

ANALYSIS OF AN EFFICIENT AUTOMATIC SUNTRACKING SYSTEM FOR SOLAR INDUSTRY

Submitted in partial fulfillment of the requirements for the award of Bachelor of
Engineering Degree in Electronics and Communication Engineering

By

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SCHOOL OF ELECTRICAL AND ELECTRONICS ENGINEERING**

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

Accredited with Grade "A" by NAAC

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the Bonafide work of **O.N.V.R.S.SANTHOSH**(38130153) and **K.PREM KUMAR**(38130097) who carried out the project entitled "**ANALYSIS OF AN EFFICIENT AUTOMATIC SUN TRACKING SYSTEM FOR SOLAR INDUSTRY**" under my supervision from June 2021 to April 2022.

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DECLARATION

We, **O.N.V.R.S.SANTHOSH (38130153)** and **K.PREM KUMAR (38130097)** hereby declare that the Project Report entitled “**ANALYSIS OF AN EFFICIENT AUTOMATIC SUN TRACKING SYSTEM FOR SOLAR INDUSTRY**” done by us by the guidance of Dr.Mathan N.,M.Tech.,(Ph.D)is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering Degree in Electronics and Communication Engineering.

DATE:

PLACE:

SIGNATURE OF THE CANDIDATE

1.

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ABSTRACT

Solar energy is rapidly advancing as an important means of renewable energy resource. Solar tracking enables more solar energy to be generated because the solar panel is able to maintain a perpendicular profile to the sun's rays. Though initial cost of setting up a solar tracking system is high,, this paper proposes a cheaper solution. Design and construction of a prototype for solar tracking system with single degree of freedom, which detects the sunlight using Light Dependent Resistors (LDR), is discussed in this project. The control circuit for the solar tracker is based on an Nodemcu microcontroller. This is programmed to detect the sunlight through the LDRs and then actuate the stepper motor to position the solar panel where it can receive maximum sunlight.

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LIST OF ABBREVIATIONS

LDR	Light Dependant Resistor
DTH 11	Digital Humidity And Temperature
MCU	Multipoint Control Unit
CPU	Central Processing Unit
IC	Integrated Circuit
DSP	Digital Signal Processing

CHAPTER 1

INTRODUCTION

1.1 EMBEDDED SYSTEMS

An embedded system is a special-purpose computer system designed to perform one or a few dedicated functions, often with real-time computing constraints. It is usually embedded as a part of a complete device including hardware and mechanical parts. In contrast, a general-purpose computer, such as a personal computer, can do many different tasks depending on programming. Embedded Systems have become very important today as they control many of the common devices we use.

1.2 OVERVIEW OF EMBEDDED SYSTEMS

Since the embedded system is dedicated to specific tasks, design engineers can optimize it, reducing the size and cost of the product, or increasing the reliability and performance. Some embedded systems are mass-produced, benefiting from economies of scale.

Embedded systems provide several functions

1. Monitor the environment; embedded systems read data from input sensors. This
2. data is then processed and the results displayed in some format to a user or users
3. Control the environment; embedded systems generate and transmit commands for actuators
4. Transform the information; embedded systems transform the data collected

Although interaction with the external world via sensors and actuators is an important aspect of embedded systems, these systems also provide functionality specific to their applications. Embedded systems typically execute applications such as control laws, finite state machines, and signal processing algorithms. These systems must also detect and react to faults in both the internal computing environment as well as the surrounding electromechanical systems.

1.3 RECENT TRENDS AND FUTURE

The newest wave of embedded systems is bringing innovation to a wide range of applications, often using Artificial Intelligence and machine learning, including IoT security, robotics, medical devices, autonomous vehicles, vision technologies, System-on-Chip solutions, and more.

The newest wave of embedded systems

- IoT security
- Robotics
- Medical devices

1.4 ORIGIN OF IDEA

Our team has always been fond of VLSI. MAC Unit plays an important role in DSP Applications and we were intrigued by the idea of incorporating vedic multiplier along with ripple carry adder in order to design a low power and high speed MAC Unit.

CHAPTER 2

LITERATURE SURVEY

2.1 LITERATURE SURVEY

In this paper, the energy saving algorithm for the dual axis light (solar) tracker is discussed using hardware with four photoresistors and Aurdino open source electronic prototyping platform. In addition to the specified tolerance for the light sensors, the specified tolerance for two servo motors is proposed. Here, servo motors are switched off to save the energy if the light intensity is changed within the certain range during the particular time-frame. It was shown that the load on power supply is close to zero in this case.

A sunlight based framework is the device for orienting solar photovoltaic modules and solar thermal collectors toward the sun. Thinking about the state of the art of the innovation, successful strategy, robust control philosophy and the potential added benefit of different research work which can be employed on an extensive scale in maintainable manner. Presently we are entering in a new period of processing innovation i.e. Internet of things (IoT). IoT is a sort of “universal global neural network” in the cloud which associates various things.

Limited non renewable energy resources and increasing power demand is a major topic of concern around the world. In recent decades, renewable energy resources are widely used in order to satisfy the increasing power demand and to minimize the damage to the environment. The aim of the paper is to present a unique solar tracking technique which can be used to extract maximum power from the photovoltaic cell by using a close loop control system along with a 5-LDR sensor module which is strategically designed to generate feedback signal in order to track the sun's azimuth and elevation angle.

Solar energy is rapidly gaining notoriety as an important means of expanding renewable energy resources. It has emerged as one of the most promising renewable energy source characterized by a huge potential of conversion into electrical power.

The renewable sources of energy are becoming one of the utmost priorities of the present day world due to their innumerable advantages. In particular, solar energy is progressing as a potential inexhaustible and non-polluting energy source to suffice our ever-increasing energy requirements. However, the solar panels which are the fundamental solar-energy conversion components are fixed at a certain angle and are not able to track the sunlight direction with diurnal and seasonal changes. This limits the area of exposure of sunlight on solar panels and efficiency of the solar tracking system involving solar panels.

2.2 PROBLEM STATEMENTS FROM SURVEY

Solar tracker system is used to tracks the sun's movement across the sky and tries to maintain the solar panel perpendicular to the sun's rays, ensuring that the maximum amount of sunlight is incident on the panel throughout the day.

