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LIGHTING AND CONTROL DESIGN OF LARGE-SCALE STADIUM SKATING COMPETITION

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ABSTRACT

In order to further improve the synchronicity of stadium lighting, this paper puts forward a design and analysis model of lighting and control for large-scale stadium skating competition. In this paper, the development and mode analysis of lighting system based on micro-grid control are introduced. Then, in the process of analysis, the research model of circuit automatic control for micro-grid control is designed, and the algorithm is used to assist it. Finally, the simulation system is used to test the synchronization of the micro-grid controlled lighting system. The results show that virtual synchronous machine technology can significantly improve the coordination and synchronization of lighting system, and further reduce circuit failures, ensure the smooth lighting of stadiums, and have a good development prospects.

Keywords: micro-grid control, stadium, lighting, control design, system simulation

1. INTRODUCTION

With the continuous progress of social production, people's lives are more and more inseparable from the power industry. People's dependence on electricity is also getting stronger and stronger [1]. However, the complexity of the stadium lighting micro grid system makes people pay more attention to the synchronization of power consumption. According to the voltage of electricity consumption: medium voltage line, between the high and low pressure, the general voltage amplitude between 10 KV to 30 KV [2]. Compared with the high voltage line, the distance between the medium voltage line and the high voltage line is shorter, mainly for the large industrial area; low voltage lines, which mainly use stadium facilities themselves, generally do not exceed 500V. Most of them are controlled by micro-grid [3]. In the micro-grid control mode, the normal operation of venues and facilities is affected because of the numerous and miscellaneous facilities, and the corresponding circuit and system mode often appear. Therefore, in recent years, with the continuous development of micro-grid controlled lighting engineering system, people realize the importance of lighting engineering system based on micro-grid control, and the development of automatic control system has achieved initial results [4]. But on a large scale, the lighting engineering mode controlled by micro-grid is still in the exploratory stage in our country. In many places, there are still unreasonable electricity consumption and high mode rate. Therefore, the lighting and control design analysis system of large-scale skating stadium has been put forward, which has a positive role in reducing the mode rate of power consumption, improving the synchronization of power supply and enhancing the overall service capacity [5].

2. STATE OF THE ART

Although the development of illuminated mode detection system in China started late, after more than 10 years of exploration and development, the gap between the mode detection and inspection technology of high voltage line system and

