Performance Analysis and Optimization Research of Wind Power Forecasting System

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Abstract. The power fluctuation of wind farm will affect the operation of regional power grid, mainly due to the power fluctuation caused by voltage fluctuation. In order to submit information to power dispatching department as soon as possible, it is convenient for system dispatching. It is necessary to research and develop wind power forecasting technology, especially ultra-short term wind power forecasting technology. At present, the power forecasting system of the dispatching side and some wind farms in China has been widely used. However, the system has some shortcomings in stable operation. Combined with the actual production experience of the existing wind power prediction system, analyze the performance of the existing wind power prediction system, find out the problems that affect the smooth operation of the system, and refer to domestic and foreign data to provide targeted information for each problem. Finally, some constructive optimization Suggestions and a set of optimization scheme are given. In addition, according to the final proposed solution, this paper also developed an optimization model for wind power prediction system, and compared the changes in system performance before and after optimization to verify whether the optimization plan is correct.

1. Introduction

The power fluctuation of wind farm will affect the operation of regional power grid. At present, the power prediction system on the dispatching side and the wind farm side has been popularized in China. However, in the stable operation of the system, there are generally insufficient. With the in-depth promotion of China's wind power prediction system in the power grid and wind farms, how to further improve the stability and efficiency of the system operation has become an urgent topic [1]. According to Moore's law, the performance of computer hardware is developing rapidly. Upgrading hardware is the simplest and easiest way to improve system performance. However, we cannot ignore the impact of improving software performance on the system. Software performance refers to the degree achieved by a software system or its components in the goal of real-time performance, which is a characteristic of any finished software. This feature is mainly reflected in the response time and throughput of a software, that is, the time required by the software to respond to a request and the number of requests that can be responded in a given period of time.

Wind power prediction technology is one of the effective means to relieve peak regulation pressure of power grid, reduce system reserve capacity and improve acceptance capacity of wind power grid. At
present, the power prediction system on the dispatching side and the wind farm side has been popularized in China. However, in the stable operation of the system, there are generally insufficient. With the deep popularization of China's wind power prediction system in the power grid and wind farms, how to further improve the stability and efficiency of the system operation has become an urgent topic. Europe and the United States have established a sound wind power prediction management mechanism, in the wind power prediction system promotion and stable operation of the system is effective [2].

2. Software optimization

2.1. Software optimization process
Software optimization needs to be analyzed from several aspects. Software infrastructure, software algorithms, scheduling relations between various functional modules and other aspects can be considered. First, we need to find the most lossy area in the system according to the test feedback. Then, the weak links are analyzed to find the reason of excessive performance loss [3]. Finally, an appropriate solution is proposed. In addition, it is necessary to conduct secondary analysis and test on the reformed system.

2.2. Software optimization technology
Link-time optimization techniques: first, introduce the compilation process, taking C as an example. Compilation, the process of converting source code to machine code by the compiler. For some compilers there may also be a process of converting source code to assembly code and then assembly code to machine code. Link to machine code file cannot run, must be further converted to executable. The compiler will reference the code in the file, the program of the various modules together, this is called link. Therefore, the compiler can optimize when linking target code. In most systems, the linker goes through all the program code while building the software. This means that global optimizations can be made at this point, especially if a program is written in multiple languages.

Memory optimization technique: memory is an important part of the computer, the application depends on memory to run, so the memory of good or bad, efficiency on the system performance has a very huge impact. Optimization measures can be taken for memory mainly include: the loop of reading data from memory is expanded; It is also helpful to reduce the correlation between the data and adopt the appropriate structure to organize the data[4]. Decomposition of large requests into multiple requests at a lower level; Cache data; Only perform memory access operations when necessary, and so on.

Multi-threaded parallel optimization technology: multithreading technology refers to the technology that can process multiple tasks at the same time and improve the system performance as a whole. Multithreaded parallel processing means that the throughput of the system is much larger than that of a single thread, which often means better performance. It is especially suitable for multiple highly repetitive tasks.

Software architecture optimization techniques: software architecture is the foundation of a software system, just as an architect's design drawing is the foundation of a building. Generally, a good software architecture needs to achieve the following goals: reliability, security, scalability, customization, and maintainability. Under the same conditions of other technologies, whether a software system architecture is suitable or not may directly determine the life and death of a software system, so it is especially important to design a good system architecture in the beginning.

