Predicting The Energy Output Of Wind Turbine Based On Weather Condition

A UG PROJECT PHASE-1 REPORT

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IN
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Submitted by

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2019– 2023

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

VAAGDEVI ENGINEERING COLLEGE
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2019 – 2023

CERTIFICATE OF COMPLETION
UG PROJECT PHASE-1

This is to certify that the UG Project phase -1 entitled **“PREDICTING THE ENERGY OUTPUT OF WIND TURBINE BASED ON WEATHER CONDITION”** is being submitted by **P.AVINASH(H.NO:19UK1A0559),A.POOJITHA(H.NO:19UK1A0543),K.SAISUDHA(H.NO:19UK1A0522),K.SRUTHI(H.NO:19UK1A0557)** in partial fulfilment of the requirements for the award of the degree of **Bachelor of Technology** in **Computer Science and Engineering** to **Jawaharlal Nehru Technological University Hyderabad** during the academic year **2022-23**, is a record of work carried out by them under the guidance and supervision.

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ABSTRACT

Predicting the energy output of a wind turbine based on weather conditions is a machine learning problem that involves using data on the energy output of a wind turbine and the corresponding weather conditions to train a model that can make predictions about future energy output. This can be achieved using a variety of machine learning models, such as linear regression, decision trees, or neural networks. The goal of this type of prediction is to optimize the operation of the wind turbine and the larger renewable energy system it is a part of. Accurate predictions of energy output can help energy producers better forecast their electricity generation, optimize the maintenance and repair of their wind turbines, and improve the efficiency and reliability of renewable energy systems.

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1. INTRODUCTION

1.1 Overview

Predicting the energy output of a wind turbine based on weather conditions is a common problem in the renewable energy industry. To solve this problem using machine learning, you would need to first gather data on the wind turbine's energy output and the corresponding weather conditions. This data could include variables such as wind speed, temperature, humidity, and atmospheric pressure.

Next, you would need to choose a machine learning model to use for the prediction. Some common models for this type of problem include linear regression, decision trees, and random forests. You would then need to train the model using the data you collected, which involves splitting the data into a training set and a test set and using the training set to adjust the model's parameters.

1.2 Purpose

The purpose of using machine learning to predict the energy output of a wind turbine based on weather conditions is to help optimize the operation of the wind turbine and the larger renewable energy system it is a part of. Accurate predictions of energy output can help energy producers better forecast their electricity generation, which is important for managing the grid and meeting demand.

Predicting wind turbine energy output can also help energy producers optimize the maintenance and repair of their wind turbines. For example, if a machine learning model predicts that a wind turbine will experience a decrease in energy output due to adverse weather conditions, the energy producer may choose to proactively schedule maintenance or repair work to minimize the impact on electricity generation.

2. LITERATURE SURVEY

2.1 Existing problem:

One potential problem that could arise when using machine learning to predict the energy output of a wind turbine based on weather conditions is the quality of the data used to train the model. If the data is incomplete, noisy, or biased, it could lead to inaccurate predictions. To address this problem, it is important to carefully collect and preprocess the data to ensure that it is representative of the wind turbine and the weather conditions it operates in. This may involve filtering out bad data points, handling missing values, or applying data transformations.

Another potential problem is overfitting, which occurs when the model is too closely tuned to the training data, and is unable to generalize well to new, unseen data. To mitigate this risk, it is important to use a sufficiently large and diverse training dataset, and to use techniques such as cross-validation and regularization to prevent overfitting.

2.2 Proposed Solution:

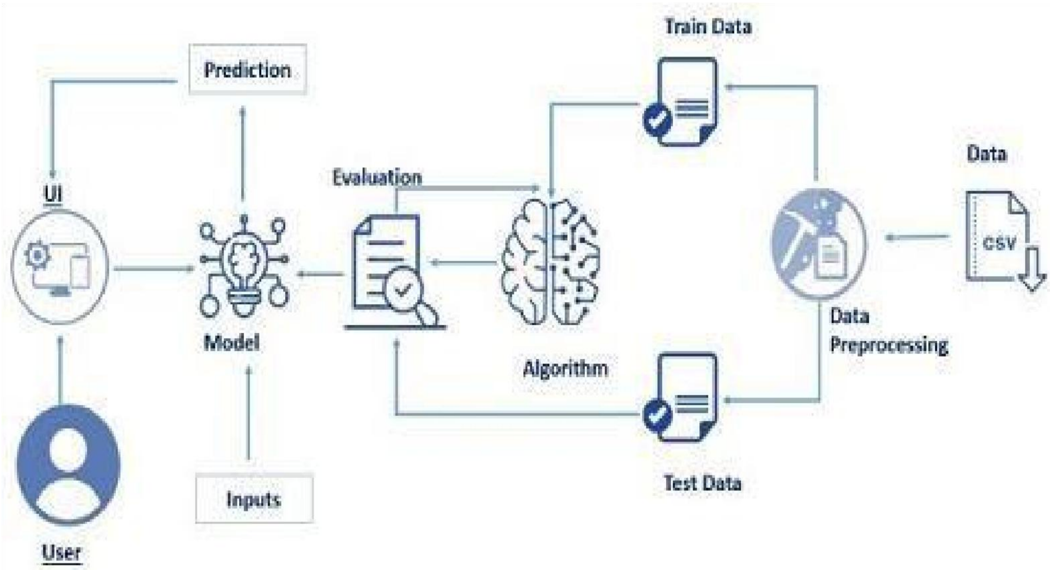
Collect high-quality data: To ensure that the model is able to make accurate predictions, it is important to collect a large and diverse dataset that is representative of the wind turbine and the weather conditions it operates in. This may involve installing sensors on the wind turbineto measure variables such as wind speed, temperature, and humidity.

