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Survey of Smart Data Acquisition System in Wind Turbine Machines Using Labview and IoT

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***Abstract*—** The embedded cum LabVIEW technology is now its prime and wealth of knowledge. Embedded technology plays a important role in integrating the various functions associated with it. This needs to tie up the various sources of the department in a closed loop system. This proposed system reduces man power, it also save time and operates efficiently without human interference. This project gives forth to first step for achieving the desired target. I have implemented Report generation & IoT unit for the wind turbine based industry for continuously acquiring the data and implementing the cryptography algorithm in it for security reasons.

Keywords: IoT, Lab VIEW, Report Generation.

I. INTRODUCTION

Present world rapidly moves towards the Renewable energy due to the quantitative and quality impact of fossil fuels on the environment. But using these natural resources as a clean energy requires lot of in between processes. Solar and wind are the most popular energy sources at present scenario due to the tremendous improvements in the area of power Electronics and transmission systems. The space or land Occupied by solar panels is more compared to wind turbine Generator system. Since the wind energy system has upper Hand over the solar system, monitoring of wind turbine system is important. Wind power plants are one of the top rising sources of power generation in the world today. So the need of proper operation and maintenance is mandatory for providing reliable and cost effective green energy.

Fig.1. Wind turbine in wind farms

Generally, wind turbine systems are more prone to fault and maintenance of wind turbine-generator at remote location regularly is huge task. Therefore it requires a novel technique to measure and sense important parameters. Condition monitoring is a tool universally employed for the premature detection of faults and failures so as to reduce downtime and increase the productivity With growing number of wind power plants being erected offshore, there is a need for commercial, predictive, and proactive maintenance. A major portion of wind turbine downtime is due to bearing failures, particularly in the generator and gearbox.Smart data acquisition system in wind turbine machines using labview and iot is a Embedded domain proposed work for wind turbines. It helps for monitoring and performance analysis of wind turbines.

Fig.2.Wind turbine in different areas

Main idea is to implement a data acquition system for wind turbine manufacturing industries which can monitor parameters like temperature, speed, voltage, current and Power with respect to time. It also controls the turbine when the temperature value reach high and on that time turbine automatically stopped. In general sensors are affected by atmosphere changes but these changes can be converted to raw data.

Data Acquisition refers to reading the data continuously from any sensor. The machine values are collected by using various sensors under data acquisition mechanism. Those values are controlled by MSP 430 controller with energia software coding. Here we are continuously acquiring the data using embedded system and it is continuously monitored using Lab VIEW and data base is created using it. We are focused mostly on serial communication. The data we receiving from the sensor is received by the controller using ADC. Data monitoring is done in PC and for communication VISA serial port communication is used. We can get the information like Date and Time along with our data.

The data is stored in the PC is easier to monitor or retrieve at any time compared to storing in a particular memory. Nowadays we are using the same process as storing the data in the PC in any kind of industries. Send that monitoring information's to the user Or any one administrator daily Or weekly (depends upon the need) through the labVIEW.

II. RELATED WORK

R. Morello et al [15] proposed the propelled detecting frameworks in the electric grid. Improvements and experimental values of a smart power meter is described in this project. smart power meter is used here for screen power among various nodes in a effective way. The smart power meter constructed with Single-Board RIO 9626. They use two transducers for find the voltage and current signals. That signals are progressively carefully changed over for data handling. That board has been modified by utilizing the LabVIEW programming. Two test seat setups have been utilized to execute three diverse test set outcomes. First, a primer test set allowed validating results given by the voltage and current transducers. Second test set verify the FFT calculations of the voltage and current signals.

D.Kalyanraj et al [4] proposed to IoT based wind turbine for control and monitoring a system. Turbine control is based on the vibration level. Here IoT is implemented by using Raspberry Pi and arduino microcontrollers. This proposed work dependent on a minimal effort Wind turbine observing and control framework with information logging facility. Using this proposed system, following parameters are monitored measure of Power generation , Magnitude of immediate voltage and flows, level of vibration, Turbine speed, Humidity and Temperature . Proposed system consists of sensing unit, monitoring unit and control unit. Control unit giving alarms to alert. Proposed system use memory card or PC for information logging. The put away information is open just in that specific PC alone.