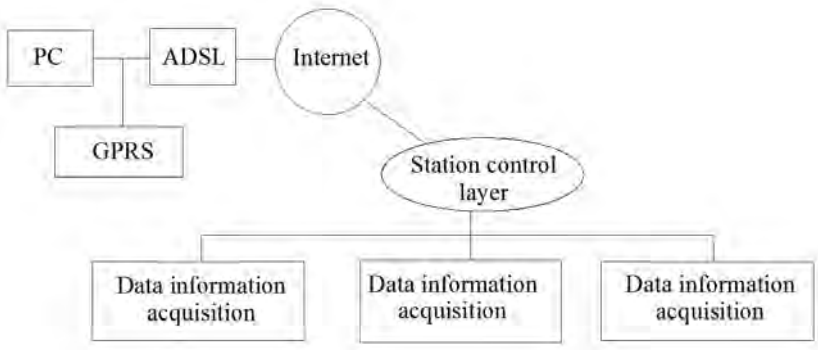

Fig.1. Structure diagram of photovoltaic monitoring system

foreign countries has been narrowed. However, it should be recognized that the research on lighting system mode controlled by micro-grid is still in a backward state, based on the huge population base and relatively backward scientific and technological level in China [6]. Many individual venues and facilities in the process of automatic control, which is rely basically on simple meters, and it is difficult to find control mode effectively [7]. In the overseas automatic control of lighting system, the more advanced intelligent mode is combined, which can give a certain warning to the appearance of the mode. After the appearance of the mode, the source of the mode can be found in the first time. It has greatly facilitated the operation of venues and facilities [8]. In recent years, the national government has also realized that besides the high voltage system, the improvement and construction of the medium and low voltage system is the fundamental to improve the satisfaction of venues and facilities and to solve the problem of high mode rate [9] China's Beijing, Shanghai, Shenzhen and other developed areas, advanced computer technology has been used in the management of low-voltage lines, greatly improving the management efficiency and reducing the occurrence of the mode. However, due to the imbalance of regional development in China, the lighting engineering system model based on micro-grid control in China is not perfect and mature [10]. There are still some problems, such as low automation, inadequate real-time supervision of electricity consumption, inadequate supervision and investigation of modes. Therefore, it is necessary to explore the mode of lighting system in sports venues controlled by micro-grid [11].

3. METHODOLOGY

3.1. Design Concept and Principle of Lighting System for Stadium Skating Competition

In sports venues, the demand for electricity is high and widely distributed [12]. Firstly, the object of study is micro-grid control [13], so from the point of view of virtual synchronization, a real-time control and detection system is designed based on General Packet Radio Service technology. With the development of modern communication technology, the transmission and analysis of power consumption data can be accelerated. After the information collection is completed, the data in the process of power consumption can be detected in real time by using the powerful information processing capability of the terminal. The equipment mainly includes plug-in box, transformer and power output switch lamp. The twisted pair transmits the centralized data of the equipment to the field trunk line, then the fibre ring network receives the data of the communication unit, which is pre-processed and the

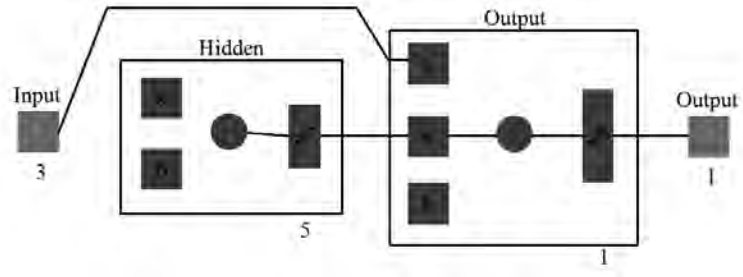

Fig.2. Monitoring system of Lighting Power Generation system

multidimensional conversion. The system is composed of three parts, as shown in Fig. 1.

As shown in Fig. 1, the top layer is the central layer, the brain of the entire system, which is responsible for regulating the entire system. The supervision of the whole lighting system is mainly applied in the central layer. The lowest layer is the equipment layer, which is mainly for data acquisition. For example, the current temperature of the line and the amount of power generated need real-time measurement of the equipment layer. According to the relevant data analysis of the most intermediate station control layer, it is mainly a data transmission centre, similar to the construction of the Broker. The information collected at the device layer can be fed back to the central layer through simple processing, or the commands placed at the central level can be transferred to the device Layer. Among them, the central layer and the station control layer use optical fibre lines. Because of a large amount of information transmission, Personal Computer intelligent instructions can be applied to the central layer, the central layer as the core of data processing. Through the application of the system, human and material resources will be greatly saved, and the relevant personnel only need to control the central level of data management. In the research process of the system, the design of the system contains three important steps. The first is the information collection phase. Since the design of the system is aimed at controlling and checking the power consumption of venues and facilities, the management requirements of venues and facilities should be collected and analyzed in the process of information collection. In addition, it is a functional analysis of products, which involves research and analysis of classic venues and facilities. The third stage is the integration stage, which mainly integrates the collected information and reflects the implementation of the feedback mechanism. The preliminary process design is as shown in Fig.2.

