Challenge Title : ***IBM Hack Challenge 2020***

Project ID : ***SPS_PRO_992***

Project Title : ***Regional Power Generation Predictor***

Team : ***Yash Vishwakarma & Siddharth Kulkarni***

Project Report

Source Code-
https://github.com/SmartPracticeschool/SBSPS-Challenge-1368-Regional-Power-Generation-Predictor.git

Video Presentation-
https://drive.google.com/file/d/1ixcptca8k8yZN8OPeSb6UJp6347gzvTK/view?usp=sharing

Overview-

Renewable energy will be the prime mover for the next industrial revolution. Solar , Wind, Biomass, Tidal are important sources of renewable energy. Renewable energy depends on the environmental conditions and hence its output is always varying. But renewable energy is available in atleast 1-2 forms in any place of the earth.The energy output of a wind farm is highly dependent on the wind conditions present at its site. If the output can be predicted more accurately, energy suppliers can coordinate the collaborative production of different energy sources more efficiently to avoid costly overproduction.

Purpose-

To create a web application and mobile app for assisting energy distribution manager. This application will predict the energy production by a wind farm at least 72 hours in advance. So that the officials can get a brief idea about the power generated and can take necessary actions in case of any shortfall. The main aim of the project is to help the village/town become self sufficient in the terms of energy dependency.

Problem-

Many villages in India have a very high wind potential i.e they have conditions suitable for being a highly productive wind farms. Hence, using wind energy to generate power might be the answer to solving the energy crisis in rural areas. However, there are some limitations to the use of wind energy which might affect the production-

1. The wind mill operates at a fixed wind velocity that is the mill doesn't produce power under the cut in limit of wind velocity and above the cut off limit of wind velocity.

Cut In Velocity-

Depending on technical construction or process control wind turbines have different cut-in wind speeds. Most wind turbines start with energy production at wind speeds between 2.5 m/s (9 km/h) and 3.5 m/s (12,6 km/h).

Cut Out Velocity-

Wind turbines stop production, if wind speeds reach a 10 second medium of 20 to 30 m/s (72 bis 108 km/h). Due to safety reasons blades are turned out of the wind.

2. The energy production rate of the wind mill depends highly on the weather conditions.

Hence, the amount of energy produced is often inconsistent.(eg- wind mill doesn't function in thunderstorms etc)
3. Hence, In order to get consistent energy output we can provide alternative energy sources that may be most efficient in that region.

Proposed Solution-

The solution we came up with is to create an app that would provide to the management of energy Distribution, possible energy outcome at least 72 hours in advance. Hence, officials will have an idea of wind energy that will be generated in next 3 days. Also the app will provide alternative methods that can be used to fill in the shortfall in the energy production. It will suggest best economical alternative source of energy (solar, grid, diesel generator) considering the weather conditions in the given area.

Highlights:

1.It will tell us the estimated energy output of the wind mill 72 hours in advance.
2.It will tell us the estimated demand based on the data of the previous month.
3.Finally it will suggest optimum alternative sources viz. solar/grid in case of shortfall.

Software Designing -

We divided our project into various tasks in order to make the work more efficient.

1. *Task 1-*
    1. Aim - Get the data from weather prediction website. The aim of this task was to write a program that would get us the current wind speed of the selected area, and also provide the amount of power generated under current weather conditions.
    2. Sources-
        - API- Here we are using openweather api to get the wind speed of the region.(http://api.openweathermap.org/data/2.5/weather?appid=#)
        - datetime- We are also using Date time (inbuilt package) in python to give us the time of the exact movement the request was made.
        - xlsxwriter- We are using xlsx writer module in python to create a workbook and write data in it using python.
    3. Logic & Code-
        - First, we created an excel workbook by the name of 'Wind.xlsx'.

- Using the python library 'requests' we contacted the "open Weather API'.http://api.openweathermap.org/data/2.5/weather?appid=#
- Using the API we collected the current weather data.
- We wrote a code to access just the wind speed from the complete json data.
- Using the collected data, we calculated the power that a single windmill will generate in that hour.
- All the collected data was stored in the excel sheet created
- Code for Task 1

2. *Task 2*-Calculate the power output using wind speed data

1. Aim- The aim of this task is to create an algorithm that would calculate the power generated by the wind turbine in a day, considering all the weather conditions and cut-in and cut-off velocities of the turbine.

