IOT BASED SOLAR POWER MONITORING SYSTEM

TAYIR GULZAR NAQISHBANDI[1], SHAVET SHARMA[2]
[1]PG SCHOLAR, DEPARTMENT OF ELECTRICAL ENGINEERING, Sri Sai College Of Engineering and Technology, Badhani Pathankot.
[2]assistant Professor, DEPARTMENT OF ELECTRICAL ENGINEERING, SRI SAI COLLEGE OF ENGINEERING AND TECHNOLOGY, BADHANI PATHANKOT
Email id :-tayirgulzar@gmail.com

Abstract:— ***The present work is based about the Internet of Things (IOT) that is the latest and the developing technology and has the capability to transform the world in smart concepts like more-efficient industries, intelligent vehicles, and urban communities, all fall in the IOT world. IOT leads the work quicker and smarter specifically in today's advancing technologies. However, the utilisation of innovation like IOT in power systems could have the most prominent effect and can greatly enhance the performance, monitoring and maintenance of solar power plants. Solar power plants require remotely monitoring for efficient and optimum power output. This helps gain efficient power output from power plants while monitoring for faults in solar panels, connections, dust accumulated on solar panels that lowers the output and other such issues affecting solar effectiveness. So in my research I am working on a model based on IOT technology that allows for smart solar power monitoring from anywhere over the internet. In my model I am using arduino based system to monitor a10Watt solar panel parameters. This present system will regularly monitor the solar panel and will transmit the power output to IOT system over the internet and thus by resolving the circuit in Proteus software.***

Keywords:- IOT, smart concepts, solar power, arduino, proteus software

1. INTRODUCTION

Solar power is today the common source of electricity used daily. Solar power has resolved the shortage of electricity to a great extent and also includes most of the consumers belonging to backward category. In Jammu and Kashmir solar power performs a great role particularly in Kashmir division during the winter season. Govt. of India is working with a positive approach towards development of solar based Power Plants to make supply smooth to consumers. Govt. of India also launched number of schemes in-collaboration with different banks to make consumers more and more aware regarding Solar Power and offers home based Solar Power Systems.Solar energy is harnessed from the power and heat of the sun's rays. It is renewable, and thus a "green" source of energy. The most general way of harnessing energy from the sun is through photovoltaic (PV) panels – those large, mirror-like panels we see on rooftops, handheld solar devices, and even spacecraft's. These solar panels work as conductors, harnessing the sun's rays, heating up, and generating energy (and electricity). On a bigger scale, solar thermal plants also harness the power of the sun to generate energy. These solar plants make the use of the sun's heat to boil water and, thus, power steam turbines. These plants can supply power to many thousands of people. These days every person is aware about the Solar power system but now the main thing is how to monitor these Power Plants using latest and emerging technologies to make efficient power output. . Implementing innovations for monitoring Solar power Plants helps to retrieve optimum power output. In my research I am going to in-corporate different innovations like internet, Internet of Things (IOT) and the Arduino based system means in simple word deployment of Information Technology in Electrical Engineering. As wind power, solar power is an unlimited and inexhaustible resource (unlike power produced from fossil fuels). As technologies improve and also the materials needed in PV panels become "greener," the carbon footprint of solar power decreases and the technique becomes more easily accessible to the masses.

1.1 DATA COMMUNICATION

Solar Photovoltaic monitoring systems can have wired or wireless data communication. Most Photovoltaic monitoring systems are wireless based; Wireless remote monitoring is not restricted by region and distance, especially in remote areas and it may serve the purpose bettermonitoring and control go hand in hand and invariably SCADA systems are the backbone of any Remote monitoring system.

In Remote Monitoring systems, the attributes like voltage, current etc. of the Solar PV sub-systems are measured by the Sensors, processed by the Signal Processors and the collective information is then transferred electronically to the central station where an operator can access the received data and perform necessary actions. SCADA is one such Remote Monitoring Software Tool which not only monitors but also does Data Acquisition, has Human Machine Interface (HMI), Event & Alarm Management, Archiving, Provides Real time data and Historical Data Storage, Performance based alerts features.

FIGURE-1.1 SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA):

SCADA systems have updated with following types (SCADA Architecture)
a) First Generation (Monolithic SCADA System)
b) Second Generation (Distributed SCADA System)
c) Third Generation (Networked SCADA System)
d) Fourth Generation (Internet of Things)
In fourth generation systems, the infrastructure cost of the SCADA system is reduced by adopting the internet of things technology with the commercially available cloud computing. The maintenance and integration is also very easy for the fourth generation compared to the earlier SCADA systems
Solar Cell:-The model of solar cells is based on the photovoltaic effect. The photovoltaic effect is almost similar to the photoelectric effect, where electrons are ejected from a material that has absorbed light with a frequency above than a material-dependent threshold frequency.
Solar Panel:-A solar panel is a device that absorbs and transforms solar energy into electricity or heat. Solar photovoltaic panels are made so that the sunlight excites the atoms in a silicon layer between two protector panels. Electrons which are excited form a current, which can be utilised by external devices.

