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Monitoring system for Solar panel using IoT

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Abstract: *Solar power is emerged as a likely supply of renewable power over the last to 3 decades. This sun power is transformed into electric power with the aid of using the use of sun panel in line with the precept of photovoltaic effect. Out of diverse renewable power reassets sun power is extensively used. Because it is easy and it is straightforward to apply in family too. Solar Trackers is a tool used for the rotation of sun panel in line with the solar's rays. To make use of this renewable sun power sun trackers are employed. For static sun panel, there may be no motion withinside the panel. But the placement of the solar adjustments in the course of growing and setting (solar rises withinside the east and units withinside the west). Due to this reason, unmarried axis sun tracker is advanced for rotation of sun panel in east and west direction. But because of the rotation and revolution of earth we can not get same quantity of sunrays all through the year.*

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I. INTRODUCTION

Nowadays each individual wishes electric strength for his or her high-satisfactory of life. The intake of strength is growing regular lives, and on the equal time, different power reassets are depreciating day through day.

Therefore, to fulfill the call for for strength, different reassets of strength is required. For the Generation of Electricity, there may be approaches first one is from Non-Renewable Sources, and some other one is Renewable Sources. Non-renewable reassets aren't regenerated through nature after first use such Fossil Fuels, Coal, Natural Gas, Nuclear Fuel at the same time as Renewable Sources may be applied time and again which isn't always depreciating in no way consisting of sun, Geothermal, Wind Energy and Tidal Energy. Solar strength is, therefore, is stated to be a sustainable strength source.

Solar strength has emerge as extra famous withinside the global as it's miles to be had in masses quantity with minimum effect at the environment. Though, the sun strength technology turns into inexpensive with advances withinside the conversion technology. To make the sun device reachable the tracking on the consumer stage is the want of present. More appropriate reassets of power and in few upcoming years, can also additionally triumph over non- renewable power reassets completely. Solar PV device continually producing sufficient quantity of strength.

II. LITERATURE SURVEY

Dr. Lavanya Dhanesh,Abarna M(2019), "Solar Panel monitoring system using IoT"

The paper proposed to monitor the solar panels remotely using Internet of Things. The proposed project used only current and voltage sensors. It was mainly used to calculate the power and efficiency of the solar panel and modules. They incorporated an ATMega2560 Arduino which was connected to the voltage sensors and the current sensors. Other sensors like temperature, humidity, UV radiation sensors were not incorporated therefore detailed information was not given to analyse the fault.

Monika P. Tellawar, Nillesh Chammat (2019), "An IOT based smart solar photovoltaic monitoring system"

This system monitors solar cells continuously from remote areas using data loggers. It contains many sensors which can monitor temperature, humidity etc. Data are collected and analysed using microcontroller and sent to a website. If any information was required it was to be downloaded from the website itself.

Ankit kekre, Suresh K Gawre (2018) "Solar Photovoltaic Remote monitoring system using IoT"

The system described in this paper was to measure voltage, current and temperature and check if any of these values would go to abnormal conditions. A dedicated computer with a dedicated IP address was only allowed to access the data as the recorded values were not accessible easily.

III. PROPOSED WORK

The purpose of the proposed paintings is to increase a prototype of a sun monitoring system, that is capable of decorate the overall performance of the photovoltaic modules in a sun strength system. The working precept of the tool is to maintain the photovoltaic modules continuously aligned with the sunbeams, which maximises the publicity of sun panel to the Sun's radiation.

A. Hardware Design

Design a framework that tracks the sunlight based UV light for sun oriented boards in double pivot.

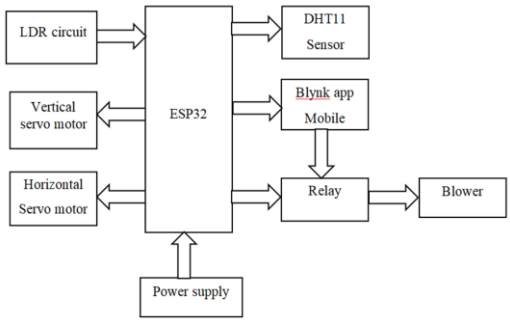

Fig. 1: Block Diagram

B. ESP32 Controller

This is ESP WROOM 32 MCU Module. ESP WROOM 32 can be a powerful, well-known WiFi- BT-BLE MCU module that objectives an excellent form of applications, beginning from low-energy sensor networks to the most disturbing tasks, like voice encoding, song streaming, and MP3 decoding.

At the center of this module is that the ESP32S chip, which is supposed to be scalable and adaptive. There are 2 CPU cores in an effort to be in my view managed or powered, and consequently the clock frequency is adjustable from eighty MHz to 240 MHz.