Preprocess the data: Before training the model, it is important to preprocess the data to ensure that it is clean and ready for analysis. This may involve filtering out bad data points, handling missing values, or applying data transformations.

Choose an appropriate model: There are many different machine learning models that can be used to predict wind turbine energy output, such as linear regression, decision trees, and neural networks. It is important to choose a model that is suitable for the problem at hand, taking into account the complexity of the data and the required level of accuracy.

3. THEORITICAL ANALYSIS

3.1 Block Diagram



3.2 Hardware / Software Designing

The following is the Hardware required to complete this project:

- Internet connection to download and activate
- Administration access to install and run Anaconda Navigator
- Minimum 10GB free disk space
- Windows 8.1 or 10 (64-bit or 32-bit version) OR Cloud: Get started free, *Cloud account required.

Minimum System Requirements To run Office Excel 2013, your computer needs to meet the following minimum hardware requirements:

- 500 megahertz (MHz)
- 256 megabytes (MB) RAM
- 1.5 gigabytes (GB) available space
- 1024x768 or higher resolution monitor

The following are the software s required for the project:

- Jupyter Notebook
- Spyder

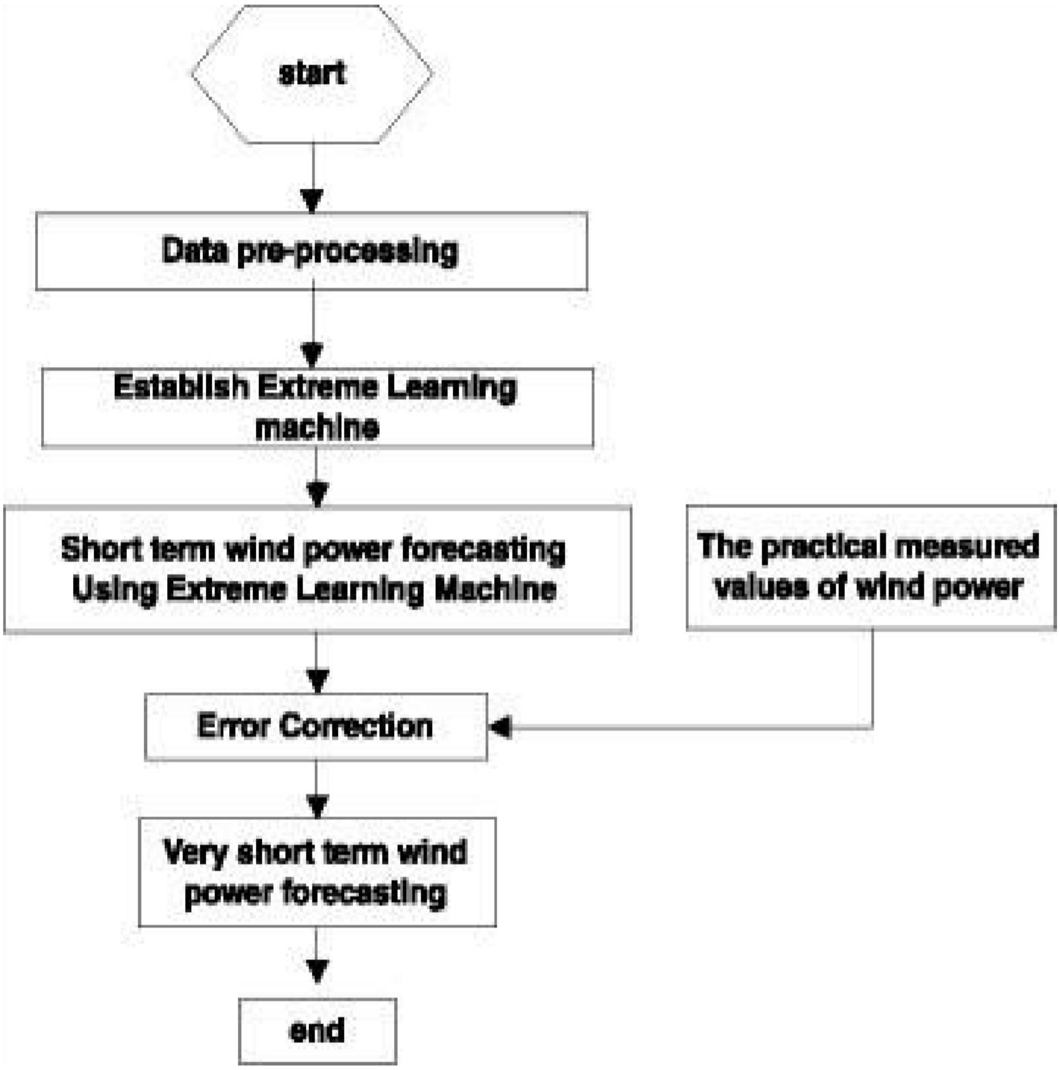
4. EXPERIMENTAL INVESTIGATIONS

To investigate the effectiveness of using machine learning to predict the energy output of a wind turbine based on weather conditions, one could conduct an experiment in which the energy output of a wind turbine is measured under a variety of weather conditions, and a machine learning model is trained on this data to make predictions about future energy output.

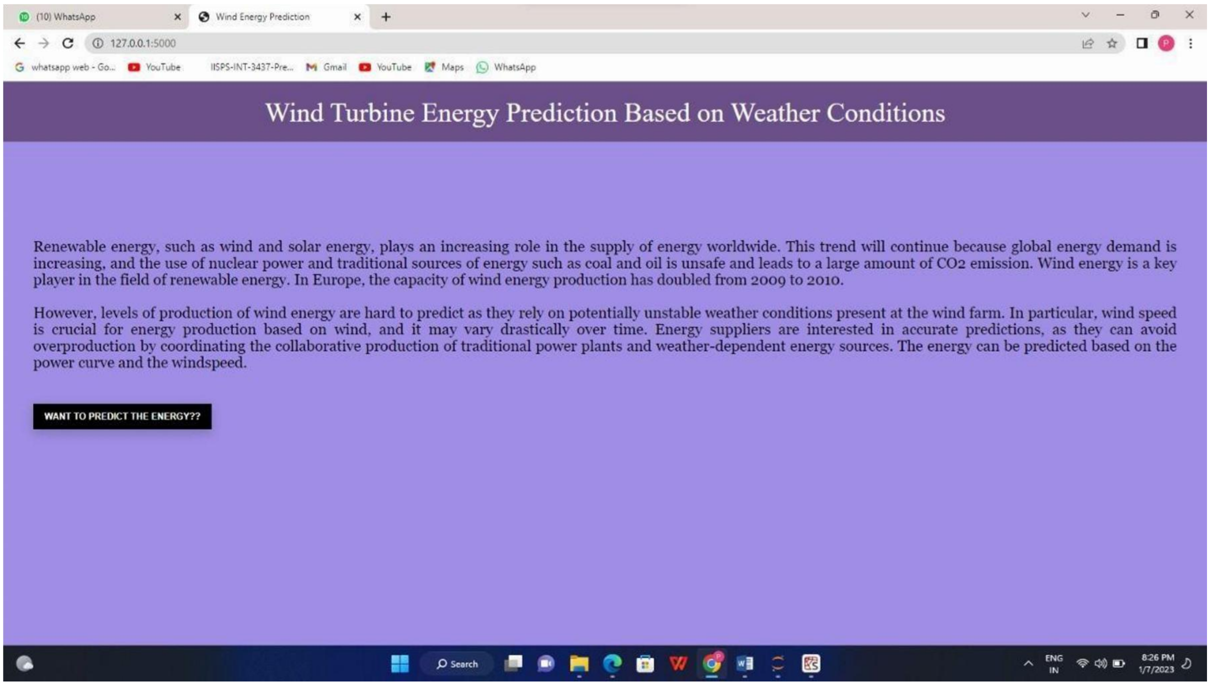
To measure the performance of the model, one could use a metric such as mean absolute error (MAE) or mean squared error (MSE), which measures the average difference between the predicted energy output and the true energy output. The model's performance can then be compared to a baseline, such as a simple average of the energy output over time, to determine if the machine learning approach is more accurate.