2. Sources -

   a. xlsx writer, xlrd- Here, we are using xslsx writer module to access the .csv file that contains the weather data(on hourly basis) of the day under consideration.

   b. Database- In this task we are using an small extract from the daily wind database of 2018 available on the

   c. reference site- https://www.kaggle.com/berkerisen/wind-turbine-scada-dataset

3. Logic & Code -
   a. We declared all the necessary elements required for the task, i.e we opened an excel file in read only mode and specified the worksheet on which we will be working, at the starting of the code.
   b. Then, we wrote the code to access the particular columns in the excel worksheet and store it in the respective lists/dictionaries we defined earlier.
   c. We also set the cut in and cut off velocity of the turbine,i.e we set the limit in such a way that if the wind speed is less than 3.3 m/s or greater than 20 m/s no power will be generated.
   d. Now the amount of power that would be generated per hour is stored in the dictionary "dict2".

e. At last we we appended the power generated values in "dict2" into a column in excel worksheet.
f. Code for task2

- *Task 3 -Web Scraping*
  1. Aim- As we developed the code for predicting the energy generation of the next three days, we realized that the database that we were using(Database Given as Reference) was very old and didnt provide information regarding all the weather aspects that affect the production rate of the wind farm. Hence, we decided to get the current weather forecast for the next three days from Accuweather Website.
  2. Sources- In order to get the weather forecast of the next three days from accuweather website we are using Web scraping methods.
     a. BeautifulSoup- This is a python library that we are using to access the HTML code present at the backend of website.
     b. Pandas- We are using Pandas here to create a excel file to store the scraped data in organized manner.
  3. Logic & Code -
     a. We took the input of the City name and the day of which the user wants the forecast about from the user.
     b. Accuweather uses a location key in their URL in order to pin point on any specific location(the location key is unique for every location).
     c. We created an api key on accuweather. Now, using that api key we sent the request for all the json data regarding the city (entered by user).
     d. We wrote a code to filter out the location key from the json data pile.
     e. Using the user input and the location key we created a URL where the weather forecast regarding the requested day was present.
     f. Now using the web scraping techniques we extracted the necessary data from the URL and stored it in an excel workbook using pandas.
     g. Web Scraping Code.
- *Task 4-Graphical User Interface*
  1. Aim- To create a mobile app and a web app with interactive user interface

that will-

a. Tell the user estimated energy output of the wind farm 72 hours in advance.
b. Give the power generation report on an hourly basis.
c. Give the power generated at the exact movement if requested.
d. Suggest alternative sources to compensate the shortfall.

2. Web App-
   a. django- Here we are using django to link the backend of the web app to the front end.
   b. HTML & CSS- We are using HTML and css for the front end of the app.
   c. The code from task 1,task2, task3 is combined to form the backend.
   d. Web app source code
3. Mobile App-
   a. Kivy- Here we are using kivy to create the user interface of the mobile application.
   b. Python3 - The backend of the application is written in python using various modules.
   c. The code from task 1,task2, task3 is combined to form the backend.
   d. Mobile App source code

Experimental Investigations-

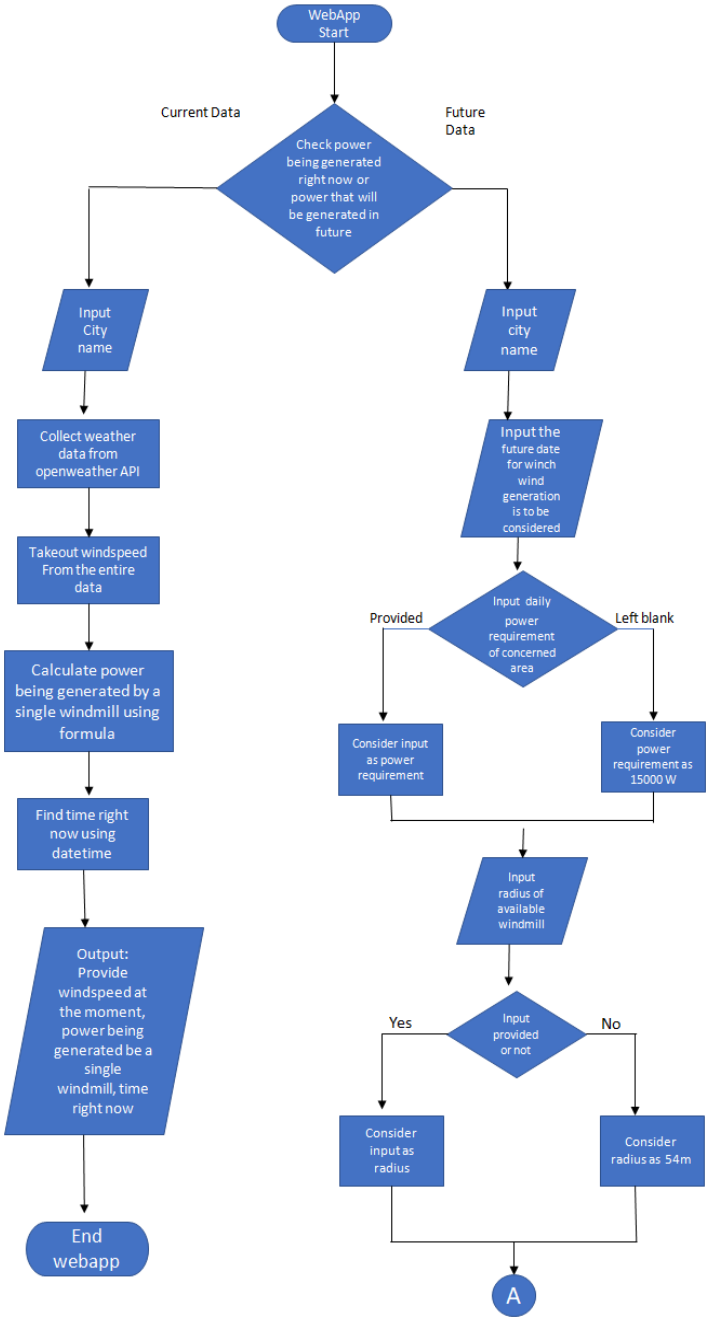
i. Database Research- The most challenging part for us during this project was to acquire the weather forecast of any day (in future) requested by the user. We realized in order to make our app employable we needed to work with real time data. Hence, after doing the initial trials on the database of 2018 provided as reference we decided to work with real time data; as the provided data base didn't have all the necessary weather information that affects the working of a wind farm.At first we tried to get hourly weather forecast provided on the Weather Underground site. For the purpose of extracting the data from the site we were using the python libraries like selenium and beautiful soup(Selenium Code). However, we were not able to properly extract the data from the site. After many hours of brainstorming we were able to scrape data from the accuweather website(