TABLE I. Specifications

Specification	
Processor	Two Low-Power Xtensa 32-bit LX6 Microprocessors
Operating voltage (v)	3.0V – 3.6V
Operating current (mA)	80
Clock Frequency (MHz)	80 ~ 240
Flash memory (MB)	4
Data Rate (Mbps)	150
SRAM Memory (KB)	520
Length (mm)	28

TABLE I. Specifications

Specification	
Width (mm)	50
Height (mm)	14
Weight (gm)	10
Shipment Weight	0.015 kg
Shipment Dimensions	6 × 8 × 2 cm

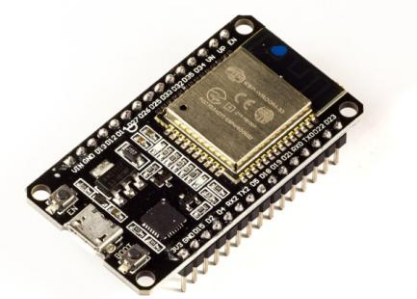

Fig. 2: ESP32 Microcontroller

C. Temperature and Humidity Senso(DHT 11)

The DHT11 is a basic, extremely low-price virtual temperature sensor. It makes use of capacitive humidity sensor and a thermistor to degree the encircling air, and spits out a virtual sign at the records pin .It's pretty easy to use, however calls for cautious timing to seize records.

Fig. 3: Temperature and Humidity Sensor

D. LDR

It is a picturegraph-resistor is a tool whose resistivity is a feature of the incident electromagnetic radiation. Hence, they're mild touchy devices. They also are referred to as as picturegraph conductors, picturegraph conductive cells or absolutely photocells.

They are made from semiconductor substances having excessive resistance. LDR works at the precept of picturegraph conductivity. Photo conductivity is an optical phenomenon wherein the material's conductivity is extended whilst mild is absorbed through the material.

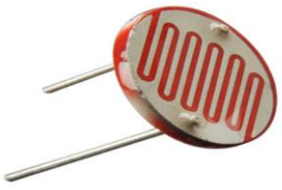

Fig. 4: LDR

E. Solar Panel

A photovoltaic cell, regularly known as a sun based cell, is the innovation utilized for transformation of sun oriented specifically into electrical power. The photovoltaic cell is a non-mechanical gadget made of silicon amalgam. One cell can however deliver just 1 or 2 watts that isn't sufficient for generally machines. Execution of a photovoltaic cluster relies upon daylight. Climatic conditions like mists and mist essentially influence the measure of sun oriented vitality that is gotten by the exhibit and in this manner its execution. The vast majority of the PV modules are in the vicinity of 10 and 20 percent effective.

Fig. 5: Solar Panel

F. Servo Motor

A DC servo motor includes a small DC motor, comments potentiometer, gearbox, motor power digital circuit and digital comments manipulate loop. It is greater or much less just like the ordinary DC motor. The stator of the motor includes a cylindrical body and the magnet is connected to the inner of the body. A brush is constructed with an armature coil that elements the present day to the commentator. At the returned of the shaft, a detector is constructed into the rotor to be able to locate the rotation speed. With this construction, it is easy to layout a controller the use of easy circuitry due to the fact the torque is proportional to the quantity of present day float thru the armature.

Fig. 6: Servo Motor

G. Relay Module

Relay is an electromechanical tool that makes use of an electric powered contemporary to open or near the contacts of a switch. The single-channel relay module is a lot greater than only a simple relay, it incorporates of additives that make switching and connection less complicated and act as signs to expose if the module is powered and if the relay is lively or not.

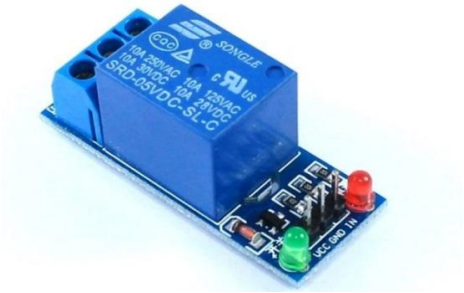

Fig. 7: Relay Module

H. DC Blower

DC blower used to smooth dirt particle the sun panel. DC blowers supply high-stress cooling answers in a compact package. They are best for packages requiring small envelope dimensions and dependable airflow with more pressure. DC blowers pull air from one facet and pressure air via an outlet passage. A blower's radial airflow direction offers specific cooling alternatives or tight areas and enclosures.

Features:

- High static pressure
- Compact profiles
- Multiple voltage options
- Optional tachometer output, locked rotor alarm, PWM speed control, environmental coatings available.

