IoT Based Solar Panel Fault Monitoring and Control

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Abstract- **Continual monitoring of the status and detecting the faults to guarantee the infallible faculties administering of Solar panel in aloof district is our contribution in this form, this work is part of occupation. This paper describes the hardware implementation for fault detection and continual monitoring system for solar panel in remote area using IOT. This analysis problem has been stated by engineers working in Solar panel maintenance system. As expectedsolution to this wireless sensor node is provided with Voltage sensor, Existing antenna, Light sensor, Temperature sensor and Dust sensor and XBeeS2 to implement WSN. Materials are being continuously stored and monitored at central station called HUB and through that data are being sent to server via Ethernet.A accessible GUI using Python is implemented to visualize monitoring performance and save data on Excel file. The described system is built and acceptable results has been obtained.**

Keywords—Wireless Sensor Network (WSN), Light Dependent Resistor (LDR)

I. INTRODUCTION

As non-renewable energy resources are depleted with time it is prime to use renewable energy resources like Solar and air efficiency because of its unlimited supply, monetary long-term benefits and environmental friendliness. According to DJ Pandian, principal secretary, energy and petrochemicals department of the stategovernment, they foretaste more 300 MW of solar proficiency generation capacity to be commissioned in the state before 31st December 2015. The heaping of solar photo-voltaic promotes in consumer market shows awareness of renewable energy. In function to reach maximum benefit and efficiency and to prevent damage it is necessary to monitor the condition of photovoltaic panels continuously [1][2][5]. No matter how here is frank debased luck of sway mistreat of capacity fitting adventitious or unconditional nervous breakdown of encode it is vital to limit and notify the center station to prevent from damage as the cost of components are unconditionally decidedly snobbish.

Essential cause like bolt strikes, cyclone, blast and heavy rain or even a insect can also damage solar panel and overloading in supply grid can also force power reduction and sometimes shutdowns in addition to. So it is foremost to monitor each and every smallest fault and give result to central station quickly otherwise it leads to large financial losses. Expect for it is plead to acquire losses fitting to hesitating of Solar panel. In present industrial scenario PLC and SCADA structures are being used to monitor Voltage and Current of Solar panel plant. In this manufacture of monitoring system all the panels are connected and the monitoring system is placed after the inverter. Calling with this type of monitoring system is we cannot get each solar panel Voltage and Current of individual solar panel and also we can't detect fault or take effort to crash of solar panel. Corporation orthodoxy is very much costlier also and once it is wired it is static.

In order to overcome this problems and as a better alternative solution to this we provide wireless solar panel condition monitoring system that measures electrical parameters of all of the solar panel individually and also it monitors the condition of solar panel continuously. This micro-controller based system is also cost-effective as it does not requires any extra sensor circuits for voltage and current, also the end node is powered by solar panel so it is versatile solution.

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II. PROJECT ARCHITECTURE

For electrical parameter measurement of all the panels it is difficult for engineer to measure them on the field so wireless sensor network is a solution to this. The Project system architecture wireless sensor node [4] which is affiliated to each individual solar panel and second part is central computer or HUB which is a computer is connected wirelessly with all devices that displays the data of all panels using GUI [3]. The XBee unit affiliated to juncture must be in objective device or router mode arrangement where as the HUB should be in Supervisor mode [12]. Supervisor asks each node to assign their information and that device responds with acquired information. As that data acquired by HUB it stores it internally on excel file and transmit the information to cloud via internet.

III. RELATED WORK

Kian Jazayeri; SenerUysal [1] et al developing an smart arrangement which provides real time monitoring and defect recognition for solar panels. Utilizing artificial neural network technology, the solar panel defect recognition system is capable of perceiving sun's position in the atmosphere and estimating the equivalent output power of a solar panel based on the algorithms.

Yuji Higuchi ; TadatoshiBabasaki [2] et al report various methods for classifying faults that use the data of string measurement devices used for continuously monitoring solar power panels remotely.

MoathAlsafasfeh; Ikhlas Abdel-Qader[3]et al concentrating on creating a framework for automating defect recognition in a solar energy system using thermal imaging to create an accurate and a timely alert system of hazardous conditions.