In the process of running the system, the corresponding principles must be met: First, the principle of real-time, facilities on the monitoring of electricity consumption, the transmission of electricity in a state of change at all times, which requires the establishment of a regulatory system should contain a large number of data analysis plates. Secondly, the principle of accuracy is different from the complexity of other multi-functional systems. From the point of view of venues and facilities, venues and facilities are sure to want to control the more accurate the detection of the better, can quickly take the right measures for control. Thirdly, the principle of rapidity is that the feedback mechanism of the system should start to operate as soon as the control is detected. Because the system is cyclic, regulation is a continuous process, if there is no timely data transmission, it is likely to lead to a link can't be carried out.

3.2. Design of Synchronization System for Lighting Engineering Based on Micro-grid Control

In sports venues, the system needs to collect basic data, and it needs to measure the effective value of data. Using the system, the direct ratio between *U* and *I* is adopted in the measurement of voltage and current in the line, where *U* represents the real-time RMS of voltage, *I* is the RMS of current, i is the instantaneous value of current, u is the instantaneous value of voltage. The stability of *U* and *I* is verified by substitution of corresponding formulas. After the valid voltage and current values are obtained, the data should be converted into corresponding digital signals for data processing. It can be seen that in order to maintain the accuracy and accuracy of data conversion, it is necessary to synchronize the acquisition information to prevent the mutual change of current and voltage from affecting the accuracy of detection. According to the sampling theorem, the higher the sampling frequency is, the more complete the analogue signal can be restored. However, in practical design, the sampling frequency will be affected by capture time, A / D conversion accuracy, Central Processing Unit speed, the sampling frequency can't be too high. The rationalization frequency should be worked out according to the actual needs of the line, rather than the pursuit of sampling frequency. The following formula is for the calculation of charge amount for large stadium power supply technology, as shown in the following formula:

$$\sum_{i \in A} P_{Gi} - \sum_{j \in A} P_{Li} - P_{loss} > \varepsilon. \tag{1}$$

Dijkstra algorithm is used to calculate the quantity of charge with negative weight. For solving the problem of negative weight in the model, the defi-

Table 1. Computer Aided Lighting System Design Hardware

Project	Hardware constitution	The main influencing factors of the system energy
Graphics workstation	Professional graphics cards	Memory, hard disk
Collaborative design system	Data transmission line	Network status
VR system	Excellent integrated display	Data acquisition
Microcomputer	A central processor	Graphics accelerator card

nition of safety factor shows that it is advantageous to the safety factor F_s.

$$F_s = \sum \tau_f / \sum \tau. \tag{2}$$

Since all anti-sliding forces are positive, if one sliding force is negative, it is equivalent to making the denominator smaller, so the safety factor will increase. So for module overlap, it is beneficial to deal with it. Define the size relationship as follows:

$$F_s(P) - F_s(P') = \frac{a+c}{b+d} - \frac{a+e}{b+f}. \tag{3}$$

If the formula holds, then $\left(P'\left(v_s, v_j\right)\right)$ can be deduced as the shortest path by the method of counter-proof, and the problem can be transformed into a mathematical expression as follows:

$$F_s\left(P'\left(v_s, v_j\right)\right) = \frac{\tau_f(Q) + \tau_f\left(v_i, v_j\right)}{\tau(Q) + \tau\left(v_i, v_j\right)}. \tag{4}$$

It is very difficult to satisfy the power supply, because if there is an edge, its safety factor is relatively small, but its position is far from the shortest path, the shortest path will not pass.

$$F_s\left(P\left(v_s, v_j\right)\right) = \frac{\tau_f(Q) + \tau_f\left(v_i, v_j\right)}{\tau(Q) + \tau\left(v_i, v_j\right)}. \tag{5}$$

Second, the hardware and software requirements of the Personal Computer terminal should also be taken into account. The application of new technology requires a certain degree of detection performance. Because the system has the corresponding graphics, video and other integration and output functions, its configuration as is shown in Table 1.