Optimization techniques used by the model: after a comprehensive analysis of the existing wind power prediction system, the hardware and software problems are summarized. Here, we mainly discuss the problems involved in software, leaving aside the problems in hardware, while the problems in software mainly focus on the architectural defects of the system, so this model mainly USES software architecture optimization technology. In this paper, the defects of wind power prediction system in stable operation are analyzed.
3. System problem analysis and optimization plan

3.1. Stable operation problem
Collection module cannot run stably: through the observation of the actual production process, it is found that among the modules of the wind power prediction system, the data acquisition module is especially vulnerable to the influence of the change of the external environment, which will lead to the loss of system performance, or even cause the system crash. After a long time of observation and summary, it is easy to cause the collapse of the acquisition module for the following reasons:

Upstream data source dead: in the process of real-time data collection, if the service program on the collected server suddenly dies, and there is no hint before disconnection, the real-time data collection program will appear empty mining, and the collection program using individual collection protocol will even die directly.

Data format change: in the process of system development, the development of data acquisition module relies on the upstream data service program provides real-time or meteorological data, when the upstream data service program changes due to program and did not inform all rely on the it system, so very easy to cause the downstream collection procedures unable to parse the data correctly and hang up[5].

The collection module cannot run stably: The above problem is one of the most common problems we encounter in the actual maintenance process. Through observation, we can easily find that the data collection program cannot achieve good functional isolation due to its dependence on the data source. Therefore, this part of the main focus of optimization on the warning information on the alert, to ensure that problems in this part of the first time to notify the system management. On the one hand, sufficient exception handling is done inside the module to improve the fault tolerance of the module; on the other hand, supervision module is set up to ensure that the first time the module stops working is informed. The message notification scheme that is considered to be adopted mainly includes the prominent prompt of data visualization interface, window popup, email reminder, SMS reminder and other forms.

3.2. Performance loss problem
Problem of machine performance loss under abnormal operation: in the actual production process, when the real-time data acquisition module changes due to the environment it depends on, the super short-term power prediction will change, which will hinder the normal operation of other system modules, and may even lead to the chain collapse of other modules. Similarly, when the weather data acquisition program crashes, the short-term power prediction program will also produce performance loss problems. Performance loss is mainly reflected in that when a certain module of the system cannot run normally, other modules make frequent and meaningless judgments, requests and calculations.

Optimization scheme of machine performance loss under abnormal operation: First, the frequency of data verification should be reduced appropriately. Secondly, when the production failure of prediction data is caused by data failure, the frequency of power prediction should be timely controlled to avoid the problem of system performance loss.

3.3. The alarm problem
Existing system, when the system internal abnormal situation, can not timely feedback to the system management or system maintenance personnel. Therefore, the maintenance time of the system is often delayed, which increases a lot of unnecessary time costs and causes unnecessary losses to the electric field.

Warning information prompt schemes mainly include the following:
Web interface tips: the wind farm system management personnel need to log into the system every day, power query, can timely find abnormal and deal with. The disadvantage is that the time at which exceptions cannot be found depends on how long the system administrator has been using the system.

Window popover prompt: compared with Web interface prompt, window popover is one step closer. It can ensure that as long as there are on-site personnel logging in the server, they can be informed of
the abnormal situation of the system and deal with it in the first time. Similarly, if there is no maintenance staff to log on to the system for a long time, the system problem may not be solved for a long time.

Email, SMS notification: the advantages of these two methods are very obvious, can reduce the dependence on people. However, it is necessary to access the outer network, and the electric field is not allowed to access the outer network, which is applicable to the case of having its own internal mail server [6].

To sum up, we can consider the scheme of combining static prompt and dynamic reminder to ensure that the abnormal information of the system can be delivered to the management personnel of the system accurately and timely.

4. Requirements analysis and system design

4.1. Demand analysis

The purpose of optimization model of wind power prediction system is to verify the optimization model and verify whether it can solve relevant problems. The design took into account the usage habits of the system administrators and decided to move the web data presentation to the forms application to increase the system friendliness.