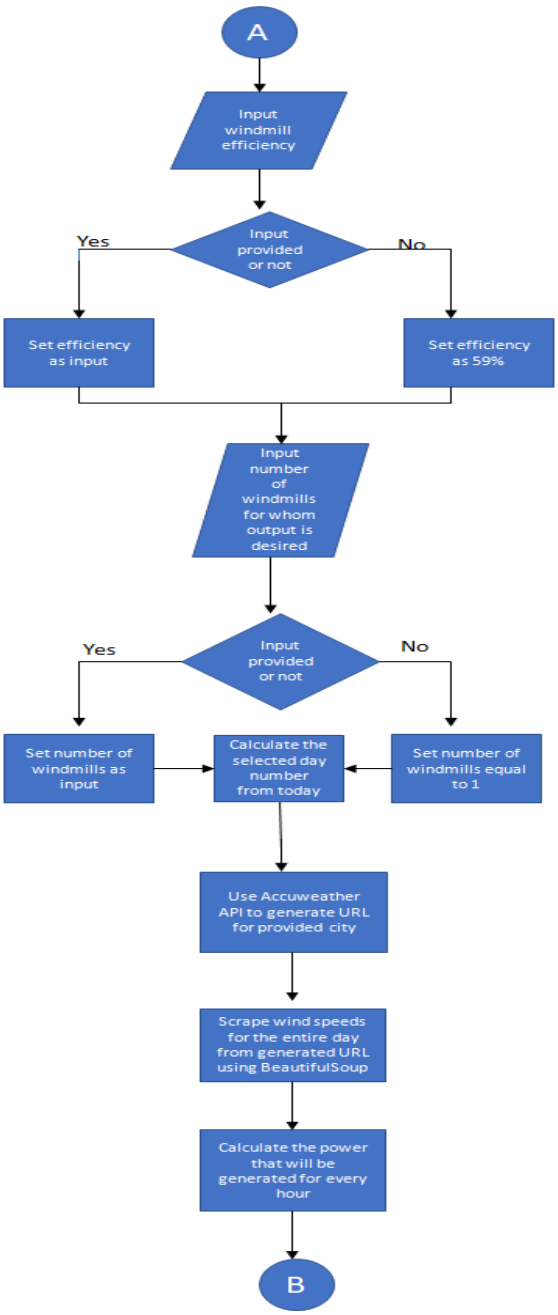
Accuweather Code).

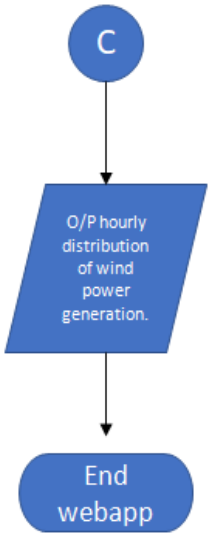
ii. Power Generation Parameters- The equation for power generated by wind mill(P) is given by $P= 0.5 \times \rho \times A \times Cp \times V^3 \times 0.59$ where, ρ = Air density in kg/m3 , A = Rotor swept area (m2). Cp = Coefficient of performance V = wind velocity (m/s). In the App we take the input for number of windmills present and the radius of turbine from the user(input is needed only once, it wont be changed unless changed manually). The wind turbines cannot have efficiency greater than 59% according to the Bettz Limit, this is also taken into consideration during calculations.