1.2THE INTERNET OF THINGS

The IOT is fastly becoming a reality that surrounds us and interacts with a number of aspects of people's lives. Good connectivity and advances in ICT innovations have made possible the connection of more and more gadgets to the web.

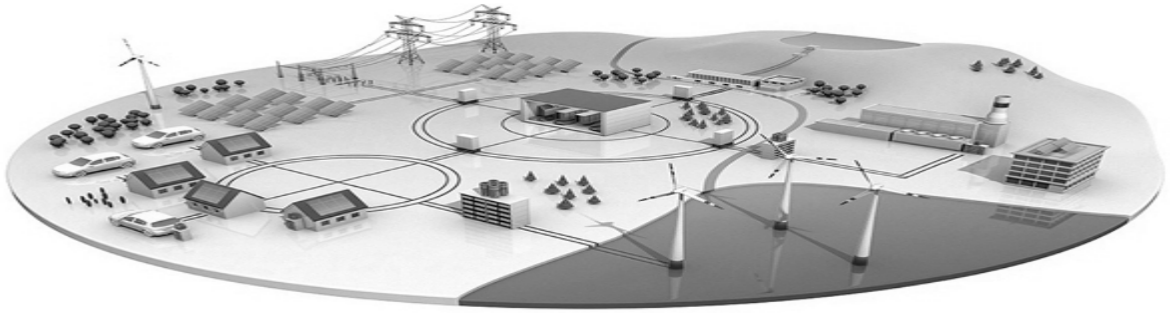


FIGURE-1.2 SENSORS USED IN IOT TECHNOLOGY

2. PROBLEM IDENTIFICATION

Everyone is aware about Solar Power because Solar Power makes possible only smooth and continuous supply to consumers specially consumers belonging to rural areas. There are number of things involved that lower

down the efficiency of Solar System. Solar power plants need to be monitored for optimum power output That is we need to detect current voltage, power, humidity and temperature on solar panels. This helps retrieve efficient power output from power plants while monitoring for faulty solar panels, connections, dust accumulated on panels lowering output and other such issues affecting solar performance So here I propose an automated IOT based solar power monitoring system that allows for automated solar power monitoring from anywhere over the internet. At start I came across many problems while implementing this model which needs to be rectified. First of all current and voltage was to be measured, so I proposed current sensor and voltage sensor for measuring current and voltage. Similarly humidity and temperature was to be measured which I rectified by using sensors. Also a problem was faced that how the solar panel will absorb the heat of sun for most part of the day as solar panel was getting under shade area for a half day time. So, I used a motor which will rotate the solar panel and align it with sunlight for efficient absorbing.

2.1OBJECTIVES

- Remote Monitoring of Solar Based Plants to detect faulty solar panels, connections, dust accumulated to increase the Solar Plant efficiency.
- To increase efficiency (light intensity) of solar panels
- To measure values of current , voltage, power , temperature, humidity at a particular time remotely

3. METHODOLOGY

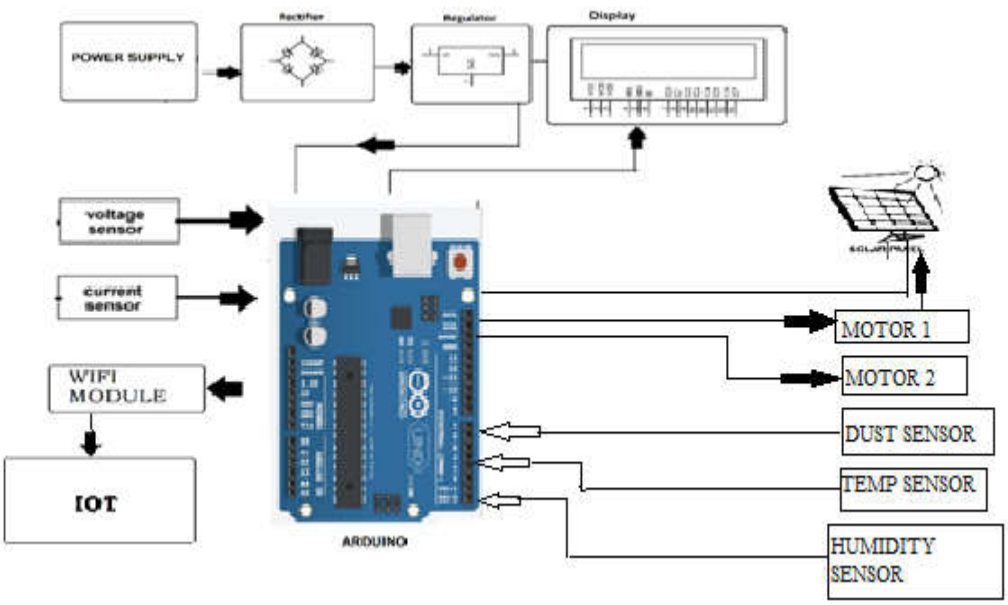


FIGURE 3.1 BLOCK DIAGRAM

3.1 IOT IMPLEMENTATION

The phrase “Internet of Things” was first instituted by Kevin Ashton in year 1999. He expressed that, “the Internet of Things (IoT) can possibly change the world, similarly as the Internet did – perhaps more so.”IC Insights expects that somewhere in the range of 2014 and 2019, sensor shipments will flood with a CAGR of 11.4 %, coming in full circle in an aggregate of 19.1 billion sensors by 2019. Incomes will rise 6 % annually as a result.There arealso some basic critical features that organisations need to consider for a effective IOT implementation.

