SOLAR ENERGY TRACKING AND MONITORING SYSTEM OVER IOT

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Abstract— Solar is a non conventional source of energy, considering this we have developed solar panels so that we can fulfil our electricity need. But due to revolution of the earth, solar source i.e., sun does not face the panel continuously hence less electricity is produced. The energy panel should face the SUN till it is present in a day.

The problem above can be solved by our system by tracking the solar energy. The main goal of this project is to design a very precise solar tracker and share the information through IoT. The block diagram below shows system architecture it consist of a LDR sensor senses max solar power which is being given to the Microcontroller which digitizes the LDR output. Controller then takes the decision according to then algorithm and tilts the panel towards the direction of the max energy given by LDR with the help of DC Motor. The Motor is used to rotate the LDR to sense the max solar power. The solar Panel is placed on the arrangement made on the shaft of the DC motor and is controlled using microcontroller. The microcontroller here we are using is Arduino UNO. The motor is driven by a motor driver. Current and voltage values monitoring and displayed on LCD correspondingly its operation. With stored energy we can control loads and share this current and voltage values over IoT.

Keywords: Artificial intelligence markup language, Python, TensorFlow, Flask, Natural language processing.

I. INTRODUCTION

Solar Panels are a form of active solar power, a term that describes how solar panels make use of the sun's energy; solar panels harvest sunlight and actively convert it to electricity. Solar Cells, or photovoltaic cells, are arranged in a grid-like pattern on the surface of the solar panel. Solar panels are typically constructed with crystalline silicon, which is used in other industries (such as the microprocessor industry), and the more expensive gallium arsenide, which is produced exclusively for use in photovoltaic (solar) cells. Solar panels collect solar radiation from the sun and actively convert that energy to electricity. Solar panels are comprised of several individual solar cells. These solar cells function similarly to large semi-conductors and utilize a large area p-n junction diode. When the solar cells are exposed to sunlight, the p-n junction diodes convert the energy from sunlight into usable electrical energy. The energy generated from photons striking the surface of the solar panel allows electrons to be knocked out of their orbits and released, and electric fields in the solar cells pull these free electrons in a directional current, from which metal contacts in the solar cell can generate electricity.

The more solar cells in a solar panel and the higher the quality of the solar cells, the more total electrical output the solar panel can produce. The conversion of sunlight to usable electrical energy has been dubbed the Photovoltaic Effect. A solar tracker is a device that orients a payload toward the sun. The use of solar trackers can increase electricity production by around a third, and some claim by as much as 40% in some regions, compared with modules at a fixed angle. In any solar application, the conversion efficiency is improved when the mod ules are continually adjusted to the optimum angle as the sun traverses the sky. As improved efficiency means improved yield, use of trackers can make quite a difference to the income from a large plant.

An embedded system is a combination of software and hardware to perform a dedicated task. Some of the main devices used in embedded products are Microprocessors and Microcontrollers. Microprocessors are commonly referred to as general purpose processors as they simply accept the inputs, process it and give the output. In contrast, a microcontroller not only accepts the data as inputs but also manipulates it, interfaces the data with various devices, controls the data and thus finally gives the result.

The sun's position in the sky varies both with the seasons (elevation) and time of day as the sun moves across the sky. Hence there are also two types of solar tracker: • Single Axis Solar Tracker • Dual Axis Solar Tracker Single Axis Solar Tracker: Single axis solar trackers can either have a horizontal or a vertical axle. The horizontal type is used in tropical regions where the sun gets very high at noon, but the days are short. The vertical type is used in high latitudes (such as in UK) where the sun does not get very high, but summer days can be very long.

HARDWARE COMPONENTS

This project uses hardware components such as DC Motors, Solar panel, ArduinoUno, LDR's X 2 (Light DependentResistor), Motor driver, ICBattery (6 to12V), LCD 16X2, Load(motor), Wifi Module, Current sensor and Voltage sensor.

ARDUINO UNO

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs

Comp onent	Specifications	Number of units used
DC Motors	12V, 300RPM	2
Solar Panel	12V, 5Watt	1
Arduino uno	ATmega3 28P 5V	1
LDR	5V	4
Battery	12V	1
Voltage sensor	5V	1
Current sensor	5V	1
Wifi module	ESP8266	1
Motor Driver IC	L293D, 5V	1
Load(motor)	12V, 300RPM	1

from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter. Revision 2 of the Uno board has a resistor pulling the 8U2 HWB line to ground, making it easier to put into DFU mode. Revision 3 of the board has the following new features: 1.0 pinout, Stronger RESET circuit, Atmega 16U2 replace the 8U2.

