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IoT based Fault detection in Solar Panel using Arduino UNO with Wi-Fi Module ESP 8266

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Abstract: ***Increase in population increases the power demand. Solar is one of the natural resource used for generation of electricity. Solar panels are used for generation. If any scratch or small damage occurs in the panel then it will cause degradation in output. To improve the energy efficiency the damages should be detected. For deducting the damages various techniques had been used but they are time consuming process and are of high cost. This project proposes that whenever fault is occurred it is automatically detected with the help of internet of things. Each solar panel is connected to a current sensor if a fault occurs due to cracks on the surface of the panel then the current values in the damaged panel gets varied. This information is obtained with the help of current sensor. Then these values are sent to the monitoring centre through WI-FI module. By this the fault can be easily detected and automatically send to the engineers.***

Keywords: IoT, WI-FI module, Arduino uno, pulse-width modulation, General purpose input/output pins (GPIO)

I. INTRODUCTION

Embedded system is programmed by controller and it consists of hardware and mechanical parts. It is controlled by RTOS (Real time operating system). The hardware of the embedded system can be a microcontroller or microprocessor. Embedded system software is written in high level setup and is used to perform specific function. The main characteristic of the embedded system is to produces output within its time limit. It consumes less power and operates at a fast rate. It is highly reliable and is economical.

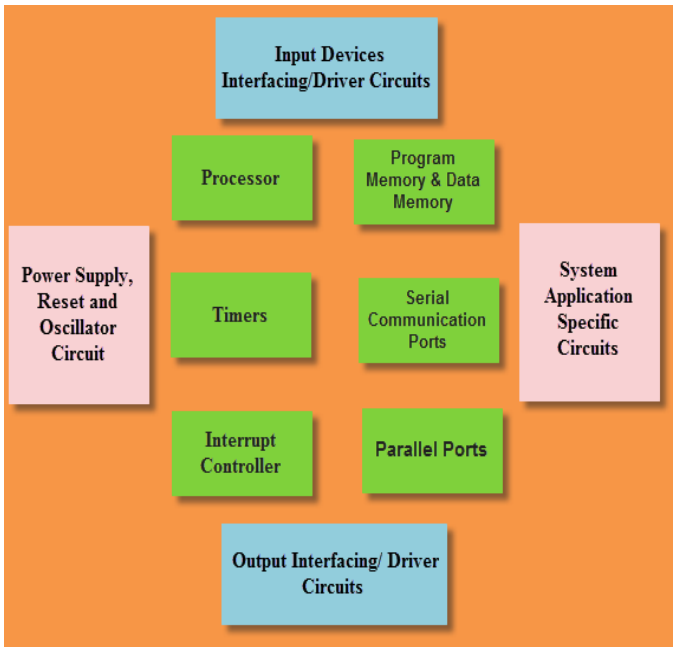

Fig. 1. Embedded System

II. EXISTING SYSTEM

A. Internet of Things

The term IOT is the interconnection via internet of computing devices. It is used for monitoring and supervisory actions. It can collect information and send it and it can also receive information and act on it. Here the information is collected by providing the sensors accordingly to the use of the organization. So with the combination of internet and the sensors it is possible to sense the information to make accurate decisions automatically and also by gathering the data we can reduce the human performance or effort, cost and losses. For instant, when any physical objects are connected to IOT, it starts to monitor and control the objects automatically without any human effort.

B. Thermal Imaging Process

One of the methods for evaluating the photovoltaic cell is by monitoring the panel with a thermal imaging camera. Now a day the uncooled thermal imaging cameras are widely used for better quality control of the panel because of its flexibility and lightweight features. One of the advanced features is that it can be linked with the GPS data which can result in clearing the fault in a huge area like solar farms easily. Un-cooled micro bolometer detector consists of glass which is not transparent.

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When we view the panel from the front side with a thermal imaging camera we can able to view the heat distribution in the solar panel which describes the thermal performance of the solar panel.

If the glass surface of solar panel is small in size then the temperature variation can be found with thermal image processing. In order to make the thermal differences to be visible, thermal sensitivity of the camera must be more than 80k. Due to the automatic equalization of camera's histogram which adjusts to the measured temperature which exist between maximum and minimum, many of the small thermal irregularities are not visible. But this process consumes more time; it needs human involvement and is of high cost.

