A Project Report

On

IoT based SOLAR TRACKING SYSTEM FOR EFFICIENT POWER GENERATION

A Project Work Submitted in Partial Fulfillment of
the requirements for

DEGREE
In
COMPUTER SCIENCE AND ENGINEERING

By

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PES
UNIVERSITY

CERTIFICATE OF APPROVAL

This is to certify that the work embodied in this project entitled **IoT based SOLAR TRACKING SYSTEM FOR EFFICIENT POWER GENERATION** submitted by Tejus.D and Mukti Prada.G.M to the Department of Computer Science and Engineering, have carried out under my direct supervisions and guidance.

The project work has been prepared as per the regulations of PES University and I strongly recommend that this project work be accepted in partial fulfillment of the requirement for Degree.

Supervisor-

Mr.Nagegowda.K.S
(Associate Professor, Dept. of CSE)

Certificate by the Board of Examiners

This is to be certified that the project work entitled **IoT based SOLAR TRACKING SYSTEM FOR EFFICIENT POWER GENERATION** submitted by Tejus.D and Mukti Prada.G.M to the Department of Computer Science and Engineering of PES university, Bengaluru has been examined and evaluated.

The project work has been prepared as per the regulations of PES University and qualifies to be accepted in partial fulfillment of the requirements for the Degree.

Project Coordinator Board of Examiners
Mr.Nagegowda.K.S
(Associate Professor, Dept. of CSE) ________________

ACKNOWLEDGEMENT

We students of Degree 3rd year, Computer Science and Engineering, have successfully completed the project under the guidance of esteemed faculties of this very institute.

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ABSTRACT

In this modern world, Electricity is also added to the most basic needs in everyone's life. The graph of energy consumption is getting increased day by day whereas the energy resources are diminishing parallel. In order to balance the scarcity for electricity, various sources are used to generate electricity. For the generation of electricity, there are two ways: one is by conventional method and other one is non-conventional method. Some of the energy carriers like fossil fuels and nuclear fuels are also used, but they are not renewable resources (i.e., they are not 'refilled' by nature) and it is said to be non-conventional. In its broadest sense, a sustainable power source can be achieved by using solar power as a source. Solar energy has wide availability throughout the world. The sun has produced energy for billions of years. The sun's rays may cast as an important source for the generation of electricity by converting it into an electric power. Such application is called solar thermal energy, which is conventional.

IoT plays an important role in harvesting this conventional source of energy efficiently using solar tracking systems. An active tracker uses motors to direct the panel toward the sun by relying on a sensing circuit to detect light intensity. There are two main ways to mount a solar panel for tracking; single axis and dual axis. Single axis trackers usually use a polar mount for maximum solar efficiency. Polar trackers have one axis aligned to be roughly parallel to the axis of rotation of the earth around the north and south poles. When compared to a fixed mount, a single axis tracker increases the output by approximately 30%, the second way is a two axis mount where one axis is a vertical pivot and the second axis is the horizontal. By using a combination of the two axes, the panel can always be pointed directly at the sun. This method increases the output by approximately 36% compared to stationary panels.

1. CHAPTER I: INTRODUCTION

OVERVIEW

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 innovation, successful strategy, robust control philosophy and the potential added benefit of different research work which can be employed on an extensive scale in a 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. The IoT is an intelligently connected device and framework containing brilliant machines connecting and communicating with different machines, environments, objects and infrastructures and the radio frequency identification (RFID) and sensor network technologies will rise to meet this new challenge. Furthermore the investigation gives the different related works on iot empowered solar panel monitoring modules for the proficient way to gain power from the solar radiation.

Developing the Advanced Metering Infrastructure (AMI), one of the key factors for smart city strategy, will allow, through remote data reading and bi-directional communication, an active participation of the consumers to load balancing in critical situations and implementation of dynamic tariffs in order to stimulate the integration of renewable energy source and electric vehicles. On the other hand, AMI will allow the operators (distribution operator, energy supplier or the municipality) to elaborate load forecasts for variable load intervals.