Haolin Yin et al [9] proposed to found the correlations between the two parameters. That parameter data is collected by SCADA according to the principle of wind turbine operation. Polynomial regression was used for established normal relations between the two different speed wind turbine parameters. Mat lab is used for verify the validity of this method. The final result confirmed that this method can reflect faults two months ahead of the SCADA system. The polynomial regression method was used to establish SCADA data correlation coefficient model of normal condition and unknown condition of wind turbines. Main aim to achieve real-time condition monitoring for wind turbine.

Yan Pei & Zheng Qian et al[20] Implemented the wind turbine condition monitoring system for wind farm operators to realize condition-based operation & maintenance. It was reducing the operation & maintenance cost and improves the reliability of wind turbine. In this paper proposed a wind turbine condition monitoring method using only SCADA data based on data mining Algorithm. Firstly, ARD (Automatic Relevance Determination) algorithm is adopted for determine the wind turbine condition based effective variables. Feature vector was used in here to represent the wind turbine condition .Then the OD (Outlier Detection) algorithm is adopted to determine a wind turbine is in normal condition or abnormal condition according to the calculated feature vector. Wind turbine faults are arrivewhen the wind farm is in operation condition. This will make more lost to the wind farm owners. The proposed method can provide advanced failure alarm for wind turbines many days before failure happens.

Chandra Bajracharya et al [3] implemented the wireless sensor networks for observing wind turbines. Judge the performance of wireless sensor network for observing wind turbines. Conclusive outcomes are obtained from simulations. Principle point is to examine the performance of wireless sensor network that is used in wind turbine monitoring. Numerous sensors are deployed on the wind turbine surface to gather the information’s like temperature, speed, vibration, etc. Sensor report on these values into sink node through gateway. At long last that information’s forwarded to the end user. That forwarding is happens through the satellite or access points.

S. S. Tian et al [17] evaluated the power generation execution of wind turbines under fault condition. This evolution is important for economic use of wind energy and arrangement of maintenance plan. Here they uses a strong measurable technique consolidates with Gaussian statistics method and least trimmed squares for assess the PGP. First step is the

data set preprocessed by the GS method for eliminate the abnormal data which is caused by illegal operations. Second step is use the LTS method for fit the wind-power curve (WPC). The decay proportion of PGP with faults can acquired at long last by looking at the change proportion of WPC area among fault and ordinary wind turbines. The final evaluation result give guidance and it is also used for make economic maintenance plan.

Zhixin Fu et al [21] proposed to a reliability analysis method of wind turbines blade. This analysis is dependent on the wireless sensor networks. Condition observing system of wind blade is analyzed in this paper. Two factors assume critical jobs in reliability evaluation of networks. One is reliability of sensor nodes and the second one is the reliability of communication links. The reliability establishment is based on the Monte Carlo method. Reliability of overall network is improved by measure the one time data transmission. A hierarchical-clustered topology is adopted as the general structure of monitoring network. 3 clusters are used in the checking system of wind turbine blade. Also use 13 sensor nodes in each cluster. Over all reliability of monitoring network is measure in this cluster by Monte Carlo method. This proposes is used for high-performance condition monitoring and control system of wind blades.

WU Xin et al [19] implemented to SCADA monitoring data and vibration data consolidate to complete the observing and fault diagnosis of wind turbine. Initially, we introduce vibration sensors at the parts that sensors have a high failure rate on wind turbine. At that point we use NSET as a modeling method for set up gearbox, generator and main bearing vibration model individually. The model form by NSET is very sample & has a high accuracy and simultaneously it gives another line of thought for wind Vibration examination. These models can likewise be utilized as a reference to help identify early failure.

Peng Sun et al[14] proposed a peculiarity recognition in wind turbines utilizing typical conduct models (NBMs) in view of SCADA data. A fractional least squares relapse joined with genetic algorithm is utilized for info parameter choice. That decreases the repetitive parameters for anomaly detection. The typical conduct models for 14 temperature parameters of SCADA structure are made by utilizing back spread neural systems. The proposed strategy is confirmed by an instance of a 1.5MW wind turbines fault. Results demonstrate that the normal behavior models have a low prediction error under normal operation condition and a high prediction error proceeding to the fault. The forecast mistake is utilized as a compelling pointer for oddity recognition in turbines.