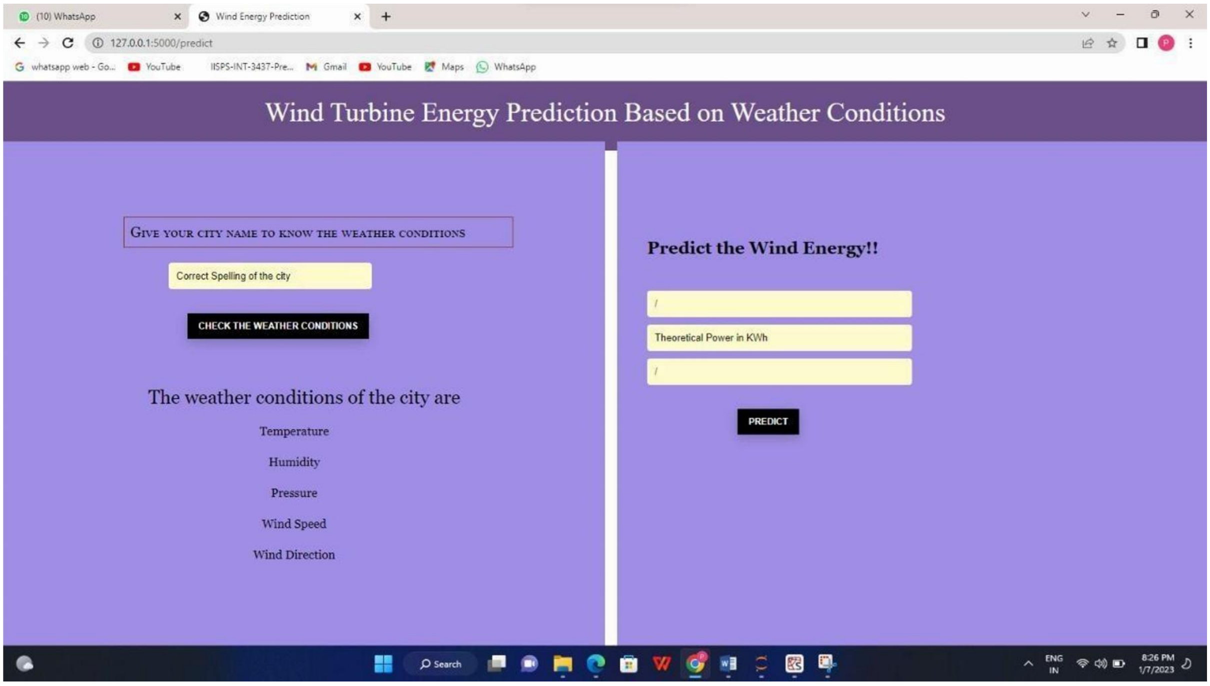
Other factors that could be varied in the experiment include the type of machine learning model used, the size and diversity of the training dataset, and the hyperparameters of the model. By conducting a series of controlled experiments, one can determine which factors have the greatest impact on the model's performance, and identify the most effective approach for predicting wind turbine energy output based on weather conditions.