Power:

The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically. External (non-USB) power can come either from an AC- to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center- positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector. The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts. The power pins are as follows: VIN, 5V, GND.

Memory:

The ATmega328 has 32 KB (with 0.5 KB used for the boot-loader). It also has 2 KB of SRAM and 1 KB of EEPROM (which can be read and written with the EEPROM library).

Input and Output:

Each of the 14 digital pins on the Uno can be used as an input or output, using pin Mode(), digital Write(), and digital Read() functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kOhms. In addition, some pins have specialized functions: Serial: 0 (RX) and 1 (TX); External Interrupts: 2 and 3; PWM: 3, 5, 6, 9, 10, and 11; SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK); LED 13.

LIGHT DEPENDENT RESISTOR

A photo resistor or light dependent resistor or cadmium sulfide (CdS) cellisa resistor whose resistance decreases with increasing incident light intensity. It can also be referred to as a photoconductor. A photo resistor is made of a high resistance semiconductor. If light falling on the device is of high enough frequency, photons absorbed by the semiconductor give bound electrons enough energy to jump into the conduction band. The resulting free electron (and its hole partner) conduct electricity, there by lowering resistance. A photoelectric device can be either intrinsic or extrinsic. An intrinsic semiconductor has its own charge carriers and is not an efficient semiconductor, e.g. silicon. In intrinsic devices the only available electrons are in the valence band, and hence the photon must have enough energy to excite the electron across the entire band gap. Extrinsic devices have impurities, also called dopants, added whose ground state energy is closer to the conduction band; since the electrons do not have as far to jump, lower energy photons (i.e., longer wavelengths and lower frequencies) are sufficient to trigger the device. If a sample of silicon has some of its atoms replaced by phosphorus atoms (impurities), there will be extra electrons available for conduction.

LCD

Liquid Crystal Display also called as LCD is very helpful in providing user interface as well as for debugging purpose. The most commonly used Character based LCDs are based on Hitachi's HD44780 controller or other which are compatible with HD44580. The most commonly used LCDs found in the market today are 1 Line, 2 Line or 4 Line LCDs which have only 1 controller and support at most of 80 characters, whereas LCDs supporting more than 80 characters make use of 2 HD44780 controller. To send commands we simply need to select the command register. Everything is same as we have done in the initialization routine. But we will summarize the common steps and put them in a single subroutine. Following are the steps:

- move data to LCD port
- select command register
- select write operation
- send enable signal
- wait for LCD to process the command
- Sending Data to LCD

- To send data move data to LCD port
- select data register
- select write operation

DC MOTOR:

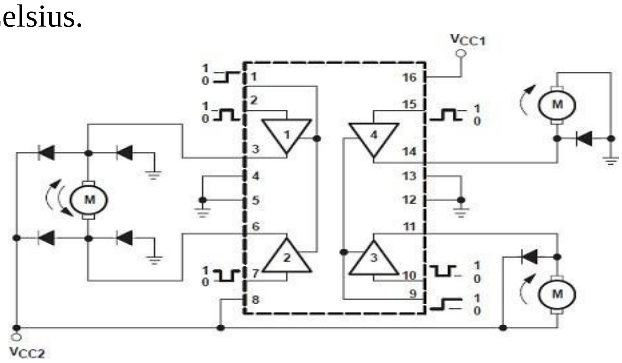
The speed of a DC motor is directly proportional to the supply voltage, so if we reduce the supply voltage from 12 Volts to 6 Volts, the motor will run at half the speed. How can this be achieved when the battery is fixed at 12 Volts? The speed controller works by varying the average voltage sent to the motor. It could do this by simply adjusting the voltage sent to the motor, but this is quite inefficient to do. A better way is to switch the motor's supply on and off very quickly. If the switching is fast enough, the motor doesn't notice it, it only notices the average effect.

When you watch a film in the cinema, or the television, what you are actually seeing is a series of fixed pictures, which change rapidly enough that your eyes just see the average effect - movement. Your brain fills in the gaps to give an average effect. Now imagine a light bulb with a switch. When you close the switch, the bulb goes on and is at full brightness, say 100 Watts. When you open the switch it goes off (0 Watts). Now if you close the switch for a fraction of a second, then open it for the same amount of time, the filament won't have time to cool down and heat up, and you will just get an average glow of 50 Watts. This is how lamp dimmers work, and the same principle is used by speed controllers to drive a motor. When the switch is closed, the motor sees 12 Volts, and when it is open it sees 0 Volts. If the switch is open for the same amount of time as it is closed, the motor will see an average of 6 Volts, and will run more slowly accordingly.