In Table 1, it can be seen that the operation of a good system improves the configuration of the computer to a certain extent, which not only has a certain technical advantage in the graphics processor, but also in the coordination of network patency. In the aspect of regulating system, higher configuration requirements are put forward to the computer, which not only considering the accuracy of data processing, but also considering the surrounding environment. Finally, based on the addition of General Packet Radio Service module technology, a benign system cycle requires timely information exchange between facilities and systems. The first is the control and monitoring of the whole line. Before the Internet has been put into practice, many electric facilities can only receive rated power. Once the control occurs, it is impossible to adjust the voltage quickly and autonomously, resulting in further expansion of the control. Secondly, due to the lack of a corresponding rapid adjustment range, so many times there will be an embarrassing situation of power failure. Under such circumstances, it is urgent to deal with the intellectualization of power generation and supply. Based on the above design ideas, for the power generation system, the following

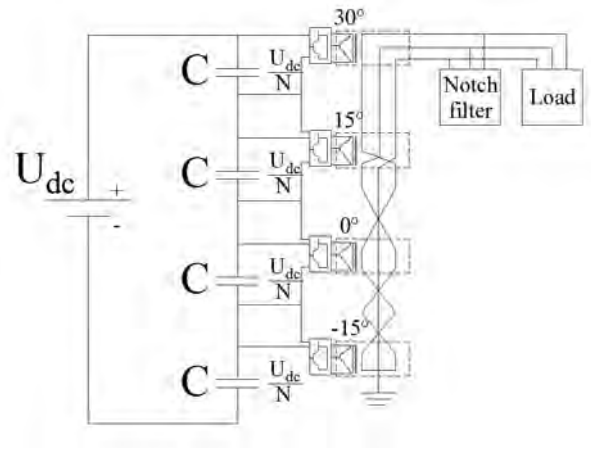

Fig.3. Optimization of communication structure of monitoring system for stadium lighting

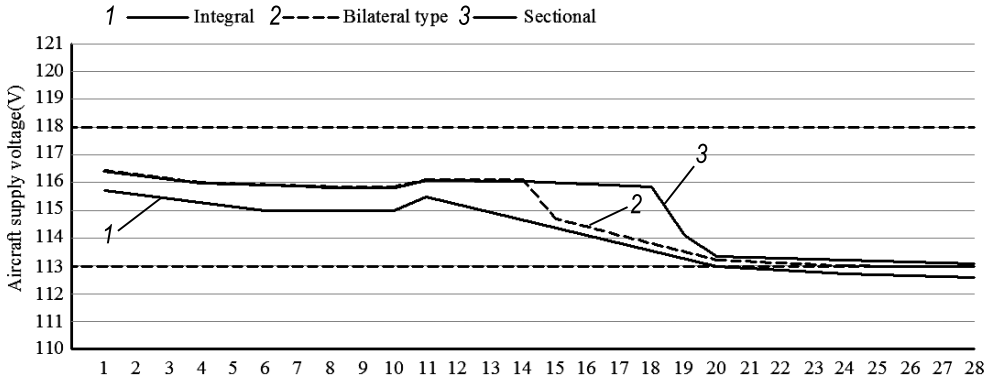

Fig.4. Comparing experimental results versus graphs

is the main idea, as shown in Fig. 3, In this mode, it is found that the line appears to be controlled, the order is issued through the venues and facilities, the General Packet Radio Service touch-board is used to reach the service terminal on the spot, the simple information processing is interrupted, the line is fed back to the multi-function meter, and the multi-function meter influences the transmission of the transformer to complete the control of the power generation system. This transmission mechanism is bidirectional, so in the process of venue facilities to manage the power generation system, the data will be updated in real time, greatly reducing the possibility of control. The detailed drawing is shown in Fig.3.