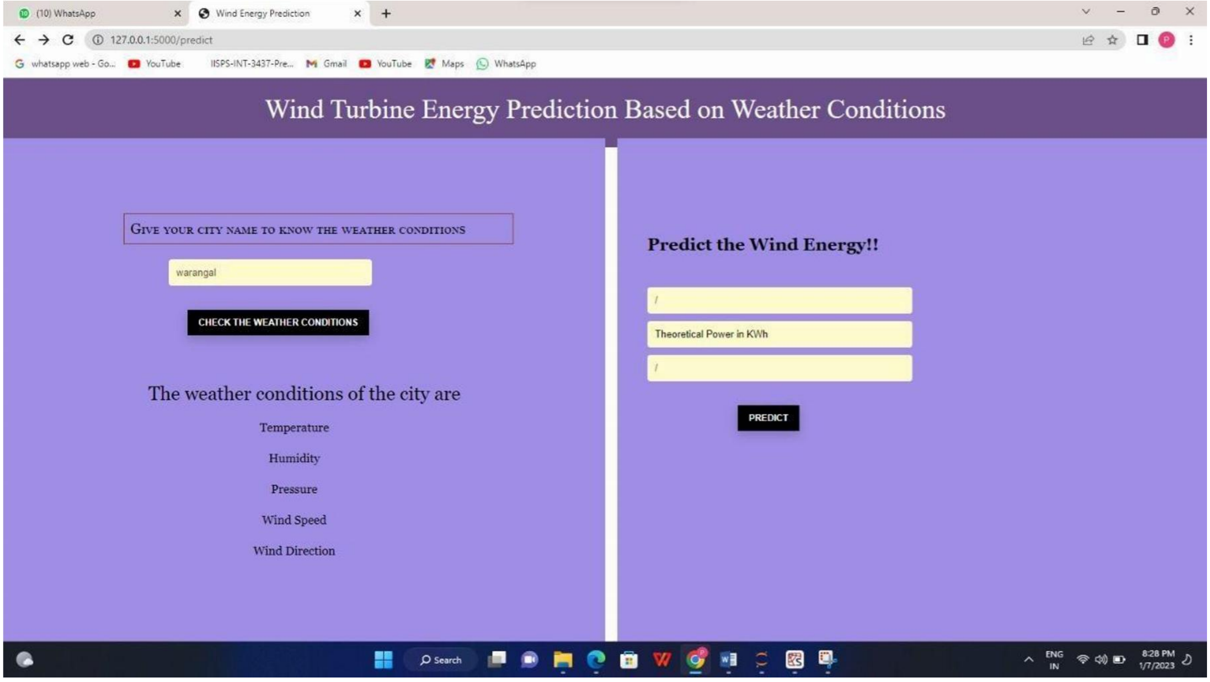
5. FLOWCHART

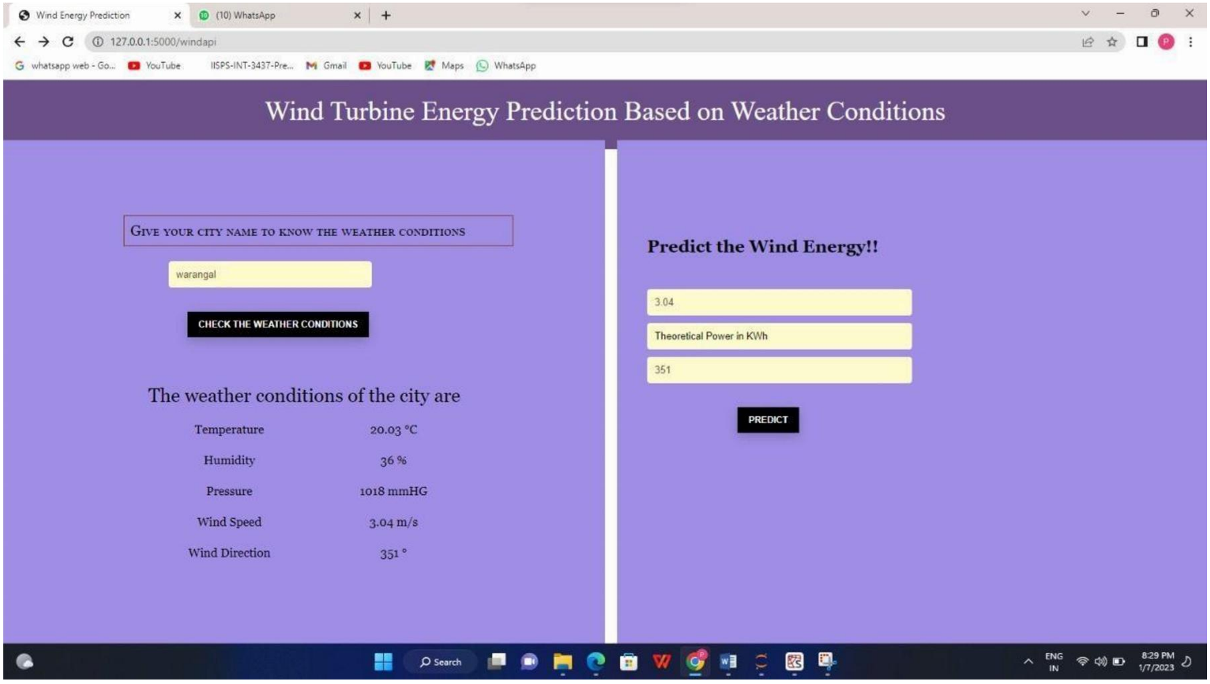

start
Data pre-processing
Establish Extreme Learning machine
Short term wind power forecasting Using Extreme Learning Machine
The practical measured values of wind power
Error Correction
Very short term wind power forecasting
end