This project presents a Solar Tracking System with Servo Motor. The system consists of solar panel and the motion follow the direction of a sun by controlled by Lab view programming software. The purpose of this Solar Tracking System is to maximize the power generation from the photovoltaic panel. The hardware designs are of solar panel, motor controller circuit to control the servo and circuit converter comprised the voltage output from the solar panel is stabilized by circuit converter before to be used by application. Benefit of Solar power is pollution-free during use. Production end-wastes and emissions are manageable using existing pollution controls. PV installations can operate for many years with little maintenance or

intervention after their initial set-up, so after the initial capital cost of building any solar power plant, operating costs are extremely low compared to existing power technologies.

2.3 OBJECTIVES

- It is to improve the overall electricity generation using single axis sun tracking system and also to provide the design for residential use.
- The objective of this project is to control the position of a solar panel in accordance with the motion of sun.

CHAPTER 3

AIM AND SCOPE OF THE PRESENT INVESTIGATION

3.1 PROPOSED METHODOLOGIES

- The Dual axis solar tracking system is successfully designed and implemented the Arrangement of LDRs along with their partition increases solar tracking accuracy thereby increasing solar panel efficiency.
- By connecting this system to the internet, users can keep an eye on the whole system from anywhere in the world. In this way overall system efficiency is enhanced.
- The current sensor is used to calculate the current flowing through it. And it's an electrically operated switch is used for switching of large currents

3.2 LDR

Light Dependent Resistor (LDR) is made of a high-resistance semiconductor. It can also be referred to as a photoconductor. If light falling on the device is of the 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, thereby lowering resistance. Hence, Light Dependent Resistors (LDR) is very useful in light sensor circuits. LDR is very high-resistance, sometimes as high as $1000\ 000\Omega$, when they are illuminated with light resistance drops dramatically.

3.3 BLOCK DIAGRAM

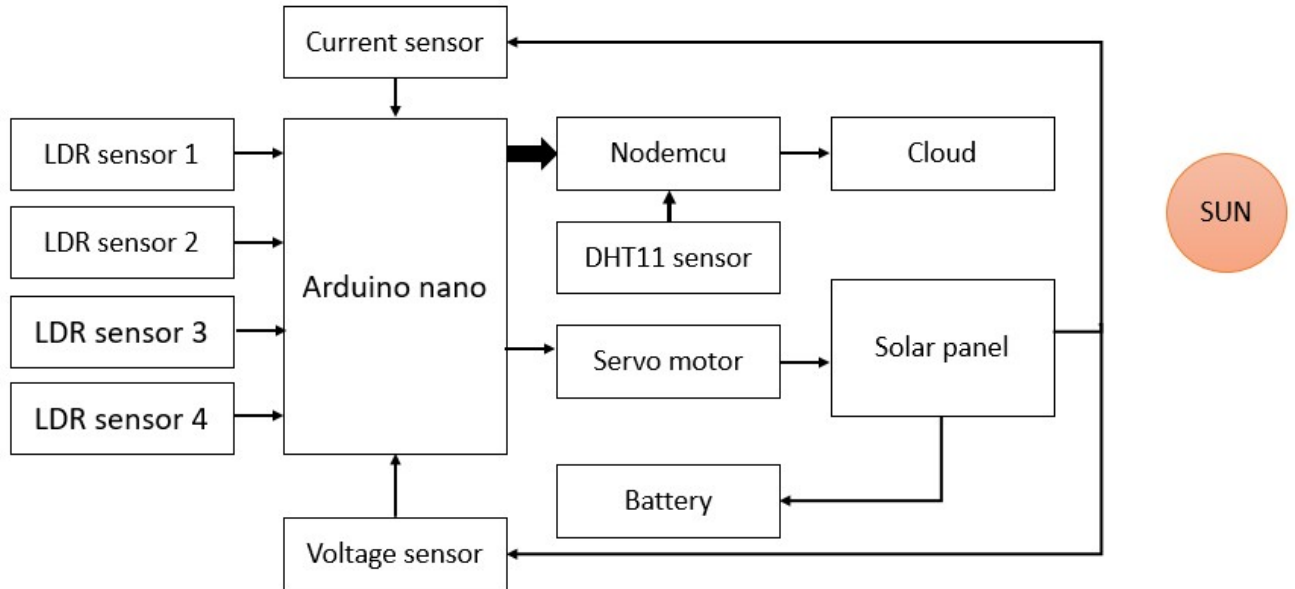


Fig: 3.1: Circuit Block Diagram

3.4HARDWARE REQUIRED

- Nodemcu
- Arduino nano
- Solar panel
- Servo motors
- LDR sensors
- DHT11 sensor
- Current sensor
- Voltage sensor

CHAPTER 4

MATERIALS AND METHODS USED

4.1 COMPONENTS USED FOR THE DESIGN

4.1.1 ARDUINO

Arduino is an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board.

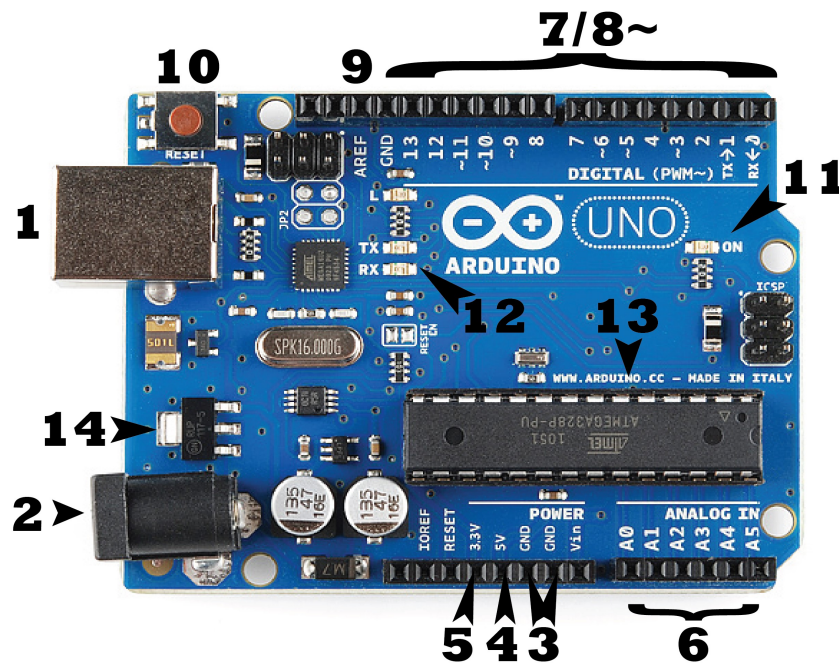


Fig: 4.1.1: Aurdino

Pins

The pins on your Arduino are the places where you connect wires to construct a circuit (probably in conjunction with a breadboard and some wire). They usually have black plastic 'headers' that allow you to just plug a wire right into the board. The Arduino has several different kinds of pins, each of which is 11 labelled on the board and used for different functions.

