Design and Research of Airfield Navaid Lighting Monitoring System Based on Data Mining Algorithm

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Abstract. Navaid lighting system is an important visual navaid to ensure the flight safety of aircraft, and plays a key role in the process of aircraft approach and landing. The normal operation of the navaid lighting system is directly related to the safety of aircraft takeoff and landing, so it must always work normally. With the rapid development of civil aviation industry, the original manual inspection method of navaid lighting can not meet the requirements. It has become the basic requirement of the navaid lighting system to automatically monitor the navaid lighting equipment and improve the reliability of the navaid lighting system. The design and research of airfield navaid lighting monitoring system based on data mining algorithm is a project involving the design, development and implementation of airfield navaid lighting monitoring system. For the sake of safety, NAV light monitoring system will be designed to monitor all lights in the airport. It can also detect any abnormal light patterns or light pattern changes, which may indicate a possible problem with one or more navigation lights. This helps the airport authorities to take immediate action before any problem occurs with one or more navigation lights, thus preventing accidents. Design includes designing a software.

Keywords: Airfield navaid lighting · Data mining algorithm · monitoring system

1 Introduction

Airport navaid lighting, poor visibility or navigation signal engineering facilities on the runway at night to provide visual guidance; In the past two decades, the airport navaid lighting system has generally adopted two ways of power supply: first, it is connected by parallel power lines, that is, the power lines are directly placed in the middle or both sides of the airport runway, and the airport navaid lighting is connected to two lines on the power supply, one is a high-voltage line, the other is a zero voltage line [1]. This wiring method is cheap and easy to increase or reduce the load; The second type is the series power mode, that is, no matter how many lights are connected in series, the navigation lights; In order to ensure that the open circuit lamp will cause minimum damage to the system, a bypass device is added and an isolation transformer is used; In order to supply

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power to the series circuit and in different circuits, a constant current dimmer (CCR) with constant current source must be added to ensure that the cable line passes through the same current [2]. The cost of modern airport navaid lighting system has increased a lot because of the addition of a large number of isolation transformers for navaid lighting (the number of isolation transformers is the same as that of navaid lighting), and the high price of constant current dimmers, However, the addition of these two devices ensures that the brightness of all bulbs on the same line is the same, and the light brightness can be adjusted from 1 to 5 levels according to different visibility conditions; The function of constant current dimmer (CCR) is to provide a stable signal source and can feed back according to the actual output current and voltage, and can quickly stabilize at a fixed current level. It exists as the "heart" of the aviation lighting system. It and other parts of the aviation lighting system, such as independent transformer room, diesel engine room, lighting cable, light box, isolation transformer, All kinds of navaid lamps together form the airfield navaid lighting system [3].

The constant current dimmer is the stable power supply of the airport navaid lighting system. It not only has stable output current, but also has adjustable output current. The constant current dimmer is a sign of the technical level of the whole airport navaid lighting system. A constant current dimmer with stable output, adjustable light level, rapid and accurate response plays an indispensable role in the safety and reliability of the whole airport navaid lighting system; In addition, the amount of navigation light cables used in the airport is nearly 46 km, 876 cable heads are made, 438 isolation transformers of various models and 438 navigation lights of various models, with a total power of 35300w [4]. Therefore, the cable heads, isolation transformers and navigation lights are introduced in detail; Based on foreign experience and taking a military standby airport in the east of Beijing as an example, combined with the actual construction situation of airport navaid lighting in China, this paper has achieved a stable and reliable navaid lighting system. The brightness of many navaid lights is consistent and adjustable, providing safe and reliable visual guidance to aircraft pilots during night flight and low runway visibility.

2 Related Work

2.1 Brief Introduction of Airport Visual Navaid Lighting System

During flight, the pilot can control the aircraft in two ways: using autopilot or manual control. Manual control is divided into two methods: one is to refer to the instrument panel, and the flight command instrument system makes some judgments for the pilot; The other method is to fully refer to the external world and make all judgments by using visual references. The latter method is based on sufficient visibility and clear horizon, which is called visual flight.

In visual flight, the most difficult task for piloting an aircraft is to judge the approach to the runway and the subsequent landing maneuver. At this time, the pilot must carefully control the speed and constantly make three-dimensional adjustments to track the correct course [5]. In order to achieve a smooth grounding, the speed and descent rate must be reduced at the same time in the "leveling" operation, so that the aircraft wheels just touch the runway when the wing stalls or is about to stall. After grounding, it is necessary to

estimate the length of the remaining runway, so it is necessary to get the prompt of runway exit position in advance. When leaving the runway, the aircraft must be parked in the apron correctly through the taxiway.

