Solar Panel Tracking and Monitoring System

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Abstract

In the current world, energy production systems are becoming the outright necessity. On one side, non-renewable energy sources are depleting the world's environment and becoming exhaustible over time. So there is profound need to have renewable energy sources at use. Solar energy, among other renewable energy resources, is propitious and ever-lasting energy source which can handle prolonged issues of energy crisis. There is also a basic necessity for having energy production system that provides transparency for end-users. This has resulted in uttermost necessity to have a prolific renewable energy system that provides supervisory viability to monitor the system. In this project, we propose beneficial methodology to draft a system that provides tracking solar panel which moves along the motion of the sun throughout the day. Transparency of this system is provided by implementing Internet of Things to monitor the system's environmental status time to time online.

Keywords- Renewable energy, Solar Energy, Solar Panel, Internet of Things, Embedded Systems

I. Introduction

In this world, every living being is dependent on energy for survival. Non-renewable energy production is becoming a difficult process every now and then. This kind of energy resources are exhaustible and cannot be replenished quite easily. The prolonged use of non-renewable resources has clear repercussion for our health and prosperity due to degradation of environment. Renewable energy sources will be the need of hour in the near future as they are generated from natural processes and can be replenished quite easily. Solar energy is one such energy source which is provided by the sun from the solar radiations. Solar panels (called Photovoltaic Panels) comprise of several individual solar cells which collect renewable energy in the form of sunlight and convert the light into electric energy.

PV panels may perfectly align to absorb the sun's radiation. But on other hand, sun does not stay at same position entire day. Tracking solar panels change their orientation throughout the day to follow the motion of the sun. This tracking methodology is novel and productive as the panel is tracked along the motion of the sun all the day. Embedded Systems are defined as dedicated computer system that has hardware with software embedded in it and designed for one specific application. In these systems, all components work according to a set of rules. Generally, an embedded system comprises power supply, memory and serial communication ports. Basic examples are engineering calculators, airbag control system, washing machine and industrial robots.

II. Architectural design

Architectural design of the system is depicted in the below diagram Fig.1. Our system is composed of both hardware and software working parts. Platform on which system will be running is Arduino Mega. It is connected with peripheral sensors like Voltage sensor, Current sensor, Dust sensor and temperature sensor. Solar panel and LDR sensors laid aside the panel - are interfaced with Arduino. Solar panel is aided with mechanical support on which gear motor is set up. Motor driving circuit is also interfaced with Arduino. Software working part resembles the functional logic of the system. It forms as thinking part of the system by directing sensing and actuation of the components connected. System is made connected to the webpage via Internet which provides monitoring of environmental characteristic values to the users.

The prototype of the automatic single-axis solar tracking solar panel with supervisory to monitor the system and feasibility to perform analysis of the system working is designed in this paper. The design of the proposed system is well depicted in the Architectural diagram. Proposed system tracks the solar panel along the motion of sun from east to west (single-axis). As depicted in the diagram Fig. 1, two LDR sensors are laid aside the solar panel such that both are separated by a mid-junction. Movement of solar panel is controlled by the gear box motor that is fitted with the mechanical support of the panel. Actuation of panel depends on the activation of LDR sensors that are present on either side of the mid-junction. This ensures that panel moves to the direction of the sun and, movement is continued until the panel is inclined perpendicular to the solar rays. Environmental values – Temperature, Dust, Current and Voltage obtained from the respective sensors are loaded to the webpage and, can be viewed time to time online.

