IOT Based Solar Panel Fault Monitoring And Control By Using Wi-Fi Modem

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Abstract-Solar power plants need to be monitored for optimum power output. 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. This project presents a hardware design of smart grid home gateway that integrates smart home network to be compatible for pv integration with solar system for fault location identification . So here propose an automated IOT based solar power monitoring system that allows for automated solar power monitoring from anywhere over the internet.In this work an Arduino based system integrated with LDR,CT and PT sensor for measuring parameters to monitor solar panel. Fault has been detected by comparing LDR sensor intensity with panel measured voltage.Our system constantly monitors the solar panel and transmits the power output to IOT system over the internet.

Keywords: **Fault system, Internet of things (IOT), Light Dependent Resistance(LDR).**

I.INTRODUCTION

Power generation based on photovoltaic sources has gradually become an increasingly larger source of power generation during the last few decades. This trend has been matched with research into more efficient solar panels. Efficiency is measured as the ratio of incoming sun energy to the maximum attainable output power, with the current record being an efficiency of 44.7%. In addition to research into solar panels there is also an established interest in the surrounding equipment. Part of these systems are power inverters converting dc energy from the solar panels to the ac grid output. The efficiency concerns of solar panels naturally extend throughout the system, since any losses will affect the final efficiency of the complete system. Recently the area of photovoltaic (PV) inverters has progressed to distributed systems of inverters where a small inverter module is connected to every panel. This is beneficial since each panel can be optimized locally, thereby increasing the energy harvest. In addition to increased efficiency this also allows individual measurements of solar panels. These new capabilities provide new possibilities in monitoring of the health of solar panels. This process, known as fault detection, is an active research area. Fault detection aims to detect faulty and degraded solar panels as soon as possible. Degradation occurs naturally in solar panels and it is of interest to quantify the degradation rate over time.

II.RELATED WORK

Kian Jazayeri et al developing an intelligent system which provides real time monitoring and fault detection for solar panels. Utilizing artificial neural network technology Yuji Higuchi et al report various methods for classifying faults that use the data of string measurement devices used for continuously monitoring solar power panels remotely. Moath Alsafasfeh et al focusing on creating a framework for automating defect detection in a solar energy system using thermal imaging to create an accurate and a timely alert system of hazardous conditions. Shaik Ayesh_et al presents the method of monitoring the performance and yield of individual photovoltaic (PV) panels in a PV plant using Wireless Sensor Networks (WSN).Radu Platon et al presents the development of a practical fault detection approach in photovoltaic (PV) systems, intended for online implementation. The approach was developed and validated using field measurements from a Canadian PV system. Vinicius C. Ferreira et al proposes a solution that makes use of machine learning techniques for automated fault detection and diagnosis (FDD) on solar-powered Wireless Mesh Networks (WMNs). Y. Stauffer et al present a simple method that can be used to detect such issues. The proposed method only requires two electric power sensors to be added to an existing PV installation. Yanli Liu et al presents a new type of photovoltaic (PV) arrays connection: CTCT structure (complex-total-cross-tied array). In the array of CTCT-type PV cells, by adding a certain number of current sensors andcomparing the current, we can find the location of PV cells that have Hot Spot.

III. DESIGN OF THE 3G DATALOGGER FOR SOLAR PHOTOVOLTAIC MONITORING

A. General description

A new wireless monitoring system as well as the basic distribution of environmental and electrical sensors for monitoring the SAPV system. system. The new datalogger measures meteorological and electrical parameters; data is sent via 3G and information is stored in two different servers: a dedicated server (located in the University)and a cloud server (free storage platform). The connection to the internet allows to monitor the SAPV system from any device or computer.

B. Hardware

The previous datalogger was designed around theArduino TM UNO board as it stands out in comparison with theother open-source platforms due to its robustness, cost and developer community However, it did not cover all the functionalities for PV monitoring itself, so hardware enhancement was integrated by López-Vargas et al. [19] integrated in an ad-hoc PCB (Printed Circuit Board): (a) a bidirectionalI2C™ bus, (b) sensors signal conditioning including the integration of electronic elements for filtering transmission systems at a low price. This device requires an external 5VDC/1A power supply and it operates over a temperature range from 10 ºC to 60 ºC and relative humidity conditions in the humidity range of 10 % RH to 90 % RH (non-condensing).