The research shows that the average time required for the driver to change from external visual reference to instrument, and then from instrument to external reference is 2.5 s. Since the high-performance aircraft will travel 150 m during this period, the visual aids should provide the maximum possible guidance and information under possible conditions, so that the pilot does not need to check his instruments when moving forward.

The requirements for navaid lighting include configuration, color, candelas, and coverage, which are referred to as four "C" for short. Configuration and color can provide important information for dynamic 3D positioning. The configuration provides guidance information, and the color tells the driver his position in the system. For example, runway edge lights, runway threshold lights and runway end lights belong to different types of configurations [6]. They are used to describe the location of the runway and provide guidance information for pilots. The pilot can judge the position of the aircraft in the system by observing the light configuration, color and color changes, and take measures to control the flight attitude. Candela and effective range refer to the characteristics of light that are very important for the normal play of the role of configuration and color.

The airfield navaid lighting system consists of five parts, including lamps (bulbs), isolation transformers, cables, step-up transformers and dimmers. The schematic diagram is shown in Fig. 1.

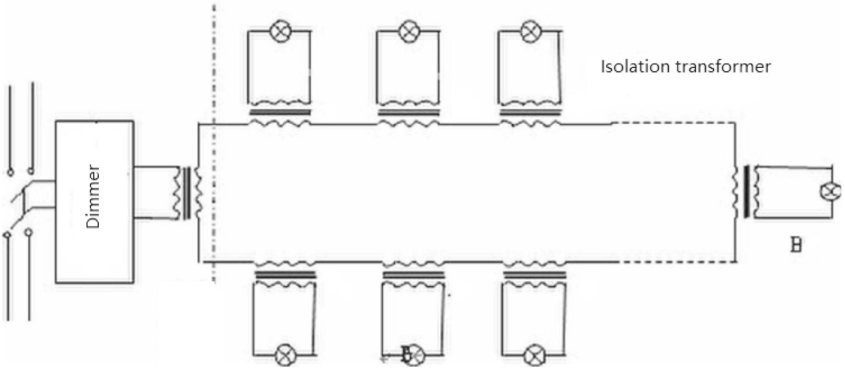

Fig. 1. Composition of airport navaid lighting system

2.2 Navigation Light Patrol Monitoring System

General medium-sized airports have more than ten circuits, including runway edge lights, runway center line lights, end lights, approach lights, slope lights, sequence lights, with a total of thousands of lights. Large airports have tens of thousands of lights. As the navaid lights are related to the safety of aircraft taking off and landing, the airport department requires the airport to inspect every day, and timely replace and repair the bulbs that are not bright or dim.

The navaid lights are distributed on the runway, taxiway and extension lines at both ends of the runway. There are many and wide points. It takes about 1–2 h for all small airports and 2–3 h for large airports. During the patrol inspection, the navaid light needs to be on all the time, which consumes a lot of power. It can be seen that manual patrol inspection requires a lot of manpower and financial resources.

Manual inspection of navaid lights is not only an economic loss, but also a conflict with aircraft flight. In the busy airport, there is an endless stream of flights from morning to night. There is no break time between them. The staff have no opportunity to patrol the runway. They can only proceed after the night flight. It is cold in winter and hot in summer. The staff work very hard, and most of the patrol inspection bulbs are not bright or dim. In addition, there are potential safety hazards in the navaid lighting. In the case of heavy fog or poor visibility, the navaid lighting needs to turn on the high light level [7]. The bulb forms a high temperature in the brightest state for a long time, and is subject to the shock wave of aircraft roar. The bulb is most likely to break the core or cause the lamp to go out or dim. The flight accumulation caused by bad weather increases the continuous time of turning on the lights. During this time period, the light bulb is easy to break, and the staff can not go on the runway for patrol inspection. There may be problems with the navaid lights, but they can not be found in time, thus affecting the visual effect of the navaid lights and flight safety. This hidden danger is an inconvenient problem to be solved in the manual patrol inspection of the navaid lights at present.

The application of intelligent monitoring system can free the staff from the heavy inspection work, and more importantly, it can find out the potential safety hazards in time to ensure flight safety, which is of great significance to flight safety.

3 Design of Airport Navaid Lighting Monitoring System Based on Data Mining Algorithm

3.1 Data Mining Algorithm

Data mining technology refers to the process of mining useful patterns or knowledge from a large amount of data. Many people call data mining knowledge discovery in database (KDD), while others regard data mining as a step of knowledge discovery. The process of knowledge discovery mainly includes data cleaning, data integration, data selection, data transformation, data mining, pattern evaluation and knowledge representation, as shown in Fig. 2.