Smart grid is a necessary industrial and economic revolution taking into consideration the advanced aging that can be still found in substation, electrical lines and transformers. With the advent of computation techniques and the innovations in the electrotechnical materials it is now possible to manufacture electrical equipment and advanced automation, protection and control systems. Efficient harvesting of solar energy places a major role, with respect to implementing a smart grid, as it is a renewable clean source.

BENEFITS OF IOT IN SOLAR ENERGY GENERATION

Solar energy has many advantages, but solar power can also be a challenge for energy companies when it comes to management. Gathering data from the edge, across a diverse and distributed range of solar assets can be a major obstacle even for tech-savvy organizations with large budgets and engineering resources.

Using IoT in solar energy can solve many of these issues with little effort and investment.
The main benefit of using IoT in solar energy is that you can see exactly what's happening with all your assets from one central control panel. By connecting your devices to a cloud network, you can identify where the problem originated and dispatch a technician to fix it before it disrupts your entire system. For instance, you may see that your network is running perfectly, but there is a problem with one of your devices. Without IoT, it would be difficult to determine whether the problem was network-related or hardware-related. The IoT provides the intelligence for you to identify issues in real time, as the error occurs so the source can be located and resolved quickly.

Using the IoT, your system will be less susceptible to outages and productivity issues (resulting from downtime) and potentially costly security breaches. By installing an all-in-one edge-to-cloud IoT solution to connect your solar assets, you can manage the largest solar grids in the world, even with thousands of individual devices connected to your network.

2. CHAPTER-II :OVERVIEW OF THE PROJECT

COMPONENTS & MODULES

1) ARDUINO UNO:

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits.The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts. It is similar to the Arduino Nano and Leonardo. The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also available.

The word "uno" means "one" in Italian and was chosen to mark the initial release of Arduino Software.The Uno board is the first in a series of USB-based Arduino boards;it and version 1.0 of the Arduino IDE were the reference versions of Arduino, which have now evolved to newer releases. The ATmega328 on the board comes pre-programmed with a bootloader that allows uploading new code to it without the use of an external hardware programmer.

2) NodeMCU ESP8266:

NodeMCU is an open source firmware for which open source prototyping board designs are available. The name "NodeMCU" combines "node" and "MCU" (micro-controller unit). The term "NodeMCU" strictly speaking refers to the firmware rather than the associated development kits

Both the firmware and prototyping board designs are open source.

The firmware uses the Lua scripting language. The firmware is based on the eLua project, and built on the Espressif Non-OS SDK for ESP8266. It uses many open source projects, such as lua-cjson and SPIFFS. Due to resource constraints, users need to select the modules relevant for their project and build a firmware tailored to their needs. Support for the 32-bit ESP32 has also been implemented.

The prototyping hardware typically used is a circuit board functioning as a dual in-line package (DIP) which integrates a USB controller with a smaller surface-mounted board containing the MCU and antenna. The choice of the DIP format allows for easy prototyping on breadboards. The design was initially based on the ESP-12 module of the ESP8266, which is a Wi-Fi SoC integrated with a Tensilica Xtensa LX106 core, widely used in IoT applications (see related projects).

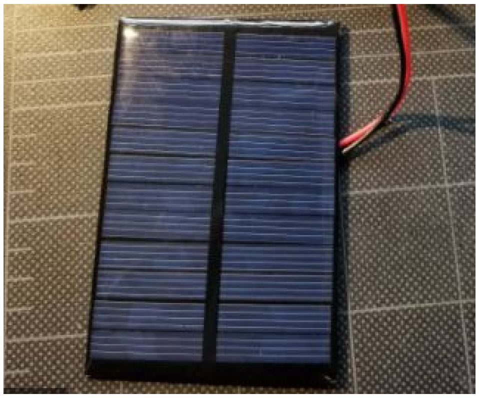
3) SENSORS

SOLAR PANEL:

Light sensors have gained recent recognition thanks to current prevalence of photovoltaic cells—or solar panels—that some green enthusiasts favor when it comes to powering houses and saving energy. However, photovoltaic cells are only one example of light sensors, which have numerous other modes of operation. Light sensors, also called photodetectors, come in many different varieties and serve a multitude of functions.