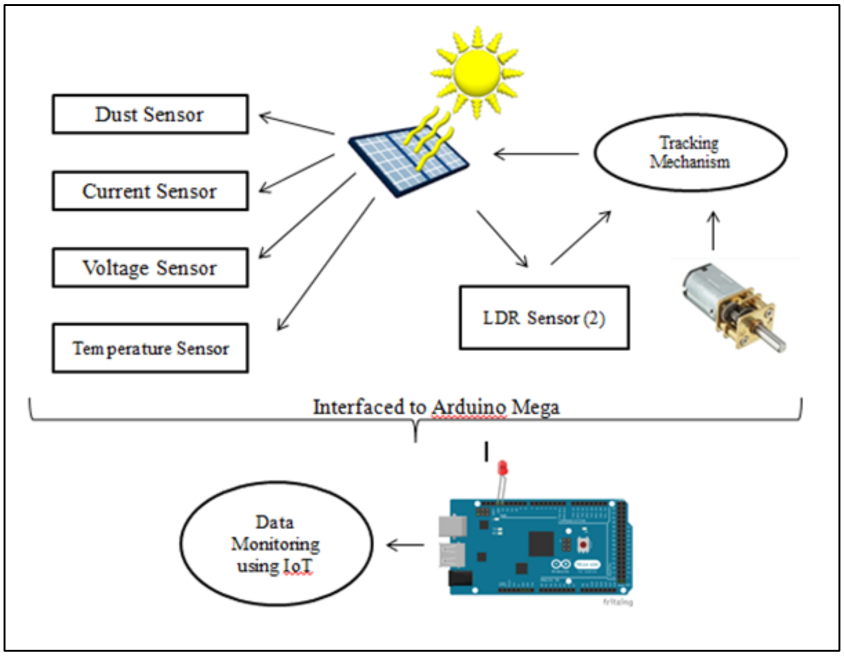

Fig. 1: Architectural Diagram

III. COMPONENT AND TECHNOLOGY STUDY

A. Arduino Mega 2560 Microcontroller

Arduino is an open-source electronics platform which is easy to use hardware and software. They are capable of reading input and producing outputs i.e they are able to sense input values from their peripherals and actuate an output based on that. Arduino Mega 2560 is microcontroller board in the series of Arduino which has 54 digital input/output pins, 16 analog inputs, 16 Mhz crystal oscillator, a USB connection, a power jack and a reset button. Generally these microcontrollers provide support of interfacing to any peripheral components. They can simply get connected to computer, connected to any sort of sensor and read values, connected to any sort of actuator and provide any motion. They are used to implement embedded systems.

B. Solar Panel

Solar Panel is an energy production component which absorbs the sun's radiation and converts them into electricity or heat. A solar panel comprise of array of photovoltaic cells which can be used to generate electricity through photovoltaic effect. To get most out of the solar panel, it has to be emplaced directly at the sun's radiant energy, the more surface area that is exposed to direct sunlight, the more output the solar panel will furnish.

C. Sensors

Sensors in the embedded systems are used for detecting changes in an object (or) a device (or) environment. Physical changes may include temperature, light, voltage, sound etc. These sensors are also called as peripherals of a system. There are many variety and category sensors which may use different sensing principles. They may be designed to operate within different ranges. A good sensor is sensitive to measured property alone.

D. Internet of Things and ESP

Internet of things is computing technology that encompasses everything connected to the internet. It is made up of devices that basically sensors to smartphones. Iot is very significant and will become very much significant in the future because an object that can represent itself digitally becomes something greater than the object by itself. The ESP 8266 part of Espressif System's Smart Connectivity which aims to provide mobile platform designers an environment to innovate systems with embedded Wi-Fi capabilities at the lowest cost with the greatest functionality. This module is used to implement internet of things by connecting the system where it resides to another system or internet for data collection.

IV. IMPLEMENTATION

This system needs to be implemented by interfacing all the peripheral components and solar panel with the Arduino Mega microcontroller and configure it using Embedded C programming language. Entire system is set on a plain board where each and every component is interfaced. Then it requires configuration of ESP module which is interfaced with Arduino for implementing Internet of things.

System setup is depicted in the Fig. 2, with all the components being interfaced and set up.