Peng Guo et al[13] proposed to condition monitoring of wind Turbine Generator Bearing with NEST method. In this History information of SCADA framework is investigated to distinguish the early failure of wind turbine generator bearing. Another condition observing strategy dependent on the Nonlinear State Estimate Technique (NSET) is proposed. NSET is used to develop the ordinary conduct model of the generator bearing temperature. At the point when the lingering surpasses the predefined thresholds, a beginning failure is flagged. Analysis of a manual float included the historical SCADA information for a wind generator bearing exhibits the effectiveness of this new condition monitoring technique. With a manual generator bearing temperature drift simulation, the introduced method can distinguish beginning wind turbine generator bearing failure well in front of the serious damage happening.

Grzegorz Swiszcz et al[6] proposed for a limitations and requirements of the data acquisition application. condition monitoring (CM) system developers use simulation due to a absence of genuine wind turbine measurements in any case, this data may not really reflect processes occurring in the real turbine application In order to decide various patterns of machinery deterioration, exact information of existing parameters at higher testing frequencies up to 20 kHz is required. Extra parameters, not as of now usually observed, similar to turbine vibrations are additionally wanted. A definite clarification of the data acquisition project developed in Lab VIEW just as the potential outcomes for remotely controlling this procedure are given. Results acquired from initial tests demonstrate that the DAQ framework is a simple to work source of reliable data. Including additional sensors doesn't require program reconfiguration and should be possible from the User interface.

Keun-Young Kang et al[11] implemented for condition checking and control system of small-scale wind turbine. It is mainly consists with three components first one is data collection unit second one is control unit and third one is coordinator. Various sensor nodes are introduced at different turbine parts. Data collection units are used for collect sensing data's from various sensors and transmit detecting data's to a facilitator via ZigBee. The facilitatoradditionally speaks with a PC and a smart device. At long last, GUI based on LabVIEW and Android is created to demonstrate the received sensing data efficiently. The GUI dependent on Lab VIEW can control the wind turbine direction by utilizing control unit.

Adel Nazemi Babadi et al [1] proposed a IoT scheme for Serviceability Optimization of the Next Generation Wind Turbines. In this a complete IoT based system including sensors, IT networks, local and wide region communication media, information base, and information analytics platform is introduced that can guarantee long term information storage, full range faults and failure root cause analysis, and low noise information transferring media. Proposed IoT scheme is sorted into three layers. They are hardware, software, and services that each layer some needed

component with explained usefulness. Exhibited methodology can improve cost, time and personnel efficiency with expanded staying valuable lifetime and flaw tolerant mechanical and electrical structure. At the end point, potential faults are recognized by a diagnosis unit by using data mining approaches.

Andrew Kusiak et al [2] proposed a methodology for predicting wind turbine states was displayed. The proposed methodology involved the following steps first step is turbine state abstraction second step is algorithm learning, and the last step is state prediction. To diminish the computational effort, data-mining calculations were prepared utilizing a stratified informational collection. Among the selected data-mining algorithms, Random forest algorithm provided the most accurate results. In this paper data mining algorithms are utilized to build forecast models for turbine faults.

Evangelos Papatheou et al [5] proposed a approach of Performance Monitoring for the Novel Lillgrund Offshore Wind homestead. This paper shows an examination of (SCADA) extricates from the Lillgrund offshore wind homestead for the reasons of monitoring. An advanced and robust machine-learning approach is applied so as to produce individual and population based power bends and after that predict measurements of the power created from each wind turbine (WT) from the estimations of the other Wind turbines in the homestead. Control diagrams with robust thresholds determined from extraordinary worth statistics. They are adequately applied for the observing of wind turbines.
Wilmar Hernandez et al [18] proposed a Wilcoxon Signed-Rank Test method for Power Performance Verification of a wind turbine. In here, a new wind turbine control execution verification method has been introduced. The verification method is depend on Wilcoxon signed-rank test and just needs the ensured Power curve and the data is collected by SCADA system. They use nonparametric statistical inference method. That is applied to structuring a basic, minimal effort strategy for checking the power execution of a wind turbine. It likewise checked the ensured power curve of the turbine. At long last it says whether the power performance of a wind turbine contrasted significantly from what would be expected.
Ravi Kumar Pandit et al [16] proposed a condition monitoring of a wind turbine by using SCADA based nonparametric models. Gaussian Process models and Regression trees are usually utilized nonlinear, nonparametric models helpful in forecasting and prediction applications. In this paper, two nonparametric techniques are proposed for a modeling of power curves. The Gaussian Process treated as the benchmark model, and a relative examination was grasped utilizing a Regression tree model. This regression models performance is evaluated by using SCADA datasets which is readily available from a solid wind turbine. Guoqian Jiang et al [7] proposed a Fault Diagnosis of wind turbine by using Multiscale Convolution Neural Networks. This is a new intelligent fault diagnosis strategy. It is consequently distinguish the distinctive wellbeing states of WT gearbox. Here proposed another Multiscale convolution neural system (MSCNN) engineering which can do Multiscale include extraction and characterization. The proposed MSCNN consolidates multistage learning into the conventional CNN engineering. It wil increase the learning ability and enables diagnosis performance as high.