Photovoltaic cells

This particular type of photodetector is frequently used as a modern, green, power source. Essentially, they consist of a panel of absorbent solar cells, which generate electricity from sunlight. Because the sun's photons activate electrons in the panel, energy is created. The direct current the panels create is then changed from DC voltage to AC voltage, and can be used to power entire households, equipment, or batteries. In order to protect against inclement weather, photovoltaic cells are often covered with a sheet of glass.



DHT 11:

The DHT11 is a basic, ultra low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin (no analog input pins needed). It's fairly simple to use, but requires careful timing to grab data.

LDR:

A Light Sensor generates an output signal indicating the intensity of light by measuring the radiant energy that exists in a very narrow range of frequencies basically called “light”, and which ranges in frequency from “Infra-red” to “Visible” up to “Ultraviolet” light spectrum.

The light sensor is a passive device that converts this “light energy” whether visible or in the infra-red parts of the spectrum into an electrical signal output. Light sensors are more commonly known as “Photoelectric Devices” or “Photo Sensors” because they convert light energy (photons) into electricity (electrons).

4) ACTUATORS

SERVO MOTOR

A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration.[1] It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors.

Servo Motors are not a specific class of motor, although the term *servomotor* is often used to refer to a motor suitable for use in a closed-loop control system.

Servo Motors are used in applications such as robotics, CNC machinery or automated manufacturing.

CIRCUIT DESCRIPTION & WORKING PRINCIPLE

The main aim is to rotate the solar panel at specific angles over the time of the day, such that it is always facing the sun directly. We have used Arduino Uno, which is a microcontroller for this purpose. The arduino board rotates the servo motors every half hour, after receiving data from the database, with respect to the elevation and azimuth value, so that the sun is at the zenith position. To get the data from the database, we have used the nodemcu ESP8266 module. There are other sensors such as DHT 11, and ldr used for monitoring the system and run analysis later. A python code running at the backend that gives us the elevation and azimuth value of the solar panel. An algorithm is used where given date, time and location as parameters, we get the elevation and azimuth value.
A dashboard where we can monitor and view the status of the whole system.
The ldr sensor, which is a photosensor, is used as a dust sensor. The idea is when there is too much dust sitting on the panel, it would create an opaque layer for the light to pass through. Hence we send an alert to clear the dust to the concerned people.

3. CHAPTER-III : ALGORITHMS & FLOWCHART

ALGORITHM

THE ALGORITHM OF OVERALL PROCESS:-
STEP 1: START THE PROCESS
STEP 2: CONNECTED TO WIFI
STEP 3: READ TEMPERATURE AND HUMIDITY USING DHT 11 SENSOR
STEP 4: SEND THIS DATA TO DATABASE THAT IS FIREBASE WHICH GETS DISPLAYED IN THE WEBPAGE.

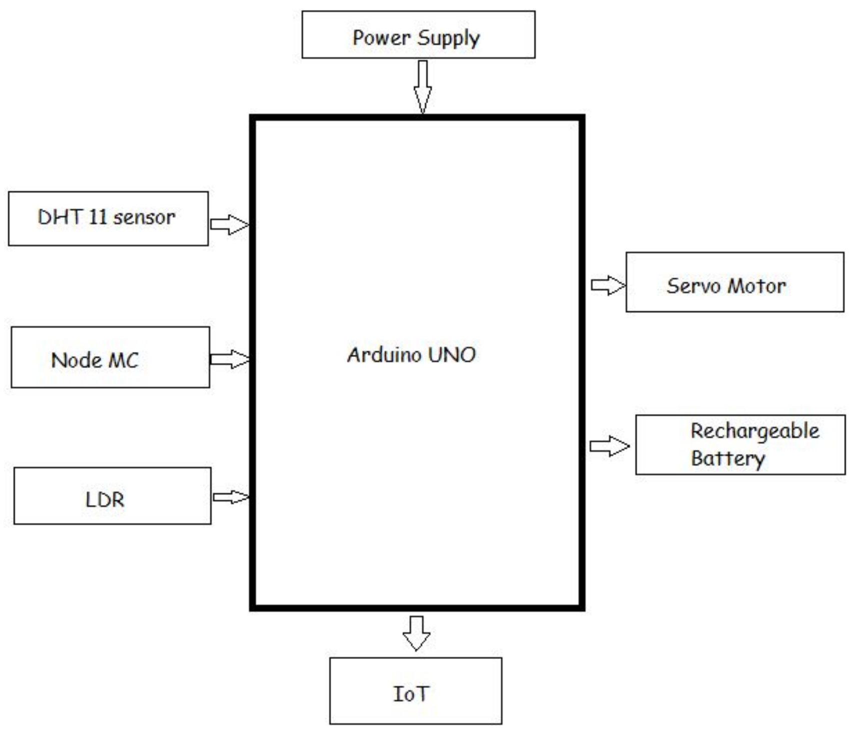
STEP 5: PYTHON CODE GENERATES THE ELEVATION AND AZIMUTH VALUES AND SEND IT TO DATABASE