IV.EXISTING METHOD

A WSN is a system comprised of radio frequency (RF) transceivers, sensors, microcontrollers and power sources. Recent advances in wireless sensor networking technology have led to the development of low cost, lowpower, multifunctional sensor nodes. Sensor nodes enable environment sensing togetherwith data processing. Instrumented with a variety of sensors, such as temperature, humidity and volatile compound detection, allow monitoring of different environments. They are able to network with other sensor systems and exchange data with external users. Sensor networks are used for a variety of applications, including wireless data acquisition , machine monitoring and maintenance, smart buildings and highways, environmental monitoring, site security, automated on-site tracking of expensive materials, safety management, and in many other areas . A general WSN protocol consists of the application layer, transport layer, network layer, data link layer, physical layer, power management plane, mobility management plane and the task management plane Currently two there standard technologies are available for WSN: ZigBee and Bluetooth . Both operate within the Industrial Scientific and Medical (ISM) band of 2.4 GHz, which provides license free operations, huge spectrum allocation and worldwide compatibility. In general, as frequency increases, bandwidth increases allowing for higher data rates but power requirements are also higher and transmission distance is considerably shorter

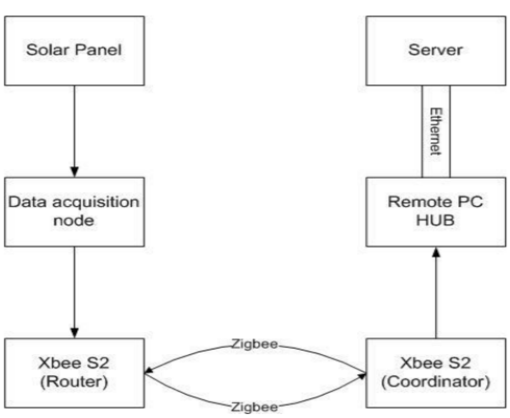

Fig4.1 Existing System

WSN Communication Architecture The nodes are generally disposed in a zone to sense, each of these nodes has the possibility to collect data and route it to one or more nodes or base station. The base station collects all the data then transmit it via a communication link eventually internet, the user can also use the base station to send some command to this network of nodes. In [16] there is an interesting example. The choice of sensors depends not only on type of default we would like to detect but also on interfacing it with microcontroller, the design should simplify the modification of the role of a node by simple adding or modifying or suppressing a sensor. A better solution for that would be to use digital sensors with I2C communication port. The choice of powerful microcontroller with I2C communication port large program memory including some characteristics such as: timers, ADC converter, EEprom for data conservation, watch dog timer, sleep mode and some parallel ports. The protocol of communication is composed of a packet 8 bytes designing: destination address, emitter address (ID of panel), type of fault and date and time. The power circuit for the microcontroller and sensors modules is provided directly by the PV panel; however it is better to add a battery for secure situation. D.Node Design Effective construction of a WSN needs the development of nodes adapted to the specific characteristics of the application as to be as small as possible, reduced price, efficacy in power consumption, equipped with calculator and memory and with adequate communication resources

V.PROPOSED SYSTEM

The Internet of Things has a vision in which the internet extends into the real world embracing everyday objects. The IoT allows objects to be sensed and/or controlled remotely over existing network infrastructure, creating opportunities for pure integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit in addition to reduced human intervention. This technology has many applications like Solar cities, Smart villages, Micro grids and Solar Street lights and so on. As Renewable energy grew at a rate faster than any other time in history during this period. The proposed system refers to the online display of the power usage of solar energy as a renewable energy and indicating faults in the solar panel.

The proposed system is for monitoring of solar energy using IoT. Solar panel helps to store the energy in the battery. Battery has the energy which is useful for the electrical appliances. Battery is connected to the Arduino. Arduino is a micro controller which is used to read the sensor values. Current sensor and voltage divider are connecting to the Arduino.

