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Dual Axis Solar Tracking System using Weather and Temperature Sensor

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Abstract: Sun is an abundant source of energy and this solar energy and this solar energy can be harnessed successfully using solar photovoltaic cells and photovoltaic effect to convert solar energy into electrical energy. But the conversion efficiency of a normal PV cell is low. One of the main reason for this is that the output of PV cell is dependent directly on the light intensity and with the position of the sun in the sky changing continuously from time to time; the absorption efficiency of an immobile solar panel would be significantly less at certain time of the day and year; for the solar photovoltaic cells are maximum productive when they are perpendicular to the sun and less productive otherwise.

Keywords: LDR, USB, PV, DC.

I. INTRODUCTION

The design and construction of an inexpensive active dual-axis tracking system for tracking the movement of the sun so as to get maximum power from the solar panels as they follow the sun. It uses Light Dependent Resistors to sense the position of the sun which is communicated to a Arduino Uno microcontroller which then commands a set of two servo-motors to re-orient the panel in order to stay perpendicular to the sun rays. The design was constructed successfully and tested using Lab View to determine the improvements in efficiency. Evaluation results show that the new system performs 13.44% better than the immobile solar PV Monitoring system and a low cost microcontroller to send the data measured at the production end on the internet, which can then be accessed anywhere on the globe. This will provide us real time information f the installation which will help us in maintenance, fault detection and will give us a record of all data at fixed intervals. Solar tracking technology uses LDR sensors to detect the direction of the coming light, so this system can adjust to various conditions to make sure the absorption is maximum. However, solar energy is constrained by the weather and the movement of the sun causing the decline in efficiency of solar panels. There has been a lot of research aiming at getting the answers to that problems, in hopes of increasing the efficiency of solar panels.

II. METHOD

The main intention of this project is to design a high-quality solar monitoring and tracker. The project is divided into two parts; hardware and software consist of three main constituent which are the inputs, main controller and the inputs are from analog value of LDR, Arduino as the controller and the stepper motor will be the output. The main component is Arduino Uno single-board microcontroller. It has an open source physical computing platform and a development environment for writing software for the board and is inexpensive. The other main components are Light Dependent Resistor (LDR), DC-motors, solar panel. The solar tracking system is done by Light Dependent Resistor (LDR), Four LDR are connected to Arduino analog pin A0 to A3 that acts as the input for the system. The analog value of LDR is converted into digital (Pulse Width Modulation) using the built-in Analog-to Digital Converter. The data from these sensors will be given to the Arduino Uno board. The data sensed from current, voltage, LDR will be given to the analogue input port of the Arduino Uno board. The data sensed from current, voltage, LDR will be given to the analogue input port of the Arduino Uno Board and the temperature sensor output will be given to the digital input port. The input power required for Arduino board will be 5V dc and this would be fed by using a dc adapter. The Arduino board is programmed using Arduino software IDE in such a way that it would send the data to the wifi module ESP8266 connected to one of the output ports. Here the WIFI module acts as a mediator and sends the data to the cloud. The webhost link is being used inside programming code of Arduino so as to communicate or establish a path between cloud when the link at the web end and the controller are same then only data can be sent securely to an authorized user. The data is been tabulated inside

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as the values are eventually received so far. Thus the data can be displayed on the website as well as the same time it can be stored in the database. The stored data can be dissolved completely by the respective user or at the database end.

III. MODEL ARCHITECTURE

A. ARDUINO UNO

Fig.1. Arduino Uno

Arduino Uno is a microcontroller board based on 8-bit ATmega328P microcontroller. Along with ATmega328P, it consists other components such as crystal oscillator, serial communication, voltage regulator, etc. to support the microcontroller. Arduino Uno has 14 digital input/output pins (out of which 6 can be used as PWM outputs), 6 analog input pins, a USB connection, A Power barrel jack, an ICSP header and a reset button. The 14 digital input/output pins can be used as input or output pins by using pinMode(), digitalRead() and digitalWrite() functions in arduino programming. Each pin operate at 5V and can provide or receive a maximum of 40mA current, and has an internal pull-up resistor of 20-50 KOhms which are disconnected by default. Out of these 14 pins, some pins have specific functions as listed below:

- Serial Pins 0 (Rx) and 1 (Tx): Rx and Tx pins are used to receive and transmit TTL serial data. They are connected with the corresponding ATmega328P USB to TTL serial chip.
- External Interrupt Pins 2 and 3: These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value.
- PWM Pins 3, 5, 6, 9 and 11**:** These pins provide an 8-bit PWM output by using analog Write () function.
- SPI Pins 10 (SS), 11 (MOSI), 12 (MISO) and 13 (SCK): These pins are used for SPI communication.
- In-built LED Pin 13: This pin is connected with an built-in LED, when pin 13 is HIGH – LED is on and when pin 13 is LOW, its off.

Along with 14 Digital pins, there are 6 analog input pins, each of which provides 10 bits of resolution, i.e. 1024 different values. They measure from 0 to 5 volts but this limit can be increased by using AREF pin with analog Reference () function.

- Analog pin 4 (SDA) and pin 5 (SCA) also used for TWI communication using Wire library.

