Research on Electric Micro-Meteorological Monitoring and Early Warning System

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Abstract: This paper studies and analyzes the influence of micro-meteorological disasters on power system, points out the main problems in the establishment of power micro-meteorological monitoring and early warning system, puts forward the system architecture of power micro-meteorological monitoring and early warning system, which provides a reference for the establishment of power micro-meteorological monitoring and early warning system.

1. Introduction

Electric power is an important basic industry and public utility related to national economy and people's livelihood. Safe, stable and sufficient power supply provides an important guarantee for the healthy, stable, sustained and rapid development of China's national economy. However, in recent years, the number of natural disasters has increased significantly, which has seriously affected the power grid system. Based on the analysis of all kinds of meteorological disasters affecting the power grid, there are a large number of micro meteorological disasters, such as local high wind, ice cover, fog, high and low temperature, heavy precipitation, sand dust, debris flow and so on. Such micro meteorological disasters have a wide range of impacts on the power grid and do great harm. In order to reduce the loss of power system caused by micro-meteorological disasters, it is necessary to establish a micro-meteorological monitoring and early warning system to realize the monitoring and early warning of power micro-meteorological disasters. This paper introduces the current situation of micro-meteorological disaster monitoring, analyzes the main problems in the construction of micro-meteorological disaster monitoring and warning system, and puts forward the framework of power micro-meteorological monitoring and warning system.

2. Research status at home and abroad

2.1. Study on transmission line galloping

Since the 1930s, foreign scholars have carried out field observation, wind tunnel experiment and theoretical research on conductor dance, and put forward Den Hartog vertical dance theory, o.nigol torsion dance theory, gust-induced dance theory and other dance theories. Aimed at DenHartog dancing and o.ngol twisting dancing and based on the principle of fluid mechanics, foreign researchers

changed the shape of the wire and aerodynamic characteristics, avoided conditions of wire dancing , causing a very good windproof effect.

In China, the research on wire galling of power grid started late, and the important achievement of anti-galling technology is the development of double pendulum anti-galling device and eccentric heavy hammer according to the mechanism of dynamic stability.

2.2. Research on transmission line icing

Based on years of meteorological observation data in the United States, combined with the guidelines for circuit design, the maximum annual wind speed and ice thickness are calculated by using the extremevalue distribution model. Then appropriate adjustments are made according to local meteorological environmental conditions, and the local direct observation data are used for verification, providing reference for power grid planning and design.

China has carried out a lot of research on the prevention and early warning of grid ice disaster. The project of "key technologies and complete sets of equipment for the prevention and treatment of large-scale grid ice disaster" organized by state grid corporation of China won the first prize of national science and technology progress award in 2013.

2.3. Pollution (fog) hazard study

In the 1970s, foreign countries began to study the remote sensing monitoring of fog. At that time, it was mainly carried out by using meteorological satellites, and good results were achieved. At present, a set of basic research algorithms has been formed, and these research results will play a role in promoting the introduction of remote sensing technology into power disaster prediction.

Of pollution flashover disaster research in China since the 1980s, related research design salt density, grayscale and impurity distribution dc pollution flashover characteristics of large-tonnage porcelain insulator and the influence of the fringe spacing of double parallel insulator pollution flash-over characteristic, the influence of and focus on leakage current measuring system is developed, a variety of suitable for transmission line insulator leakage current test system, the different characteristics of leakage current were studied.

2.4. Study on dust hazard

Since the 1970s, foreign countries have carried out studies on monitoring sandstorms with satellite remote sensing technology, such as monitoring the sand and dust over land and water by using visible and infrared bands of satellites. These work effectively monitored the occurrence and development of sandstorms and provided support for mastering their rules.

Domestic research on remote sensing monitoring of sandstorm satellites mainly uses the multi-channel data of NOAA/AVHRR, a polar orbit meteorological satellite, to distinguish sandstorm targets. In recent years, it is a relatively new research method to display the occurrence, development and transmission of sandstorms by using high resolution digital data of static meteorological satellites and low resolution simulated cloud images, and combining the main characteristics of sandstorms on cloud images with GMS data.

3. Main problems and research plan

3.1. Major problems

3.1.1. It is difficult to analyze the law of micro-meteorological disasters

The principle analysis and rule summary of micro meteorological disasters are based on the field monitoring data. Due to the small scale of micro meteorological disasters such as high wind, dancing and icing, they are easy to occur in the field, and the lack of monitoring data makes it difficult to analyze the principle and rule of micro meteorological disasters. Therefore, it is necessary to comprehensively investigate and analyze the whole network cases, combine the research results of

power system and meteorological department in micro-meteorology, and effectively apply the data of meteorological observation stations near the disaster site, satellite and radar data for comprehensive induction and analysis.