Current and Voltage Acquisition Circuit The analog inputs of an Arduino can measure up to 5V. Even when connect to a 5V circuit, you should use the resistors to help protect the Arduino from short-circuits or unexpected voltage surges .Those two resistors form a potential divider that is used to lower the voltage being measured to a level that the Arduino can read. Fig shows the voltage divider circuit. 10kohm and 100kohm register are used to reduce the voltage circuit to 5V. Breadboard is used to build this circuit. The Analog pin of arduino gives the voltage value. This actually extends the range that can be used. The formula for calculating values in a potential divider is

Vout = (R2 / (R1 + R2)) * Vin volts

If the divider for the Arduino voltmeter is functioning correctly, then Vout will be a maximum of 5V, and so you can calculate the maximum input voltage to the circuit:

Vmax = 5.0 / (R2 / (R1 + R2)) volts

For current measurement we will use a Hall Effect current sensor ACS 712 (30 A). ACS 712 measure positive and negative 30Amps, corresponding to the analog output 66mV/A. This current sensor gives the readings of the current. Those values are used in the proposed system for calculating power. In this setup DC bulb is consider as a load. Battery is considered as the power supply. Other pins of sensor is connects to the Arduino.

V.SOFTWARE AND RESULT DISCUSSION

Arduino programs may be written in any programming language with a compiler that produces binary machine code. Atmel provides a development environment for the ir microcontrollers, AVR Studio and the newer Atmel Studio. The Arduino project provides the Arduino integrated development environment (IDE), which is a cross-plat form application written in Java. It originated from the IDEfor the Processing programming_language project and the Wiring project. It is designed to introduce programming to artists and other newcomers unfamiliar with software development. It includes a code editor with features such as syntax_highlighting, brace matching, and automatic indentation, and provides simple one-click mechanism for compiling and loading programs to an Arduino board. A program written with the IDE for Arduino is called a "sketch".

The Arduino IDE supports the C and C++ programming languages using special rules of code organization. The Arduino IDE supplies a software library called "Wiring" from the Wiring project, which provides many common input and output procedures. A typical Arduino C/C++ sketch consist of two functions that are compiled and linked with a program stub main() into an executable cyclic executive program:

1. setup(): a function that runs once at the start of a program and that can initialize settings.
2. loop(): a function called repeatedly until the board powers off.
3. After compilation and linking with the GNU toolchain, also included with the IDE distribution, the Arduino IDE employs the program to convert the executable code into a text file in hexadecimal coding that is loaded into the Arduino board by a loader program in the board's firmware.

The project is based on microcontroller board designs, manufactured by several vendors, using various microcontrollers. These systems provide sets of digital and analog I/O pins that can be interfaced to various expansion boards ("shields") and other circuits. The boards feature serial communications interfaces, including USB on some models, for loading programs from personal computers. For programming the microcontrollers, the Arduino project provides an integrated development environment (IDE) based on the Processing project, which includes support for the C and C++ programming languages.

An Arduino board historically consists of an Atmel 8-, 16- or 32-bit AVR microcontroller (although since 2015 other makers' microcontrollers have been used) with complementary components that facilitate programming and incorporation into other circuits. An important aspect of the Arduino is its standard connectors, which lets users connect the CPU board to a variety of interchangeable add-on modules known as shields. Some shields communicate with the Arduino board directly over various pins, but many shields are individually addressable via an I²C serial bus—so many shields can be stacked and used in parallel. There are many Arduino-compatible and Arduino-derived boards. Some are functionally equivalent to an Arduino and can be used interchangeably. Many enhance the basic Arduino by adding output drivers, often for use in school-level education to simplify the construction of buggies and small robots. Others are electrically equivalent but change the form factor, sometimes retaining compatibility with shields, sometimes not. Some variants use completely different processors, with varying levels of compatibility.

```
crack_detection
int temperature;
void setup()
{
   lcd.begin(16, 2);
   lcd.print("panel        ");
   lcd.setCursor(0, 1);
   lcd.print(" monitoring SYSTEM ");
   delay(2000);
   lcd.setCursor(0, 0);
   lcd.print("condition");
   lcd.setCursor(0, 1);
   lcd.print("    000           ");
   delay(2000);
}

void loop()  {

   temperature= analogRead(co)/2;
   lcd.setCursor(0, 1);
   lcd.print("000         ");
   lcd.setCursor(0, 1);
   lcd.print("    ");
   lcd.setCursor(0, 1);
   lcd.print(temperature);

   if(temperature>150)
  {
    lcd.setCursor(0, 0);
   lcd.print("crack detected    ");
    lcd.setCursor(4, 1);
   lcd.print("Need safety    ");
     }
     if(temperature<150)
  {

   lcd.setCursor(0, 0);
   lcd.print(" no issues      ");
    lcd.setCursor(3, 1);
   lcd.print(" Normal       ");
     }


    delay(1000);
 }
```

fig:5.1 ArdunioCoding

The fault calculation algorithm used depends on the type of the fault that occurs. Unsymmetrical faults are

- Line to Line (LL) fault,
- Double Line to Ground (DLG) fault
- Single Line to Ground (SLG)fault

Three phase fault is the only symmetrical fault where all phases are in contact with each other. The distance Relay will first determine the type of fault with the help of a fault current magnitude detection algorithm. After that, the corresponding formula is used for fault impedance calculation.