Arduino Uno has a couple of other pins as explained below:

- AREF: Used to provide reference voltage for analog inputs with analog Reference () function.
- Reset Pin: Making this pin LOW, resets the microcontroller.

B. LDR-LIGHT DEPENDENT RESISTOR

The input to the inverting terminal is set to a certain value by varying the potentiometer and the sensitivity is set. When the rain board module's surface is exposed to rainwater, the surface of the rainboard module will be wet, and it offers minimum resistance to the supply voltage. Due to this, the minimum voltage will be appearing at the non-inverting terminal of LM393 Op-Amp. The comparator compares both inverting and non-inverting terminal voltages. If the condition falls under case(1), the output of the Op-Amp will be digital LOW. If the condition falls under case(2), the output of the Op-Amp will be digital HIGH. The below diagram shows the equivalent circuit of both the conditions. The input to the inverting terminal is set to a certain value by varying the potentiometer and the sensitivity is set. When the rain board module's surface is exposed to rainwater, the surface of the rainboard module will be wet, and it offers minimum resistance to the supply voltage. Due to this, the minimum voltage will be appearing at the non-inverting terminal of LM393 Op-Amp. The comparator compares both inverting and non-inverting terminal voltages. If the condition falls under case(1), the output of the Op-Amp will be digital LOW. If the condition falls under case(2), the

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output of the Op-Amp will be digital HIGH. The below diagram shows the equivalent circuit of both the conditions

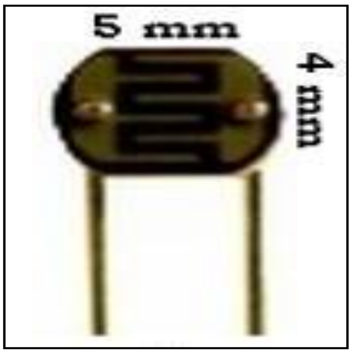

Fig. 2. LDR

Although the M1 has a Sunrise / Sunset clock built in that will determine when the sunrises and sets, hence if it is Dark or Light outside, often inside light is a totally different subject. The system needs to know what the light level is in a particular room so when automating internal lighting it needs to know if the lights should be activated or not. Otherwise it defeats the purpose of energy saving by automating the lights for cost savings. One way of doing this is with a $5.00 item from Ness with our Ness- LDR. This LDR wires directly into a M1 Zone Input (Any Zone). The Zone need to be programmed as a Analog Zone. The more light the LDR sensor has on it the lower the voltage the zone will read and the lower the light level, the higher the zone voltage. The following table will provide a summary of the type of voltages v's light you could expect to read. As the Ness LDR is very small (approx 5 mm x 4mm x 2 mm) it can be installed anywhere. Although it can be installed on a PIR detector consideration must be given as to the amount of light near the ceiling in a corner compared to lower near the floor. As a suggestion you could mount it on a blank electrical plate attached to the wall near the floor / power point level where the light is more even. This would change from site to site; room by room The LDR Sensor is wired directly to any Zone input. (Even the Keypad Zone input, (where a good location for the LDR could be on the keypad.)
Light Dependent Resistor Specification:

1. Current supply- max 75mA
2. Power dissipation- max 100mW
3. Operating temp- min -60C/max 75C
4. Power input- 5V

IV. EXPERIMENT AND RESULTS

As a result, it is observed that the location for the solar panel is one of the important things in collecting the output voltage. Solar panel will perform best when facing south as this will help to get the most exposure from the sun as it moves from east to west. For most areas, the peak performance hours of the day will be between 9a.m till 12.p.m. this is wen the sun is at its peak illumination. The measurements of the data are taken from a wide area whereby there is no obstruction that would prevent the tracker from maximum sunlight. The measurement of output voltages are taken in 3 straight days between 9 a.m to 6 p.m. The largest output voltage for the solar panel is 7V. The average of output voltages is used to draw up the graphs. There are 2 conditions of output voltage being measured. The condition are :- 1.) Static solar panel with 15 degree of angle facing south 2.) Solar panel with tracking system facing south. By pursuing these 2 conditions, the highest and lowest output voltages at the peak performances of sunlight can be measured. The highest output voltage that the author measured for solar tracking condition is 6.67V at 1,20 p.m while the lowest output voltage is 5.94V at 6.00 p. m hours while the highest voltage for static panel is 6.65 V and the lowest is 5.89 V. The sun position is one of the main factors that caused instability measurement output voltage. The position of the sun is considered unpredictable hence causing the surroundings to be dimmed at certain times. The solar panel will not be able to achieve maximum illumination from the sun.

V. CONCLUSION

As a means to provide an efficient solar distributed generation system; this paper presented a scaled down active dual-axis solar tracker system design. The system was constructed and operated successfully. The built prototype ensures design feasibility. In conclusion, high-efficiency dual-axis tracker has been developed. Based on the results obtained, it can be concluded that the system will react at their best on 10-minute intervals with a constant voltage is produced. There are significant changes in voltage at 10-minutes intervals graphs within 9.00 a.m. until 6.00 p.m. For that reason, this

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system has been proven to work to absorb maximum sunlight source for high efficiency solar harvesting applications. The economically and environmentally solar tracking system development will be a technique to use in renewable-energy more widely and wisely.

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