3.1.2. Lack of standards for classification and early warning of micro meteorological disasters
The cause of power micro meteorological disasters is complex, which is the result of the joint action of various micro meteorological disasters. It is necessary to make an in-depth analysis of the climatic, geographical and micro-environment that causes disasters. In combination with the characteristics of disaster classification, causes and meteorological elements, the paper focuses on the analysis of the impact on power system personnel, equipment, important plants and users, and combines with the weather-changing trend to form disaster classification and early warning standards.

3.1.3. It is difficult to study the early-warning model of micro-meteorological disasters
In order to establish an early-warning model of power micro-meteorological disasters, the climatic and geographical environment, historical data of previous disasters, distribution rules and characteristics of existing monitoring stations, data of meteorological service departments and other conditions must be taken into account in a comprehensive way. In addition, the micro-meteorological scale is small, and it is difficult to monitor. The reasons for the formation are complex, and the climate and geographical environment are diverse, making it difficult to study the early-warning model of micro-meteorological disasters.

3.2. Proposed research scheme

3.2.1. Analysis of regional laws of micro-meteorological disasters
By collecting and sorting out the historical data of meteorological disasters and investigating the natural environment where micro-meteorological disasters occur, the characteristics of natural environment prone to micro-meteorological disasters are summarized. The power system faults caused by micro-meteorological disasters were investigated, the causes and effects of power system faults caused by micro-meteorological disasters were analyzed, and the micro-meteorological disasters were classified and correlated with the natural environment parameters of the disaster place, so as to summarize the natural environment characteristics and disaster types of the disaster place. Through the investigation and analysis of the substation natural environment and transmission line natural environment, the micro-meteorological disaster area is classified and the key monitoring area of micro-meteorology is determined. According to the micro-meteorology and micro-topography characteristics of a specific region, the regions prone to transmission line icing, dancing, breeze vibration, pollution flash-over and other accidents, namely the ice-covered area, dancing area, breeze vibration area and pollution flash-over area, can be used as key micro-meteorological monitoring areas.

3.2.2. Study on formation principles and early warning standards of micro meteorological disasters
Firstly, based on the cases of the whole network and the previous achievements, this paper makes an in-depth analysis or assessment of the climatic and geographical phenomena or micro-environmental phenomena formed by power disasters such as high wind, dancing, ice, pollution (fog) and conventional disasters such as high and low temperature, heavy precipitation, sand dust and debris flow that have an impact on power in recent years. Secondly, the classification of micro-meteorological disasters and the causes of disasters are analyzed in depth and in detail. Combined with the characteristics of meteorological elements, a more comprehensive rule relationship is summarized according to the trend of weather changes. Finally, the classification and warning standards of micro-meteorological disasters are further improved.

3.2.3. Research on micro-meteorological disaster warning model and data processing mode

The multi-dimensional technical and economic comparison scheme based on economic and social aspects is studied, and the technical and economic indicators of power grid micro-meteorological monitoring and warning are comprehensively analyzed. For different micro-meteorological disasters, the applicable calculation methods and prediction models of early-warning data are studied. For the key disaster area, this paper studies the method of revising the forecast model of the key disaster area by combining the monitoring data of the power grid weather station. In the process of establishing power micro meteorological disaster warning model, the data exchange and sharing between power grid and meteorological service departments is of great importance, and the channel mode of data sharing between power grid and meteorological service departments is studied, as well as the method to guarantee the security of data transmission and transformation and the timeliness of application. The research implementation scheme adopted by the system is shown in figure 1.