1. Security,
2. Data sensitivity
3. Scalabilit
4. Intelligence capabilities
5. Interoperability

The above mentioned indicates are critical for endeavors to avoid major traps during the development and improvement of an IoT system. Companies are putting millions in IoT, however the most of the income is bringngabout no ROI due to persistent issues that plague the system for prolonged periods.

At present, IoT related advancements like sensors, wearables, cloud, and other related platforms are much in demand. We can likewise observe that analysts, designers, and architects from different fields including scientists and engineers are meeting up for a single cause. It looks like the world is set to see some developmental changes very soon.

Commonly used sensors in IoT:-

The different types of sensors present in market today make you baffled. They are used in many platforms benefitting everyone in world.As IOT rises to dominance, a sensor has more important and necessary part, which for the most part, is modelled to detect and calculate a physical quality and make it into a value that can be accessed by a user or another gadget. Though it is not so easy to point out about all the sensors, letus focus on those sensors which are typically used in IOT.:

Temperature Sensors, Proximity Sensors, Pressure Sensors, Optical Sensors

3.2 Existing Methodolgy:

Light from sun is directly converted to electric energy when it hits the solar panels. Almost every day, sun light falls on these solar panels . The solar panel transforms this energy into direct current ("DC") electric energy. This energy then flows out of the solar panel andgoes into an inverter . The inverter converts that "DC" power (commonly used in batteries) into "AC" power. AC power is the electrical energy that our TV, desktop monitors, and toasters use when plugged into the wall outlet.

Solar Cells:-Solar cells are small, square-shaped panel semiconductors produced using silicon and other conductive materials, fabricated in thin film layers. At the point when daylight strikes a solar cell, chemical reactions discarge electrons, generating electric current. Solar cells are also called photovoltaic cells or "PV cells"

Solar Photovoltaic (PV) System Components:-A PV system components incorporate PV modules (groups of PV cells), which are usually called PV panels; one or more batteries; a charge regulator or controller for a stand-alone system; an inverter to covert solar power from direct current (DC) to the alternating current (AC) of the utility grid-connected system; wiring; and mounting hardware or a framework. The individual solar cells are grouped in a PV module, and the modules are then assembled together in a cluster. Some of the arrays are put on special tracking gadgets to follow sunlight throughout the day and improve solar efficiency.

Existing methodology includes a lot of researches in the domain of solar power. I am here mentioning a few:

- Remote monitoring of solar power inverter (An application of IoT) :
- Solar energy analytics using internet of things
- Smart power monitoring and control system through Iot using cloud data storage
- Management of solar power in micro grids using iot based dependable control
- Design and development of a remote monitoring and maintenanace of solar plant supervisory system
- Solar powered green house monitoring and controlling using AWS cloud by android application
- Improving monitoring and fault detection of solar panels using arduino mega in WSN: This system is dependent on installing WSN nodes with some needful sensors for more commonly occuring faults on forty five solar panels set on the roof of IT faculty.
- An intelligent solar energy harvesting system for wireless sensor networks
- Design and optimization of photovoltaic solar energy in a small domesticated establishment.

3.3 PROPOSED METHODOLOGY:

Solar power is becoming best source of energy day by day because of depleting nature of fossil fuels and the disastrous demerits such as pollution they contribute to atmosphere. So maintaining solar power system, solar panels is an increasing need for the researchers and scholar concerned. Solar power needs to be monitored for optimum and efficient output. This helps to retrieve efficient power from solar plants while monitoring for faulty solar panels, connections, and dust accumulated on panels which lowers output and also many critical concerns affecting solar efficiency.So in my research , I propose an automated IOT based solar power monitoring system that allows for automated solar power monitoring from anywhere over the internet. We use Arduino based system to monitor a solar panel (say 10 watt) parameters. Our system constantly monitors the solar panel and transmits the various outputs to IOT system over the internet. Here in practical we can use IOT Gecko to transmit solar power parameters over the internet to IOT Gecko server. It then displays these parameters to the user using an effective GUI and also gives alarm to user when the o/p goes below specific limits. This makes remotely monitoring of solar plants very efficient and easy and gives best power output.We performed the simulation of research on simulator- Proteus design suite. It is a software used generally for electronic design automation. It is commonly used by electronic design engineers to create schematics and electronic prints for manufacturing PCBs. It was created in Yorkshire, England by Labcenter Electronics Ltd and has versions in English, French, Spanish and Chinese languages. The circuit diagram of the model is shown below:

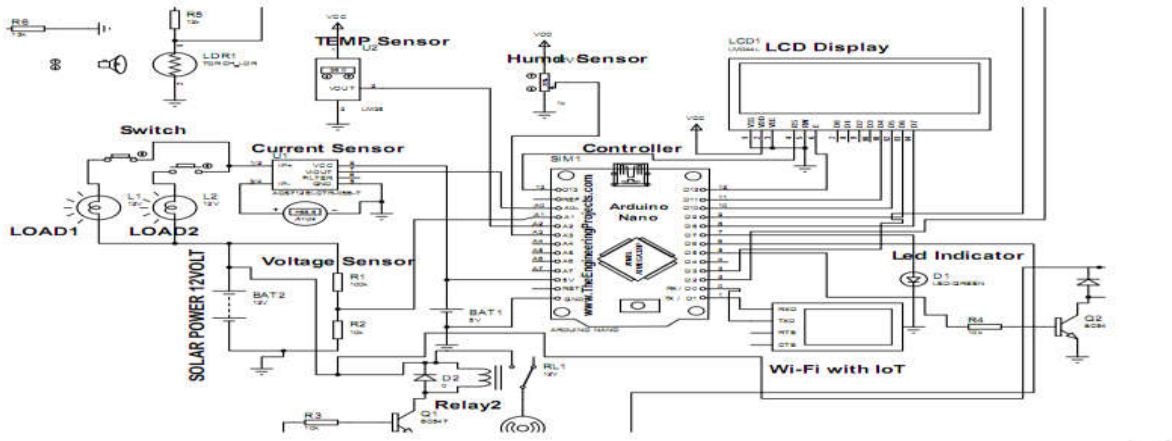


FIGURE 3.3 CIRCUIT DIAGRAM

In this research , current value , voltage value and power are displayed on LCD by using current sensor for measuring current and voltage sensor for measuring voltage anywhere over the internet.Similarly, humidity sensor is used to detect and calculate humidity on nearby solar panel. Temperature sensor is also used to detect and measure temperature on solar panel. Also, dust accumulated on solar panel can be detected by dust sensor. We can also address the dust accumulated on solar panel by cleaning it automatically with the help of water pump controlled by a motor. We can find light intensity by LDR sensor which helps us maintaining optimum power. We can also address the low intensity light on solar panel by turning the solar panel with the alignation of sun (i.e., solar panel will rotate automatically towards the sun where intensity of light is more) with the help of another motor. We can also detect fault on connections or on load by displaying 'efficiency low' signal on LCD. We can all control this over the internet. Which is time savvy , efficient and smart mode concept.

4. RESULTS AND DISCUSSIONS

4.1. INTRODUCTION TO PROTEUS :-The Proteus Design Suite is an exclusive programming tool suite utilized basically for electronic design mechanization. The product is utilized for the most part by electronic outline architects and experts to make schematics and electronic prints for assembling printed circuit boards.The main adaptation of what is currently the Proteus Design Suite was called PC-B. The Proteus Design Suite is a Windows application for schematic catch, simulation, and PCB format plan.

4.2 SIMULATION RESULTS

The simulation of the Solar power monitoring system is shown in fig 4.2.1.

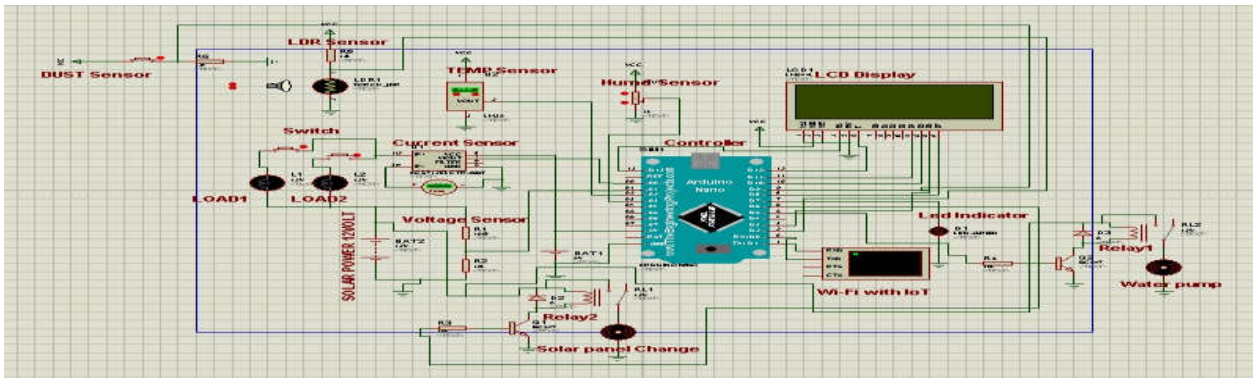
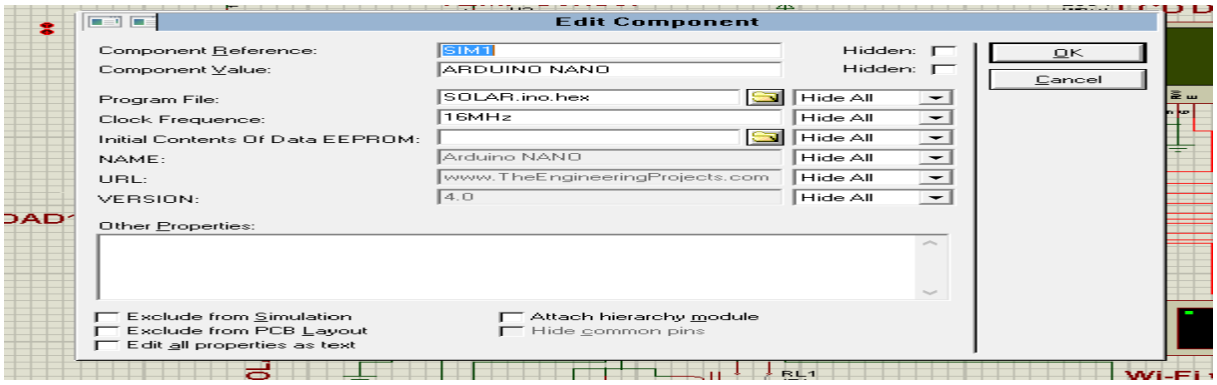