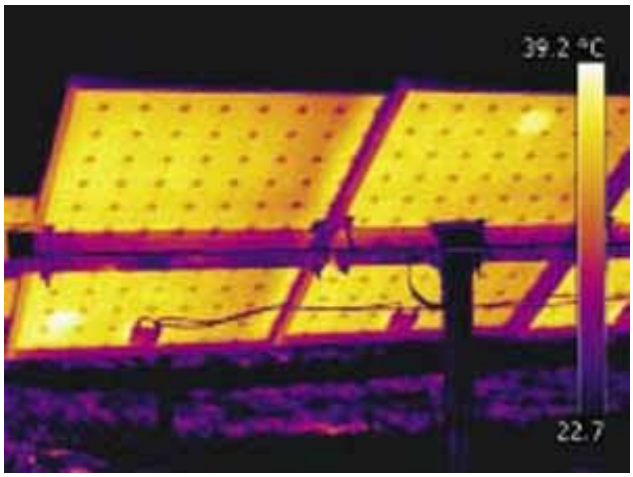

Fig. 2 Thermal imaging of solar panel

C. Electro Luminescence Process

Due to the uniform background characterization of the mono crystalline cell, the Micro-crack detection is relatively straight forward. As multi crystalline cell does not have uniform background micro crack detection is very complex due to intrinsic structures like dislocation clusters and grain boundaries which form the dark areas. Differentiating micro crack pixels from the background is called multi crystalline grains which is procedure due to the grayscale values of these two areas are significantly same and is more challenging. This problem becomes more complex when there seems a presence of other defects like the broken fingers, darker grains and dark area. It is possible to identify the micro-cracks as it appears in a strong line form with high gradient and low intensity.

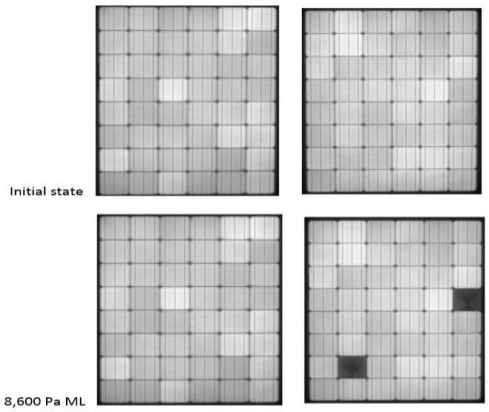

Fig. 3. Micro cracks in solar panel

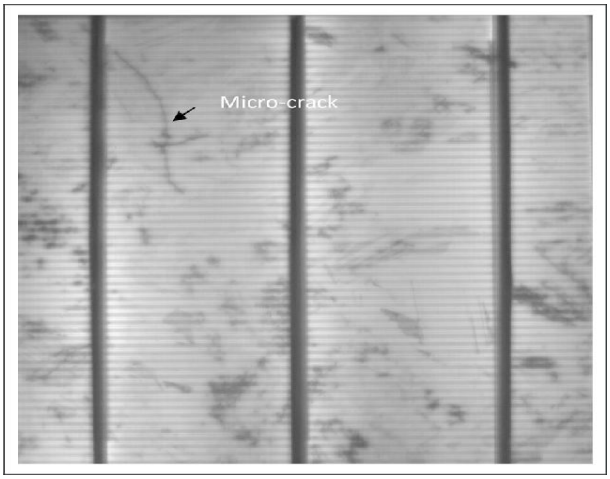

Fig. 4. Micro crack in the solar panel

D. Drawbacks Of Existing System

- The existing system is of high cost and it is uneconomical.
- The existing system consumes more time and there will be shutdown of solar power plant for a short period of time if fault occurs.
- Human involvement is used for detecting the fault.
- Micro cracks and small damage in the panel can't be found with the help of existing model.

III. PROPOSED SYSTEM

A. Introduction

To increase the current solar cells are connected in parallel and to increase the voltage they are connected in series. We consider only few cells but to generate high power in practical photovoltaic cells are connected either in series or in parallel. If a fault occurs in any one panel it is difficult to find fault in large area. The current sensor is connected to the output of each panel. The output of the sensor is in the form of analog value and using Analog to digital converter (ADC) it is converted into digital value. These values are given to the Arduino UNO. If any fault occurred in the solar panel the current value will be less than that of the threshold value. Then this information is send to the monitor control unit with the help of Wi-Fi module. By this the fault is detected in the solar panels and the information is updated immediately to the monitoring unit.

