Solar Tracking System Using Cloud Computing

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Abstract— In this modern world, nations are looking forward for renewable energy since they are free, clean to use and are available abundantly in the nature when compared to the fossil fuels. According to the latest reports, India is becoming a solar superpower because international airport like CIAL is running purely over renewable energy. And one of the world's largest solar projects has just been completed in Tamil Nadu, India. This project aims to build a trial device which can be used prior to the implementation of solar plant which uses a huge investment for its completion. The project is divided into two parts- hardware and software. Hardware parts comprises of Arduino, LDR sensors and servo motors whereas software consist of a mobile application for accessing graph. For cloud computing Amazon web server is used. Data that we obtained from the LDR sensors are sent to the cloud and computational processes will be done there. And finally, after processing, the output will be a graph. The graph can be accessed by the mobile application. By analyzing the graph, we can decide whether the location we are planning to have a huge project like solar plant, will be suitable or not. Benefit from this project is the early prediction about future of the solar plant, planning for a particular location. And, thus, it helps to prevent huge investment before knowing the feasibility of the project.

Keywords: AWS, API, LDR, CdS

I. INTRODUCTION

Solar energy has become a very attractive energy source in the world due to the rise of oil prices and the negative environmental effects that conventional energy production causes. Here, a servo motor is used since the sun changes its position during morning and all the way to evening. Solar energy is the energy obtained by capturing light from the Sun. Energy obtained from the Sun is referred to as solar energy. Solar projects are mainly focused on obtaining solar energy through some devices like solar panels but solar projects are usually highly expensive and without any proper planning, it would be a greater disaster. If the location that client intend to install the solar project is not feasible, it would be a wastage of money and time.

In this project, it is focused to develop a test device that can be run prior to installation of actual solar project. In this device, software and hardware components have integrated. Hardware components include Arduino, Light sensors and Servo motors. Software components include User Interface, Mobile Application, Webpage and AWS (Amazon Web Services).

II. ARDUINO PIN DIAGRAM EXPLAINED

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:

1) 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.
2) 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.
3) PWM Pins 3, 5, 6, 9 and 11: These pins provide an 8-bit PWM output by using analogWrite() function.
4) SPI Pins 10 (SS), 11 (MOSI), 12 (MISO) and 13 (SCK): These pins are used for SPI communication.
5) 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.
6) Along with 14 Digital pins, there are 6 analog input pins, each of which provide 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.
7) Analog pin 4 (SDA) and pin 5 (SCA) also used for TWI communication using Wire library.
8) Arduino Uno has a couple of other pins as explained below:
9) AREF: Used to provide reference voltage for analog inputs with analogReference() function.
10) Reset Pin: Making this pin LOW, resets the microcontroller.

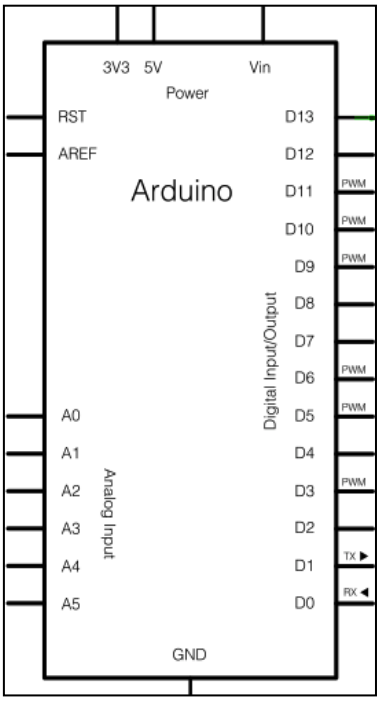

Fig. 1: Arduino Pin Diagram

III. BASIC ARCHITECTURE OF CLOUD COMPUTING

Cloud computing is a platform where a user can access. It is available according to the need of the client. Cloud computing includes a set of computer systems and provide services like data storage, computing power without any intervention of user.

This project chose Amazon web service as the cloud computing since it is cheap and very helpful in educational purposes. EC2 management console is used to perform some functions. Average of the intensity values are taken and are done by EC2 management console. Amazon Web service is a paid cloud computing service. After getting an account on the AWS, user will get an instance. Instance is a virtual server. This server has an IP. This IP is used to get access to the interface.