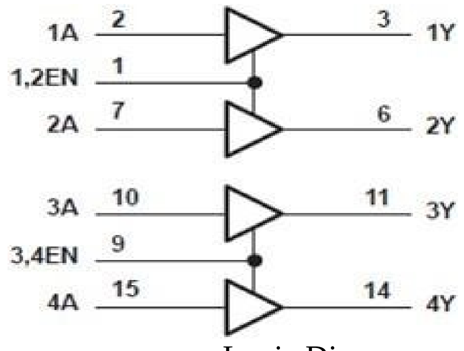
L293D- CURRENT DRIVER

The L293 and L293D are quadruple high-current half-H drivers. The L293 is designed to provide bidirectional drive currents of up to 1 A at voltages from 4.5 V to 36 V. The L293D is designed to provide bidirectional drive currents of up to 600-mA at voltages from 4.5 V to 36 V. Both devices are designed to drive inductive loads such as relays, solenoids, dc and bipolar stepping motors, as well as other high-current/high-voltage loads in positive-supply applications.All inputs are TTL compatible. Each output is a complete totem-pole drive circuit, with a Darlington transistor sink and a pseudo- Darlington source. Drivers are enabled in pairs, with drivers 1 and 2 enabled by 1,2EN and drivers 3 and 4 enabled by 3,4EN. When an enable input is high, the associated drivers are enabled and their outputs are active and in phase with their inputs. When the enable input is low, those drivers are disabled and their outputs are off and in the high-impedance state. With the proper data inputs, each pair of drivers forms a full-H (or bridge) reversible drive suitable for solenoid or motor applications. On the L293, external high-speed output clamp diodes should be used for inductive transient suppression.

A VCC1 terminal, separate from VCC2, is provided for the logic inputs to minimize device power dissipation. The L293 and L293D are characterized for operation from 0 to 70 degree Celsius.



Block Diagram



Logic Diagram

The logic chip contains 4 enable pins. Each enable pin corresponds to 2 inputs. Based on the input values given, the device connected to this IC works accordingly.

SOLAR PANEL

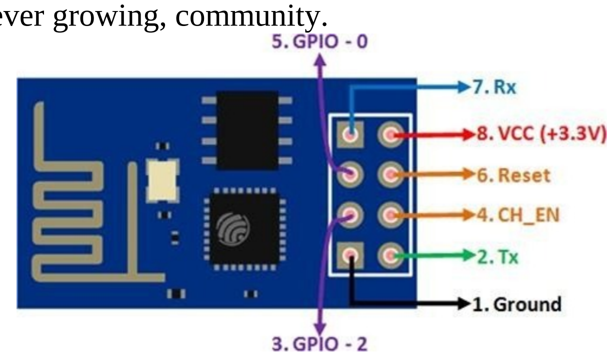
Solar energy begins with the sun. Solar panels (also known as "PV panels") are used to convert light from the sun, which is composed of particles of energy called "photons”, into electricity that can be used to power electrical loads. Solar panels can be used for a wide variety of applications including remote power systems for cabins, telecommunications equipment, remote sensing, and of course for the production of electricity by residential and commercial solar electric systems.

We will learn how solar panels work, how they are made, how they create electricity, and where you can buy solar panels.

Solar panels collect clean renewable energy in the form of sunlight and convert that light into electricity which can then be used to provide power for electrical loads. Solar panels are comprised of several individual solar cells which are themselves composed of layers of silicon, phosphorous (which provides the negative charge), and boron (which provides the positive charge). Solar panels absorb the photons and in doing so initiate an electric current. The resulting energy generated from photons striking the surface of the solar panel allows electrons to be knocked out of their atomic orbits and released into the electric field generated by the solar cells which then pull these free electrons into a directional current. This entire process is known as the Photovoltaic Effect. An average home has more than enough roof area for the necessary number of solar panels to produce enough solar electricity to supply all of its power needs excess electricity generated goes onto the main power grid, paying off in electricity use at night

WIFI-MODULE

The ESP8266 WiFi Module is a self contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your WiFi network. The ESP8266 is capable of either hosting an application or offloading all WiFi networking functions from another application processor. Each ESP8266 module comes pre-programmed with an AT command set firmware, meaning, you can simply hook this up to your Arduino device and get about as much WiFi-ability as a WiFi Shield offers (and that's just out of the box)! The ESP8266 module is an extremely cost effective board with a huge, and ever growing, community.