Flow Chart-

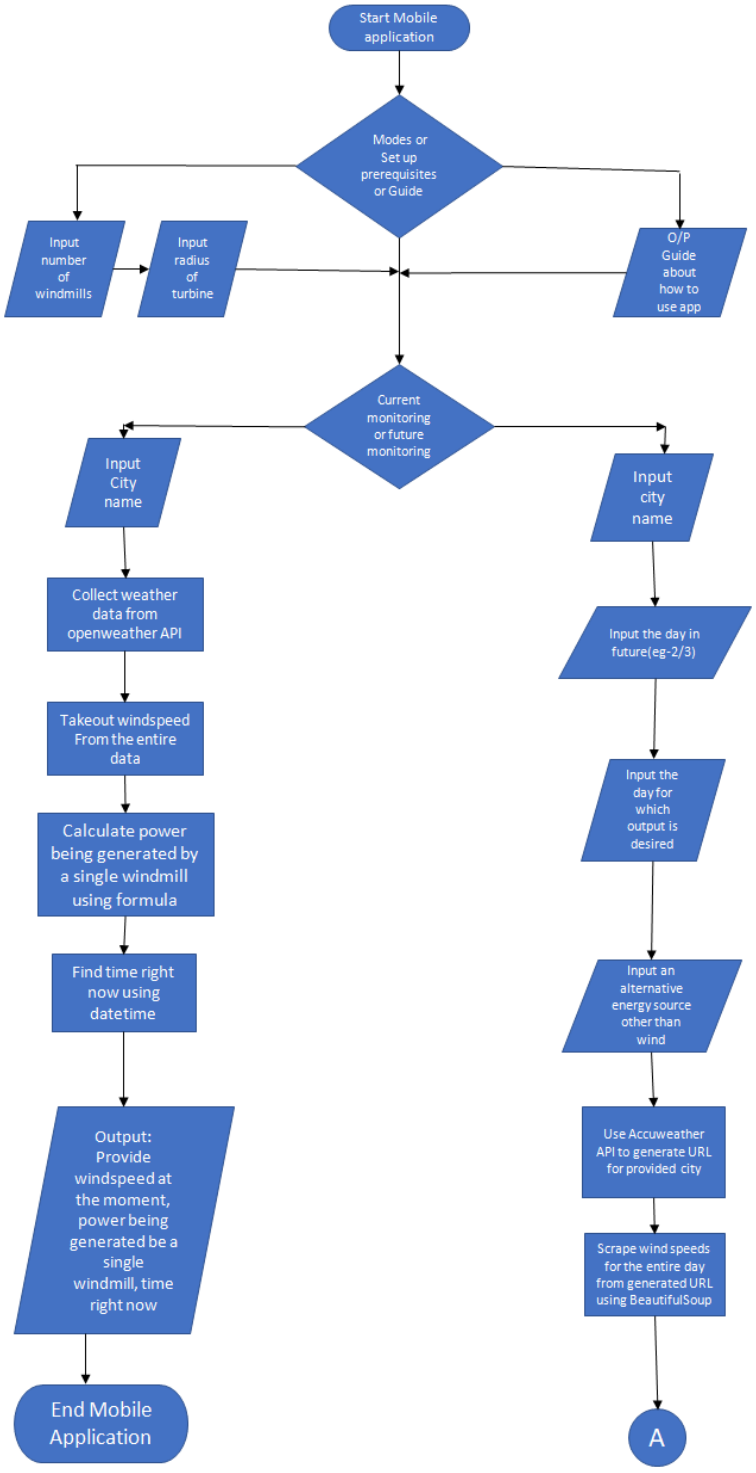
- Web App-

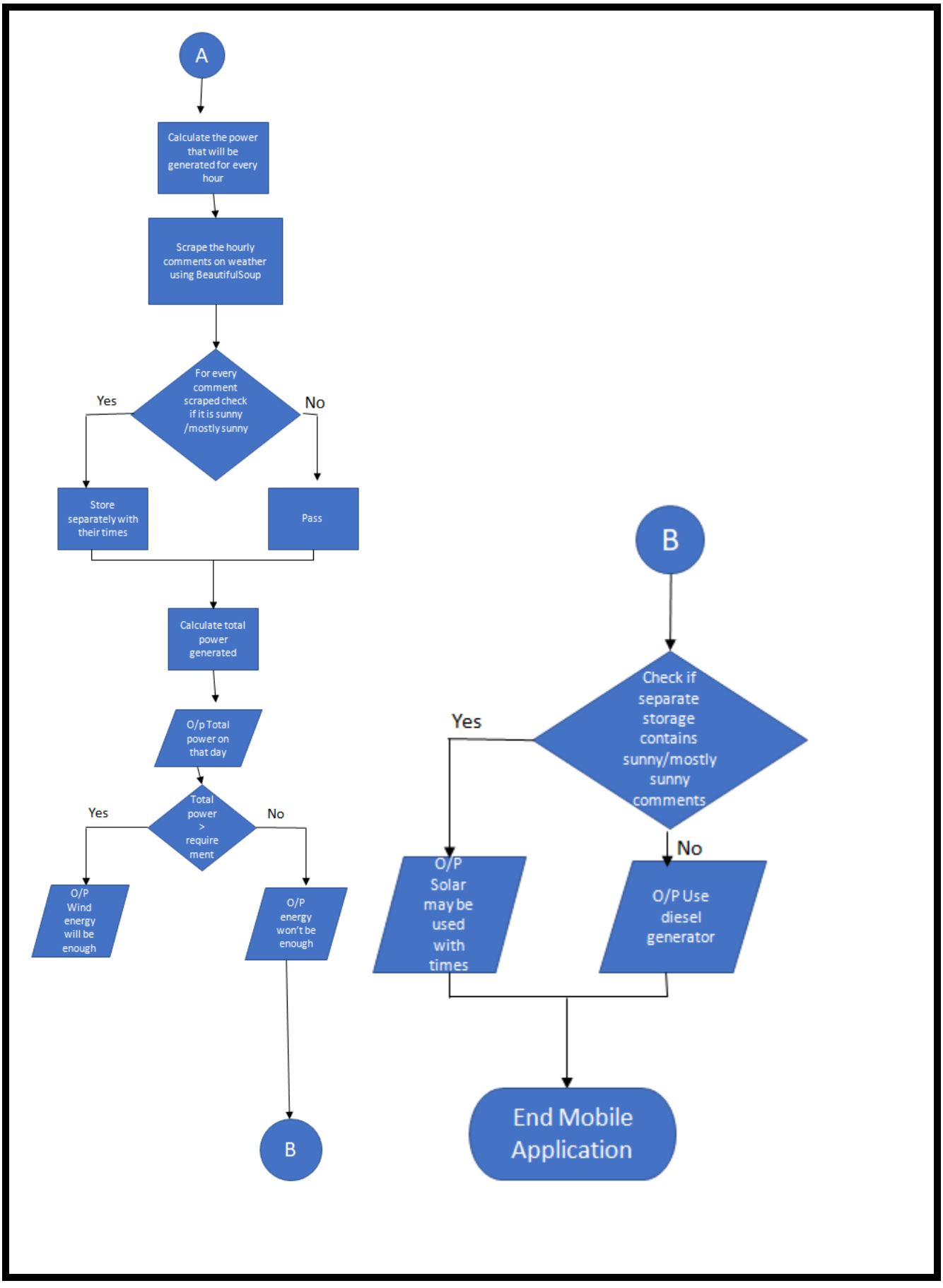

WebApp Start
Current Data
Future Data
Check power being generated right now or power that will be generated in future
Input City name
Collect weather data from openweather API
Takeout windspeed From the entire data
Calculate power being generated by a single windmill using formula
Find time right now using datetime
Output: Provide windspeed at the moment, power being generated be a single windmill, time right now
End webapp
Input city name
Input the future date for winch wind generation is to be considered
Provided
Input daily power requirement of concerned area
Left blank
Consider input as power requirement
Consider power requirement as 15000 W
Input radius of available windmill
Yes
Input provided or not
No
Consider input as radius
Consider radius as 54m
A


A
Input windmill efficiency
Input provided or not
Yes
No
Set efficiency as input
Set efficiency as 59%
Input number of windmills for whom output is desired
Input provided or not
Yes
No
Set number of windmills as input
Calculate the selected day number from today
Set number of windmills equal to 1
Use Accuweather API to generate URL for provided city
Scrape wind speeds for the entire day from generated URL using BeautifulSoup
Calculate the power that will be generated for every hour
B