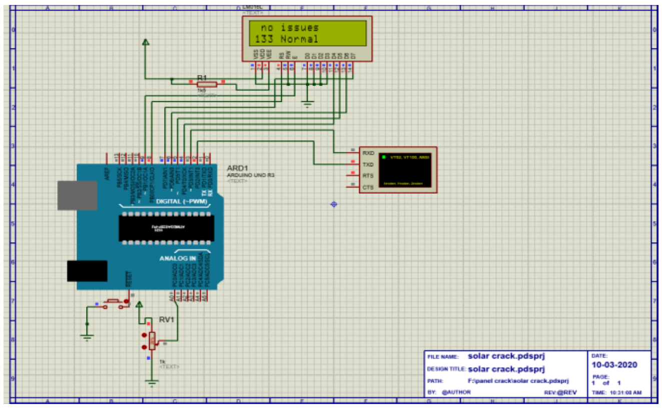

Fig 5.2 Normal panel Condition

The above fig5.2 shows the arduino controller software when the LDR resistance value and panel output voltage both are high or low then no issue condition shows in the LCD display.

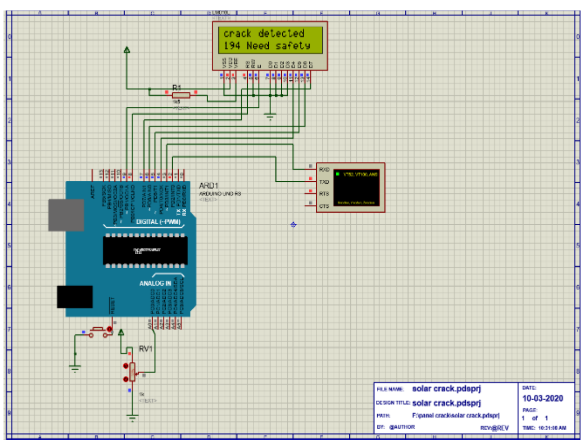

Fig 5.3 Crack Detected in solar panel

The above fig 5.3 shows the arduino controller software when the LDR resistance value high but panel output voltage low then crack detected condition show in LCD display.

VI.BLOCK DIAGRAM

The Internet of Things has a vision in which the internet extends into the real world embracing everyday objects. The IoT allows objects to be sensed and/or controlled remotely over existing network infrastructure, creating opportunities for pure integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit in addition to reduced human intervention. This technology has many applications like Solar cities, Smart villages, Micro grids and Solar Street lights and so on. As Renewable energy grew at a rate faster than any other time in history during this period. The proposed system refers to the online display of the power usage of solar energy as a renewable energy and indicating faults in the sola5rdr panel .

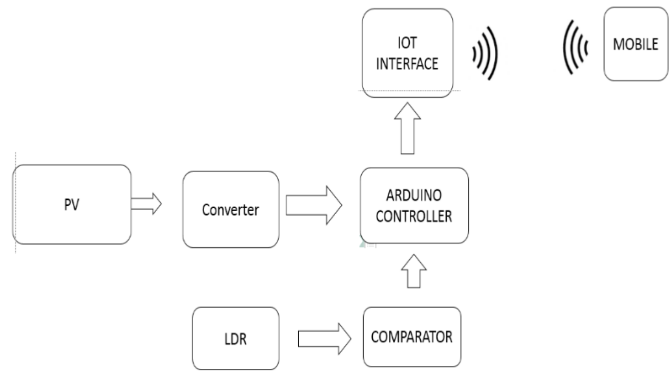

Fig6.1 Block Diagram

The proposed system is for monitoring of solar energy using IoT. Solar panel helps to store the energy in the battery. Battery has the energy which is useful for the electrical appliances. Battery is connected to the Arduino. Arduino is a micro controller which is used to read the sensor values. Current sensor and voltage divider are connecting to the Arduino.