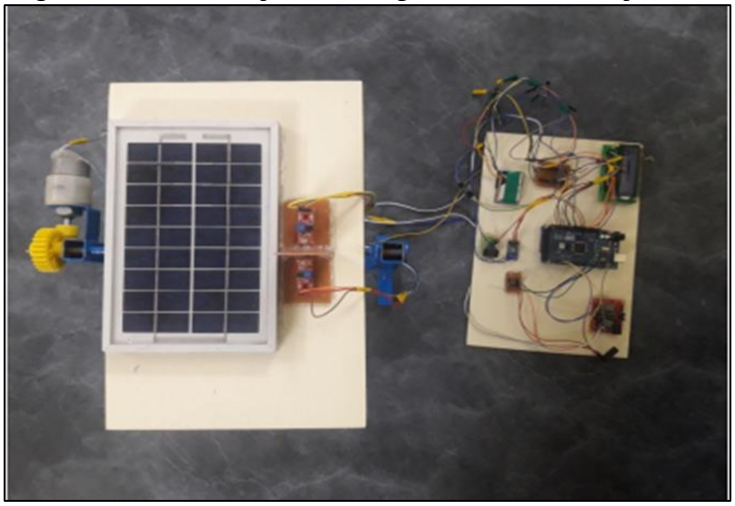

Fig. 2: System Setup

A. Setting up the System

Each sensor is interfaced to Arduino Mega by getting connected to ground (GND) pin, voltage (VCC) pin and analog pin (like A0). In our system all sensors are connected to common ground and voltage pin and, then connected to arduino. LDR sensor's digital pin is connected to Analog pin of the arduino. Voltage and Current sensors simply gets themselves connected to analog pin of the arduino respectively. In case of temperature sensor, vout pin is connected to analog pin of the arduino. Similarly, dust sensor is also interfaced with the arduino. A 16 X 2 LCD Pin is placed on the board and interfaced with the Arduino Mega.

Setting up of solar panel is done by establishing a mechanical support to lay a stand for the panel. Solar panel is laid on a board with LDR sensors grouped and placed aside. Two LDR sensors are placed in such a way that there is mid-junction that separates both the LDR. This is done to cast a shadow on respective LDR if it is not exposed to sunlight. Then the board is laid on the mechanical support aided with Gear motor for rotation. The motor is placed to the side of the board such that when supply is given, motor manoeuvre the panel forward and backward.

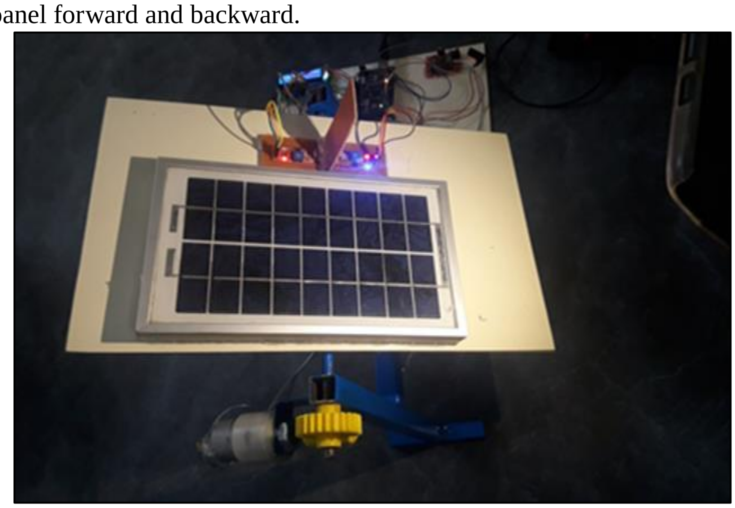

Fig. 3: Mechanical Support of the Solar Panel with the Motor

With this setting up, entire system is established. With the loading of code into the Arduino from Arduino IDE, programming part for the system will be done. Arduino IDE Code enables logic for sensing sensor values from Current sensor, Voltage sensor, Temperature sensor, and Dust sensor. It also senses activation value from two LDR's placed aside the panel. From the comparisons between the states of LDR, motor is made to actuate the solar panel. If only one LDR is activated, then motor rotates the panel in the direction of LDR and vice versa. This movement of solar panel is continued until both the LDR sensor gets activated.

