Web Based Information System for Wind Turbine Power Generation

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Abstract — Wind energy has the possibility for bringing out energy in a very constant and sustainable manner being a notable and eligible source. Although, wind energy does include numerous challenges like, the halted asset of wind plants, early investment costs, and therefore, the strain in discovering areas of wind efficiency. The major objective for proposing this work is to determine the power efficiency of wind turbines, which will also aid in the formulation of a proposal to reduce wind turbine maintenance costs.

During this research, data analysis of turbine generators is performed on day to day wind speed info using machine learning and deep learning algorithms. A way is put forward by us to support deep learning and machine learning algorithms which can predict different values of power reliably. Hence, the execution of machine and deep learning algorithms are analyzed. For forecasting for a longer term these algorithms may be used for wind generation rate with historical relation to wind speed info.

Index Terms: Wind turbine,machine learning algorithm

1. INTRODUCTION

The policy challenges associated with global warming, the prospect of increasingly expensive fossil fuels, and serious concerns about the safety of nuclear power are encouraging many country of world economies to develop smart grids (SGs) as a component of their energy policy portfolios. To meet the growing demand for energy in the world, various projects are being developed. These projects using renewable energy sources in the project are attracted more attention from the general. Wind energy stands out because it is one of those energy sources which can be used in many parts of the world, unlimited, clean and pollution free for the environment [1].

SGs are complex systems that may provide five major applications:

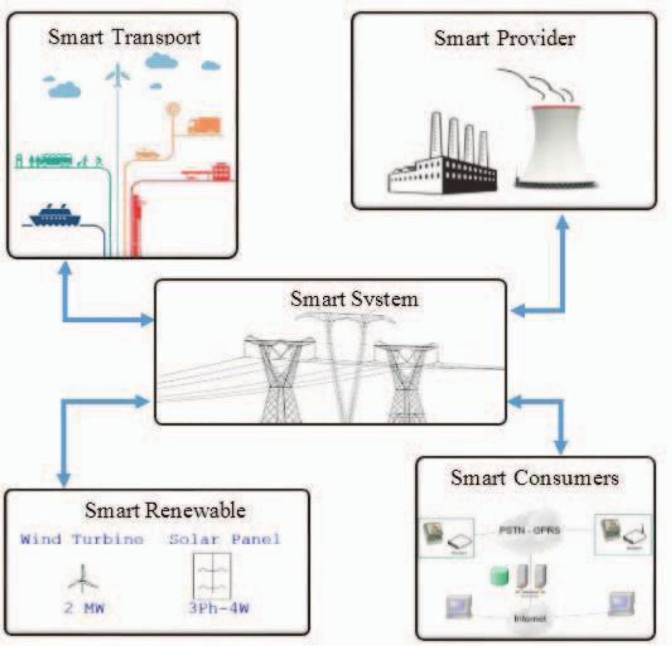

Figure 1 Five major applications of smart grids.

Today's grids are mostly designed for centralized supply sources and are therefore less accommodating to renewable resources that are intermittent and widely distributed. SGs can accommodate a variety of generation, including renewable energy resources such as wind and photovoltaic solar, and other forms of distributed generation such as small-scale combined heat and power, and energy storage [2]. SGs are regarded as essential to mainstreaming renewables because through state-of-the-art modeling and decision support tools, wind forecasting, and contingency analysis, for example, can be improved and these can enhance the integration of these intermittent sources into the power system [2].

Renewable energy resources has gained importance and has been accelerated and entering the trend further studies on this topic with the depletion of fossil fuel which pollutes the environment, The most important environmental benefits of electricity generation from wind energy is that a reduction in the level of carbon dioxide released into the Earth's atmosphere. Carbon dioxide is the most important gas increasing the greenhouse effect which led to the catastrophic effects of global climate change greatly. But now with the wind energy transition, million tons of CO_2 into the atmosphere will be prevented. World countries signed the Kyoto Protocol in 1997 to reduce greenhouse gases that cause climate change [1].