In Fig. 2, the knowledge discovery process can be summarized into three main steps, namely, data preprocessing, data mining, knowledge evaluation and representation. Data preprocessing mainly includes data cleaning, data integration, data selection and transformation [8]. Data cleaning mainly refers to deleting irrelevant data, duplicate data, smoothing noise data in the original data set, filtering out data irrelevant to the mining topic, and processing missing values, outliers, etc. Data integration refers to merging data from different data sources into a unified format. After data cleaning and data integration, the dirty data with noise from different data sources will be transformed into intermediate data to be further processed, and then the intermediate data will be transformed into the target data required by data mining after selection and transformation. Data selection is to

select the features needed for data mining from the integrated data. Data transformation mainly refers to the standardized processing of data and the transformation of data into appropriate forms to facilitate the needs of data mining. Data cleaning and integration, data selection and transformation together constitute the data preprocessing process [9]. Data preprocessing is an important step of data mining. It is the key to the success of data mining. After obtaining the target data through data preprocessing, we can use the relevant data mining algorithms to mine the potential useful patterns in the data [10]. It should be noted that not all the patterns found by data mining algorithms are valid. We also need to evaluate them according to the actual situation. The effective patterns after evaluation are called knowledge. Because the knowledge obtained by data mining is often abstract, we often need to visualize the relevant knowledge in order to facilitate understanding.

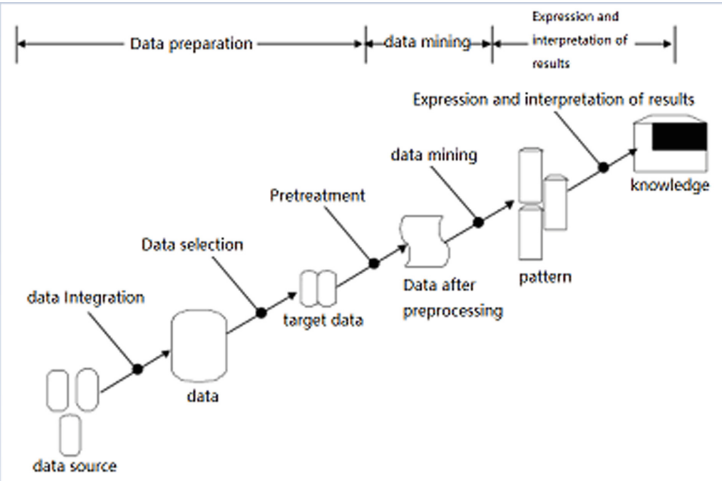

Fig. 2. General process of data mining in monitoring system

3.2 Navigation Light Patrol Monitoring System

The main functions of the system include:

(1) Complete the detection of normal, open circuit, dark bulb in each lamp position and water ingress in the lamp barrel enclosing the isolation transformer.
(2) provide fault warning information, and display the lamp position distribution diagram of each dimming circuit and other relevant information.
(3) store the fault light position information, and support the query and printing of the fault light position information. At the same time, it also needs to store the work operation records.
(4) The tower computer sends the patrol command to the lighting station management computer to realize the unattended working mode of the lighting station; The

lighting station management computer requests the tower computer for weather information, flight information, etc.

According to the functions to be completed by the system, it can be determined that the navaid lighting patrol monitoring system is mainly composed of four parts, namely, the tower computer, the lighting station management computer, the main control unit and the light position detection unit.

The working process of the system is as follows:

(1) The tower computer directly sends the command to the lighting station management computer, and the lighting station management computer issues the lighting on and patrol inspection commands; Or after receiving the telephone notification from the tower, the staff of the lighting station will operate the management computer of the lighting station to issue the lighting on and inspection commands, which will be sent to the corresponding main control unit.
(2) After receiving the command from the lighting station management computer, the main control unit sends the light level setting command to the specified dimmer.
(3) The dimmer sets the light level.
(4) After the circuit is stable, the lamp position detection unit detects the lamp state, and transmits the detection results to the main control unit using the power line carrier time sharing.
(5) The main control unit transmits the received information to the lighting station management computer, which processes, displays and stores the data.
(6) If necessary, the tower computer can view the light position patrol information in the light station management computer.

4 Conclusion

It is an inevitable trend to install and use navigational lighting patrol monitoring system in airports. In this paper, the design of airport navaid lighting monitoring system based on data mining algorithm realizes the automation of inspection and monitoring of navaid lighting system. The system can monitor the operation of lighting equipment in real time, realize the intelligent monitoring of the whole navaid lighting system, and ensure the safety of aircraft approach and landing. The use of two-way power frequency communication technology eliminates the need to re lay communication lines and saves human and material resources. The monitoring computer can reasonably arrange the light maintenance time and improve the maintenance efficiency. The use of the navigation light patrol monitoring system is of great significance to improve the reliability of the lighting system, enhance the ground support capability of the airport, reduce the malignant accidents caused by the navigation light, and ensure flight safety.

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