B. Configuration of ESP

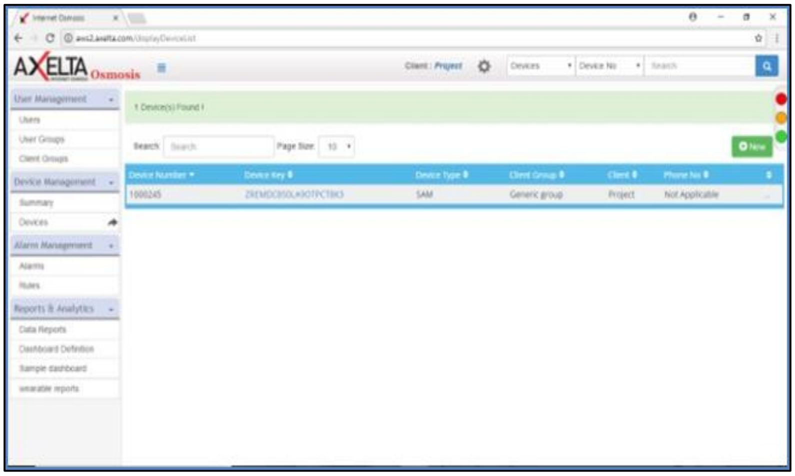

Fig. 4: ESP Configuration Details in the Axelta Website

Axelta website is used for monitoring the data read from the system. After signing up and logging in the site, new device is added to obtain device id, device key and node number. ESP module is configured with the code where initialization with SSID, Password and Website link is done. Device number, device type, device key is loaded into the code along with the data that has to be sent to the website for configuring. The code is loaded finally into the Arduino Mega for the implementation of the Solar Panel system with tracking and data monitoring over the website.

V. WORKING AND RESULTS

When the system is kept in an open place with exposure to sun, tracking of the solar panel can be seen along with the motion of the sun. If the sun's position is present towards one side of the solar panel, then respective LDR sensor gets activated. This activation is sensed by arduino and it actuates the motor to move the panel in that direction (towards the sun). This movement is stopped until both the LDR sensors gets activated such that panel is inclined perpendicularly to the sun rays. Movement of the panel stops even where there is no activation on both the LDR sensors. This activation can be viewed on the LCD screen present in the system. Along with the LDR sensors, other peripherals like temperature sensor, voltage sensor, dust sensor and current sensors response can also be viewed from the LCD screen. These environmental characteristic values can be viewed as system responses. All these responses (i.e data values) are loaded to Axelta webpage time to time. User can view those responses and system status from their account in the respective site with time and date.

A. System Response

System response can be viewed from the LCD that is interfaced within the system. Sensors that are present in the system respond its values to LCD during its working.

Fig. 5: LDR1 and LDR2 not detected

In the Fig. 5, both the LDR sensors are not detected. This response is obtained to actuate the motion of the panel. Similarly if one of the LDR sensors is detected, then arduino senses the detection and actuates the motor to move the solar panel in the direction of detected LDR sensor.