C
O/P hourly distribution of wind power generation.
End webapp

- Mobile App-


Start Mobile application
Modes or Set up prerequisites or Guide
Input number of windmills
Input radius of turbine
O/P Guide about how to use app
Current monitoring or future monitoring
Input City name
Collect weather data from openweather API
Takeout windspeed From the entire data
Calculate power being generated by a single windmill using formula
Find time right now using datetime
Output: Provide windspeed at the moment, power being generated be a single windmill, time right now
End Mobile Application
Input city name
Input the day in future(eg-2/3)
Input the day for which output is desired
Input an alternative energy source other than wind
Use Accuweather API to generate URL for provided city
Scrape wind speeds for the entire day from generated URL using BeautifulSoup
A

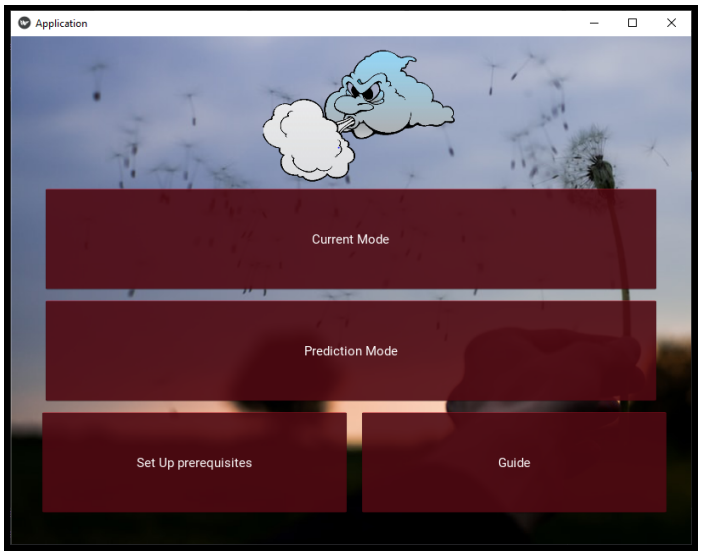

A
Calculate the power that will be generated for every hour
Scrape the hourly comments on weather using BeautifulSoup
For every comment scraped check if it is sunny /mostly sunny
Yes
No
Store separately with their times
Pass
Calculate total power generated
O/p Total power on that day
Total power > require ment
Yes
No
O/P Wind energy will be enough
O/P energy won't be enough
B
B
Check if separate storage contains sunny/mostly sunny comments
Yes
No
O/P Solar may be used with times
O/P Use diesel generator
End Mobile Application