1. **GND (3):** Short for 'Ground'. There are several GND pins on the Arduino, any of which can be used to ground your circuit.
2. **5V (4) & 3.3V (5):** As you might guess, the 5V pin supplies 5 volts of power, and the 3.3V pin supplies 3.3 volts of power. Most of the simple components used with the Arduino run happily off of 5 or 3.3 volts.
3. **Analog (6):** The area of pins under the 'Analog In' label (A0 through A5 on the UNO) are Analog In pins. These pins can read the signal from an analog sensor (like a temperature sensor) and convert it into a digital value that we can read.
4. **Digital (7):** Across from the analog pins are the digital pins (0 through 13 on the UNO). These pins can be used for both digital input (like telling if a button is pushed) and digital output (like powering an LED).

5. PWM (8): You may have noticed the tilde (~) next to some of the digital pins (3, 5, 6, 9, 10, and 11 on the UNO). These pins act as normal digital pins, but can also be used for something called Pulse-Width Modulation (PWM). We have a tutorial on PWM, but for now, think of these pins as being able to simulate analog output (like fading an LED in and out).

6. AREF (9): Stands for Analog Reference. Most of the time you can leave this pin alone. It is sometimes used to set an external reference voltage (between 0 and 5 Volts) as the upper limit for the analog input pins.

4.1.2 LDR

A Light Dependent Resistor (LDR) or a photo resistor is a device whose resistivity is a function of the incident electromagnetic radiation. Hence, they are light sensitive devices. They are also called as photo conductors, photo conductive cells or simply photocells. They are made up of semiconductor materials having high resistance. There are many different symbols used to indicate a **LDR**, one of the most commonly used symbol is shown in the figure below. The arrow indicates light falling on it.

A light dependent resistor works on the principle of photo conductivity. Photo conductivity is an optical phenomenon in which the material's conductivity (Hence resistivity) reduces when light is absorbed by the material. When light falls i.e. when the photons fall on the device, the electrons in the valence band of the semiconductor material are excited to the conduction band. These photons in the incident light should have energy greater than the band gap of the semiconductor material to make the electrons jump from the valence band to the conduction band. Hence when light

having enough energy is incident on the device more & more electrons are excited to the conduction band which results in large number of charge carriers. The result of this process is more and more current starts flowing and hence it is said that the resistance of the device has decreased. This is the most common working principle of LDR.

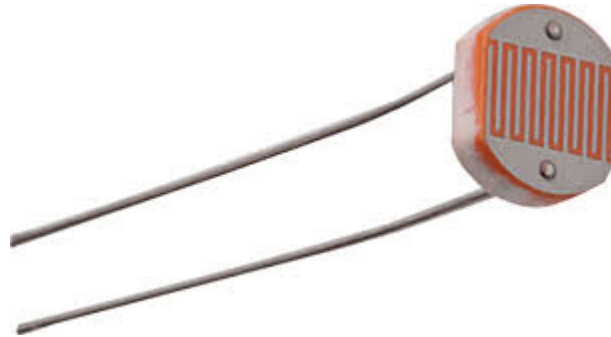


Fig: 4.1.2: Light Dependent Resistor

LDR's are light dependent devices whose resistance decreases when light falls on them and increases in the dark. When a **light dependent resistor** is kept in dark, its resistance is very high. This resistance is called as dark resistance. It can be as high as $10^{12} \Omega$. And if the device is allowed to absorb light its resistance will decrease drastically. If a constant voltage is applied to it and intensity of light is increased the current starts increasing. Figure below shows resistance vs. illumination curve for a particular **LDR**. Photocells or LDR's are non linear devices. Their sensitivity varies with the wavelength of light incident on them. Some photocells might not at all respond to a certain range of wavelengths. Based on the material used different cells have different spectral response curves.

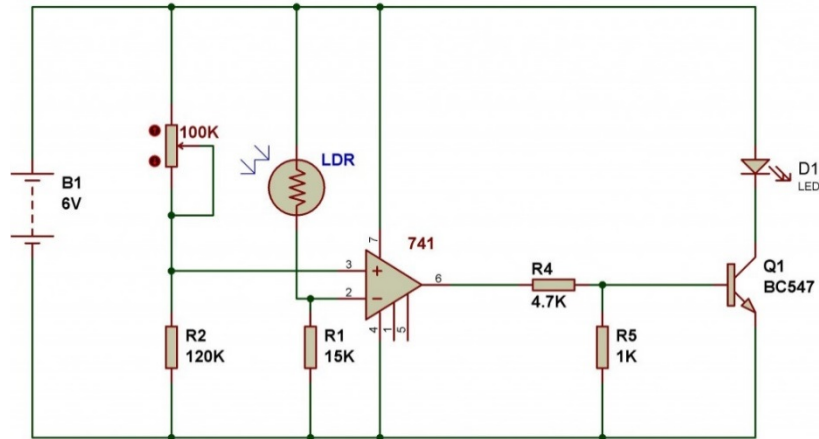


Fig: 4.1.3: Circuit Diagram Of Ldr

LDR's have low cost and simple structure. They are often used as light sensors. They are used when there is a need to detect absences or presences of light like in a camera light meter.