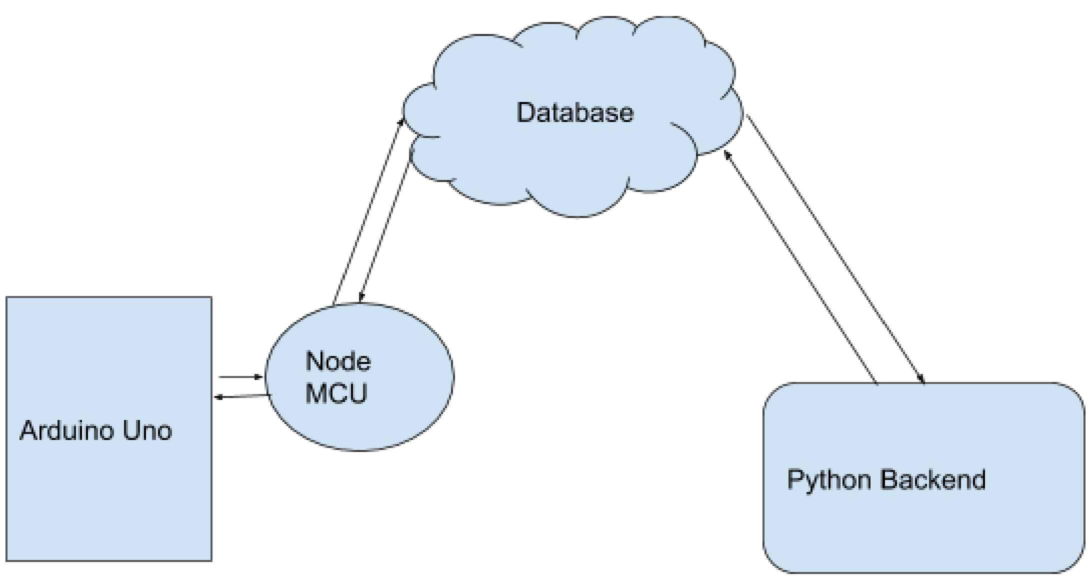
STEP 6: ARDUINO GETS THIS DATA USING NODE MCU AND ROTATES THE RESPECTIVE SERVO MOTORS