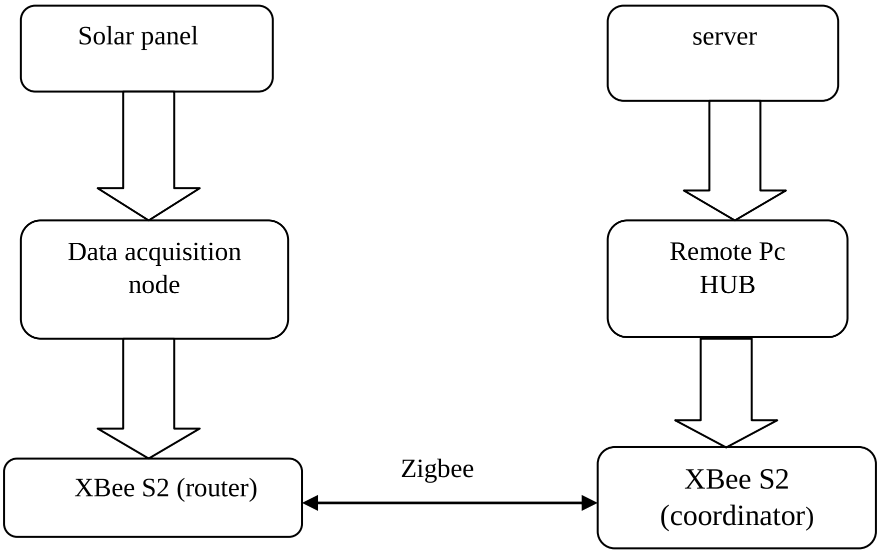
ShaikAyesh; P. Ramesh; SabithaRamakrishnan [4] et al puts forward the technique of monitoring the operation and yield of individual photovoltaic (PV) panels in a PV plant using Wireless Sensor Networks (WSN).

Ali Al-Dahoud [5]et al designed classifier based on Fuzzy logic controller is integrated within the Joint. The WSN joints are implemented with suitable sensors for usually occurring faults on the solar power panels.

Vinicius C. Ferreira ; [6]et al designs a solution that makes use of machine learning techniques for automated defect recognition and diagnosis (FDD) on solar-powered Wireless Mesh Networks (WMNs).

IV. EXISTING SYSTEM

Data Acquisition Node The data acquisition node is made by various sensors ,that are Voltage sensor, Current sensor, Light sensor, Dust sensor and Temperature sensor. MSP430f6779 microcontroller has seven channel on chip SD-24 bit ADC and 6 channel 10- bit ADC. So at a time three solar panel data can be supervised with it. Accordingly as shown in figure-2.



Block diagram of existing architecture

All the sensors are associated to 10 bit ADC and Voltage and Current front-end sensor are connected to Sigma-Delta ADC. Rather than using this type of exorbitant Voltage and Current sensors to reduce cost We have used ordinary resistor divider circuit. This circuit vary from panel to panel but its price is reduced to my joint structure side I will be having three Voltage and three Current front-end circuit to measure electrical parameter. As we forth DC Voltage and Current for each panel we can acquire power that is being consumed by load. MSP430f6779 has on chip RTC consequently we can acquire real time information through it [11]. For the power supply of our board we have used secondary power supply which is taken off from solar panel itself consequently my device becomes self powered. Also temperature sensor, light sensor and dust sensor are also powered by solar panel itself consequently there is no necessity to supply the power from any other device to joint. Now converted data from 10 bit ADC is integrated with SD-24 bit ADC and it is joined with current date-time one frame of XBee S2 is made and that frame is sent to UART serially.

Our UART baud rate is 9600bps we can make it to higher data rate also. XBee is connected to joint via UART communication protocol. We have to set Zigbee communication protocol and then only we can transmit a information to focal station. Transmit frame structure of XBee s2 is shown in figure 3[12]. XBee module works on mesh protocol. XBee unit ensures the information received by focal station by receiving acknowledge frame. The joint often monitors the sensors and electrical parameters of all solar panels but it does not send it until the HUB requests it for. As soon as HUB asks it to send its Fig. 2. Node Design parameters it transmit its frame which involves the data of sensors and panel parameters and current time. We need to connect external coin cell battery with RTC module to keep it ON while solar panel is OFF. B. Wireless Sensor Network The frame structure of XBee transfer request frame is shown in figure. Here, RF information contains all the data of joint containing electrical parameters, sensor information and time also.