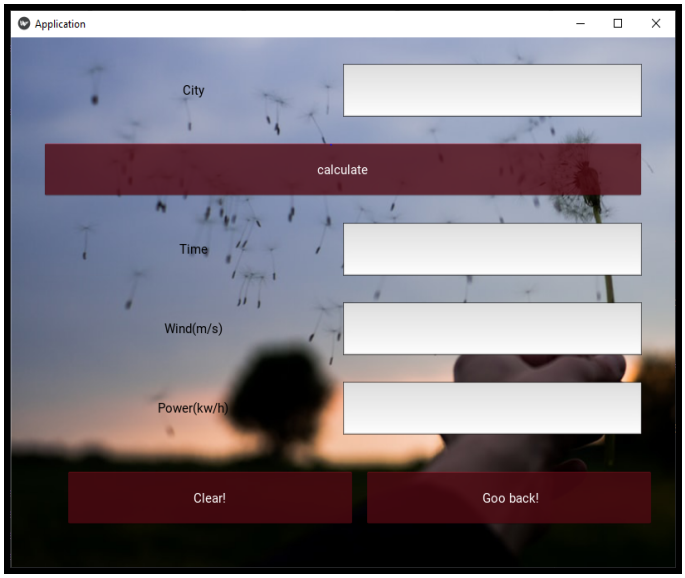
RESULT-

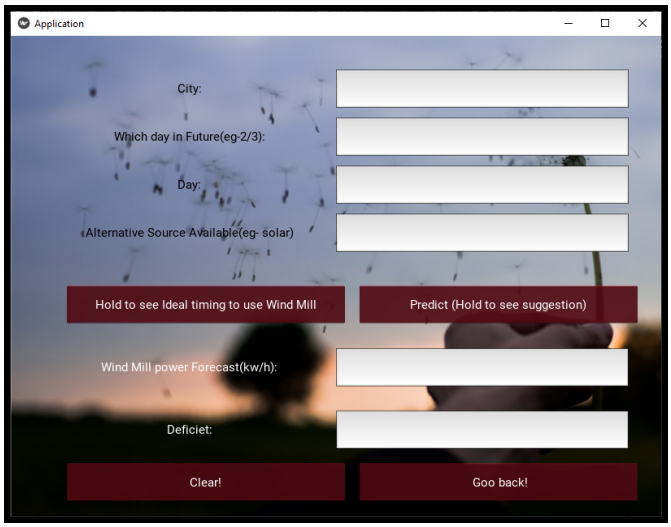
- *Mobile App-*

  We successful created a mobile application. The following are its features-

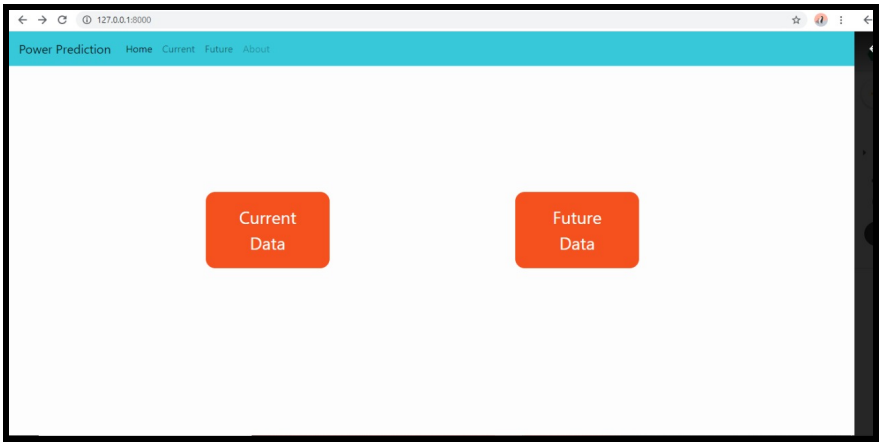
  i. The app has 2 main modes the Current Mode and Prediction Mode.
  ii. In Current mode the user has to enter the name of the region he wants the data about. And the application will provide the user with the wind speed of the exact moment and also the amount of power that would be generated in the next hour.
  iii. In Prediction Mode, the user has to enter the name of the region. He also has to enter the day of which he wants the prediction about for example- 1st, 2nd or 3rd with respect to the current day.Moreover, the user should also give any alternative energy sources available. Based on this input the algorithm will provide the user the amount of power that would be generated on the requested day. And also suggest alternative methods if the requirements of the region are not full filled.
  iv. Moreover, the user will be able to see all the collected data in the form of excel sheet if he wishes.
  v. There is also a guide window present in the app that helps the user through any difficulties while running the app.
  vi. We have also provided a setup window where the user has to enter the wind farm specifications like how many windmills are present and the the radius of the turbine. However, the user wont have to enter it again as it will be stored in the memory(it can be changed again manually.


Application
Current Mode
Prediction Mode
Set Up prerequisites
Guide

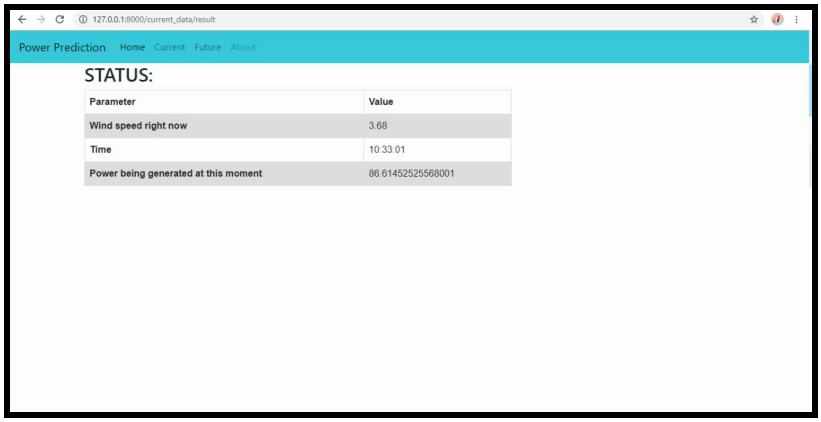

Application
City
calculate
Time
Wind(m/s)
Power(kw/h)
Clear!
Goo back!

