventions gave by means of system administrations. Therefore, an actuator gadget does not have to know which controller is controlling it or how numerous repetitive ones are utilized for unwavering quality. This deliberation consequently enables one controller to at the same time control various sunlight based trackers and gadgets while in the meantime demonstration as a repetition for different controllers. It likewise permits on the web assets, for example, continuous meteorological and cosmic information to be recovered and coordinated into the framework so that a worldwide enhancement can be directed bringing about better energy gathered.

3.3 Using Arduino and RPi

Strategy employed in this type is to exhibit the Solar Energy Monitoring System's framework plan. The observing information transfer to the cloud through RPi as appeared in the fig. 3.

3.3.1 Arduino & Cloud Setup:

Remembering the economic constraints and also the easiness of the framework, Arduino Uno has been utilised which lessens the programming activities. Arduino sense the current and voltage esteem through Simple pins. With

the assistance of these qualities, Arduino programming ascertains the power and vitality.

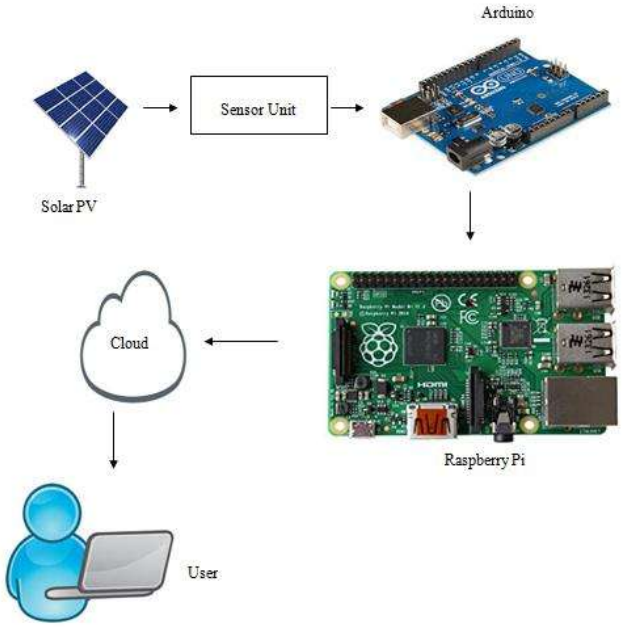

Fig – 3: System Design using Arduino and RPi

Raspberry Pi Raspberry Pi is utilized as a part of the venture as a focal observing framework. As Raspberry pi board is a compact and minimal effort. Thing Speak is an open source IoT application and API to store and recover information from things utilizing the HTTP convention over the Internet or through a Local Area Network. Thing Speak empowers the making of sensor logging applications, area following applications, and an informal organization of things with announcements. The client ought to make the record first.

3.3.2 Work process:

Fig. 4 speaks to the procedure of proposed framework from load to the checking framework. The work stream of the sun oriented vitality checking framework is exhibited as venture underneath:
Stage 1: Arduino show the power use utilizing detected values through current sensor and voltage divider.
Stage 2: Raspberry pi bring the arduino yield information through serial port and show on the web page through python content.
Stage 3: Raspberry sends the checking information on to the cloud.
Stage 4: The information in the form of chart is shown by Cloud, which is obvious to the whole client.

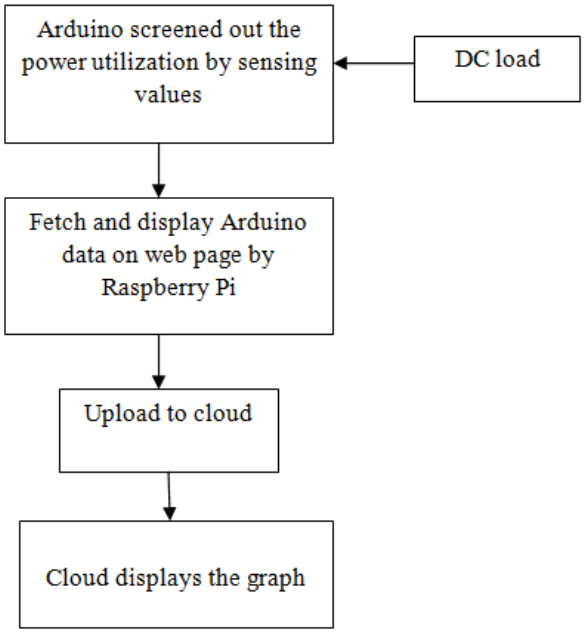

Fig – 4: Workflow of Arduino based solar panel Monitoring

3.4. Using IOT module

This design configuration is utilized for remote observing of current and voltage estimation of PV cells. The transmission among the photovoltaic boards and server is performed by IoT (Internet of Things). The current and voltage information is handled by Microcontroller unit (MCU).