With the continuous development of intelligent detection, its data processing ability in the circuit system is no longer the same. After the process of the whole system is clear, it is necessary to perfect the control data model with the corresponding auxiliary technology, so that the venues and facilities can participate in the actual control improvement. In the previous article, the establishment of the feedback system of the whole line is improved, and then through the development of wireless technology and Internet technology, venues and facilities can be managed by themselves using the Internet. This model is mainly related to the establishment of facilities and the central level between the relevant links. The original line system monitoring is transmitted to the Internet in real time, and then the Internet is used to directly provide feedback to the monitoring. Each facility has an independent account that can be monitored remotely. The facility then has the right to supervise on-site and in-station monitoring. It can use its own needs to change the mode of power consumption at any time and enable intelligent self-regulating circuit control.

4. RESULT ANALYSIS AND DISCUSSION

After the completion of the research and design, in order to verify the feasibility of the theoretical design, the corresponding experimental tests are carried out on the system. In the exploration of specific applications, a real lighting micro net system is selected for performance testing. In the control and detection system of the original venue lighting micro-grid system, because most of them are manual investigation, the work efficiency is low, and each time the control and inspection can't be completely improved, and the actual effect is quite different.

Table 2. Steady-state Experimental Data of Lighting System Control for Stadiums

Reference value /V	Actual output value /V	Steady difference /V	Steady-state error/%
200	241	3	1.45 %
300	423	5	4.33 %
400	124	4	6.75 %
500	566	9	7.2 %
600	133	14	4.87 %
700	556	15	7.57 %

Table 3. List of Common Emotion Research Directions

Project	Total survey	Number of failures	Other factors interference	Failure rate
Experience group	1000	2	0	0.2 %
Control group	1000	20	0	2 %

After using this system, the system first collects the data of the whole venue lighting micro-grid system. According to the real-time power consumption status provided by each venue facility, the corresponding stadium lighting balance adjustment is made, the voltage and current and the adjustable amplitude are normalized, and the possible control according to the abnormal processing of the circuit. With the introduction of this system, the company's control, investigation and testing system has been on the road of automation and information in a relatively short period of time.

As shown in Fig. 4, this is the real-time operation of the line after the completion of the information collection. In the past, the line statistics can only be distinguished by normal and abnormal. In this line statistics, both the overall operation of the line, as well as the real-time voltage, current maximum and minimum fluctuation range, the traditional line detection is difficult to achieve comprehensive coverage. In the analysis of the system, the possible risks are estimated, which indicates that there is a strong early warning capability. When the control occurs, even the fastest remedy will affect the normal operation of the whole line, but the early warning mechanism will reduce the possibility of runaway, while ensuring the continuous and stable operation of the whole line. In addition, based on its huge database function, every real-time data can be saved in time. The investigation of historical control can greatly reduce the likelihood that the same control will occur again and greatly reduce the difficulty of work. Traditional workers often need a few days to check and control. After the application of the lighting engineering system control system controlled by micro-grid, the accuracy and efficiency of the control check-up have been greatly improved. The result data of the power system using the algorithm are shown in Table 2.

The Table 2 shows the power supply technology using the new algorithm. The data show that the efficiency of power transmission has been significantly improved and the efficiency of oil resources exploitation has also been significantly improved after the application of the new algorithm.

In order to prove the specific performance of the system, through the application of the lighting engineering system controlled by micro-grid in large stadium, the feasibility of the system is explored in detail. A comparative study of traditional lighting engineering system control and exploration system based on micro-grid control is organized. A total of 2000 venues and facilities controlled by micro-grid in a large stadium are selected as the experimental subjects and divided into control group and experimental group according to the situation. 1000 people in the experimental group adopted the control and management mode of lighting engineering sys-