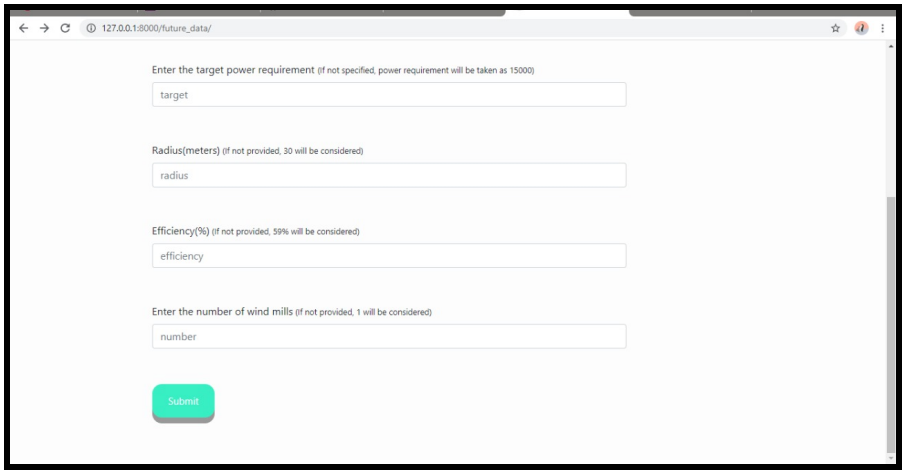


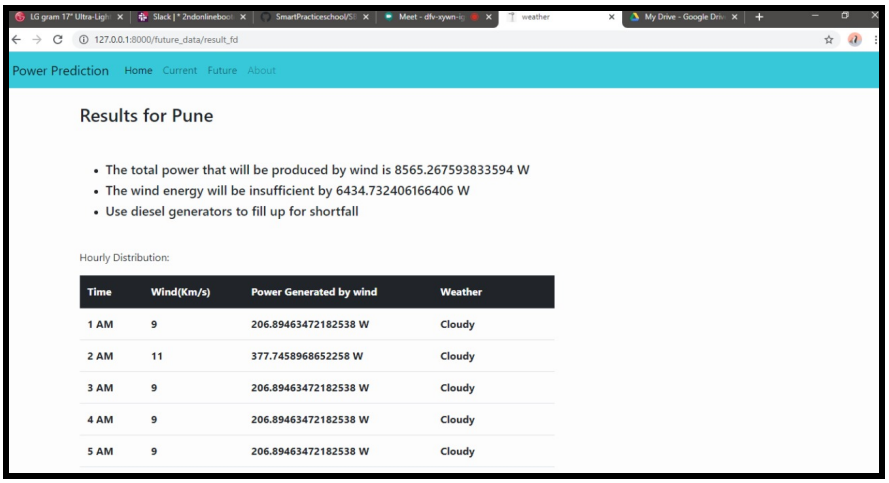
- *Web App-*
    a. Just like the mobile app the web app also has two modes; current and prediction respectfully.
    b. The prediction mode is also similar to the one of the app, the additional feature is instead of raw input from the user, the user will be able graphically slelct the date.
    c. Moreover, the user can see all the data in tabular format on the website itself.
    d. Images-




127.0.0.1:8000/current_data/
Power Prediction
Home
Current
Future
About
Current Data
Enter City
City
Submit


127.0.0.1:8000/current_data/result
Power Prediction
Home
Current
Future
About
STATUS:
Parameter
Value
Wind speed right now
3.68
Time
10:33:01
Power being generated at this moment
86.61452525568001


127.0.0.1:8000/future_data/
Enter the target power requirement (If not specified, power requirement will be taken as 15000)
target
Radius(meters) (If not provided, 30 will be considered)
radius
Efficiency(%) (If not provided, 59% will be considered)
efficiency
Enter the number of wind mills (If not provided, 1 will be considered)
number
Submit



ADVANTAGES & DISADVANTAGES-

- Advantages-
  i. Easy to use.
  ii. Can be used on all android phones.
  iii. User can access the data in the form of excel sheet if requested.
  iv. Highly accurate readings.
  v. No special technical skills required to handle the app.
- Disadvantages-
  i. Due to limitations of the framework calendar mode cannot be implied.
  ii. The excel files are stored locally and cannot be seen inside the application, However, all the necessary readings are shown in User friendly manner.
  iii. We are going to work with Java in the future in order to overcome this shortcomings.

CONCLUSION-

We created an Web and Mobile app to solve the given problem. The applications provide highly accurate readings in a very user friendly format.

FUTURE SCOPE-

Our aim is to pitch this applications to potential buyers having wind farms. We would take the inputs from the app user and make suggested changes as per the requirement. Making this app more user friendly.

Source Code-

https://github.com/SmartPracticeschool/SBSPS-Challenge-1368-Regional-Power-Generation-Predictor.git

Here you can find the source code for our mobile and Web application; The code for the Mobile Application is present in the Folder "App_Final". The code for the Web Application is present on google drive as we faced issues while uploading it on git drive link: https://drive.google.com/drive/folders/1UoRhrDO8Zz8BaoCYBqOzVz6GGCAL6299?usp=sharing also we have uploaded the zip file containing all the code regarding our web app. As Mentioned in the report we divided the project into various tasks. The code used for backend is present in the Folder "Backend"(this code is divided into small parts according to the tasks.) Mobile Application- For the mobile app we are using kivy framework for creating the user interface. Web Application- For the web application we are using django for linking the backend while' the front end is written in HTML and css. Backend for both the applications is written in python3.

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