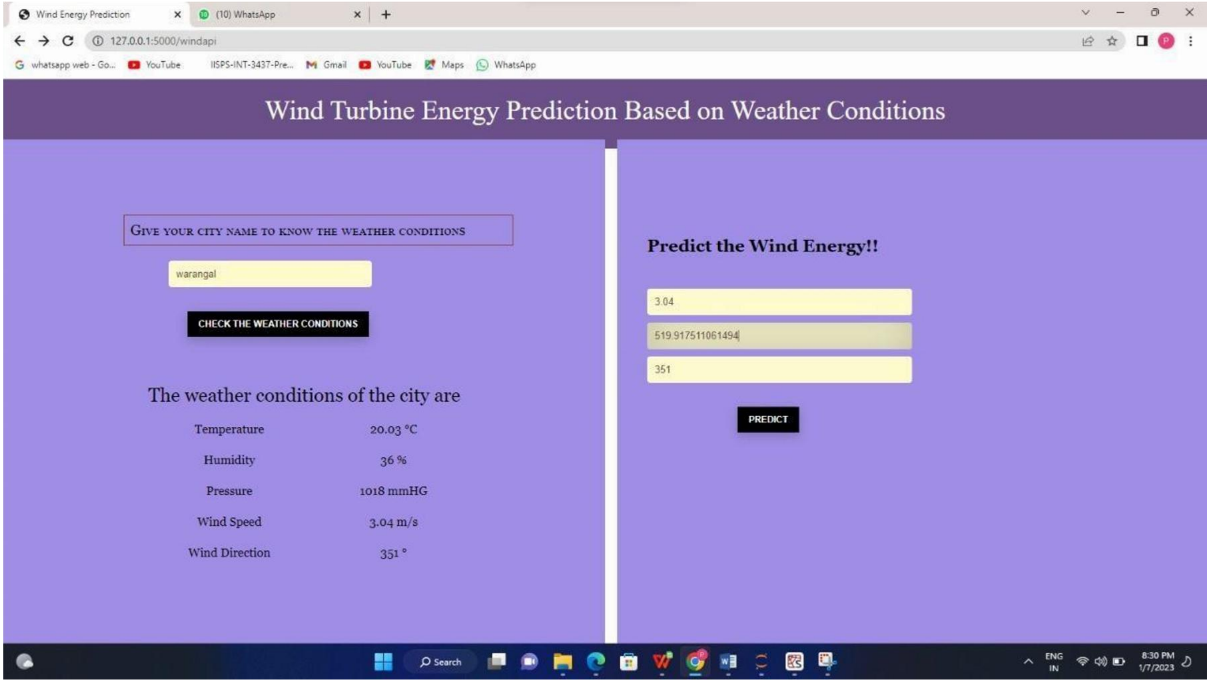
6. RESULT

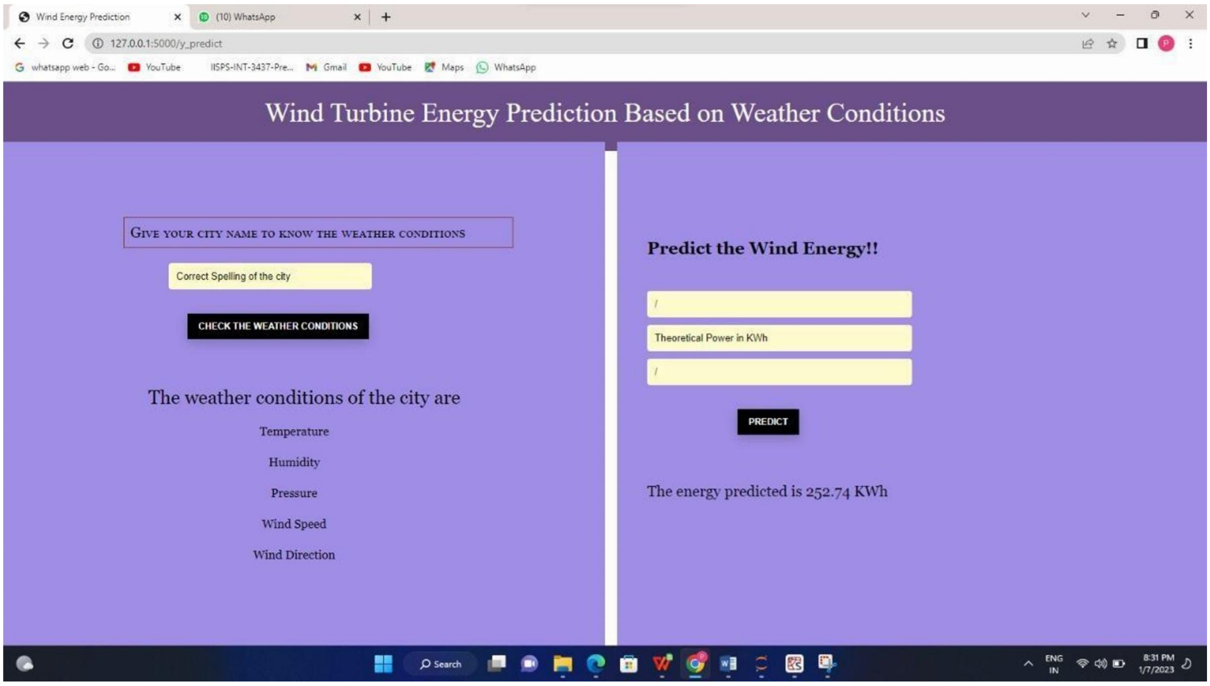

(10) WhatsApp
Wind Energy Prediction
127.0.0.1:5000
Wind Turbine Energy Prediction Based on Weather Conditions
Renewable energy, such as wind and solar energy, plays an increasing role in the supply of energy worldwide. This trend will continue because global energy demand is increasing, and the use of nuclear power and traditional sources of energy such as coal and oil is unsafe and leads to a large amount of CO2 emission. Wind energy is a key player in the field of renewable energy. In Europe, the capacity of wind energy production has doubled from 2009 to 2010.
However, levels of production of wind energy are hard to predict as they rely on potentially unstable weather conditions present at the wind farm. In particular, wind speed is crucial for energy production based on wind, and it may vary drastically over time. Energy suppliers are interested in accurate predictions, as they can avoid overproduction by coordinating the collaborative production of traditional power plants and weather-dependent energy sources. The energy can be predicted based on the power curve and the windspeed.
WANT TO PREDICT THE ENERGY??


(10) WhatsApp
Wind Energy Prediction
127.0.0.1:5000/predict
whatsapp web - Go...
YouTube
IISPS-INT-3437-Pre...
Gmail
YouTube
Maps
WhatsApp
