An Information Management System of Spot Check in Wind Farms

Jian ZHAO\textsuperscript{1,*}, Jia-hao HE\textsuperscript{2}, Shu-xiang GUO\textsuperscript{1} and Tao YANG\textsuperscript{2}

\textsuperscript{1}China Huadian Engineering Co., LTD (CHEC)
\textsuperscript{2}Huazhong University of Science & Technology, School of Energy and Power Engineering, China

Keywords: wind turbine generators; spot check; fault; management system.

Abstract. At present, wind farms are dispersed all over China. At the same time, the devices are always provided by different factories, which make it difficult to monitor and diagnosis the devices. And the traditional inspection is in a low efficiency. In order to solve this problem, it is necessary to develop an information management system. The system can collect, analyze and store some information, like temperature, noise, vibration and image, it can find the problems in time and reduce the maintenance cost. This management system can assign inspection tasks reasonably, to avoid miss and over inspection, reduce the cost of manpower and time.

Introduction

With China’s emphasis on energy-saving emission reduction, China has reduced the development of thermal power, and vigorously developed clean energy. Wind power is one of the important part. The health and reliability of the equipment is an important factor that affecting the wind turbine. in order to solve the problem of equipment maintenance, China introduced spot check method in the 20th century, this method is developed from a maintenance system in the United States on the basis of preventive maintenance system\cite{1}, it emphasis on fixed point, quantitative, standard, fixed line, cycle, fixed method and check record\cite{2}.

The spot check system is a kind of dynamic management of the equipment, the core of which is to maximize the overall efficiency of the equipment, the goal is to ensure the normal operation of equipment. Spot check method is more scientific than traditional equipment inspection, not just a simple detection method. Spot check is a set of scientific and orderly system, clear responsibility of equipment management system; it has the characteristics of compatibility, openness, continuous improvement by the majority of countries in the world of equipment management experts. Well-defined equipment management system, which is compatible with the characteristics of compatibility, openness and continuous improve attract many equipment management experts attention. However, the shortcomings of existing technology in the inspection management of wind turbine is still in the manual processing level, due to the fact that the spot check management has the characteristics of complicated data, large workload and complicated operation, the manual operation makes the advantage of the spot check management system not to be fully utilized.

The Constitution of Wind Power Information Management System

Section Headings

The inspection information management system is developed based on the.NET platform, and uses C/S architecture, this architecture is generally used in special network, local area network through a dedicated server to provide links and data exchange services, it has good security. So it is applicable to the regional management of wind farms.

Selecting the three layer architecture\cite{3} to develop the software, this structure consists of three layers: the UI layer, business logic layer and data access layer, in addition it has two attached layers, which is model layer and general layer. the model layer is the carrier of data, it correspond to database, general level is used to package some commonly used methods, and provide to three layers, this two
attached layers has no direct relationship with three layer architecture. The three layers are shown in figure 1:

![Figure 1. Sketch of the three layer structure.](image)

**System Module**

This system is designed for the development of wind farm information management, the interface requirements are simple and clear, and it need to meet the requirements of the wind power in the process of inspection, improve the efficiency of inspection.

In the design of the system function use the modular idea, this system include 6 modules, it divided into the inspection information acquisition module, wind turbine, wind turbine information database storage information acquiring module, assessment module, operation module and storage module, six modules as shown in figure 2:

![Figure 2. Schematic diagram of system function module.](image)

The inspection information acquisition module includes the equipment number information acquisition module, the query information module and the signal analysis module, equipment number information acquisition module is used to receiving wind turbine equipment information, and send inspection information to the wind turbine equipment. Inspection information query module can send the query request to the outside of the system and receive the inspection information of the wind
turbine send request and receive information measurement system of external wind turbine inspection. The inspection information query module converts the received wind turbine inspection measurement information send to the signal analysis module, the signal analysis module is used for DC, integral, filtering and amplification to the signal, finally, generate wind turbine inspection information.

The information database of wind turbine is used to classify the data of wind turbine vibration, temperature and so on.

The state evaluation module is used to compare the information of the wind turbine generator with the corresponding threshold information, to make sure send wind turbine equipment number information and comparison results when the information is not in the corresponding threshold information.

Operation guidance module includes maintenance guidance information acquisition module and inspection information generation module, operation guidance information includes wind turbine maintenance guidance information acquisition module and inspection planning information generation module, based on the wind turbine equipment number information and comparison results the maintenance guidance information acquisition module can generate maintenance guidance information, at the same time send the maintenance guidance information inquiry request to information database of wind turbine, receives the wind turbine maintenance instruction information.

Partial Technology Implementation

Interface and Data Display

This system is a WinForm program written by C# language based on .NET platform, this language has rich controls, and can customize the third controls, DataGridView control can display the data file, PictureBox can display pictures, and it is easy to write a user-friendly Windows program. To cite a rich third party .dll file can get more features, such as export data to Excel, use data in the database to draw rich visual graphics which makes management more intuitive understanding the various conditions of equipment.