1. Street Lamps
2. Alarm Lamps
3. Burglar Alarm Circuits

4.1.3 SERVO MOTORS

A servomechanism, or servo, is an automatic device that uses error-sensing negative feedback to correct the performance of a mechanism. The term correctly applies only to systems where the feedback or error-correction signals help control mechanical position or other parameters. For example, the car's cruise control uses closed loop feedback, which classifies it as a servomechanism. A servo pulse of 1.5 ms width will typically set the servo to its "neutral" position or 45°, a pulse of 1.25 ms could set it to 0° and a pulse of 1.75 ms to 90°. The physical limits and timings of the servo hardware varies between brands and models, but a general servo's angular motion will travel somewhere in the range of 90° - 120° and the neutral position is almost

always at 1.5 ms. This is the “standard pulse servo mode” used by all hobby analog servos.

4.1.4 CURRENT SENSOR

The Allegro ACS712 provides economical and precise solutions for AC or DC current sensing in industrial, commercial, and communications systems. The device package allows for easy implementation by the customer. Typical applications include motor control, load detection and management, switched mode power supplies, and over current fault protection. The device is not intended for automotive applications. For the automotive grade version, see ACS714.



Fig: 4.1.4: Current Sensor

The device consists of a precise, low-offset, linear Hall sensor circuit with a copper conduction path located near the surface of the die. Applied current flowing through this copper conduction path generates a magnetic field which is sensed by the integrated Hall IC and converted into a proportional voltage. Device accuracy is optimized through the close proximity of the magnetic signal to the Hall transducer. A precise, proportional voltage is provided by the low-offset, chopper stabilized Bi CMOS Hall IC, which is programmed for accuracy after packaging.

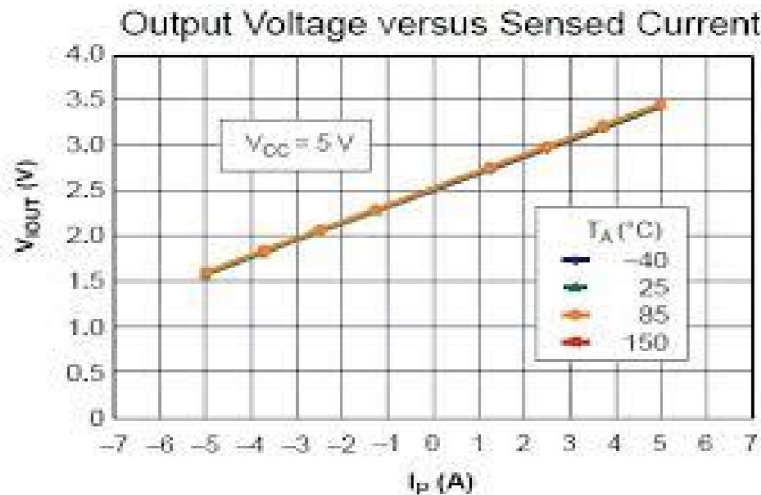


Fig: 4.1.5: Voltage vs Current

4.1.5 VOLTAGE SENSOR

We have already seen how to measure external voltages using Arduino in the project DIGITAL ARDUINO VOLTMETER. If you want to measure external voltages using Arduino, you have to make use of the Analog Input pins of the Arduino Board. If you recall a little bit about the Arduino Analog Pins, their input voltage is limited to 5V i.e. you can measure up to 5V directly using the Analog Input Pins of the Arduino. But what if you want to measure voltages that are greater than 5V? You cannot directly use the Analog Input Pins of the Arduino as you might fry the Atmega328P IC on the Arduino UNO board (or the relevant Microcontroller IC depending on the Arduino Board you are using). Here comes the Voltage Sensor Module to the rescue. Using this Voltage Sensor Module, you can measure voltages up to 25V. Before going into the details of the Voltage Sensor like its functionality and schematic, let me give you an overview of the available Pins of the Voltage Sensor Module. Basically, a 25V Voltage Sensor, like the one used here, has 5 pins in total. Two of them are on the two-pin screw terminal and three are male header pins. The following image shows the pins of a Voltage Sensor Module.

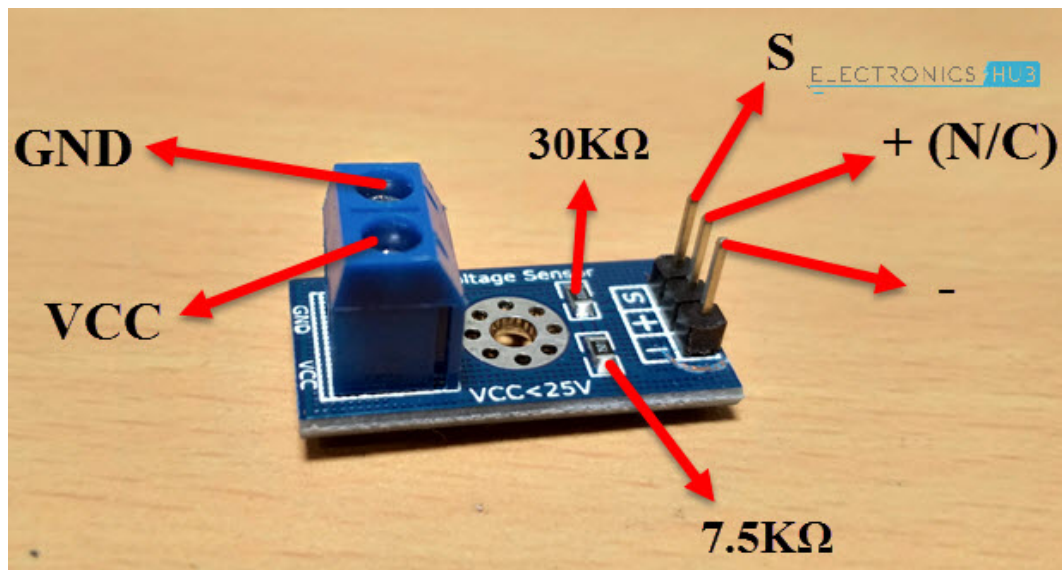


Fig: 4.1.6: Voltage Sensor Module

- **VCC**: Positive terminal of the voltage to be measured (0-25V)
- **GND**: Negative terminal of the voltage to be measured
- **S**: Analog Input of Arduino
- **+**: Not connected (N/C)
- **-**: GND of Arduino

Using a pre-built voltage sensor module is very easy and if you don't have one then you can easily build one yourself. All you need are two resistors. If you want to make your own voltage sensor that can measure voltages up to 25V like this Voltage Sensor Module, then you have to get a 30KΩ and a 7.5KΩ resistor. Interfacing a Voltage Sensor with Arduino

Now that we have seen a little about the Voltage Sensor, let us now proceed with Interfacing a Voltage Sensor with Arduino and measure some external voltages. The Arduino Voltage Sensor Interface is pretty straight forward. Connect the voltage to be measured to the screw terminal of the Voltage Sensor,

connected the output of the voltage divider to the Arduino. That's it. After interfacing the Voltage Sensor with Arduino, you can either view the results on the serial monitor of the Arduino IDE or on a 16×2 LCD Display. I have gone with the LCD Display.