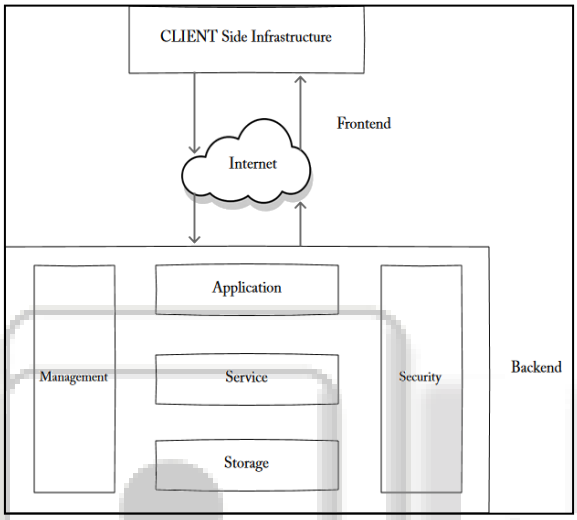

Fig. 2: Cloud Computing Architecture

IV. BASIC STRUCTURE OF PLASTIC COATED PHOTOCELL

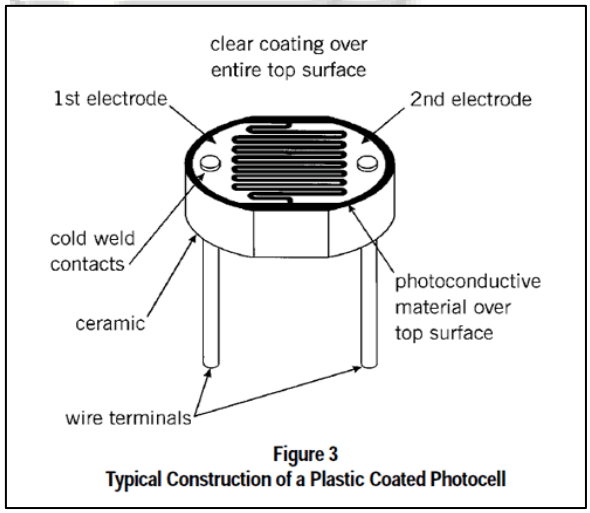

Figure 3
Typical Construction of a Plastic Coated Photocell

A Light Dependent Resistor (LDR) is also called a photoresistor. It is also called a photoconductor. It is basically a photocell that works on the principle of photoconductivity. This hardware component is basically a resistor whose resistance value decreases when the intensity of light decreases. This photoelectric is mostly used in light varying sensor circuit. Some of its applications include street lights, solar tracking system of lower power applications,

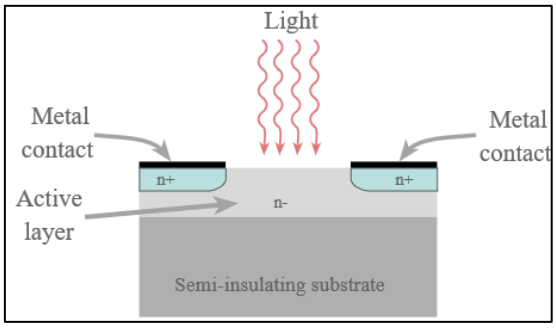

Fig. 3: Structure of LDR

The zigzag track shown above is the Cadmium Sulphide (CdS) film which also passes through the sides. On top and bottom are metal films which are connected to the terminal leads. It is designed in such a way as to provide maximum possible contact with the two metal films. As mentioned above, the main substance for the construction of LDR is cadmium sulphide (CdS), which is used as the photoconductor and contains very few electrons when not illuminated. In the absence of light it is designed to have a maximum resistance in the range of 10^6 ohms. As light falls on the sensor, the electrons are start to mobilize and the conductivity of the material increases. This causes the free electrons or holes to conduct electricity and thus dropping the resistance rapidly (< 1 Kiloohm).The equation to show the relation between resistance and illumination can be written as:-

$R = A.E^{a}$

Where E= Illumination (lux)
R= Resistance (ohms)
A,a = Constants

The value of 'a' depends on the CdS used. Values usually range between 0.7 and 0.9.

V. STRUCTURE OF THE SERVO MOTOR

Servo motor is used to move the sytem to the position of the sun. It uses a feedback signal to regulate direction and speed of the motor. This will help to achieve intended output. Servo moto always check and adjust its position until it meets the real target position. User can control the servo motor by programing its initial value and/or its terminal value. A conventional analog servo motor expects to receive a pulse roughly every 20 milliseconds (i.e. signal should be 50Hz).

The length of the pulse determines the position of the servo.

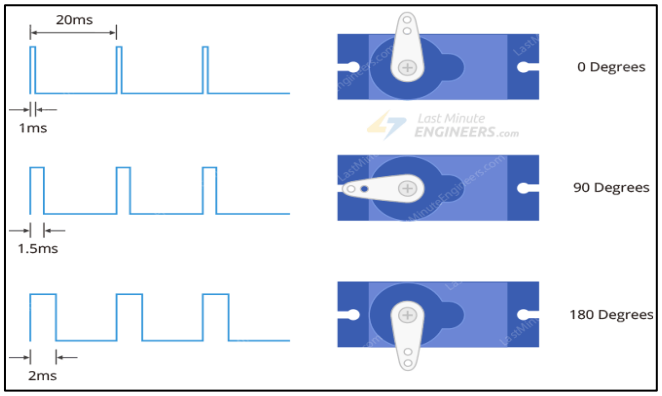

Fig. 4

If the pulse is high for 1ms, then the servo angle will be zero.If the pulse is high for 1.5ms, then the servo will be at its center position. If the pulse is high for 2ms, then the servo will at 180 degrees.