Option filed contains whether to receive acknowledgement or not. Destination address contains 64 bit of destination physical address which is identical to all other XBee modules. No other XBee can have same physical address. Because of this field of XBee we can assure that duplicate nearby device can interfere in our communication. If exceeding frame than one frame is being sent to other device frame id is provided with it. API identifier indicate type of frame. Length specifies the length of our data. If length is lesser than 0xFFh value it is stored in LSB only and if more than it MSB and LSB both are habituated to specify the length of upcoming data. Start delimiter specifies following frame is arriving and check-sum is 2’s complement of addition of all above fields. XBee module won’t send imperfect frames. Any of fields is not identical to the data is coming to its UART pins as a result of inaccurate data it discards frame by itself.

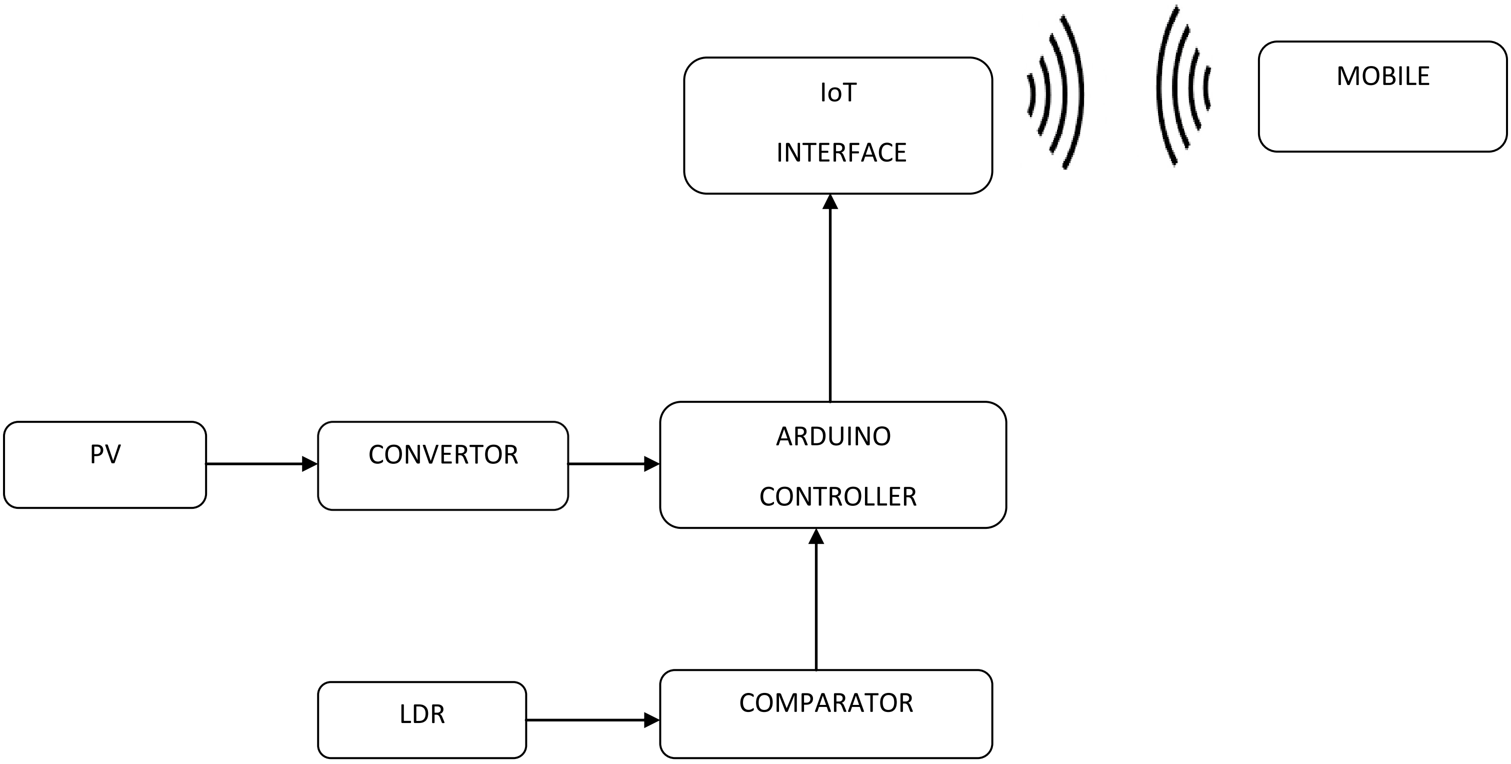
V. SOLAR PANEL FAULT MONITORING SYSTEM

The Internet of Things has a view in which the internet extends into the reality embracing everyday objects. The IoT allows objects to be sensed and/or composed distantly over current network structure, creating opportunities for pure combination of the physical world into computer-based systems, and brings about in improved efficiency, accuracy and economic benefit in addition to reduced human intervention. This technology has several applications like Solar cities, Smart villages, Micro grids and Solar Street lights and so on. As Renewable energy grew at a rate faster than all other time in history during this period. The suggested arrangement refers to the online exposure of the power utilization of solar energy as a renewable energy and indicating defects in the solar panel.