Data Access Technology

There are a large number of equipment parameters in wind farm, which will have temperature, vibration, image data and so on. At this time database is needed to storage and management these data. Also there chose the Microsoft SQL Server 2012 as a database management system which provide by Microsoft Corp. In order to facilitate the data access and storage there encapsulated a SqlHelper class in the data access layer. There are three methods in this class, ExecuteNonQuery() is used to execute the Sql statement returns true or false; ExecuteScalar() is used to execute the Sql statement and return the first line of the data; GetDataTable() can obtain DataTable and display the data in the UI presentation layer.

Each time the inspection information management system visit to the database a new database access connection will be build, so multiple visits will be slow. At this time database connection pool technology will improve this shortcoming, so the database connection can be reused, we should first search the connect pool when need to connect to the database. If we find it there is no need to build a new connection, this method can improve the access speed.

Data Security

The security of the management system is very important, a large number of unencrypted information are stored in the database directly.

Programming will inevitably produce loopholes, sometimes equipment and personnel data is easy to be stolen by SQL injection, and bring huge losses to the wind farm.

In order to solve this problem there use SqlParameter() method to parameterize the SQL statement. The traditional way is directly spliced SQL statement, easily lead to SQL injection, however, after the
parameterization of SQL statements, only first parsing can be performed, so greatly enhanced the security of the data, such as traditional statements:

```
Select * from tb_Duty where id='1';
```

The parameterized SQL statement:

```
Select * from tb_Duty where id=@id;
SqlParameter sp = new SqlParameter("@id", id);
```

This statement does not appear the value of ID directly, only after parametric analysis can this SQL statement be executed, this method can effectively ensure the safety of wind farm information.

**Operator Management Rights**

Wind power inspection information management system is a large system, and it stores a large amount of information, but different information should be show to different people. For example, all of the temperature, vibration, health and spot check tasks data should be show to the master of the wind farm, but inspector only need to see the wind turbine’s data and tasks of their own, there is no need to care about others information. So it is important to add rights management function in this system, when someone login in the management system they can only see the information within their own jurisdiction, rights control window is shown in figure 3.

![Rights management window](image)

**Figure 3. Rights management window.**

**System Function**

**System Main Function**

Figure 4 is the main interface of wind power information management system, which shows 11 main functions[6]:

1. Basic information: the main function is department settings, job settings, professional settings, personnel management, equipment ledger, inspection equipment management, configuration code and set up personal information.

2. Standard management: manage the standard of the parameters in the spot inspection, in order to facilitate the use of different standards in different circumstances, so that the system is suitable for different wind farms and different generators.
(3) Project management: including planning, planning setting, task start and stop, the planning settings include frequency settings, time settings, time settings, value setting, duty shift setting and personnel allocation; planning including regional settings, route management, planning and task allocation.

(4) Communication management: the task is to download spot check tasks, spot check data upload and send SMS, which can send important messages in the first time to the relevant personnel.

(5) Performance management: The main function is query result, record the log and missed detection statistics.

(6) Data analysis: the vibration signal is mainly used in the inspection process, and the vibration signal is mainly used to analyze the vibration in time domain and frequency domain, finally compare the data with different time.

(7) Defect management: record defect type, defect registration, defect management, defect acceptance, integrated query and defect statistics.

(8) Maintenance management: make maintenance records and downtime records after wind turbine failure.

(9) Report management: deal with the management of the path report, the task report, the abnormal report, and the hour statistics.

(10) System settings: password modification, permissions settings, record system logs and data cleaning.

(11) Help: including the relevant information of the wind power inspection information management system and the help document in the process of using the system.

Figure 4. Main interface of inspection management system.

System Main Function

The communication function of the information management system of wind power can realize the data sharing function, and the data can be uploaded to the database through the storage module.

Check wind turbine by spot inspection instrument, and acquire data information, and the data will be sent to router[7], then the router will sent the data to Inspection information acquisition module through LAN; The wind turbine inspection management system also includes client monitor, wind turbine inspection information management system send data to switches through the local area network, then the switch sends the inspection information of the wind turbine to the detection client through the wide area network.
**System Main Function**

When check the generator can obtain temperature, vibration, images and some other information. As to vibration signal, it is an important parameter to judge whether the machine is working properly, so the vibration signal is analyzed emphatically in this system. This system can present vibration analysis picture by analysis vibration signal, Vibration analysis of waveforms, including frequency spectrum, order spectrum, Bode diagram, polar coordinate chart, trend chart, cascading waterfall chart, map, trajectory, axis center position map, vibration parameter list, and rolling bearing envelope spectrum. All of these parameters have the corresponding threshold, once it exceeds the threshold value and some others abnormal situation, inspection system will issue a warning, and gives suggestion of maintenance information.

**Conclusions**

At present, intelligent inspection information management system is widely used in thermal power plants and some other fields, but in wind farms field China is still in its infancy. This system consists of detection, maintenance, communication, data storage and sharing function, make the intelligent management of wind farm more easier, it can greatly improve the existing programs, such as inspection is not in place, inspection staff can’t carry out the inspection tasks according to the requirements, the difficult to store inspection data, missing data, historical data can’t be fully utilized, can’t use find hidden problems by inspection data. The system is developed by .NET, which is convenient for the later improvement. Makes it possible to maintain and manage the wind farm, and it also has great reference value for the management of wind farm.

**References**