Wind Turbine Energy Prediction Based on Weather Conditions
Give your city name to know the weather conditions
Correct Spelling of the city
CHECK THE WEATHER CONDITIONS
The weather conditions of the city are
Temperature
Humidity
Pressure
Wind Speed
Wind Direction
Predict the Wind Energy!!
Theoretical Power in KWh
PREDICT
Search
ENG
IN
8:26 PM
1/7/2023


Wind Turbine Energy Prediction Based on Weather Conditions
Give your city name to know the weather conditions
warangal
CHECK THE WEATHER CONDITIONS
The weather conditions of the city are
Temperature
Humidity
Pressure
Wind Speed
Wind Direction
Predict the Wind Energy!!
Theoretical Power in KWh
PREDICT


Wind Turbine Energy Prediction Based on Weather Conditions
Give your city name to know the weather conditions
warangal
CHECK THE WEATHER CONDITIONS
The weather conditions of the city are
Temperature 20.03 °C
Humidity 36 %
Pressure 1018 mmHG
Wind Speed 3.04 m/s
Wind Direction 351 °
Predict the Wind Energy!!
3.04
Theoretical Power in KWh
351
PREDICT





7. ADVANTAGES AND DISADVANTAGES

ADVANTAGES:

There are several advantages to using machine learning to predict the energy output of a wind turbine based on weather conditions:

Improved accuracy: Machine learning models can learn complex relationships between weather conditions and energy output, and can make more accurate predictions than simpler approaches such as linear regression.