Fig. 8: DC Blower

I. Software Design

The whole design is designed in the arduino platform. The panel connected with the microcontroller is connected to a particular wifi which is coded in the arduino platform. The mobile in which blynk app is installed is also connected to the same wifi network.

J. Arduino IDE

The Arduino incorporated improvement environment (IDE) is a crossplatform application (for Windows, macOS, Linux) this is written withinside the programming language Java. It is used to put in writing and add applications to Arduino well suited boards, however also, with the assist of third birthday birthday celebration cores, different dealer improvement boards.

The supply code for the IDE is launched below the GNU General Public License, model 2. The Arduino IDE helps the languages C and C++ the usage of unique regulations of code structuring. The Arduino IDE elements a software program library from the Wiring project, which affords many not unusualplace enter and output procedures.

Fig. 9: Arduino IDE

K. Blynk Application

Configure the Blynk App:

- Download the Blynk App from Google play store or Apple store.
- Create a new project in the Blynk app. Enter the project name and choose the device. In this IoT project, I have used NodeMCU, so I have selected NodeMCU.
- After that Blynk will send an Auth Token to the registered email id. The Auth Token will be required while programming the ESP8266.

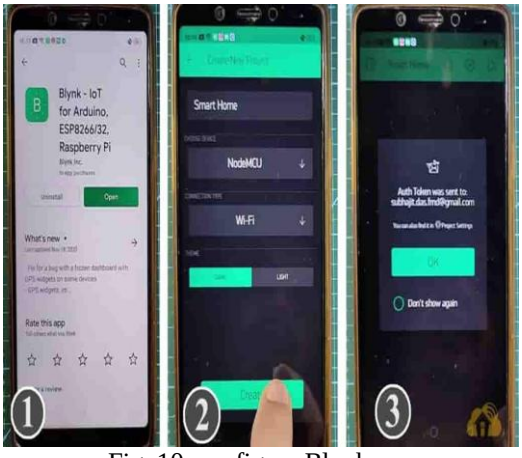

Fig. 10: configure Blynk app

IV. IMPLEMENTATION

The proposed following framework does following of daylight all the more adequately by giving PV board revolution in two diverse pivot. DC engines are essentially performing capacity of sun following. Upper board holder dc engine tracks sun directly and base stepper engine tracks the allegorical uprooting of sun. These dc engine and sensors are interfaced with a microcontroller which is controlling dc engines based on sensors input. LDR sensor sense the light and sends flag to microcontroller.

A. Work Flow

The work flow of the model is given in the form of steps below:
Step1: Start
Step2: Initialise all necessary inputs and outputs to zero.
Step3: Assign Analog LDR outputs and PWM servomotor inputs to ESP32.
Step4: If centre LDR = 0, then delay (longer).
Step5: Check alignment (Simultaneously for north-south and east-west)
Step6: If up (LDR)greater than centre and down (LDR)lesser than centre, then increase position of servomotor1by 1 unit.Give delay.
Step7: Else if up (LDR) lesser than centre and down (LDR) greater than centre, then decrease position of servomotor1 by 1 unit. Give delay.
Step8: (Simultaneously along with step6) If right (LDR) greater than centre and left (LDR) lesser than centre then increase the position of servomotor2 by 1 unit. Give delay.
Step9: Else if right (LDR) is lesser than centre and left (LDR) greater than centre then decrease position of servomotor2 by 1 unit. Give delay.
Step10: Goto Step 5.
Step11: End.

B. Hardware Setup

The above picture depicts the solar panel attached with 4 LDR sensors in the same plane. The whole panel is connected to two servo motors one being the vertical servo motor which tilts the panel by 45 degree and another one being the horizontal servo motor which rotates the whole module by 180 degree. 4 LDRs are placed so that it can capture sunlight from all directions. The cardboard piece is given in between the LDRs so that the light distribution can be differentiated easily. The rotation as well as the tilting of the solar panel is decided with the help of the values received by the LDRs. For example if the light intensity is greater in the top 2 LDRs than in the bottom the vertical servo motor will tilt in that direction and vice-versa. Similarly if the right 2 LDRs is having a greater intensity than the left, then the horizontal servo motor will rotate the whole panel to the right side and thus increasing the amount of sunlight received.