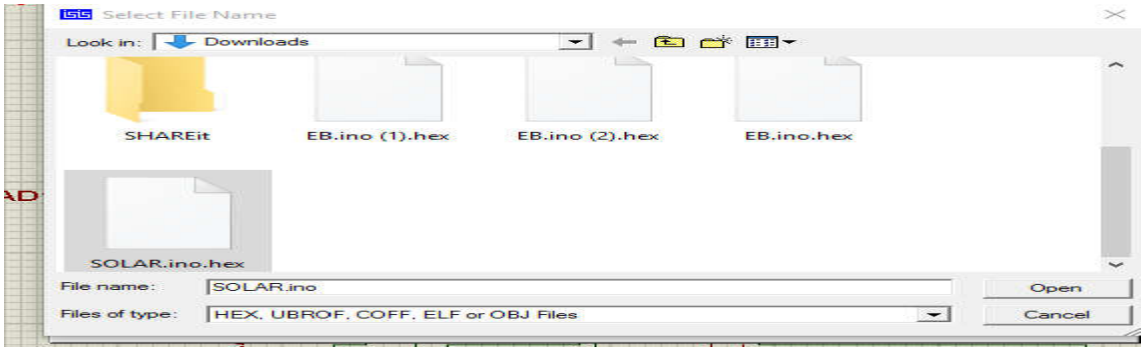
FIGURE 4.2.1 SIMULATION CIRCUIT DIAGRAM OF SOLAR POWER MONITORING SYSTEM

Working : The simulation will work by following the steps mentioned below :

1. Double click on the microcontroller selected



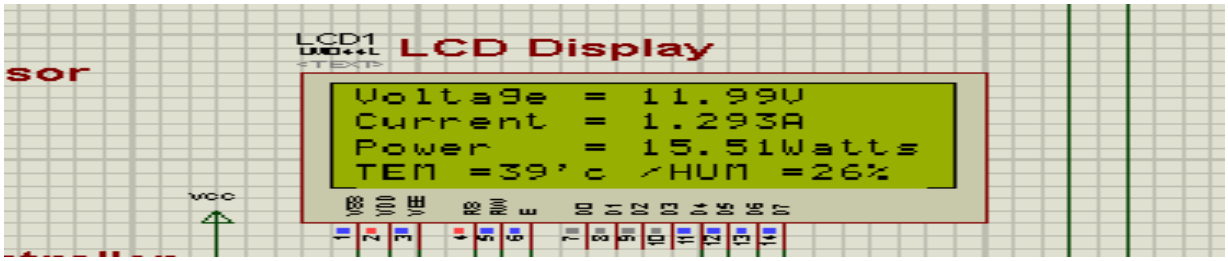
1. Load the hex file as shown



2. Your hex file will be loaded, now you can run the circuit.
3. When the circuit is run, first select any load using turn on switch.

RESULTS : The results of the simulation are as :

Case 1: LCD Display shows the value of voltage , current ,power , temperature and humidity at a particular time.