In the optimization model of wind power prediction system, the function of data simulation is added, including real-time data simulation and meteorological data simulation. The time unit of real-time data is set as sub-15s, and the time unit of meteorological data is set as sub-3hour. The same is true for prediction algorithms. Data presentation is presented as a table in a Windows Form.

The key function of the model is divided into two parts. One part is the scheduling module, which can also be called the detection module. The main function is to detect whether each function module is in normal operation, and when it is found that a certain module is not in normal operation, it can timely adjust the running state of relevant modules and release system resources. The other part is the alarm module, which is mainly in the form of reminding in the data display interface.

For users, the main functions include basic registration, login, password modification, simulation data, data collection, power prediction, power query, module scheduling and other main functions.

4.2. System architecture design

This paper focuses on the system design of wind power prediction system optimization model [7]. It mainly analyzes the function structure and system architecture.

![Function structure diagram of optimization model of wind power prediction system.](image-url)

**Figure 1.** Function structure diagram of optimization model of wind power prediction system.
Data simulation: including real-time data simulation, meteorological data simulation two parts of the function.

Real-time data simulation: simulation is the wind farm sub-15 real-time data. Considering the characteristics of the model demonstration, only one /15 second simulation is done here, and the simulation data only includes wind speed.

Weather data simulation: the data type is the same as the real-time data, only the instantaneous wind speed is simulated, and the instantaneous wind speed is simulated every 15 seconds in the next three hours.

Real-time data acquisition module: considering the time cost and the simplified demonstration function of the model, the data acquisition method from the data source table is directly adopted to simplify the acquisition process. Acquisition frequency is per second /15 seconds. When the collection result is continuously empty to a certain number of times, the real-time data acquisition module will actively reduce the collection frequency.

Weather data acquisition module: sleep for 3 hours after a successful collection from the weather data source table. If a collection fails, a collection attempt will be made every 15 minutes. After a certain number of consecutive failures, the meteorological data acquisition module will actively reduce the collection frequency.

Real-time power: in the model, the real-time wind speed is directly converted into real-time power through the real-time power comparison table.

Super short-term power prediction module: the commonly used prediction methods in the actual production process include: statistical prediction method based on deterministic timing model and prediction method based on intelligent class model. The prediction interval is also sub /15 seconds.

Short-term power prediction module: short-term power prediction mainly relies on the weather data provided by the local meteorological bureau in the next few days for power prediction. In the model, for the sake of simplifying the workload, the short-term power prediction is carried out in the form of wind-power control.

Module scheduling: check the normal operation of each module regularly, and write a scheduling log and reduce the running frequency if any exception is found. Every once in a while, the detection module will detect whether the abnormal module is restored, and cancel the scheduling exception if it is restored. Otherwise, the system alarm will be conducted through the alarm module.

Data presentation: for the convenience of the model's presentation features, the power data is visualized in the Form of Windows Form. The data to be displayed mainly include time, real-time power, ultra-short-term power and short-term power.

Alarm message: alarm message is reminded in the data display window by the delegation module scheduling module [8].

Among common architecture for deployed wind forecasting systems, real-time data acquisition module, meteorological data acquisition module and ultra-short-term power prediction module are marked with orange. Short-term power prediction module is a module that often produces abnormalities and crashes in the actual production process, which is a weak link in the system. This optimization is also carried out around these modules. The optimization model mainly adopts the system architecture optimization technology, which mainly supervises the unstable module through the operation of the supervision module. The optimization model will alert the alarm information through the alarm window. The modules marked with green are newly added modules after optimization, which mainly function as module scheduling, alarm information acquisition and prompt. Among them, module scheduling spans the data source, data acquisition layer, data processing layer and data display layer, belonging to a comprehensive module that mainly plays a scheduling role.

5. Conclusion
In general, this paper analyzes the performance of the existing wind power prediction system and finds out the problems that affect the smooth operation of the system. By consulting relevant materials, constructive optimization Suggestions are given for each problem, and finally a set of optimization
solutions are given. To be clear, the actual production environment of the wind power prediction system is a very complex environment, and many factors can affect the smooth operation of the system. Therefore, it also determines that improving the stability of the system is a long process.

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