Following image shows the circuit diagram of Interfacing a Voltage Sensor with Arduino.

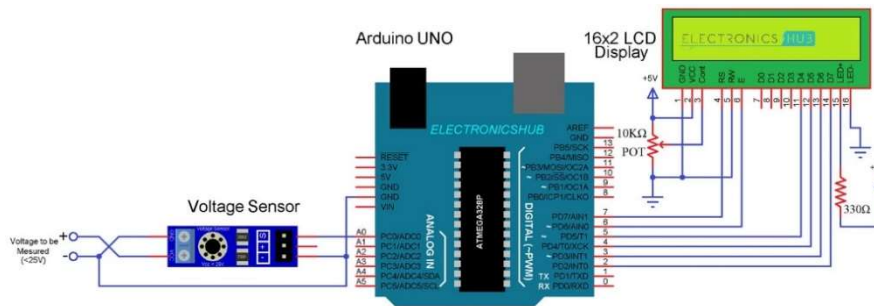


Fig: 4.1.7: Sensor interface

4.1.6 SOLAR PANEL

The term solar panel is used colloquially for a photo-voltaic (PV) module. A PV module is an assembly of photo-voltaic cells mounted in a framework for installation. Photo-voltaic cells use sunlight as a source of energy and generate direct current electricity. A collection of PV modules is called a PV Panel, and a system of Panels is an Array. Arrays of a photovoltaic system supply solar electricity to electrical equipment.

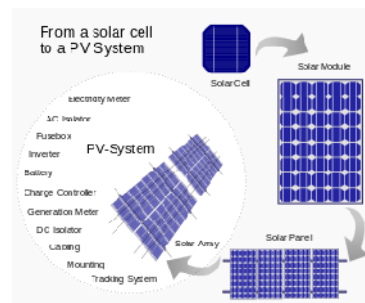


Fig: 4.1.8: Solar panel

Photovoltaic modules use light energy (photons) from the Sun to generate electricity through the photovoltaic effect. Most modules use wafer-based crystalline silicon cells or thin-film cells. The structural (load carrying) member of a module can be either the top layer or the back layer.

Cells must be protected from mechanical damage and moisture. Most modules are rigid, but semi-flexible ones based on thin-film cells are also available. The cells are connected electrically in series, one to another to the desired voltage, and then in parallel to increase amperage.

The wattage of the module is the mathematical product of the voltage and the amperage of the module. The manufacture specifications on solar panels are obtained under standard condition which is not the real operating condition the solar panels are exposed to on the installation site.

Research by Imperial College London has shown that solar panel efficiency is improved by studding the light-receiving semiconductor surface with aluminum nanoylinders, similar to the ridges on Lego blocks. The scattered light then travels along a longer path in the semiconductor, absorbing more photons to be converted into current. Although these nanocylinders have been used previously the light scattering occurred in the near-infrared region and visible light was absorbed strongly. Aluminum was found to have absorbed the ultraviolet part of the spectrum, while the visible and near-infrared parts of the spectrum were found to be scattered.

4.2 SOFTWARE USED

As in IoT, all the IoT devices are connected to other IoT devices and application to transmit and receive information using protocols. There is a gap between the IoT device and IoT application. An IoT Platform fills the gap between the devices (sensors) and application (network).

4.2.1 IOT PLATFORM

HSPICE Synopsys is the most widely used, trustworthy, and comprehensive simulation software in the business. HSPICE is the software used for accurate circuit simulation in the industry and foundry for MOS device models and cutting-edge simulation and analysis techniques.

Thus we can say that an IoT platform is an integrated service that 20abelle the gap between the IoT device and application and offers you to bring physical object online.

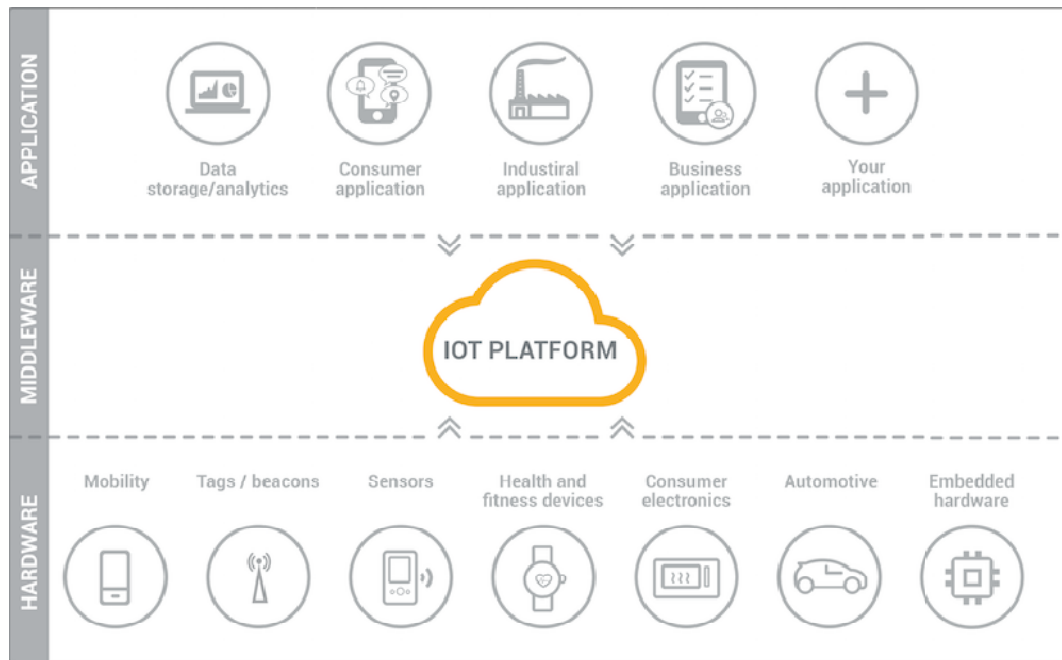


Fig: 4.2.1: Iot Platform

- **Amazon Web Services (AWS) IoT platform:** Amazon Web Service IoT platform offers a set of services that connect to several devices and maintain the security as well. This platform collects data from connected devices and performs real-time actions.