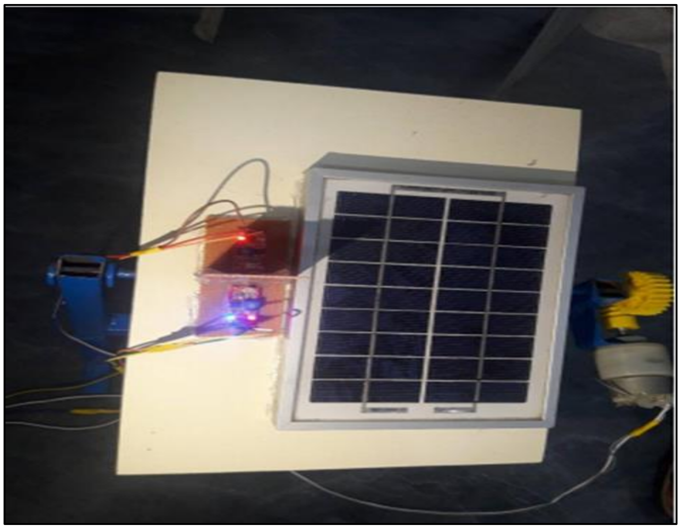

Fig. 6: Solar Panel tracked in the direction of detected LDR Sensor

Similarly other components like temperature sensor, voltage sensor, dust sensor and current sensor sense values. Those values are read by arduino and, it sends those values to LCD screen.

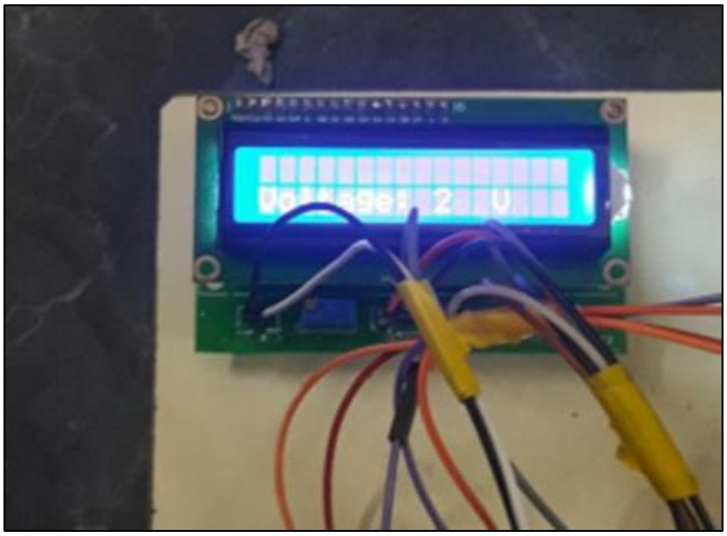

Fig. 7: Voltage Value on LCD Screen

In Fig.7, voltage value is displayed on the LCD screen. In the same way Fig.8, shows the temperature value getting displayed on the LCD Screen.

Fig. 8: Temperature Value on LCD Screen

B. Data Monitoring over Webpage

Data is monitored over the Axelta webpage by configuring the ESP. System initializes the WIFI connection successfully and then updates the sensor values – Current, Temperature, Voltage, Dust and Current time to time.

Working steps for monitoring the system status in the webpage is done by signing into the Axelta page. After successful logging into the webpage, available device can be viewed by opening devices tab. Within the device tab, device details such as device key, device type can be seen. Clicking device key displays the data list that is stored till current instant. By selecting a record from the list, respective system data can be viewed.