With decreasing in the cost of energy produced by wind energy, the payback period of investment in the energy produced by wind farms, has also decreased in recent years in a reasonable manner. Studies for economic independence, effective use of scarce resources and environmentally friendly energy to render dominate the sector, has gained speed. Developed and developing countries increased work in the legal and financial fields on behalf of assessing the wind potential available today. By including the private sector in this area, consider the scientific and technical studies on the subject made a step value [3].

In Turkey, the fast-growing wind energy reaching the highest value compared to other energy production methods and it has become the fastest growing sector. However, it is still well below the capacity utilization rate. Moreover, increasing energy consumption and rising costs have made it accessible to both large and small type wind investment types [4].

Turkey is Europe's largest wind energy market with it's licensed over 11,000 mW the power plants. The target is determined at 20,000 MW according to Ministry of Energy of Turkish Republic 2023 strategy report [5].

The prospects for future SG development are very favorable. Key drivers such as the continuing growth in the deployment of renewable energy technologies, especially wind and solar power, growth in electric transport, and overall increases in the demand for electricity look set to create a positive environment for SGs over the period to 2020 and beyond. By 2020, renewable capacity is expected to increase by around 300 %, electric transport, including cars, by 45 %, and electricity demand itself by 27 % [6].

After the development of the Smart Grid concept, devices and systems developed to perform remote administration of the system, the differences in the methods used to provide communication between the user and the control system or controller is one of the most remarkable cases. In parallel to the development of IP technology, showing the most improvement in the remote control system and was preferred embodiment of the internet. In recent years, lots of innovation and new aspects in remote control systems has discovered thanks to the spreading of internet and web-based applications [7].

With the help of remote access control system in the wind turbine unit, all the control functions of an internet-connected computer grants to be fulfilled easily anywhere in the world; like monitoring, reporting and maintenance. In this way it is possible to operate wind turbines always at optimum conditions. System components and parameters should be monitored continuously. Data can be evaluated very quickly with the help of Remote Access Control System and it also provides the opportunity to intervene in any problem immediately [8].

2. DESIGN AND IMPLEMENTATION

Focuses on the pre-processing of the raw dataset which contains several parameters that could affect the performance of the classification. The pre-processing of the raw data involves finding out the missing values and replacing the missed values with some appropriate value in such a way that it would impact the recommendation positively. Here, we bring Data analytics. To perform data analytics we follow the below steps :

1. Data Collection
2. Data Cleaning
3. Data Visualization
4. Data Modeling
5. Data Training
6. Data Testing
7. Data Prediction

Data Collection

Data collection is the gathering of information from multiple sources, and data analytics is the processing of that information in order to derive usable insights. To process and gain insights from data acquired from various sources and methods, specific data analysis methodologies and tools are required.

Training Dataset:

In Wind Turbines, Scada (Supervisory control and data acquisition). Systems measure and save data's like wind speed, wind direction, generated power etc. for 10 minutes intervals. This file was taken from a wind turbine's scad a system that is working and generating power in Turkey.The data's in the file are:

• Date/Time (for 10 minutes intervals)

• LV Active Power (kW): The power generated by the turbine for that moment

• Wind Speed (m/s): The wind speed at the hub height of the turbine (the wind speed thatturbine use for electricity generation)

• Theoretical Power Curve (KWh): The theoretical power values that the turbine generates withthat wind speed which is given by the turbine manufacturer

• Wind Direction (°): The wind direction at the hub height of the turbine (wind turbines turn tothis direction automatically)

	Date/Time	LV ActivePower (kW)	Wind Speed (m/s)	Theoretical_Power_Curve (KWh)	Wind Direction (°)
0	01 01 2018 00:00	380.047791	5.311336	416.328908	259.994904
1	01 01 2018 00:10	453.769196	5.672167	519.917511	268.641113
2	01 01 2018 00:20	306.376587	5.216037	390.900016	272.564789
3	01 01 2018 00:30	419.645905	5.659674	516.127569	271.258087
4	01 01 2018 00:40	380.650696	5.577941	491.702972	265.674286

Table. 3.1 Dataset

Testing Dataset:

The provided full-year hourly time-series are simulated using the National Renewable Energy Laboratory (NREL) software for a location in Texas, US. It has perfect data completeness, and no noisy data; challenges that hinder forecasting tasks with real datasets and distract from the goal .The dataset contains various weather features which can be analysed and used as predictors.