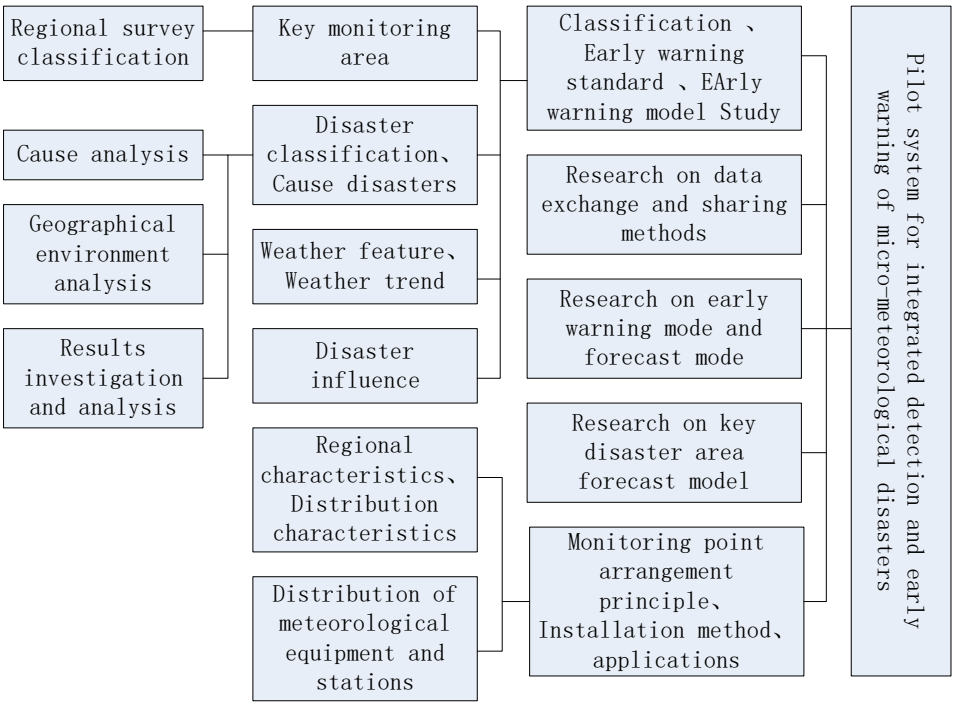

Figure 1. System research implementation plan diagram

4. Discussion on the construction of power Micro meteorological monitoring and early warning system

The architecture of power micro meteorological monitoring and early warning system is shown in figure 2. Based on layering country or industry standards, to all grid information in the form of object-oriented description, take into account synthetically the attribute of all equipment in the power grid type, behavior, power characteristics and constraint rules, relationships, and so on, the corresponding object model was constructed after the abstraction, based on uniform grid object model, follow the technology system of desktop applications and Web applications. In terms of design, it emphasizes openness, secondary development ability and industry application support ability, and supports application integration of C/S and B/S modes. Provide COM interface, JAVA components, Web Service, Flex components and other interfaces, using the componentization, dynamic, service-oriented design idea, according to the data layer, component layer, application layer, business layer for multi-layer architecture design. It mainly has the following functions:

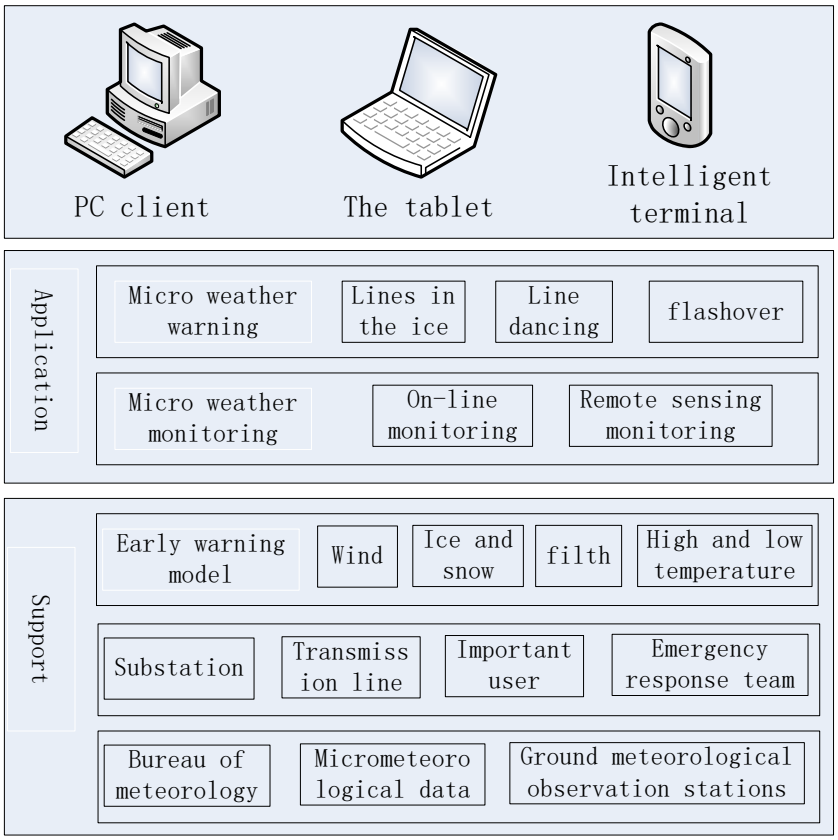

Figure 2. System architecture model diagram

1) Real-time weather monitoring and warning for power grid

Combined with power grid GIS platform to deepen the application, thereal-time meteorological data of meteorological stations in power grid GIS platform and transformer substation, and tower, such as vector data overlay can be real-time control substations and transmission corridor near the temperature, wind direction, wind speed, relative humidity, rainfall intensity, surface pressure, visibility, such as meteorological monitoring information, provide intuitive real-time meteorological data grid at the same time, provide the above factors in the past 24 hours to the evolution of the curve, the understanding of weather the influence law of evolution of power grid operation.

2) Real-time meteorological monitoring threshold alarm

The meteorological warning thresholds of high temperature, low temperature, high wind, heavy rain, high humidity and heavy fog are preset by using real-time meteorological monitoring information and combining with the actual distribution and operation requirements of the power grid.When the threshold meteorological conditions are reached, the automatic warning is given by rolling subtitles, which is conducive to timely grasp the trend and research of the influence of weather on power grid.

3) Professional meteorological monitoring, analysis, forecast and early warning

Provide the forecast information of wind speed, wind direction, maximum temperature, minimum temperature and weather phenomenon within 7 days by 12 hours, as well as the warning information of typhoon, rainstorm, blizzard and other meteorological disasters. Provide short time near the weather forecast, short-term weather forecast, medium-term aim of weather forecasts, weather forecast, the important weather forecast, early warning of geological hazard meteorological risk grade, level of forest fire danger weather warning, meteorological disaster warning signals, etc., at the same time can provide early warning and emergency state meteorological department within the professional use of the next 24 hours of wind direction, wind speed, temperature, humidity, rainfall, precipitation type, such as visibility forecast.

4) Refined meteorological element forecast

Relying on the moderate-scale numerical model system, to specify the substation, power lines and other facilities near the next 24 hours high space-time resolution ground wind direction, wind speed, temperature, humidity, precipitation, precipitation type, visibility weather elements such as field and related physical quantity, updated once every three hours, the highest time resolution for 1 hour, the highest spatial resolution 4 km along the refinement of the analysis and forecast early warning.

5. Conclusions

This article focused on micro meteorological disasters' influence on power system and analyzed the present status of research, on the basis of the analysis of the micro power meteorological disaster monitoring and early warning of problems, put forward the research plan of power micro meteorological disaster monitoring and warning system. Micro meteorological disaster monitoring and early warning system for power construction were discussed in this paper, which can be used for reference when building power micro meteorological disaster monitoring and early warning system.

Acknowledgments

The project is State Grid co., LTD. Technology project funding：Analysis of typhoon disaster loss prediction and response technology research of power grid. The global energy Internet research institute co., LTD. is responsible for the project. Under the support of information communication institute mainly analyzes the micro meteorological disasters on the impact of the power system, and points out the main problem, put forward the micro meteorological monitoring and early warning system of electric power system architecture, in order to establish power micro meteorological monitoring and early warning system to provide the reference.

References

[1] Zhang Xian. Mechanism and countermeasures for ice-coa-ted transmission line in micro-terrain and microclimate region[J]. Power System Technology,2017,31(S2):87-89.
[2] Li W, Zhou J, Xie K, et al. Power System Risk Assessment Using a Hybrid Method of Fuzzy Set and Monte Carlo Simulation[J]. IEEE Transactions on Power Systems, 2016, 23(2):336-343.
[3] Xiao F, Mccalley J D. Power System Risk Assessment and Control in a Multi objective Framework[J]. IEEE Transactions on Power Systems, 2016, 24(1):78-85.
[4] Feng Y, Wu W, Zhang B, et al. Power System Operation Risk Assessment Using Credibility Theory[J]. IEEE Transactions on Power Systems, 2015, 23(3):1309-1318.
[5] Liu X, Shahidehpour M, Li Z, et al. Power System Risk Assessment in Cyber Attacks Considering the Role of Protection Systems[J]. IEEE Transactions on Smart Grid, 2017, 8(2):572-580.
[6] Hasan K N, Preece R, Milanovic J V. The Influence of Load on Risk-based Small-Disturbance Security Profile of a Power System[J]. IEEE Transactions on Power Systems, 2017, PP (99):1-1.
[7] Merrill H M, Wood A J. Risk and uncertainty in power system planning[J]. International Journal of Electrical Power & Energy Systems, 2016, 13(2):81-90.