Automation: Machine learning models can be trained to make predictions automatically, without the need for manual intervention. This can save time and reduce the risk of human error.
Adaptability: Machine learning models can continue to improve their accuracy over time as they are exposed to more data, making them well-suited to dynamic environments where the relationships between weather conditions and energy output may change.

Scalability: Machine learning models can be trained on large datasets, and can handle large volumes of data without requiring significant additional resources. This makes them well-suited to predicting energy output for large wind farms or renewable energy systems.

Overall, using machine learning to predict wind turbine energy output based on weather conditions can help optimize the operation of the wind turbine and the larger renewable energy system it is a part of, improving efficiency and reliability.

DISADVANTAGES:

There are also some potential disadvantages to using machine learning to predict the energy output of a wind turbine based on weather conditions:

Data requirements: Machine learning models require a large and diverse dataset in order to learn effectively. If the data is incomplete or of poor quality, it can negatively impact the model's performance.
Model complexity: Some machine learning models, such as deep neural networks, can be very complex and may require significant computational resources to train and deploy. This can be a disadvantage in situations where resources are limited.

Lack of interpretability: Some machine learning models, such as black box models like random forests, are difficult to interpret, making it hard to understand how the model is making its predictions. This can make it difficult to identify the underlying relationships between weather conditions and energy output.

Potential for biased results: If the training data contains biases, the machine learning model may learn and reproduce these biases in its predictions. It is important to carefully evaluate the training data and take steps to mitigate any biases that may be present.

Overall, while machine learning can be a powerful tool for predicting wind turbine energy output based on weather conditions, it is important to carefully consider the potential advantages and disadvantages, and to choose an appropriate model and dataset to ensure the best possible results.

8. APPLICATIONS

Optimizing renewable energy systems: Accurate predictions of wind turbine energy output can help energy producers optimize the operation of their renewable energy systems, by allowing them to better forecast electricity generation and plan for maintenance and repair work.

Improving grid management: By predicting wind turbine energy output, energy producers can help ensure that the grid has sufficient electricity generation to meet demand, and can help mitigate the need for fossil fuel backup generation.

Reducing costs: By optimizing the operation of renewable energy systems, machine learning can help reduce the costs of generating electricity from wind turbines, and can contribute to the adoption of clean energy sources.

Enhancing sustainability: By reducing reliance on fossil fuels, machine learning can help reduce greenhouse gas emissions and improve the sustainability of the energy sector..

9. CONCLUSION

In conclusion, predicting the energy output of a wind turbine based on weather conditions is a common problem in the renewable energy industry, and machine learning can be a powerful tool for solving this problem. By training a machine learning model on data about the energy output of a wind turbine and the corresponding weather conditions, it is possible to make accurate predictions about future energy output. These predictions can help optimize the operation of the wind turbine and the larger renewable energy system it is a part of, improving efficiency and reliability. While there are potential disadvantages to using machine learning, such as the data and resource requirements, the potential benefits make it a valuable tool for predicting wind turbine energy output based on weather conditions.

10.FUTURE SCOPE

Incorporation of additional data sources: Machine learning models could be trained on a wider range of data sources, such as satellite imagery or weather forecasts, to improve the accuracy of the predictions.

Integration with other renewable energy technologies: Machine learning could be used to predict the energy output of other renewable energy technologies, such as solar panels or hydroelectric power plants, in conjunction with wind turbines.

Real-time prediction: Machine learning models could be used to make predictions in real-time, allowing energy producers to adjust the operation of their wind turbines and other renewable energy systems in response to changing weather conditions.

Improved model interpretability: Researchers could develop machine learning models that are more interpretable, making it easier to understand how the model is making its predictions and identify the underlying relationships between weather conditions and energy output.

11.BIBILOGRAPHY

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International Journal of Forecasting 2008;24:694e709.

[5] Kotanchek M, Smits G, Vladislavleva E. Pursuing the Pareto paradigm: tournaments, algorithm variations & ordinal optimization. In: Genetic programming theory and practice IV.

Genetic and evolutionary computation, chapter
12, vol. 5. Springer, ISBN 0-387-33375-4; 11e13 May 2006. p. 167e86.