Data Cleaning

The first step is to perform data cleaning. If there's any incorrect, redundant, irrelevant or partially formatted data that will be removed or changed, as these data are not beneficial nor necessary because it might produce false results. Data cleaning is the process of eliminating or changing data that is erroneous, incomplete, irrelevant, redundant, or incorrectly formatted in order to prepare it for analysis. When it comes to data analysis, this data is usually not necessaryor beneficial because it can slow down the process or produce false results. To reduce this we first find months for the dates given in the dataset. Then the wind speed is rewritten for 0.5 intervals. For example: wind speeds between 3.25 and 3.75 turns 3.5,wind speeds between 3.75and 4.25 turns 4.0.The wind direction is rewritten for 30 intervals. For example: wind directions between 15 and 45 turns 30, wind speeds between 45 and 75 turns 60

Index	Direction	ActivePower(kW)	Theoretical_Power_Curve (KWh)	WindSpeed(m/s)	Loss_Value(kW)	Loss(%)	count
2	N	1171.54	1383.10	7.4	211.56	17.91	1294
4	NNE	1511.73	1739.18	8.4	227.45	13.76	7533
3	NEE	1773.33	1969.08	8.8	195.75	13.02	13042
1	E	1209.27	1345.86	7.4	136.59	3.68	2088
8	SEE	579.82	631.63	5.6	51.80	7.88	485
9	SSE	912.14	1047.23	6.7	135.09	16.16	511
7	S	2409.73	2517.83	11.7	108.10	6.82	3710
10	SSW	2300.71	2439.50	10.9	138.79	8.12	6119
11	SWW	1252.60	1359.33	7.4	106.73	11.59	1663
12	W	761.26	852.20	6.2	90.94	17.57	1065
6	NWW	952.25	1064.97	6.6	112.72	19.54	520
5	NNW	873.20	992.67	6.4	119.47	19.01	388

Table.3.2 Transformed Dataset (after data cleaning)

A function for rewriting wind direction with letters is done. For example: 0=N, 30=NNE 60=NEE etc. The data that has wind speed is smaller than 3.5 and bigger than 25.5 is removed. We do that because according to turbine power curve turbine works between these values. Number of values where wind speed is bigger than 3.5 and active power is zero. speed is bigger than 3.5 and active power is zero, this means turbine is out of order. we must eliminate these. Eliminate data where wind speed is bigger than 3.5 and active power is zero. We create summary direction dataframe from clean data and remove the unnecessary columns. A column from index is created and change the name of mean_ Wind Speed column as Wind Speed change the place of columns, change the index numbers. A count column that shows the number of directions from clean data is created and we round the values to 2-digit, sort by mean Direction.

Data Visualization

The graphical depiction of information and data is known as data visualization. Data visualization tools make it easy to examine and comprehend trends, outliers, and patterns in data by employing visual elements like charts, graphs, and maps. Here we data analysis because it helps us to spot developing patterns and respond quickly based on what we observe.