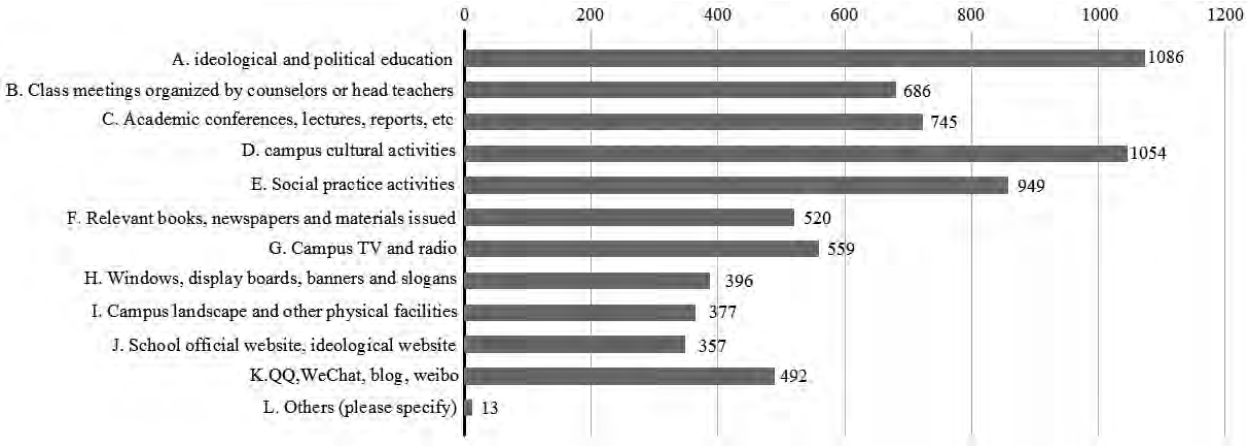

Fig.5. Synchronization test of lighting system controlled by micro-grid circuit system

tem proposed by this time, and 1000 venues and facilities in the control group adopted the traditional control and management mode. In order to study the stability and practicability of the system, it is decided to take the control in the process of power consumption of venues and facilities as the object of study. In order to improve the accuracy of the experimental data, the investigation time is set at the peak of electricity consumption. The control occurrence rate of the experimental group and the control group is compared between 7:00 and 9:00 in 10 days. The findings are shown in Table 3.

Through the detailed analysis of Table 2, it can be seen that the control rate of the experimental group is 0.2 % and that of the control group is 2 % after adding the computer supervision mode and excluding other interference factors. By comparison, the control rate of the venues and facilities in the process of power consumption is significantly reduced, which also shows that the system has a strong function of adapting to the environment and can play a good role in different environments. The whole research shows that the control of lighting engineering system based on micro grid has strong feasibility, Fig. 5.

The system can find out the control of the circuit more easily and quickly, and make the early warning and the corresponding investigation at the first time when the control occurs. The application of this system makes the whole regulation only need 3–5 cycles of coordination work, the number of cycles is greatly reduced, thus improving the work efficiency and speeding up the repair time of the line. In addition, the speed of each coordination work is also increased, saving money and reducing rework. However, this survey did not involve the application in a special environment, so there is a certain flaw in the comprehensive investigation. In future tests and research, emphasis will be placed on the application of the system in special environments.

5. CONCLUSION

With the development and application of information technology in gymnasium lighting system in China, the lighting engineering system controlled by micro-grid has a great prospect in large-scale skating competition. Therefore, the application of virtual synchronization technology in micro-grid control of stadium lighting micro grid system is put forward. The proposed system model is conducive to the realization of the optimization of lighting power lines, the safety of lighting power is improved, and the ability to check the synchronous control of lighting is increased. Considerable results have been achieved in the actual stadium lighting system test. In order to further verify the feasibility of the system, the effect of the application of the control system in lighting engineering system is explored. In order to further verify the performance of the system, the synchronous control processing of large stadium circuit is studied. By comparing the synchronization control rate of the traditional mode, it is found that the synchronization control rate of the large-scale stadium is only 0.2 % after adopting the control system, but in the traditional mode, the synchronization control rate of the line is 2 %. By comparing, it is found that the lighting and control system of the large-scale stadium skating competition has very strong function. However, this test has some flaws in the comprehensive investigation. In future tests and research, emphasis will be placed on the application of the system in special environments.

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