- **Amazon Web Services (AWS) IoT platform:** Amazon Web Service IoT platform offers a set of services that connect to several devices and maintain the security as well. This platform collects data from connected devices and performs real-time actions.
- **Microsoft Azure IoT platform:** Microsoft Azure IoT platform offers strong security, scalability and easy integration with systems. It uses standard protocols that support bi-directional communication between connected
- **Google Cloud Platform IoT:** Google Cloud Platform is a global cloud platform that provides a solution for IoT devices and applications. It handles a large amount of data using Cloud IoT Core by connecting various devices.
- **Artik Cloud IoT platform:** Artik cloud IoT platform is developed by Samsung to enable devices to connect to cloud services. It has a set of services that continuously connect devices to the cloud and start gathering data. It stores the incoming

4.3 ALGORITHM USED

The sun position algorithms calculate the solar azimuth () and elevation (EL) () angles of the sun. These angles are then used to position the solar panel toward the sun. The zenith angle () is the angle between the direction of the sun (direction of interest) and the zenith.

4.3.1 DUEL AXIS ALGORITHM

- The altitude angle and azimuth angle of the sun are changing all the time. The dual-axis tracking device tracks the sun to collect more solar energy.
- According to the type of axis, the dual-axis tracking device can be divided into two types: polar-axis tracking and altitude–azimuth tracking.
- Polar-axis tracking is also called spinning-elevation tracking. The principle of the polar-axis tracking device is one axis of the collector or concentrator pointing to the celestial north pole, which is parallel to the earth's rotation axis.
- The other axis is perpendicular to the polar axis, called the declination axis. When the device is working, the mirror or the collector rotates around the pole axis and the rotation speed is the same as that of the earth's rotation angle, but the rotation direction is opposite

CHAPTER 5

Results and Discussion

5.1 RESULTS AND DISSCUSSION

First, connect the “S” and “-” pins of the Voltage Sensor to A0 (Analog Input) and GND of Arduino respectively. Then connect the external voltage pins (voltage to be measured) to the screw terminal (check for polarity). Coming to the LCD, Digital I/O Pins 7 and 6 of Arduino UNO are connected to RS and E while the Pins 5 through 2 of Arduino UNO are connected to D4 through D7 respectively.

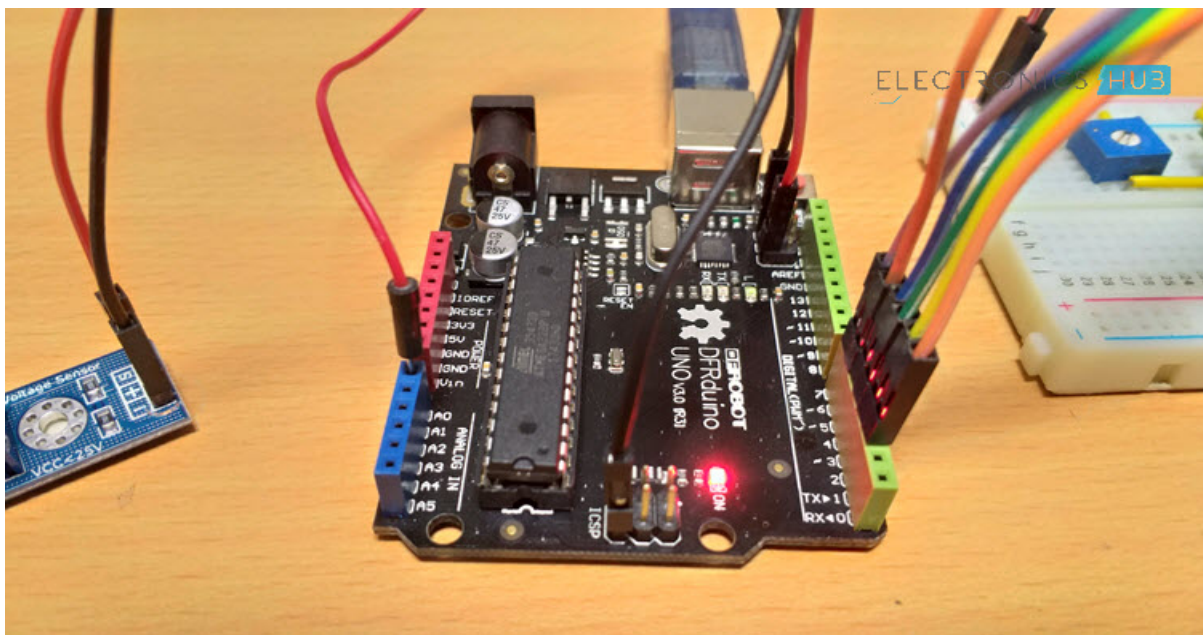


Fig: 5.1: Connections

The working of the project might be understood by now. Since the Voltage Sensor module is basically a voltage divider circuit, you can calculate input voltage using the formula