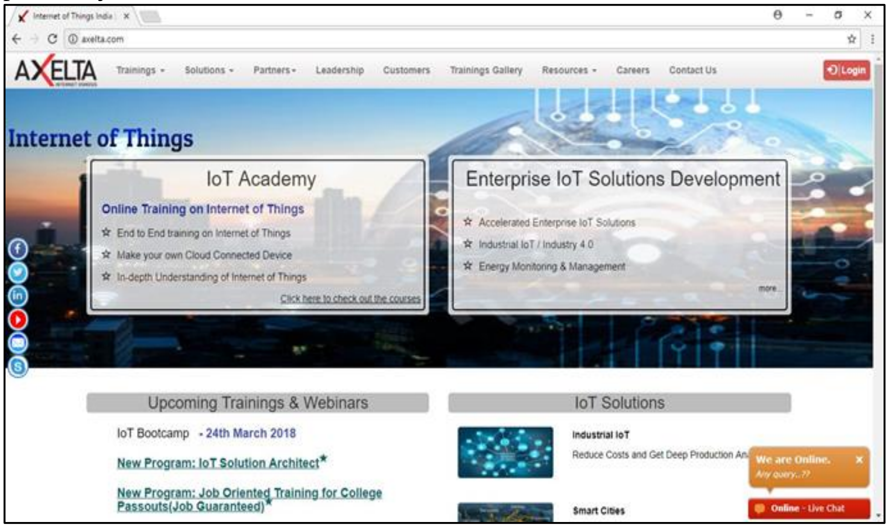

Fig. 9: Axelta Home Screen

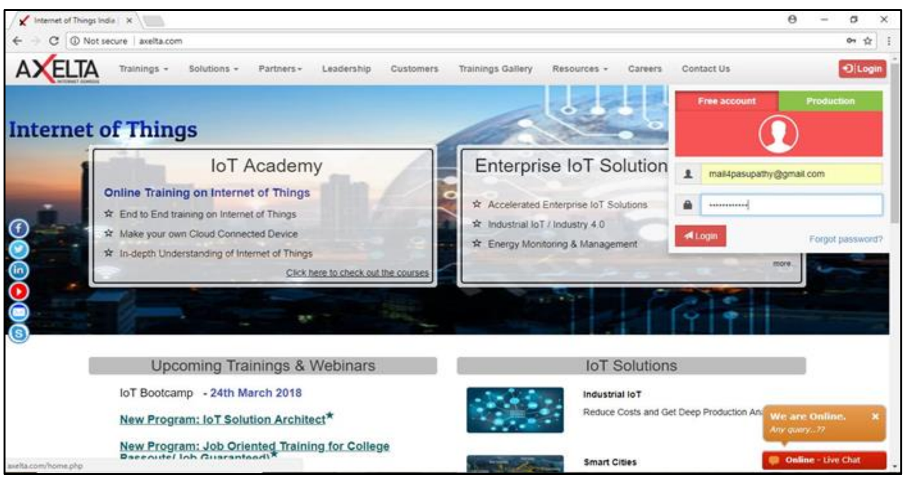

Fig. 10: Signing into Axelta

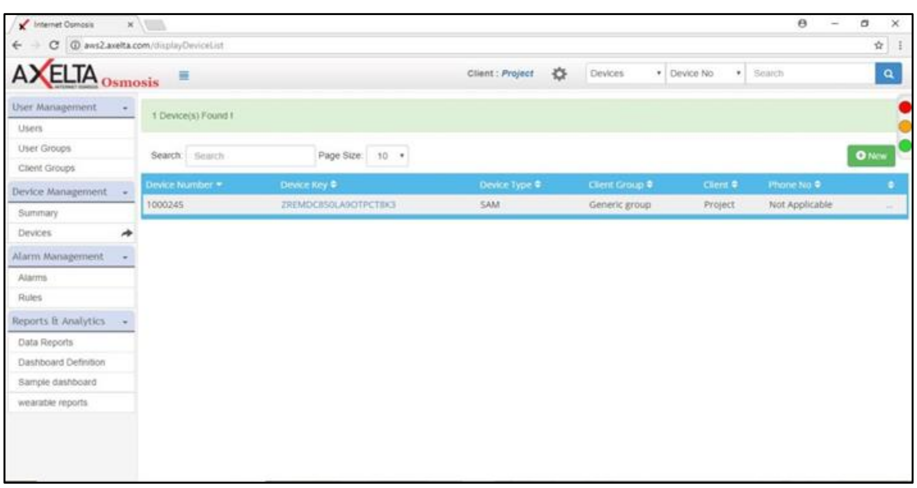

Fig. 11: Viewing the device

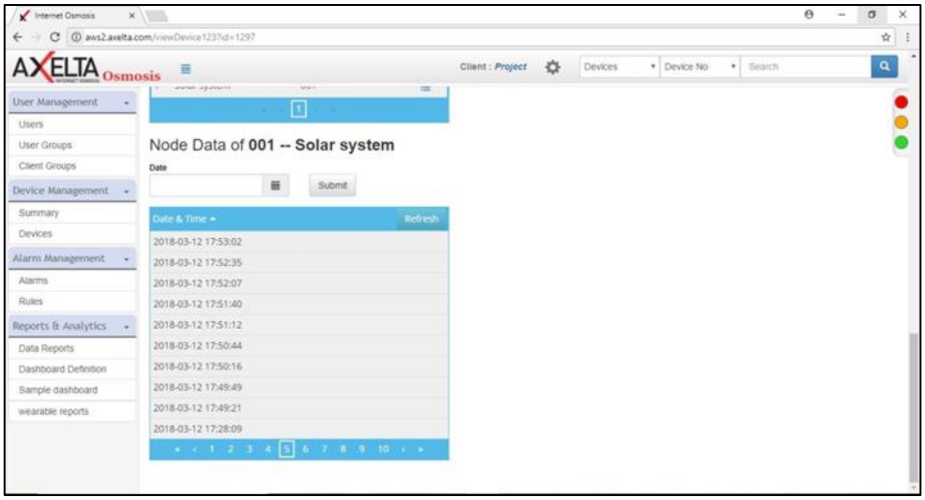

Fig. 12: Data List with time and date

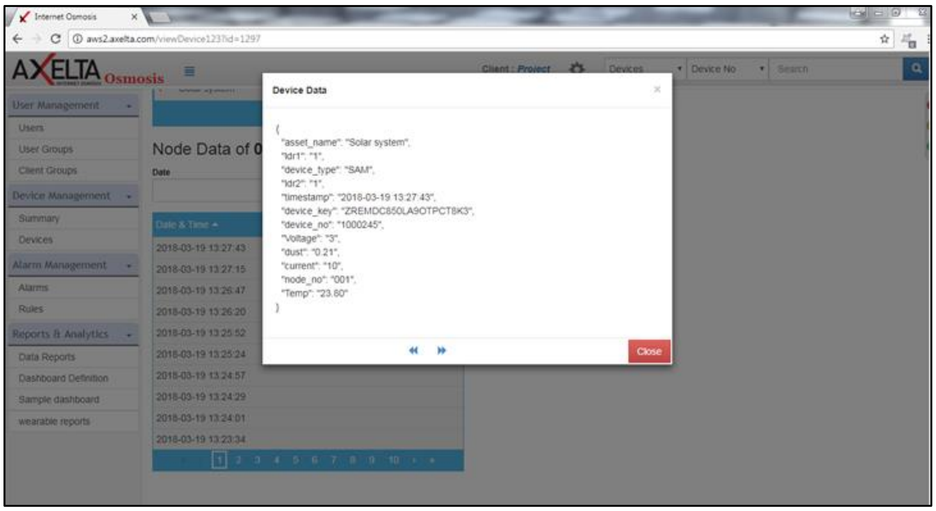

Fig. 13: System data

VI. CONCLUSION

Current world faces lot of concern over the utilization of non-renewable energy resources due to its nature of being exhaustible and hazardous. We have presented a novel methodology for designing a system that manoeuvres the solar panel along the motion of the sun. Our proposed system furnish a methodology to utilize the solar energy (which itself is renewable energy) in a productive and beneficial manner. It also ensures transparency for the users by providing a functionality of monitoring the system status every now and then on the website. With cohesive coupling of embedded technology and Internet of Things, our project provides beneficial system design which encourages the utilization of solar energy resource system with productivity and novelty.

VII. FUTURE SCOPE

This project is designed in such a way that it can track the solar panel along the motion of the sun all the day. And it also furnishes the provision to monitor the environmental characteristic values like voltage, temperature, current and dust – time to time online. In future, it will be better if system can also monitor other environmental values like humidity. Feasibility to view the system data from the mobile application can also be developed in future to increase its beneficial gains.

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