VOLTAGE SENSOR

A voltage sensor is a sensor used to calculate and monitor the amount of voltage in an object. Voltage sensors can determine the AC voltage or DC voltage level. The input of this sensor is the voltage, whereas the output is the switches, analog voltage signal, a current signal, or an audible signal.

CURRENT SENSORS

Current measurement is of vital importance in many power and instrumentation systems. Traditionally, current sensing was primarily for circuit protection and control. However, with the advancement in technology, current sensing has emerged as a method to monitor and enhance performance. Knowing the amount of current being delivered to the load can be useful for wide variety of applications. Current sensing is used in wide range of electronic systems, Battery life indicators and chargers, 4-20mA systems, over-current protection and supervising circuits, current and voltage regulators, DC/DC converters, ground fault detectors, programmable current sources, linear and switch-mode power supplies, communications devices , automotive power electronics, motor speed controls and overload protection, etc.

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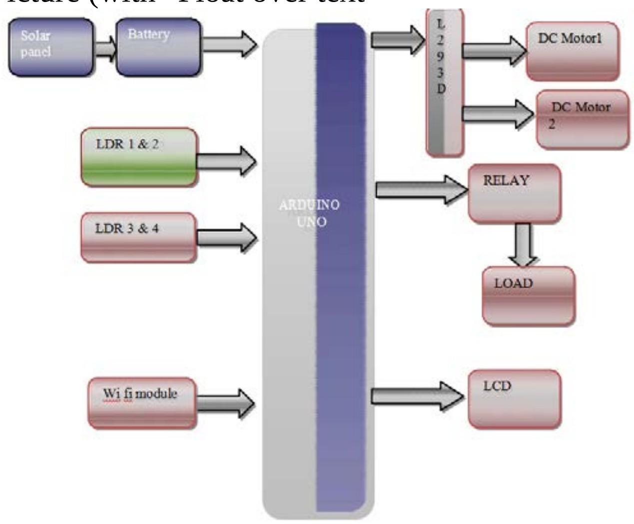


BLOCK DIAGRAM

HOW IT WORKS

- To develop this dual axis tracking system light dependent resistor (LDR) is used as sensor. The resistance of LDR decreases with increasing light intensity.
- DC motors are used here for rotating the solar panel in two different axes.
- Two of light dependent resistors (LDR) is used as sensors to track the sun’s exact position One senses the position of the sun east and side and other in west side.
- This information is then passed to the micro controller that digitizes the LDR analog output.
- Microcontroller is the main control unit of this whole system
- Controller then takes the decision according to the algorithm and tilts the panel towards the direction of the maximum energy given by LDR with the help of DC Motor.
- The Motor driver is used to rotate the DC motor.
- The Solar Panel is placed on the arrangement made on the shaft of the DC motor and is controlled using microcontroller.
- The microcontroller here we are using is ArduinoUNO.
- The motor is driven by a motor driver and we here are using L293D Motor driver IC.
- Current and voltage values are being monitored and displayed on LCD

correspondingly its operation. LCD also displays, which LDR is being active.

With the stored energy in the batteries we can control loads. The information related to current and voltage are uploaded to cloud using IoT and can be viewed

SOFTWARE INSTALLATIONS

ARDUINO SOFTWARE

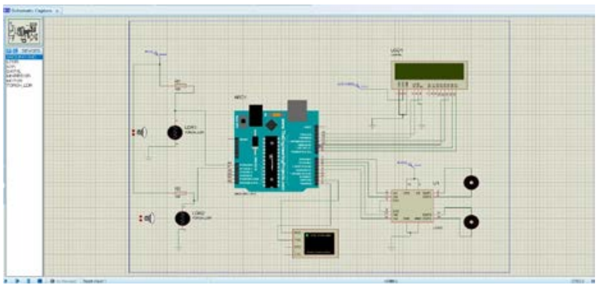
Arduino IDE (Integrated Development Environment) is required to program the Arduino Uno board.

PROTEUS DESIGN SUITE

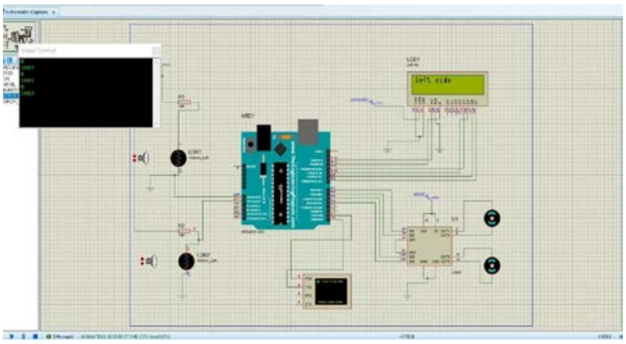
The Proteus Design Suite is a proprietary software tool suite used primarily for electronic design automation. The software is used mainly by electronic design engineers and technicians to create schematics and electronic prints for manufacturing printed circuit boards.