Long Wang et al [12] proposed a Failure Identification of Wind Turbine Gearbox with Deep Neural Networks. The strategy of observing the soundness of wind turbine (WT) gearboxes relying upon the oil weight information in the SCADA system is explained in here. A deep neural network framework is created to screen states of WT gearboxes. Also it is additionally distinguish their impending failures. The proposed system was constructed with two phases, one is modeling and the another one is monitoring the lubricant pressure. A DNN algorithm was applied to develop the prediction model and it is compared with five benchmarking data-driven models. The proposed framework was validated with original gearbox failure occurrences.

Huan Long et al [10] proposed a performance monitoring of power generation in wind turbine depend on SCADA data. The proposed approach distinguishes turbines with power age execution through reviewing the wind power bend profiles. A data-driven methodology for monitoring the variation of a turbine power bend was introduced to recognize impaired power generation performance. Two power bend models, the direct and Weibull CDF based model, were applied to deliver the straight and WCDF power bend profiles. That profiles dependent on a grouping of SCADA sub-datasets. In the monitoring, a multivariate methodology was applied to break down power curve profiles while a residual methodology was used to investigate errors created by fitting power bend models.

Hae-Jin Sung et al [8] proposed a HTS Pole Performance Evaluation System that is used for Long-Scale HTS Power Generators. This paper manages with a PES structure for a 10-MW HTS power generator and a near examination of the PES with the full generator. At last, the torque and power of the full generator and PES were analyzed and compared. The PES was finalized for testing HTS coils for large-scale HTS generators. Design specifications of 10 MW HTS generator were dissected utilizing the special FEM program. Finally calculated the output torque and power of 10 MWHTS Generator. At that point dependent on the details of the full generator the PES for full generator was analyzed. The final result values of the radial force and unrelated power of the HTS pole were 53.7 kN and −69 kN, respectively.

Table1. Comparison of data acquisition system in wind turbine.

S.No	Author	Implementation details	Advantages	Disadvantages
1.	R. Morello et al.(2017)	The smart power meter is monitor electricity among different nodes. It uses a graphical programming language; the source code has been developed with the LabVIEW Real Time Tool.	The smart power meter are remotely programmable and controllable	The smart power meters are able to share information only with the electric company control centre for just to bill the user power consumption.
2.	D.Kalyanraj et al.(2016)	IoT based wind turbine control and monitoring system by using SCADA software	Low cost wind turbine control and monitoring system	Installation of SCADA system is very difficult
3.	Haolin Yin et al.(2018)	Find correlations between the two parameters. That parameter data is collected by SCADA according to the principle of wind turbine operation.	Find the failure of wind turbines before two months	SCADA system need frequency maintanence
4.	Yan Pei & Zheng Qian et al.(2018)	Wind turbine condition monitoring by using SCADA and Data-mining method for operation and maintenance	Reducing the operation & maintenance cost and improves the reliability of wind turbine.	SCADA system occupy more space for installation
5.	Chandra Bajracharya et al. (2015)	Monitoring wind turbines by evaluate the parameters of wireless sensor networks	Easy to do the Performance analysis of wind turbine	Large wind turbine network monitoring is not done by using this method
6.	S. S. Tian et al.(2016)	Find the power generation performance evaluation for economic use of wind energy .	Help to make economic maintenance plan	Processing time is high because it using more methods for find each results
7.	Zhixin Fu et al.(2018)	Condition monitoring network of wind turbine blade is analyzed by using wireless sensor networks	Improve the reliability of the network	Bit error rate increased means it will affect the reliability
8.	WU Xin et al.(2017)	vibration acceleration signals combined with SCADA data to implement condition monitoring and fault diagnosis of wind turbines	The vibration Model build by NSET is very simple and high precision.	Require ling research period to get accurate results.
9.	Peng Sun et al.(2014)	Anomaly detection in wind turbines using normal behavior models based on SCADA data	Improve the wind turbine accuracy and efficiency	Processing period is high
10.	Peng Guo et al.(2012)	Detect the incipient failure of wind turbine generator bearing by using NEST method	Reduce the maintenance cost of wind turbine	No efficiency
11.	Grzegorz Swiszcz et al.(2008)	Create a Data Acquisition Platform for the Development of a Wind Turbine Condition Monitoring System	LabVIEW is a user friendly tool	Not allow sampling rates for individual channels.
12.	Keun-Young Kang et al.(2014)	Implemented for condition monitoring and control system of small-scale wind turbine.	User friendly	Cost is high