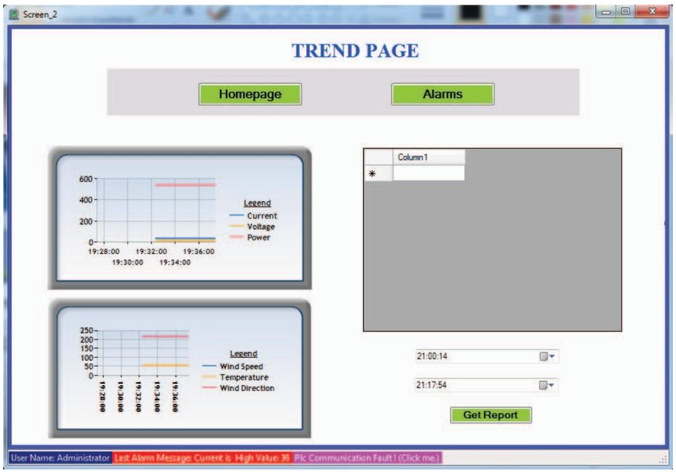

Figure 2. Trends page.

The alarm page, in fact is a SCADA page that high or low values, which prevent system to work normally, is shown with definitions identified at SCADA and stored. Alarm page can be reached by pressing the button on the main page or trends page. Here, alarms occurring in wind turbines and past all the events can be displayed. Figure 2 shows the alarm pages.

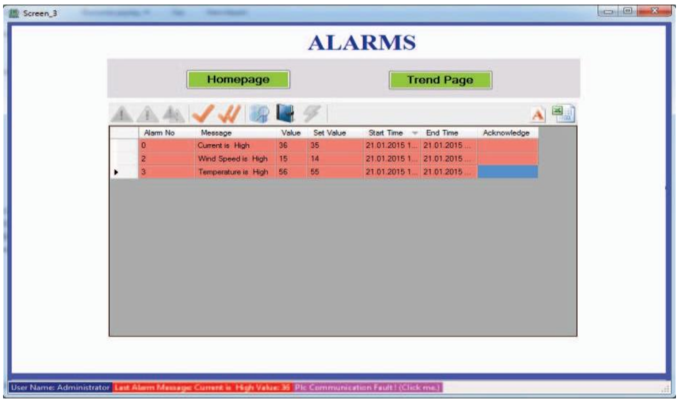

Figure 3. Alarm page

Contents of the user alarms and present or past events situations, which alarm is active, which alarm is passive, date and time of the event can be seen from the alarm page. When alarms occur in the system, or when the failure condition disappears, the alarm is cross off. Alarms crossed off continue to display on the alarm page until they are approved. The data on the alarm page can be analyzed retroactively by transferring to a detailed text or excel.

Internet monitoring page was created by using the web server feature of WinTr SCADA. SCADA pages desired to be accessed via the Internet, can be monitored with the web browser programs by using the Internet or local network. By entering IP address of the computer on the local network and the port number used by the web server can be accessed in the program. Port forwarding needs to be done on the modem for sharing over the internet. Wintr webserver uses port number 8001 to connect to the internet. Address bar of the client wanting to connect to http: // IP address of the computer where the SCADA: 8001 should be entered in the form. When the application web browse address bar http://192.168.1.157:8001 entered; landing page in Figure 3, the main page is displayed in Figure 4 from the Internet.