Case 2 : When LOAD 1 is ON, the efficiency remains normal as there is no fault anywhere and system is stable

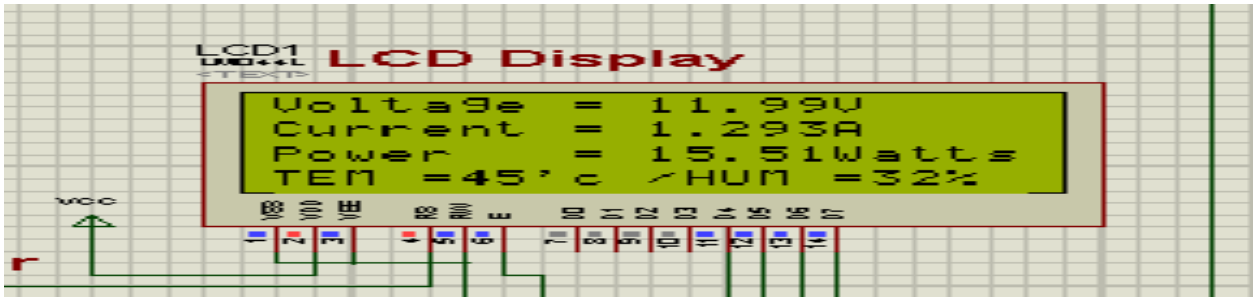


Figure 4.2.2 A) LCD DISPLAY READINGS

B) VERTUAL TERMINAL VALUES

CASE 3 : WHEN LOAD 2 IS ON efficiency remains low , as there is fault in load 2 or in connections or because of dust

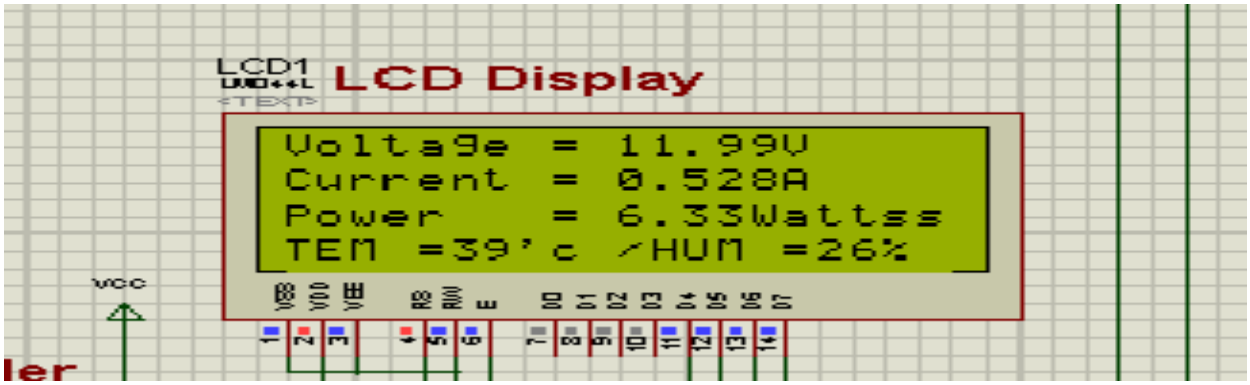
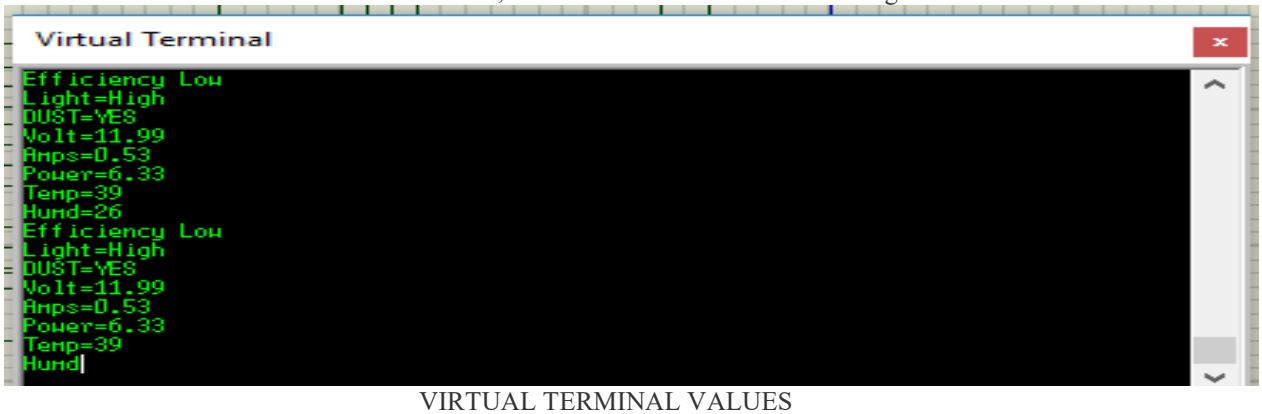