$$V_{in} = V_{out} * (R2/(R1+R2))$$

Here $R1 = 30000$, $R2 = 7500$ and V_{out} can be calculated from Analog

Input of Arduino by using

$$V_{out} = (\text{analogvalue} * 5 / 1024).$$

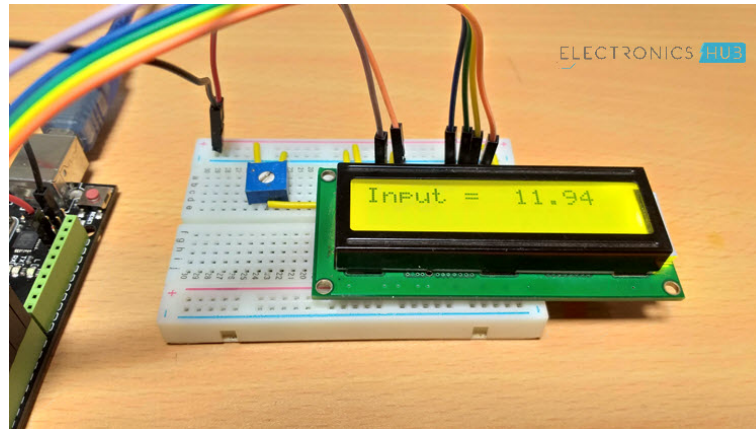


Fig: 5.2: Temperature Display

It has been implemented the same in the code. When I connected a 12V external supply as input to the Voltage Sensor, the calculated voltage is 11.94V, which is accurate enough.

Ubidots

Ubidots REST API hardware docs. Here you would reference how to send or retrieve data from your hardware devices using our supported communication protocols: HTTP, MQTT and TCP/UDP.

The purpose of this section is to help you understand what happens in the backstage when communicating with Ubidots, so you can replicate this in your firmware. For this reason, we avoid the use of examples using libraries. However, if you'd like to use one of our libraries (Python, C, and more),

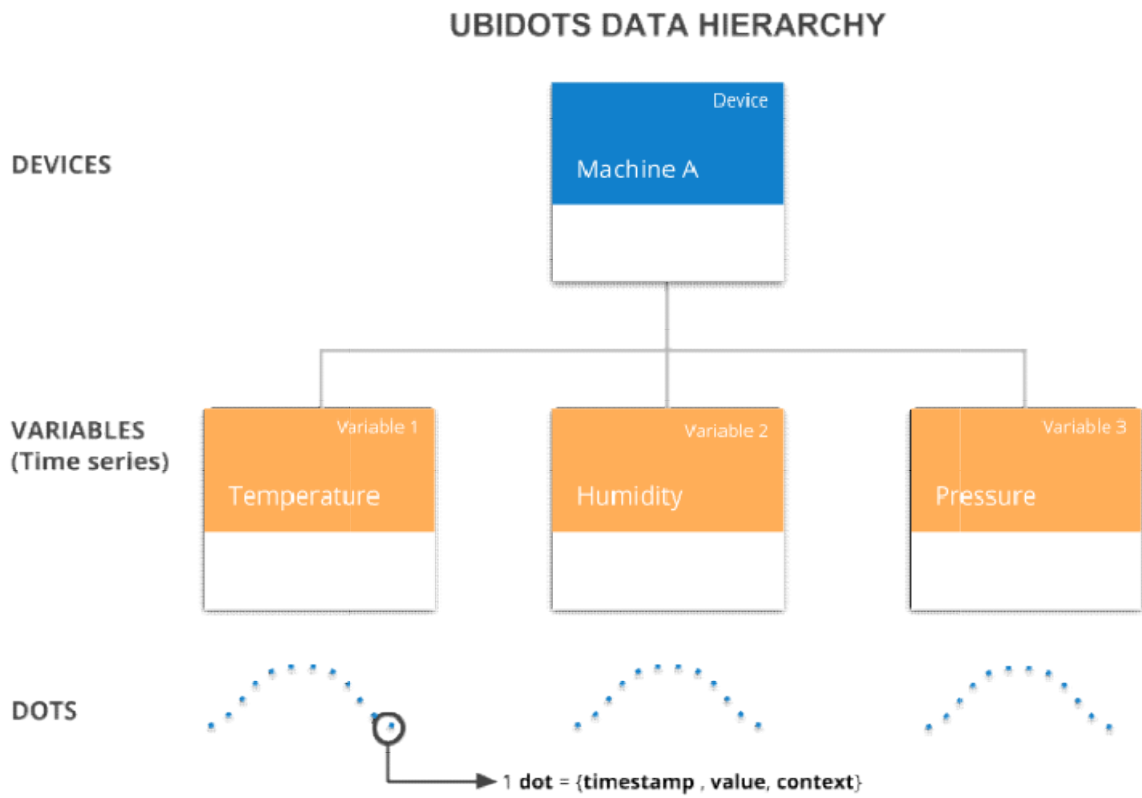


Fig: 5.3: Data Hierarchy

TABLE 5.1: ANALYSIS OF EXISTING DATA

Item	Description	Mandatory
value	A numerical value. Ubidots accepts up to 16 floating-point length numbers.	YES
timestamp	Unix Epoch time, in milliseconds. If not specified, then our servers will assign one upon reception.	NO
context	An arbitrary collection of key-value pairs. Mostly used to store the latitude and longitude coordinates of GPS devices.	NO

A timestamp, as best described here, is a way to track time as a running total of seconds. This count starts at the Unix Epoch on January 1st, 1970 at UTC. Therefore, the unix time stamp is merely the number of seconds between a particular date and the Unix Epoch. Please keep in mind that when you send data to Ubidots, you must set the timestamp in milliseconds; also, if you retrieve a dot's timestamp, it will be in milliseconds.

HTTP

- HTTP is the main internet protocol for information exchange in the Internet. It also supports data encryption, which is usually called *secure HTTP* or *HTTPS*.
- When you use a web browser (MS Edge, Firefox, Google Chrome, etc) you are sending and receiving packages using *HTTP* or *HTTPS*. Because of this, it was not surprising to see *HTTPS* become a popular option for data exchange within IoT.
- When a developer is to implement *HTTP* communication, then he should look for a *RESTful Application Programming Interface*, or *REST API*, which

exposes all the endpoints required to interact with a third party application (like Ubidots).

- In this section, you can reference our REST API to understand how to send and retrieve data from our servers.