STEP 7: REPEAT STEP 3, 4, 5 & 6 UNTIL THE PROCESS CONTINUOUSLY

STEP 8: END

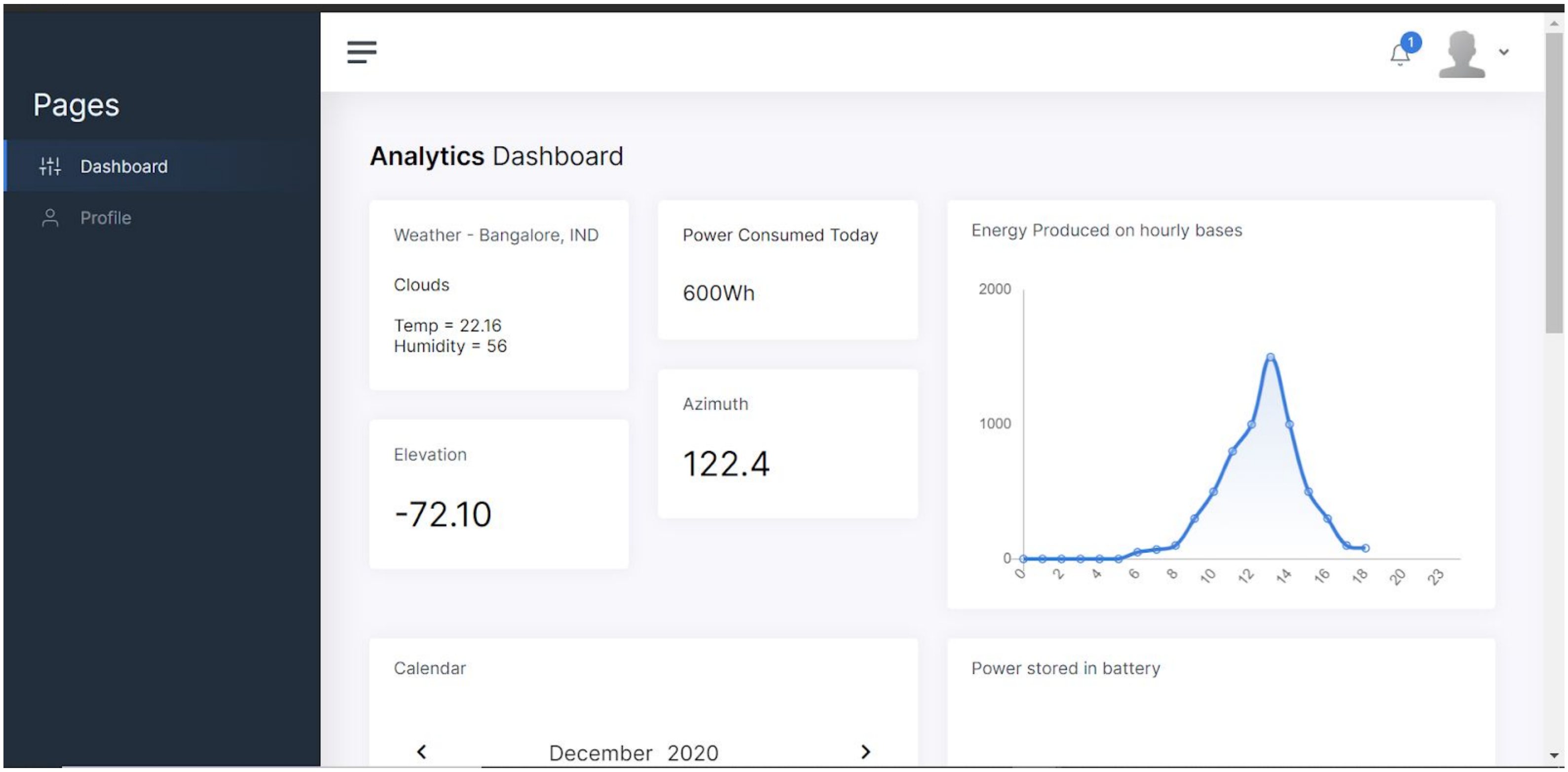
FLOWCHART:

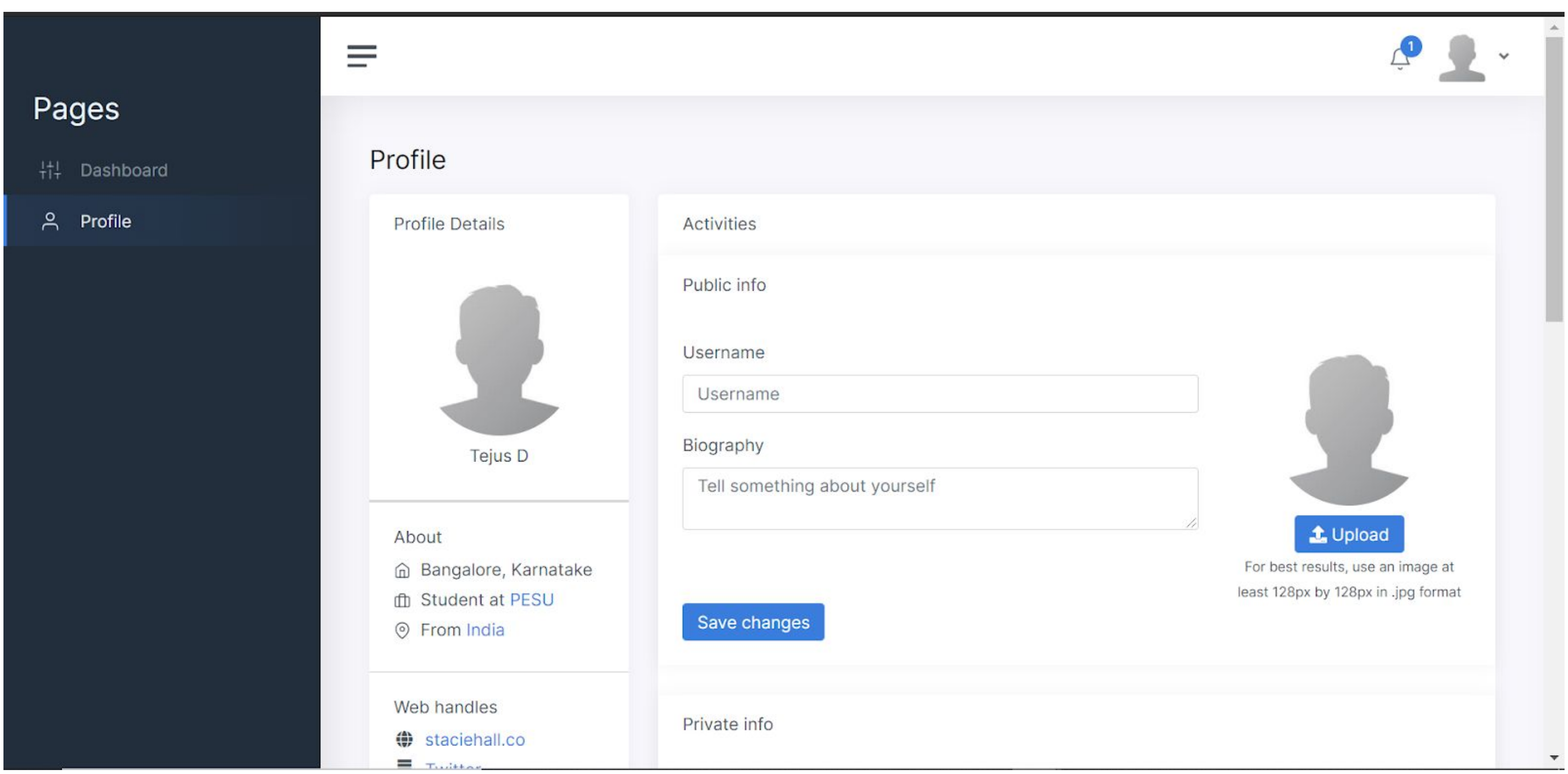




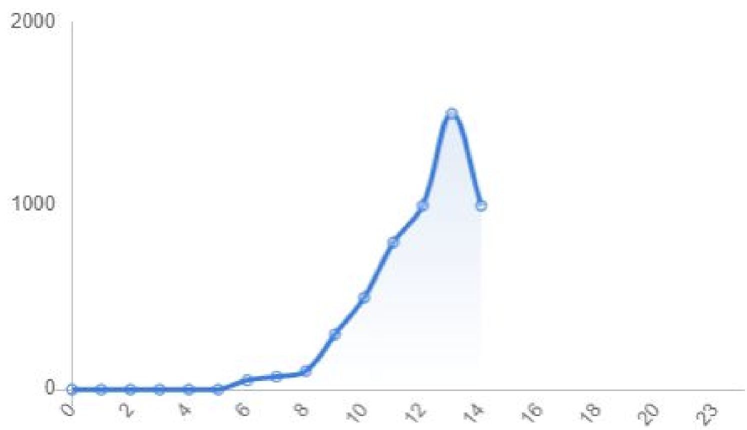
OUTPUT and GRAPHS

Frontend

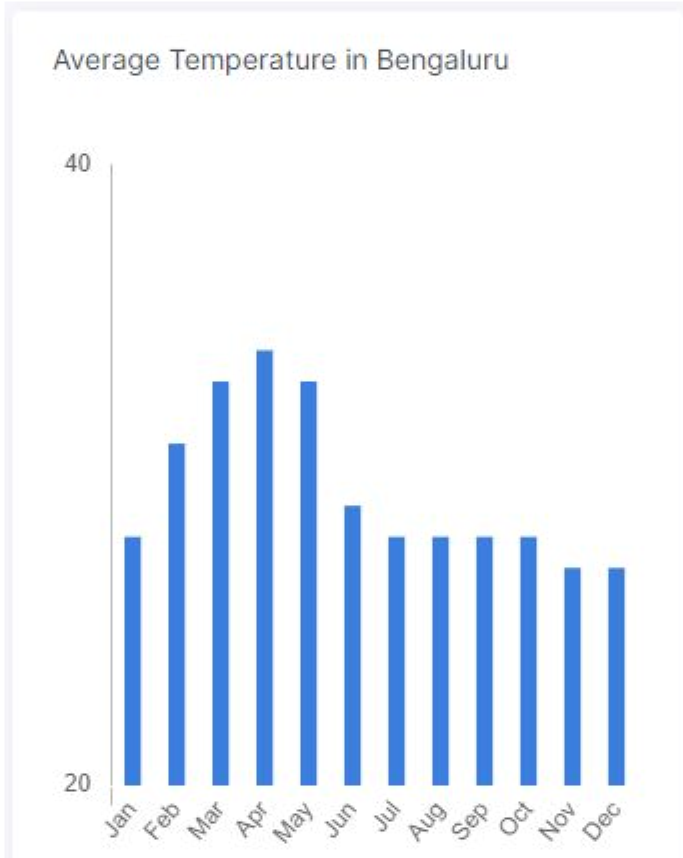




Energy Produced on hourly bases

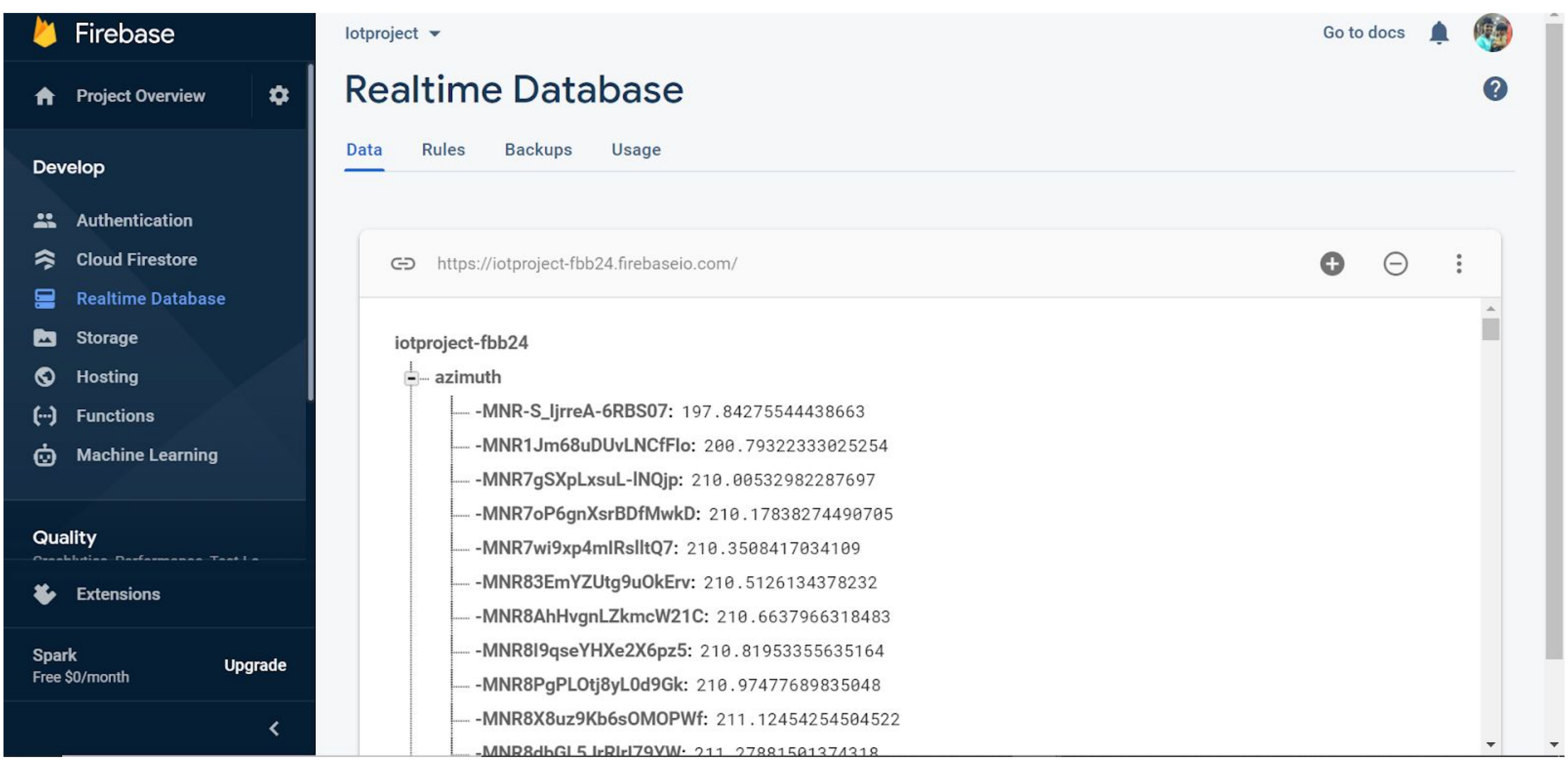


Power stored in battery



Average Temperature in Bengaluru
40
20
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Firebase



Firebase
Project Overview
Develop
Authentication
Cloud Firestore
Realtime Database
Storage
Hosting
Functions
Machine Learning
Quality
Extensions
Spark
Free $0/month
Upgrade
Iotproject
Go to docs
Realtime Database
Data
Rules
Backups
Usage
https://iotproject-fbb24.firebaseio.com/
iotproject-fbb24
azimuth
-MNR-S_ljrreA-6RBS07: 197.84275544438663
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4. CHAPTER-IV: CONCLUSION & FUTURE SCOPE

4.1 CONCLUSION