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Those values are used in the proposed system for calculating power. In this setup DC bulb is consider as a load. Battery is considered as the power supply. Other pins of sensor is connects to the Arduino

VII.HARDWARE DISCRIPTION

The hardware mode consists of Arduino controller, power supply unit, bridge rectifier, regulator IC, magnetic relay, LCD display, VI measurement unit, step up motor, Wi-Fi module, and LDR sensor. The input to the ardunio board is given through the power supply unit.The 12 voltage AC converted into 12Voltage DC through bridge rectifier by using regulator IC and filter the 12 voltage direct current converted into the 5v direct current. This 5v direct current given to the ardunio board and wifi model. The 12v direct current given directly through the magnetic relay. In VI measurement system we have to change the voltage level manually .Now we reduce the voltage level and kept light intensity level as low then the LCD display as' no issues'. It means there is no fault occur on the panel, but we reduce the voltage level and kept light intensity level as high, then the LCD display 'crack detected need safety'. Its means some fault occur on the panel.

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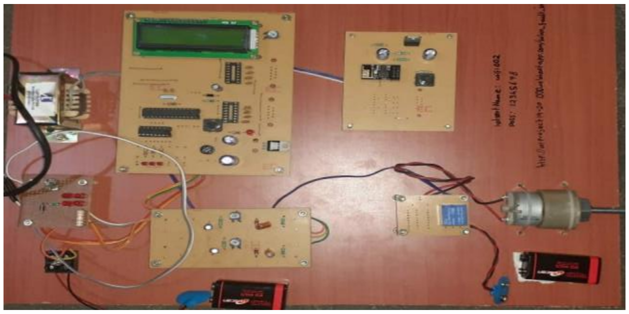

Fig 7.1 Hardware Setup

a) POWER SUPPLY UNIT

Most electronic circuits require DC voltage sources or power supplies. If the electronic device is to be portable, then one or more batteries are usually needed to provide the DC voltage required by electronic circuits. But batteries have a limited life span and cannot be recharged. The solution is to convert the alternating current lose hold line voltage to a DC voltage source.

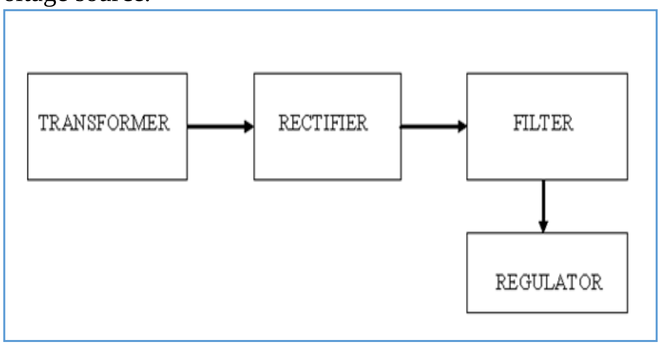

Fig 7.2 block diagram for power supply unit

The fig 7.2 shows the block diagram of AC to DC power supply, it consists of following,

1. Transformer: Steps the household line voltage up or down as required.
2. Rectifier: Converts ac voltage into dc voltage.
3. Filter: Smooth the pulsating DC voltage to a varying DC voltage.
4. Regulator: Fix the output voltage to constant value.

b)ELECTRICAL TRNSFORMER

A Transformer is an electrical device that takes electricity of one voltage and changes it into another voltage. In AC circuits, AC voltage, current and waveform can be transformed with the help of Transformers. Transformer plays an important role in electronic equipment. AC and DC voltage in Power supply equipment are almost achieved by transformer's transformation and commutation.

VIII.CONCLUSION

As the conventional sources of electricity generation are depleting, mankind is in need of renewable sources such as solar and wind energy to sustain itself. The clean and abundant solar energy is a good alternative as a source of energy with the only problems of cost of harnessing solar energy, and its variable nature. With technological advancements, cost of devices is decreasing with a rapid rate. Hence all we need is a good, up-to-date monitoring system which can perform major tasks automatically without human intervention and can provide data to the user whenever and wherever needed. To hope up with rapidly changing technology, IOT is the best solution for monitoring of solar installations. IOT based remote monitoring of the Solar PV installation will also save energy and man-labour. Because of the use of IOT in this proposed system, there is a large scope for future work.

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