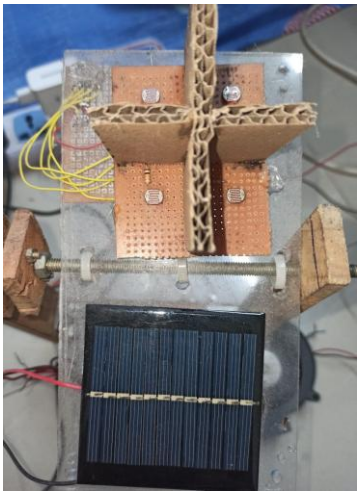

Fig. 11(a): Solar panel Unit

There are 2 Servo motors used in the proposed model one being the vertical servo motor and another being the horizontal servo motor. As shown in the above picture the vertical servo motor is attached to the panel with the solar platting and the LDRs and the horizontal servo motor is placed under the whole model which helps to rotate the whole model. The vertical servo motor is used to rotate the panel model by 45 degree and the horizontal servo motor is used to rotate the whole model by 180 degree.

The direction in which the motors are needed to rotate is decided by the LDRs placed in the top part of the model. The rotation as well as the tilting of the solar panel is decided with the help of the values received by the LDRs. For example if the light intensity is greater in the top 2 LDRs than in the bottom the vertical servo motor will tilt in that direction and vice-versa. Similarly if the right 2 LDRs is having a greater intensity than the left, then the horizontal servo motor will rotate the whole panel to the right side and thus increasing the amount of sunlight received.

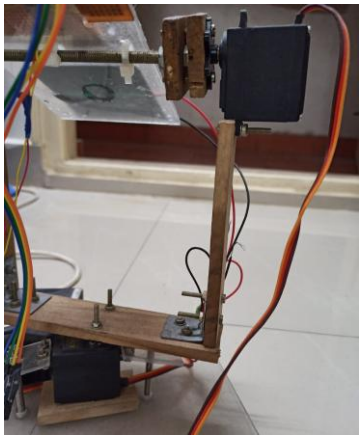

Fig. 12(b): Servo motor setup

C. Software Setup

The pin board shown in the below figure is incorporated with the sensors which is the temperature and humidity sensor. All the 4 LDR sensors as well as the humidity and temperature sensor are connected together as they all require a 5v of supply. All are connected together to esp32 microcontroller. A relay is also connected which is used to switch the blower which is controlled through the blynk app. A voltage regulator is used to convert the 12v to 5v but the blower is directly connected to the 12v supply. A dissipater is given which is used to dissipate the heat which is generated in the voltage regulator due to the overuse of the device. All the power supply is connected together as well as the ground for all the devices is connected together in the pin board.

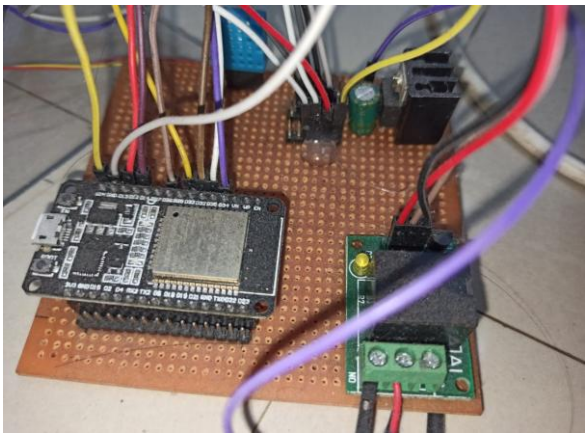

Fig. 13: Sensing unit with microcontroller

V. RESULTS AND DISCUSSIONS

The utilization of any module designed can only be verified after it is used and desired results are achieved. After the design of circuit, it is required to verify the working of the module and also it should be verified for desired results. For this purpose, the module should be tested for different gasses, temperature and humidity accompanied by a regular monitoring of desired output.

a) TESTING OF THE MODULE

The following results are obtained on the mobile application by various sensors and various plots of voltage, current, temperature and power plots are made in the mobile application interface and value of sensor is refreshed in every one minute interval and new value is recorded by the IOT device.

b) TESTING OF BLOWER ACTIVATION

Blower is used in this model for the purpose of cleaning any dust particles present on the solar panel. The blower is connected to a relay which acts as a switch to the blower. The relay is in-turn connected to the microcontroller which is controlled by the blynk application. A dedicated switch is provided in the blynk app for the purpose of turning on and off the blower at any time.