A. Design of model

This project is the combination of software and hardware. The model design will be based on that. Design of model for the hardware will be the architectural designs whereas software design includes software development model used and the environment for software development. So far, software parts are almost complete and the various software and their environments are mentioned below.

1) ARDUINO IDE:

The Arduino Integrated Development Environment (IDE) available for Windows, macOS, Linux that is written in laguages such as C and C++. It is used to compile and upload programs to Arduino compatible boards. Since this project focuses on hardware and software equally, Arduino board and its IDE are major components for the project. Programs and other things are done in this platform.

2) HTML:

HTML stands for Hyper Text Markup Language. Hypertext Markup Language (HTML) is the standard markup language for documents designed to be in a web browser. It can be assisted by technologies such as Cascading Style Sheets (CSS) and scripting languages such as JavaScript. In this project, the role this programing language is to make a layout for the interface. So that we can access the interface through internet connection. Bootstrap is used for styling the webpage.

3) PHP:

PHP code is usually processed on a web server by a PHP interpreter implemented as a module, as a Common Gateway Interface (CGI) executable. PHP stores integers in a platform-dependent range, either as a 32, 64 or 128-bit signed integer. Unsigned integers are converted to signed values in certain situations. Integer variables can be assigned using decimal (positive and negative), octal, hexadecimal, and binary notations. In this project, php is used to connect with the database.

4) Cloud Computing:

Cloud computing is a platform where a user can access. It is available according to the need of the client. Cloud computing includes a set of computer systems and provide services like data storage, computing power without any intervention of user. This project chose Amazon web service as the cloud computing.

5) API:

An application programming interface (API) is a computing interface aim specifically to access services to the user. The API was entirely specific to that software application. In order to use an API, programmers had to obtain an SDK from the software publisher, which was also often referred to as the API. API stands for Application Program. In this project, it is used to get values from the hardware and automatically uploaded to cloud without the direct interaction of humans

VI. SIMULATIONS AND EXPERIMENTAL RESULTS

This device will be placed under a location where LDR could get maximum brightness from the Sun. LDR senses the intensity values and obtain values from it. These values will be uploaded to the cloud where some of the computational procedure will done. The computational procedure includes taking average of values of the each and every second produced by LDR.

```
Starting connection...
connected
Data submitted
104
19
Connected to wifi

Starting connection...
connected
Data submitted
106
23
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Fig. 5: Real time detection of intensity values from LDRs.

Average is taken because of the uncertainty of the climate i.e. some day will be brighter and some may be cloudy. Values will be produced according. To compact this, average is taken. Final results will be uploaded to the database. An user interface is designed using PHP such a way that, web based interface can now be connected with the database.

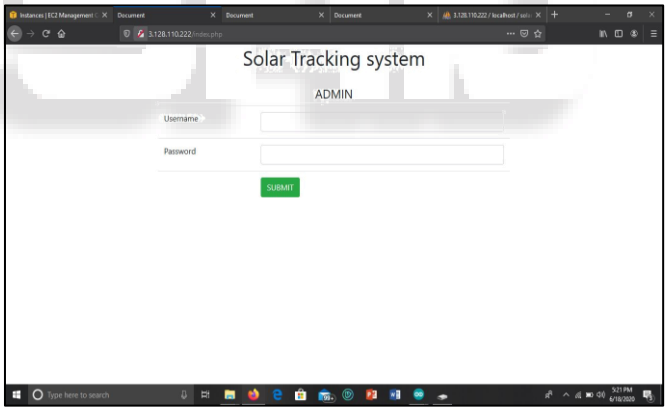

Fig. 6: Screenshot of User interface.

Output will be an average value and the value is represented by using a graph. Location of the particular place can be located by using google maps if and if we know the longitude and latitude of the location.

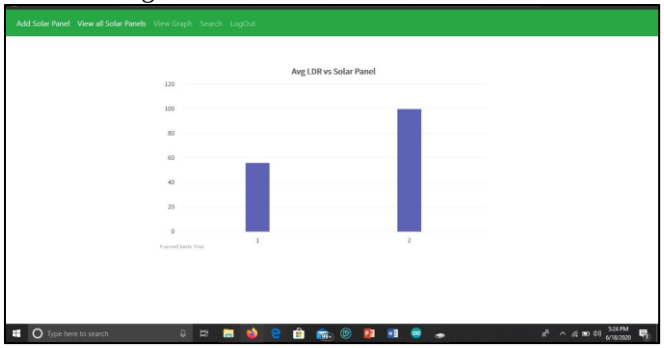

Fig. 7: Simulated output graph.

LDR produces values ranges almost from 0 to 600. If the average value of a location where the client intending to installing the solar project is above 300, that location will be good for the solar project as the LDR produces a maximum value of 600 and consider its half which is 300, take this as threshold value.

VII. CONCLUSION

Currently, there is no means to predict the future of a huge investment project like solar project.
Solar tracking system with cloud computing is an excellent way to predict future of the same. Client will get a clear cut idea about the region where it placed without any need of an expertise. The device itself is cheap, can be made from most available hardware components. It will be a huge success when it is commercially unveiled.

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