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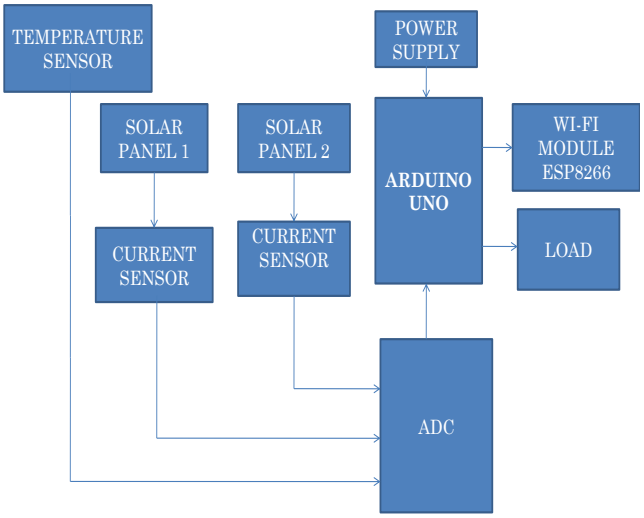

Fig. 5. Block diagram of proposed model

B. Specification of solar panel

Dimension : 128x190x2mm
Maximum Power Current : 320mA
Short Circuit Current : 250-270mA
Maximum System Voltage : 550V
Open Circuit Voltage : 12V

C. Temperature sensor

Negative temperature coefficient thermistor is used for temperature measurement. NTC provides high accuracy and its resistance varies for small temperature variation. It is a non linear resistor that varies resistance according to the temperature variation. Thermistor is a combination of thermal and a resistor. It is temperature sensitive and it is available for a wide range.

D. Arduino uno

Arduino is a open source platform that can be used to design various electronic projects. Arduino uno is hardware which is based on microcontroller AT mega 328P. It is programmed using arduino programming language. It accepts voltage between 7 volt and 20 volt so it is connected to a 9 volt battery externally.

Input Voltage is 6-20V and there are 14 Digital Input/ Output Pins of which 6 provide Pulse width modulation output. 6 Analog Input Pins are present, DC Current per I/O is Pin 40 mA, DC Current for 3.3V Pin is 50 mA, Flash Memory of arduino is 32 KB (ATmega328) of which 0.5 KB used by boot loader, SRAM is 2 KB (ATmega328), EEPROM- 1 KB (ATmega328) and Clock Speed is 16 MHz.

In this project arduino uno is used to receive the current values from each solar panel and check whether the values are within the threshold values. If the values go below the threshold range then it will send alert message to the monitor control centre. Here arduino is used as it is more reliable, economical and it operates at a faster rate.

E. Wi-Fi Module Esp 8266

Wireless network is that it used to connect anywhere and it is called Wi-Fi. The one of the most important merit is that it adapts mostly with every operating system and electronic devices. As it connects anywhere it is possible only by radio waves to deliver the information over a network. ESP8266 consists of 16 general-purpose input/ output pins (GPIO). Wi-Fi transmits data over the network at a frequency of about 2.4 GHz or 5 GHz. It uses 10 bit analog-to-digital conversion and uses pulse-width modulation (PWM). The next promoted state of WiFi is that WiMax. This is much similar to WiFi but accessibility over a large area.

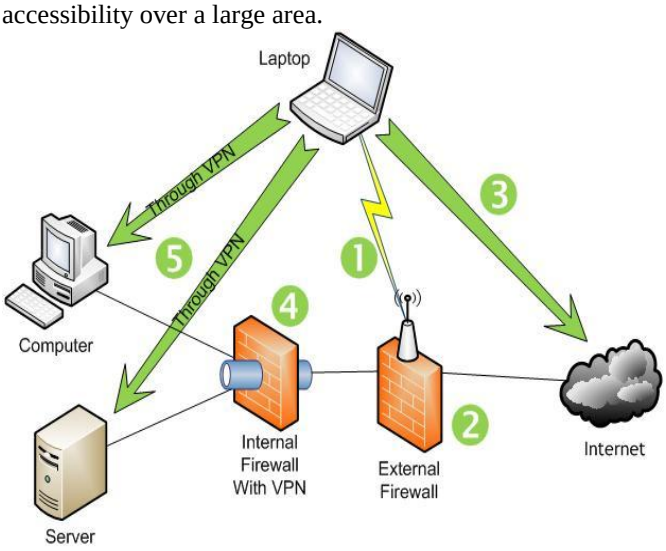

Fig. 6. Wi-Fi Module 8266

IV. CONCLUSION

This process the faults are detected using Arduino UNO which is simple and it does not consume more time and it is very economical. In this process fault is detected without any human involvement. It improves the safety and security and it can also used in large industries. The current values can be updated from anywhere using the Wi-Fi module and the system operates based on the surrounding temperature.

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