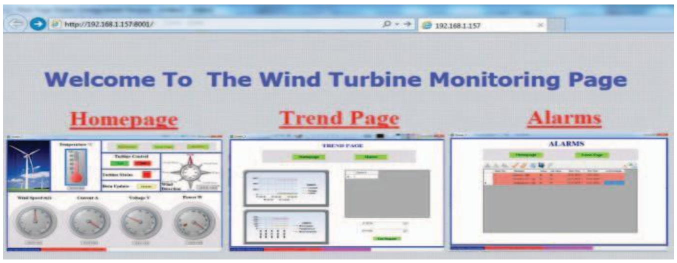

Figure 4. Tracking page the splash screen

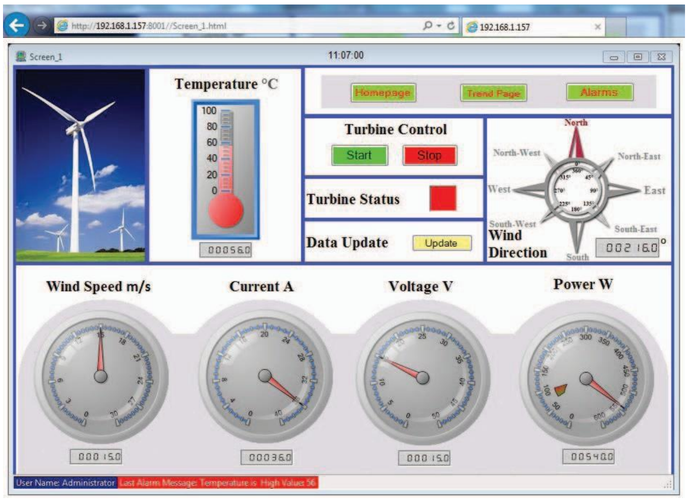

Figure 5. The main page is displayed on the Internet.

3.CONCLUSIONS AND RECOMMENDATIONS

Wind energy is one of the main renewable energy sources due to its natural, cheap, and clean nature. It is possible to produce energy from wind turbines at each hour of the day, and it is suitable for systems that require energy continuously. However, using wind energy is challenging due to its initial investment costs, the requirement of careful analyses before establishing a wind plant ,the distance of wind-efficient are as to the national grids, and its environmentally disruptive effects.

In this study, wind power forecasting was performed based on daily wind speed data

using machine learning algorithms. In particular, classification algorithms were used to forecast values of the given wind speed values. Daily mean wind speed values were generated using the hourly wind speed dataset.
The proposed method could be applied to different locations to see whether the algorithms could produce acceptable results with respect to the trained location. And check which algorithm gives the best result among them.
An important outcome of this study is that machine learning algorithms could be successfully used before the establishment of wind plants in an unknown geographical location whether it is logical by using the wind power model of a base location.
In the future work, an application will be developed by implementing this machine learning recommendationsystem.

REFERENCES

[1] L. Ye, B.J. Lence, S.M. Causal, "Comparison of Modeling Approaches for Optimizing Alternative Energy Systems: An Example of Farm Storage for Wind Energy", Industrial Electronics, *IEEE International Symposium on*, Volume: 3, DOI: 10.1109/ISIE.2006.295870, 2006,
Page(s): 1943 - 1948

[2] IEA (2011) Technology roadmap: smart grids. International Energy Agency. http://www.iea.org/papers/2011/smartgrids_roadmap.pdf, Paris

[3] C.C. Chompoo-inwai, S. Banjongjit, M. Leelajindakrairerk, P. Faungfoo, L. Wei-Jen, "Design Optimization of Wind Power Planning for a Country of Low-Medium Wind Speed Profile", *Industrial & Commercial Power Systems Technical Conference*, 2007. ICPS 2007.
IEEE/IAS, DOI: 10.1109/ICPS.2007.4292093, 2007 , Page(s): 1- 6

[4] Sakar, S. Saber İle Rüzgâr Türbinlerin Elektriksel Sistem Tasarımı, Geliştirilmesi Ve Doğrulaması, Msc thesis, ***Gazi Üniversitesi Fen Bilimleri Enstitüsü***, Ankara, 1 (2012)

[5] Web: Turkish Wind Energy Association, http://tureb.com.tr/ (2012)

[6] IEA (2013) Tracking clean energy progress 2013: IEA input to the clean energy ministerial. International Energy Agency, France. Retrieved 26 June 2013, from http://www.iea.org/publications/freepublications/publication/TCEP_web.pdf

[7] Çalış, H., Çakır, A., "Internet üzerinden ev otomasyonu", **Otomasyon**, 142: 43-46 (2004).

[8] Dewind D8.2 2,0 MW Wind Converter Technical Brochure, **UE Energy Wind Ltd**, Unıted Kıngdom, 3-7, (2006)

[9] D. Su, F. Wang , "Application of PC monitoring status of PLC port in real time in hydraulic cylinder test bed", *World Automation Congress (WAC)*, Page(s):1 – 4, 24-28 June 2012