The deliberate information is exchanged to facilitating server utilizing remote transmission. The estimation of current and voltage are checked and sent to the IoT module, at that point the IoT module stores the current also, voltage perusing with date and time.

The framework is beyond regular time effective than existing methods for remote checking framework for photovoltaic boards. The framework incorporates remote checking framework meant for photovoltaic boards. The current and voltage estimation of the photovoltaic board are estimated with the assistance of current and voltage sensor. These yields are in simple information compose so it changed over into computerized shape utilizing analog to advanced converter. The estimated information are given to the microcontroller unit. The microcontroller sends the deliberate information to the IoT.

The Internet of things (Esp8266) is that the system of physical gadgets that empowers these Modules to associate and trade data. The subtle elements of the deliberate information will be transmitted to the AWS S3 container remotely through IoT module. The photovoltaic

board voltage and current can be seen in the AWS S3 container anyplace and whenever from this server.

The fundamental reason for this undertaking is to screen the photovoltaic boards and putting away the information in the Amazon S3 container, the put away information can be examined, seen later in whatever kind we need to see. Along these lines from this venture, we can productively screen the photograph voltaic boards remotely and put away the deliberate information. The microcontroller unit (MCU) reports area unit shared to IoT.

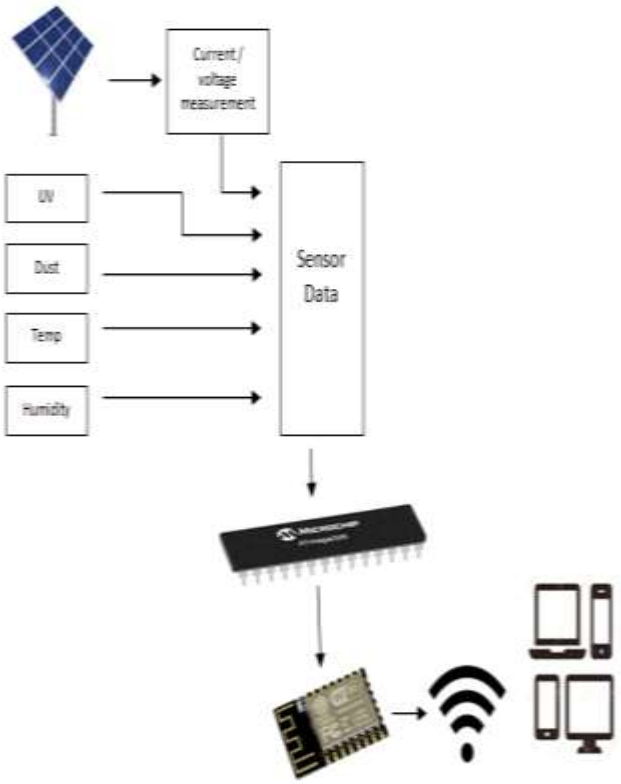

Fig – 5: Framework of panel monitoring using IOT module.

4. CONCLUSIONS

In this investigation it has been assessed various procedures that are used for the tracing of solar panel. It can be manipulated anywhere such as house-hold activities in office even in industrial purposes. The cost of the implementation of this task can be fluctuated by various methods. If the user's consideration is on cost, then the method of using arduino in the module can be a agreeable one. For this it is also a low power consuming project. Today world is confronting intense power emergency. We require a better power system to give benefits to those people who live in remote area. And also the efficient monitoring systems for acquiring of complete energy conversations. Under this circumstance these various types of project can give a decent outcome when vitality emergency is a standout among the most fundamental issue on the planet.

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