RESULTS AND CONCLUSIONS

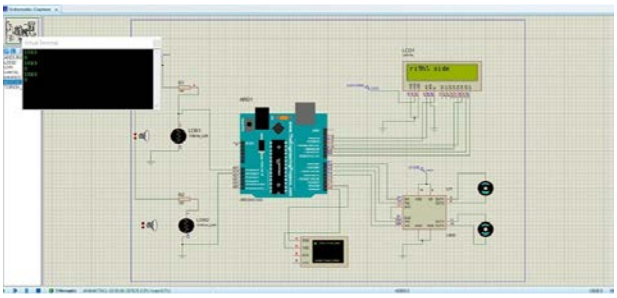
A.SIMULATION RESULTS:



SCHEMATIC MODEL:



ROTATING LEFT



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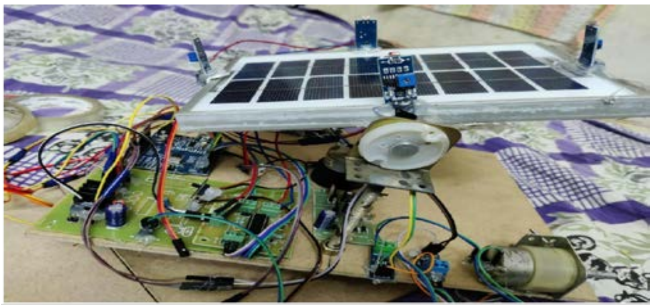
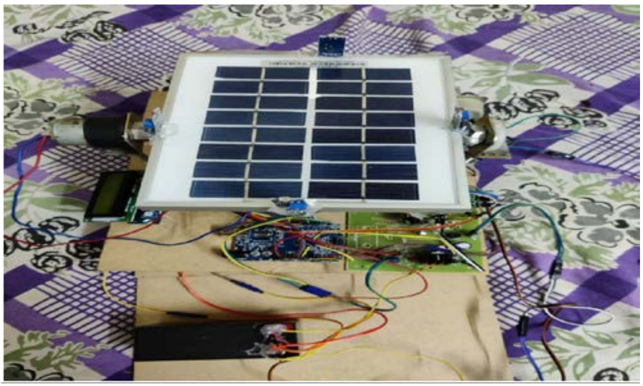
HARDWARE RESULTS:



FRONT VIEW OF THE MODEL



SIDE VIEW OF THE MODEL

LCD DISPLAY

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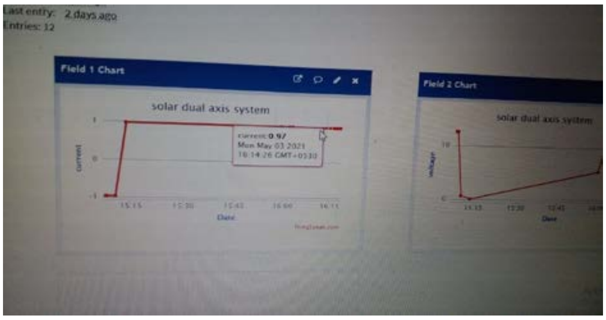
SHARING DETAILS OVER IOT:



CURRENT

VOLTAGE

B. CONCLUSIONS

Through our project, we would like to bring out the advantages of solar radiation into lime light, that is freely and abundantly available. The aim of our project consists of FOUR parts. They are (i) Tracking (ii) Monitoring (iii) Load control (iv) Sharing the info over IoT. In this report, we have seen the history and evolution of efficient tracking system. In due course of time, dual axis solar tracking system has been remarked as an efficient system to tap the sunlight compared to single axis tracking system or any other tracker. Also we have seen the components required to make the hardware and software that virtually verifies the working of the system. This makes remotely monitoring of solar plants very easy and ensure best power output.

The design assists to extract maximum power from the solar radiation by tracking using a dual axis tracker.. This is possible if the solar panel is always in proper alignment with incident rays of sun. The proposed methodology presents the following features:

A simple and economic implementation.

An ability to simultaneously adjust panel along both the axes.

Ability to adjust the tracking accuracy.

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