13.	Adel Nazemi Babadi et al.(2018)	IoT scheme for Serviceability Optimization of the Next Generation Wind Turbines.	Potential faults are identified	Maintenance of IoT Scheme is require high cost
14.	Andrew Kusiak et al. (2012)	Datamining algorithms are applied to construct prediction models for wind turbine faults**.**	Result accuracy is high	It is not suitable for training data.
15.	Evangelos Papatheou et al.(2015)	Proposes an examination of supervisory control and data acquisition (SCADA) extricates from the Lillgrund offshore wind farm for the reasons of monitoring. An advanced and robust machine-learning approach is applied here.	It produce individual and population-based power curves	SCADA data is the reason for lower detection of faults
16.	Wilmar Hernandez et al.(2017)	Using Wilcoxon Signed-Rank Test method for Power Performance Verification of a wind turbine	Nonparametric statistical inference is used to create inexpensive method for verifying the power performance of a wind turbine	Handling this method is very difficult
17.	Ravi Kumar Pandi et al.(2019)	Condition monitoring of a wind turbine by using SCADA based nonparametric models. nonparametric models are proposed for the wind turbine power curve	Gaussian Process is used for power curve modeling model with squared exponential covariance Function. it is simple and straightforward.	Gaussian Process power curve model accuracy may be degrade with a large number of data points.
18.	Guoqian Jiang et al.(2018)	Fault Diagnosis of wind turbine by using Multiscale Convolutional Neural Networks. It is automatically identify the different health conditions of wind turbine (WT) gearbox.	It can be easily deal with all machines and industrial systems.	This method is not suitable for large-scale WT gearbox
19.	Long Wang et al.(2016)	A deep neural network (DNN) based system is developed to monitor conditions of WT gearboxes and it also identify their impending failures.	A DNN will give accurate predictions without computational costs.	SCADA systems have been stopped in most of wind farms for collecting conditional data in wind turbine.
20.	Huan Long et al.(2015)	A data-driven methodology for monitoring the variation of a wind turbine power curve was introduced to recognize impaired power generation performance.	Results show a high accuracy of power curve profiles of wind turbines.	Require large time period to do the data-driven process.
21.	Hae-Jin Sung et al.(2019)	It make performance evaluation system (PES) structure for a 10-MW HTS wind power generator and a near examination of the PES with the full generator	Reduce human effects in performance evaluation process	The simulation results are in approximate not in accurate manner

III.RESULT AND DISCUSSION

The different strategies and results are compared by tabulating with the implementation details, advantages and disadvantages of each research work as shown in table 1.

IV. CONCLUSION

The survey shown in the table 1 helps to identifying the various ways of wind turbine monitoring and control system. Most of the wind turbine monitoring and control process was completed by using SCADA systems. Fault detection and sensor network of wind turbines were explained by using various algorithms. Wind energy is the most popular energy source because of the improvement of power electronics. It has countless applications and can be used in different environments and scenarios. For instance, at one way it is a popular energy source while at another instance one of the top rising sources of power generation in the world.

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