Figure 4.2.3 A) LCD DISPLAY READINGS

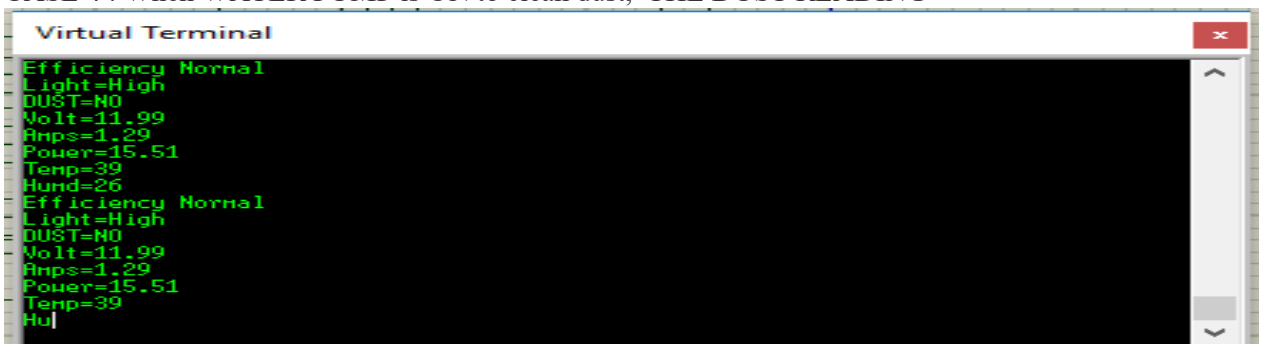
B) VERTUAL TERMINAL VALUES

CASE 3 : When DUST is ON the Solar Panel , the VIRTUAL TERMINAL readings



VIRTUAL TERMINAL VALUES

CASE 4 : When WATER PUMP is ON to clean dust, THE DUST READING



VIRTUAL TERMINAL VALUES

Case 5: When the motor near solar panel is ON to rotate solar panel to align it with sun, the VIRTUAL TERMINAL reading is LIGHT is high and efficiency is normal

VIRTUAL TERMINAL VALUES

5. CONCLUSION

Implementing Renewable Energy technologies is one highly prescribed method of reducing the negative effect that other sources of energy introduce in the environment. Because of frequent power cuts it is important to make a use of renewable energy and monitor it. Monitoring helps the user in analysis of solar energy usage. This system is cost effective. The system efficiency is about ninety five percent. This enables the optimum use of solar energy. Thus it is decreasing the electricity issues. This model/research can be further advanced, by using the results of this current project, i.e. the monitoring values obtained here are helpful in predicting the future values of the parameters considered. The internet app can be developed to interface with the end user; the user can also predict values of the future events. In the same way we can go for android application also. During the prediction 2 or more models can be used for same data set, to calculate the accuracy of each model. Thus we conclude that by monitoring solar power system i.e., solar panels , we can analyse our system parameters easily and thus can increase efficiency and concerned power output.

6. FUTURE SCOPE

In future, need is to overcome certain problems in solar panel related factors like repair, maintenance and survey thus enhance its efficiency. Solar power plant system monitoring via IOT should be improved for better performances and maintenance. Use of internet for monitoring of a solar panels is a big step as renewable energy sources are getting integrated into utility grid with time. Thus automation of solar power plant monitoring will help in enhancing the future control process for big solar power plant and grid integration of such solar plants. Also we need to connect whole solar plant grids with IOT so that its efficiency can be enhanced further and whole control of panels should be solely on users/designers over the internet, which can access it anywhere in the globe. We should also incorporate some robotics in solar panel cleaning or changing system on roofs so that human damage decreases. In this paper I implemented an IoT based solar monitoring system for solar energy plant, the model is discussed, implemented and successfully achieved the remote transmission of data to a server for monitoring. IoT based remotely monitoring of solar plants will improve solar power efficiency of the system by making use of low power consuming updated wireless modules thereby reducing the carbon foot print. Web Console based interface will significantly reduce time of manual supervision and aid in the process of scheduling task of plant management. A provision of advance remotely

manage the Solar PV plants of various operations like remote shutdown, remote management is to be incorporate with this system later.