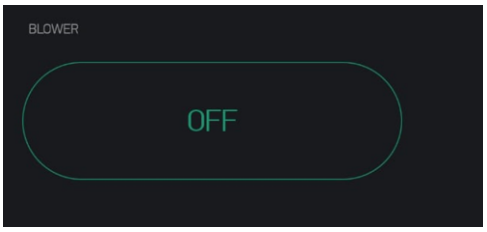

Fig. 14(a): Blower off position

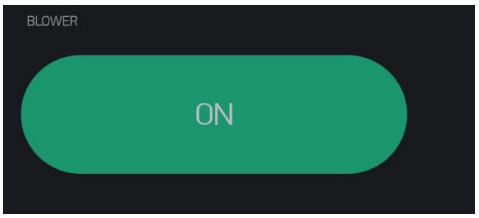

Fig. 14(b): Blower on position

c) TESTING FOR TEMPERATURE AND HUMIDITY

DHT11 is used to sense the temperature of the solar panel surface i.e.; it sense the radiance received on it by the sun during the day time in degree Celsius. Plot of temperature sensor is given below the maximum temperature reached is 40.90 degree Celsius and minimum temperature reached is 37.50 degree Celsius.

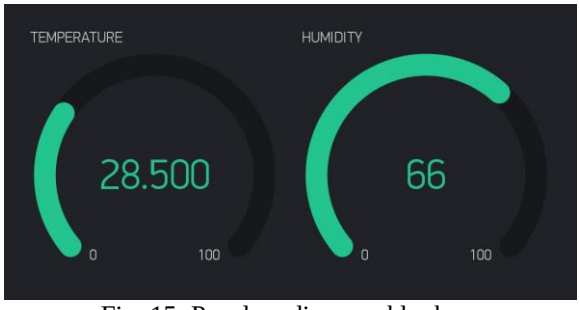

Fig. 15: Panel readings on blynk

d) TESTING FOR EFFICIENCY

The model is tested with and without the solar tracking system to check for the efficiency. The voltage and current are measured with the help of a multimeter during different times of the day. The values measured are tabulated and the comparison of efficiency is done and it is found that with the solar tracking system the efficiency is increased for around 20-30%.

TABLE II. Comparison of efficiency

Time (Hrs)	***Without Tracking***			***With Tracking***		
	Voltage (V)	Current (A)	Power (W)	Voltage (V)	Current (A)	Power (W)
9 am	5.5	.11	.605	12.2	.23	2.8
10 am	9	.19	1.71	13.5	.25	3.4
11am	10.5	.2	2.1	14	.28	3.92
12 pm	12.5	.28	3.5	14	.3	4.2
1 pm	14	.32	4.49	15	.3	4.5

TABLE II. Comparison of efficiency

	Without Tracking			***With Tracking***		
2 pm	13.5	.3	4.05	14	.3	4.2
3 pm	11	.26	2.86	13	0.26	3.38
4 pm	8	.16	1.28	10	0.25	2.5
5 pm	6	.12	0.72	7	0.2	1.4
6 pm	2.5	.05	0.125	5	0.1	0.5

e) TESTING FOR HUMIDITY AND TEMPERATURE

The module was tested for different temperature and humidity by placing it at different places at different time of the day to check whether the temperature and humidity are updating regularly and sending the updated value to the blynk app.

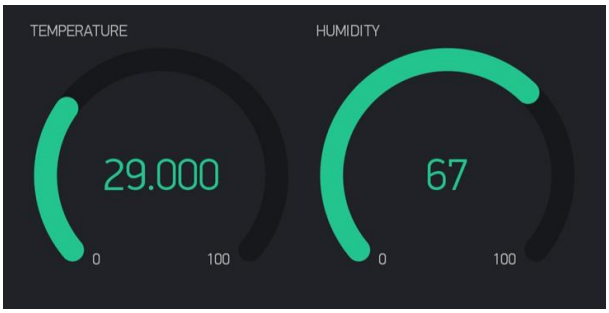

Fig. 16: Temperature and Humidity readings

VI. CONCLUSION AND FUTURE SCOPE

The designed real time solar monitoring system is utilized in order to measure the voltage and other parameters and the following conclusions were obtained:

- The designed module gives the precise value of produced power to predict future efficiency of the panel.
- The blower attached in accordance to reduce the temperature of the surface of the solar panel when it exceeds a certain threshold value.
- The sensed values of all the parameters are sent to the mobile application through wifi module.
- The motor fitted on the panel helps to tilt the solar panel in accordance to the angle of the sun. The motor is programmed in such a way that it tilts in a certain amount of time.

FUTURE SCOPE

- Fabrication of Microcontroller using ASIC concepts:

The number of wires can be greatly reduced by directly if a customized PCB is made upon which all the resistors can be directly soldered. This also eliminates the use of a Breadboard which was used to make all the external connections.

- Mounting of the Panels:

In our design, the panels are mounted on a horizontal shaft supported strongly at both ends. We can mount the panels directly onto a motor placed at the centre of the Panel-Base in order to provide East-West movement. This reduces the weight and effective cost of the project.

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