The suggested 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 beneficial for the electrical appliances. Battery is combined to the Arduino. Arduino is a micro controller which is worn to read the sensor values. Current sensor and voltage divider are connecting to the Arduino.

In Current and Voltage Acquisition Circuit, the analog inputs of an Arduino can measure up to 5V. Even when connect to a 5V circuit, you require the resistors to help protect the Arduino from short-circuits or unexpected voltage surges.

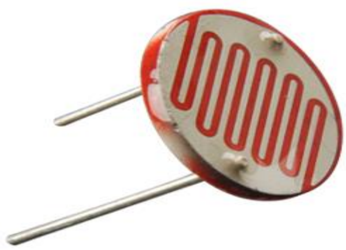
Those two resistors form a potential divider that is used to lower the voltage measuring to a level that the Arduino can read. Fig shows the voltage divider circuit. 10kohm and 100kohm register are worn to lower the voltage circuit to 5V. Breadboard is worn to build this circuit. The Analog pin of arduino gives the voltage value. This actually extends the range that can be used.



Block Diagram of fault monitoring System

The formula for calculating values in a potential divider is: Vout = (R2 / (R1 + R2)) * Vin If the divider for the Arduino voltmeter is operating 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)) For current measurement we will worn a Hall Effect current sensor ACS 712 (30 A). ACS 712 represents 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 suggested 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

A. Light dependent resistor



A photoresistor (or light-dependent resistor, LDR, or photo-conductive cell) is a light-controlled variable resistor. The resistance of a photoresistor decreases with increasing incident light intensity; in other words, it exhibits photoconductivity. A photoresistor can be applied in light-sensitive detector circuits, and light-activated and dark-activated switching circuits.

A photoresistor is bound of a high resistance semiconductor. In the dark, a photoresistor can have a resistance as high as several megohms (MΩ), while in the light, a photoresistor can have a resistance as low as a few hundred ohms. If incident light on a photoresistor exceeds a absolute frequency, photons immersed by the semiconductor give bound electrons enough energy to jump into the conduction band. The resulting free electrons (and their hole partners) conduct electricity, thereby lowering resistance. The resistance range and sensitivity of a photoresistor can significantly differ among dissimilar devices. Furthermore, unique photoresistors may react much differently to photons within certain wavelength bands.

A photoelectric device can be either intrinsic or extrinsic. An intrinsic semiconductor has its individual charge carriers and is remote an efficient semiconductor, for example, silicon. In intrinsic devices the only available electrons are in the valence band, and hence the photon must have sufficient energy to excite the electron across the entire bandgap. Extrinsic devices have impurities, also called dopantsare added whose ground state energy is closer to the conduction band; since the electrons do not have as far to jump, lower energy photons (that is, longer wavelengths and lower frequencies) are sufficient to trigger the device. If a instance of silicon has some of its atoms replaced by phosphorus atoms (impurities), there will be extra electrons available for conduction. This is an example of an extrinsic semiconductor.

B. Arduino Uno

The arduino board exposes most of the microcontroller's I/O Pins for use by other circuits. The diecimila, Duemilanove, and current Uno provide 14 digital I/O Pins , six of which can produce pulse width modulated signals, six analog inputs, which can be used as a six digital I/O Pins

VI. RESULTS IN PANEL

PANEL WITHOTUT DEFECT				PANEL WITH DEFECT			
LDR		PANEL		LDR		PANEL	
L1	90ohms	P1	10V	L1	90ohms	P1	9V
L2	91ohms	P2	11V	L2	91ohms	P2	10V
L3	90ohms	P3	10V	L3	90ohms	P3	0V

VII. CONCLUSION

In this work we have designed how to access a set of solar panel at remote area with using WSN. Continuous monitoring solar plant is prime requirement of industry. Assumed hardware and software is been obligated for the resolute monitoring purpose. In the forthcoming work the better GUI design and to make better human machine interface. Also there will be some difficulties in real environment when there is more than hundreds of a PV panel.

VIII. REFERENCES

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