APPENDIX SOURCE

CODE:

```
import numpy as np from flask import Flask, request,
jsonify, render_template import joblib import requests

app = Flask(__name__) model =
joblib.load('Wind_RFR')

@app.route('/') def
home():
    return render_template('intro.html')

@app.route('/predict') def
predict():
    return render_template('predict.html')

@app.route('/windapi',methods=['POST'])
def windapi():
    city=request.form.get('city') apikey="cc61a6050a8315e1fcc1e845ff687c50"
    url="http://api.openweathermap.org/data/2.5/weather?q="+city+"&appid="+ap
    i
key  resp = requests.get(url) resp=resp.json() te =
    resp["main"]["temp"]-273 tem =
    "{:.2f}".format(te) temp = str(tem)+" °C" humid
    = str(resp["main"]["humidity"])+" %" pressure =
    str(resp["main"]["pressure"])+" mmHG" speed =
    str(resp["wind"]["speed"])+" m/s" degree =
    str(resp["wind"]["deg"])+" °"
    return render_template('predict.html', temp=temp, humid=humid,
pressure=pressure,speed=speed, deg = degree)

@app.route('/y_predict',methods=['POST'])
def y_predict():
    x_test = [[float(x) for x in request.form.values()]]

    prediction = model.predict(x_test) print(prediction)
    output=prediction[0] return render_template('predict.html',
    prediction_text='The energy
predicted is {:.2f} KWh'.format(output))
if_name_== "_main_":
    app.run(debug=False)
```

App.IBM

```
import numpy as np from flask import Flask, request,
jsonify, render_template import joblib
 import requests
API_KEY  =  "z5w_7QoNuv-PziHyHPjrv_fKcKhYzVDd_vhj4IWS2dli"  token_response  =
requests.post('https://iam.cloud.ibm.com/identity/token', data={"apikey":
 API_KEY, "grant_type": 'urn:ibm:params:oauth:grant-type:apikey'}) mltoken
= token_response.json()["access_token"]
 header = {'Content-Type': 'application/json', 'Authorization': 'Bearer ' +
 mltoken} app = Flask(_name_)

@app.route('/') def
home():
    return render_template('intro.html')

@app.route('/predict') def
predict():
    return render_template('predict.html')

@app.route('/windapi',methods=['POST'])
def windapi():
    city=request.form.get('city')
    apikey="cc61a6050a8315e1fcc1e845ff687c50"
    url="http://api.openweathermap.org/data/2.5/weather?q="+city+"&appid="+api
key resp = requests.get(url)
    resp=resp.json() te =
    resp["main"]["temp"]-273 tem =
    "{:.2f}".format(te) temp =
    str(tem)+" °C"
    humid = str(resp["main"]["humidity"])+" %"
    pressure = str(resp["main"]["pressure"])+" mmHG"
    speed = str(resp["wind"]["speed"])+" m/s" degree
    = str(resp["wind"]["deg"])+" °"
    return render_template('predict.html', temp=temp, humid=humid,
pressure=pressure,speed=speed, deg=degree)
 @app.route('/y_predict',methods=['POST']) def
 y_predict():
     x_test  =  [[float(x)  for  x  in  request.form.values()]]  payload_scoring  =
     {"input_data": [{"fields": [["f0","f1","f2"]],
 "values":x_test }]}

     response_scoring = requests.post('https://us-
 south.ml.cloud.ibm.com/ml/v4/deployments/689614b2-8ded-4e79-aaac-
```

```
49675c769d5b/predictions?version=2022-05-31',          json=payload_scoring,
    headers={'Authorization':   'Bearer   '   +  mltoken})   print("Scoring
    response")         #         print(response_scoring.json())         pred=
    response_scoring.json()   output=pred['predictions'][0]['values'][0][0]
    print(output)
    # prediction = model.predict(x_test)
    #        print(prediction)        #        output=prediction[0]        return
    render_template('predict.html', prediction_text='The energy
predicted is {:.2f} KWh'.format(output))

 if_name_== "_main_":
app.run(debug=False)
```

Scoringendpoint

```
response_scoring             =            requests.post('https://us-
south.ml.cloud.ibm.com/ml/v4/deployments/689614b2-8ded-4e79-aaac-
49675c769d5b/predictions?version=2022-05-31',  json=payload_scoring,
headers={'Authorization':  'Bearer  '  +  mltoken})  print("Scoring
response")        #        print(response_scoring.json())       pred=
response_scoring.json()
output=pred['predictions'][0]['values'][0][0] print(output)
import requests
# NOTE: you must manually set API_KEY below using information retrieved from
your IBM Cloud account.
API_KEY = "z5w_7QoNuv-PziHyHPjrv_fKcKhYzVDd_vhj4IWS2dli"
token_response = requests.post('https://iam.cloud.ibm.com/identity/token',
data={"apikey":
 API_KEY, "grant_type": 'urn:ibm:params:oauth:grant-type:apikey'})
mltoken = token_response.json()["access_token"]
 header = {'Content-Type': 'application/json', 'Authorization': 'Bearer '
+ mltoken}
# NOTE: manually define and pass the array(s) of values to be scored in the
next line payload_scoring = {"input_data": [{"fields": [["f0","f1","f2"]],
"values":[[123,5,320]] }]}
```