REFERENCES

[1]B.ShrihariprasathVimalathithanRathinasabapathy,"A smart IoT system for monitoring solar PV power conditioning unit",2016World Conference on Futuristic Trends in Research and Innovation for Social Welfare (Startup Conclave) .
[2] Charithperera chi haroldliu, and srimaljayawardena,"the emerging internet of thing market place from an industrialperspective: a survey",december 2015,IEEEtransactions on emerging topic in computing.
[3] yejihua, wang wen, "research and design of solar photovoltaic power generation monitoring system based ontinyos", august2014, 9th international conference oncomputer science education.
[4] ChagithaRanhotigamage and Subhas Chandra Mukhopadhyay, "Field Trail and Performance Monitoring Of Distributed SolarPanels Using Low Cost Wireless WirelessSensorNetworks",October 2010,IEEE Sensor journal.
[5] Sol Moon, Sung-Guk Yoon and Joung-Hu Park, "A New Low Cost Centralized MPPT Controller System For MultiplyDistributed Photovoltaic Power Conditioning Module",November 2015, IEEE Transactions on Smart Grid
[6]Ali HoseinArianfar, M.HoseinMehrabanJahromi, Mohsen Mosalanejad and BahramDehghan "Design And Modelling RemoteMonitoring System For A Solar Power Plant'' 2009,Second International Conference on Computer and ElectricalEngineering.
[7]Ravi Tejwani, Girish Kumar, ChetanSolanki, "Remote Monitoring System For Solar Photovoltaic Systems In RuralApplication Using Gsm Voice Channel" 2013,ISESSolarWorld Congress.
[8]Martín E. Andreoni Lopez, Francisco J. GaldeanoMantinan, and Marcelo G. Molina "Implementation of Wireless RemoteMonitoring and Control of Solar Photovoltaic (PV) System" 2012 IEEE Conference Publications.
[9] J. H. So, B. G. Yu, H. M. Hwang, G. J Yu and I. Y. Choi"Performance Monitoring and Analysis of Middle Scale GridConnectedPV System'' october 2007,7th International conference on power electronics.
[9]Ms. N. S. Deshmukh, Prof. D. L. Bhuyar , Prof. A. T. Jadhav "Review on IOT Based Smart Solar Photovoltaic Plant Remote Monitoring and Control Unit" 2018, International Journal of Advance Scientific Research and Engineering Trends, Volume 3 || Issue 3
[10]Mamatha C.R, Abhishek Kumar Singh, ShaziaAmreen "Solar Powered Green House Monitoring and Controlling using AWS Cloud by Android Application" 2017, International Research Journal of Computer Science (IRJCS), Issue 05, Volume 4.
[11]ShrihariprasathBasuvaiyan, VimalathithanRathinasabapathy "IOT based Solar Photo Voltaic Monitoring System" 2017, https://www.researchgate.net/publication/321307847.
[12]R. Vignesh, Dr.A.Samydurai "Automatic Monitoring and Lifetime Detection of Solar Panels Using Internet of Things" 2017, International Journal of Innovative Research in Computer and Communication Engineering, Vol. 5, Issue 4.
[13]UrvashiNarwal, Nikita "Home Automation by Integrating Solar Based System With in Internet of Thing" 2016, International Journal of Scientific Research and Education, Volume||4||Issue||08
[14]PuttaSindhuja, M. S. Balamurugan "Smart Power Monitoring and Control System through Internet of things using Cloud Data Storage" 2015, Indian Journal of Science and Technology, Vol 8(19), DOI:10.17485/ijst/2015/v8i19/76698.
[15]Jiju K. et. al., 2014. "Development of Android based on-line monitoring and control system for Renewable Energy Sources." Computer, Communications, and Control Technology (I4CT), International Conference on.IEEE, 2014.
[16]Yoshihiro G. et. al., 2007."Integrated management and remote monitoring system for telecommunications power plants with fully DC-powered center equipment."INTELEC 07-29th International Telecommunications Energy Conference.IEEE, 2007.
[17]Alexander S. and Galkin I., 2013. "Case study on using non-intrusive load monitoring system with renewable energy sources in intelligent grid applications." International ConferenceWorkshop Compatibility And Power Electronics.
[18]Mayamiko N., Zennaro M. and Bagula A., 2011. "SM 2: Solar monitoring system in Malawi." Kaleidoscope: The Fully Networked Human?-Innovations for Future Networks and Services (K-2011), Proceedings of ITU. IEEE, 2011.
[19]Li W. and Liu K.-H., 2007."Implementation of a web-based real-time monitoring and control system for a hybrid wind-PV-battery renewable energy system."Intelligent Systems Applications to Power Systems, ISAP 2007.International Conference on.IEEE, 2007.

[20]Big data (Dec 2016) Retrieved from http://bigdatamadesimple.com Internet of things (Nov 2016) .Retrieved from http://cerasis.com/2015/10/20/10-things-toknow-about-the-internet-of-things "Internet of Things Global Standards Initiative". ITU.Retrieved 26 June 2015. "Internet of Things: Science Fiction or Business Fact?" (PDF). Harvard Business Review. November 2014. Retrieved 23 October 2016.
[21]Friedemann M. and Floerkemeier C., 2010."From the Internet of Computers to the Internet of Things."From active data management to event-based systems and more. Springer Berlin [22]Heidelberg, pp. 242-259. Stankovic J.A., 2014. "Research directions for the internet of things." IEEE Internet of Things Journal, 1(1):3-9.
[23]Jayavardhana G. et. al., 2013. "Internet of Things (IoT): A vision, architectural elements, and future directions." Future generation computer systems, 29(7):1645-1660.
[24] Jaleel, Dr. J. Abdul., et.al. 2012. Simulation on Maximum Power Point Tracking of the Photovoltaic Moduleusing LabVIEW. International Journal of Advanced Research in Electrical, Electronics and InstrumentationEngineering Vol. 1, Issue 3, September
[25] Ki, Byung., et.al. 2012. Implementation of Monitoring and Control Systems for 50KW PV Systems Using theWire-Wireless Network. International Journal of Grid and Distributed Computing Vol. 5, No. 1, March,
[26] Nazir, Refdinal., et al. 2014.“Optimization Active and Reactive Power Flow for PV Connected to Grid System Using Newton Rapshon Method” ICSEEA Energy ProcediaVol 68, pp.77-86