In this investigation it has assessed various procedures that are used for the tracing of solar panel. It can be manipulated anywhere such as house-hold activities in office even for industrial purposes. The cost of the implementation of this task can be fluctuated by various methods. If the user's consideration is on cost, then the method of using an arduino in the module can be an agreeable one. For this it is also a low power consuming project. Today the world is confronting an intense power emergency. We require a better power system to give benefits to those people who live in remote areas. And also the efficient monitoring systems for acquiring complete energy conversations. Under this circumstance these various types of projects can give a decent outcome when vitality emergencies are a standout amongst the most fundamental issues on the planet.

4.2 FUTURE SCOPE

The algorithm proposed in this paper can be extended to real time monitoring by keeping an account of all the readings and data in different weather conditions. This will aid performance improvements and help to determine efficiency in various regions of installations. Also use of high end solar panels such as concentrated photovoltaic cell panels can be used to further improve efficiency. Concentrated photovoltaic panels provide around 35-40% efficiency which is better than the normal panels.

Cost efficiency and durability of the system can be analyzed by research on the advancements of the components used. Future work can also include use of hybrid systems collectively to overcome the drawbacks of one another. This will ensure minimal system losses as well as better compatibility to application usage and maintenance resulting in improved efficiency. The various hybrid systems that can be fused with solar energy are wind energy and tidal energy. Hybrid systems will collectively enhance the system performance leading to increased number of applications.

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