HTTP requests

The following methods are specified within the *HTTP* standard:

TABLE 5.1: HTTP Methods

HTTP Method	Description
GET	Used to retrieve information
POST	Used to create a new element
PATCH	Used to update existing elements
DELETE	Used to delete existing elements

HTTP is a request/response protocol, this means that every request that you make is answered by the server. This response includes a number (response code) and a body. For example, when you make a request to retrieve a file on a webpage “(e.g. “*Get me the file ‘webside.html’*”)”, you build a GET request. If the request is correct, the server will typically return a 200 response code, along with the file requested (body).

An *HTTP* request also needs the parameters below:

- **Host:** Specifies the server you will be making HTTP requests to.
- **Path:** This is typically the remaining portion of the URL that specifies the resource you want to consume, be it a variable or a device. For example, if an

API endpoint is: `industrial.api.ubidots.com/api/v1.6/devices/my-device` then the path would be `/api/v1.6/devices/my-device`

- **Headers:** Define the operating parameters of the *HTTP* request such as authentication, Content-Type, Content-Length, etc.
- **Body/payload:** In the case of POST and PATCH requests, this is the data sent by your device to the server. GET requests typically do not have a body because they are meant to request data, not to send data.

HTTP Authentication

Every request requires a *token*. A *token* is an unique key that authorizes your device to ingest data inside your Ubidots account. The easiest way to get yours is clicking on “**API Credentials**” under your profile tab:

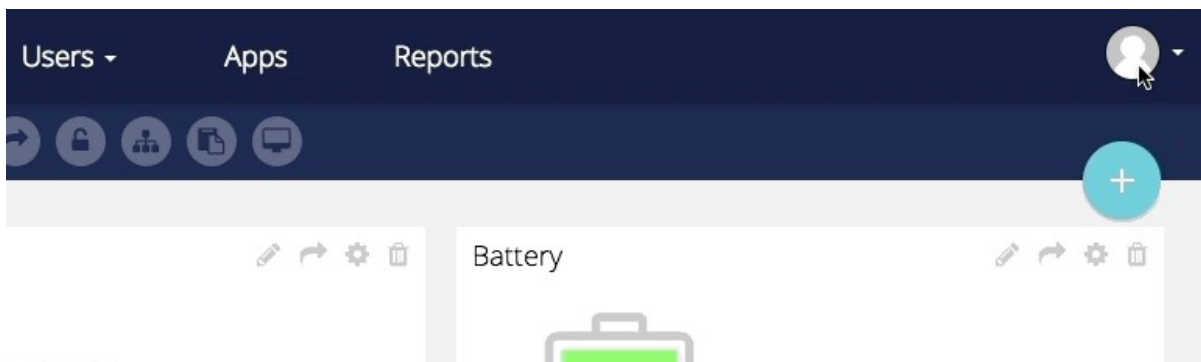


Fig: 5.4: HTTP Authentication

There are two ways to send a *token* in a request:

1. Send the *token* as parameter in the endpoint, setting it with the token. This is the easiest one to implement but the most unsecure method to send your authentication credentials.
2. Send the *token* as a request header. For this, use the X-Auth-Token header.

5.2 RESULT

The experiment that has been done, the solar panel was used to produce the outcome which is voltage, current, and power. Besides measuring from the solar panel, the parameter can be monitor from serial monitor in Arduino IDE. After a few second, the data stream created and saved in the Ubidots platform. The data that sent to the Ubidots platform will save in the data stream. All the data that saved in data stream will compile and show a few output that gain from solar panel.

5.3 OBSERVATION FROM THE RESULTS

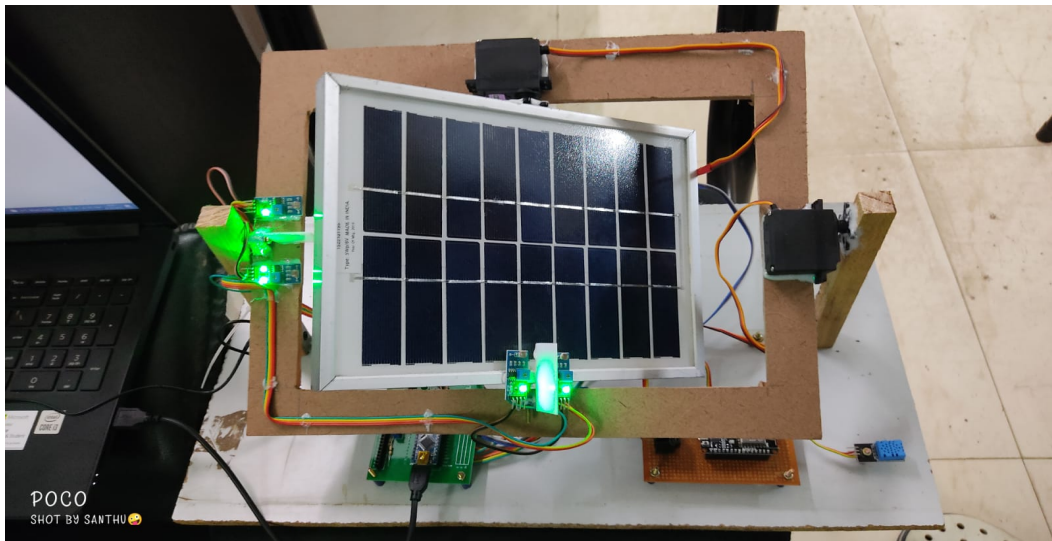


Fig: 5.5: Result

CHAPTER 6

CONCLUSION

Active solar tracking systems. These systems use electrical drives and mechanical gear trains to orient the panels normal to the sun's radiations. It uses sensors, motors and microprocessors for the tracking and are more accurate and efficient than the passive solar trackers. In this system we propose the dual axis solar tracker has been developed successfully. The monitoring system is equipped with ESP8266 WIFI module in order to transfer the data from solar panel to IOT monitoring system. The system can work in one condition which is the dual axis solar tracker must work within the WIFI coverage so that the user can attach the system with ESP8266 WIFI module and access the solar panel parameter via IOT monitoring System. The other success part is to develop the solar tracker to have two angle. There are 2 movements in this solar tracker that can be classified as horizontal and vertical. Both of the movements are used two servo motor 180-degree angle. In order to determine the functionality of the system, an experiment was done to determine either the sensor will operate properly when the tracker is tested outdoors. The outputs in storage of IOT system can improve in the future by improving or changing the platform.

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