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Performance Evaluation and Optimization of Traffic Electromechanical Engineering Based on Big Data

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Abstract: - The continuous development of big data technology and its penetration in various industries has created unprecedented development prospects for the industry, and has had an important impact on promoting digitalization, intelligence and information in specific industries. As an important part of the transportation system, traffic mechanical and electrical engineering plays an important role in planning and guiding the operation of the transportation system. Its performance reliability will largely determine the operating efficiency and safety of the transportation system. Therefore, this study takes the definition and characteristics of traffic mechanical and electrical engineering as the starting point to explore the application value of big data in traffic mechanical and electrical engineering. After analyzing the performance evaluation needs of three major traffic mechanical and electrical engineering such as monitoring, communication and charging, it gives the performance evaluation strategies and optimization measures based on big data. While providing reference for the development of traffic mechanical and electrical engineering, It is also hoped that the research results can promote the development and evolution of traffic mechanical and electrical engineering, and open up new development ideas for other mechanical and electrical engineering related industries.

Keywords:- Big data; Traffic mechanical and electrical engineering; Performance evaluation and optimization.

Introduction

The application of big data technology can provide more scientific, efficient and accurate support for the planning, construction, operation and maintenance of traffic mechanical and electrical engineering. This support is first reflected in the life cycle management of traffic mechanical and electrical engineering equipment. Through the collection and analysis of the equipment operation data, maintenance records, environmental parameters and other big data, the status of engineering equipment can be real-time monitoring, fault warning and health management, so as to extend the service life of the equipment, improve the reliability and safety of the equipment. On this basis, big data technology can be used to improve the design and planning level of traffic mechanical and electrical engineering. By obtaining and analyzing historical traffic data, urban planning data, population flow data and other data, relevant staff can more accurately predict future traffic development needs, and optimize transportation network layout and equipment configuration based on specific needs, thus improving the operating efficiency and service quality of the transportation system. In addition, the application of big data technology can also optimize the operation and management of traffic mechanical and electrical engineering. In this regard, it mainly obtains traffic flow data, vehicle operation data, signal control data and other data, and generates visual results with the help of models and corresponding algorithms to realize intelligent scheduling and optimization of traffic systems, reduce traffic congestion and accidents, and improve transportation efficiency and safety. Another point is that big data technology can support the decision-making of traffic mechanical and electrical engineering, as well as the formulation of related policies. This requires in-depth collection and analysis of traffic policies, planning schemes, economic indicators and other data, so as to provide reliable data support for relevant government departments and enterprises, guide traffic development planning and policy adjustment according to the data content, and

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realize the sustainable development of the traffic system.

1. Definition and characteristics of traffic mechanical and electrical engineering

1.1 Definitions

Traffic electromechanical engineering has a very significant systematic and comprehensive characteristics, the whole project integrates advanced traffic management technology and high-tech mechanical and electrical equipment configuration. Under the support of advanced communication technology, the project can realize the dynamic monitoring and management of the traffic situation of sections, overpasses, tunnels and access lanes, and carry out the corresponding toll and scheduling work simultaneously. This system can quickly respond to and deal with all kinds of emergencies, so as to minimize the loss of accidents and ensure the safety and smooth flow of highways. Complete traffic electromechanical engineering often covers a number of key subsystems, such as monitoring system, communication system, toll system, and many other functional systems, and the smooth and safe traffic is also dependent on the cooperation[1] of these systems. From this point of view, traffic mechanical and electrical engineering has become an indispensable part of modern traffic management, through the use of advanced technology and equipment, to achieve real-time monitoring and efficient management of traffic conditions, and then create more safe and convenient conditions for people's travel.

1.2 Features

The characteristics of traffic electromechanical engineering are first reflected in the extremely high technical level requirements. As an important part of the intelligent transportation system, the technology applied in the project represents the forefront and cutting-edge technology of today's scientific and technological development, such as electronic toll collection technology, communication technology and closed-circuit television monitoring technology. The application of these technologies requires engineers to have a deep technical foundation, but also requires them to constantly update knowledge to meet the specific needs of traffic management and control personnel.

The second feature lies in the wide range of professional fields. At the technical level, traffic mechanical and electrical engineering usually covers various modern electronic information technologies such as automatic control technology, electronic computer hardware and software technology, multimedia optical fiber transmission technology and information network technology[2]. Thanks to the integration and application of these technologies, traffic mechanical and electrical engineering can form a highly integrated and complicated system engineering, and provide reliable and complete functional support for transportation.

The third feature lies in the strong systematicness of traffic electromechanical engineering. Traffic electrical and mechanical engineering is often regarded as the last link of highway engineering, which needs to clearly demarcate the boundaries between various systems and sections, and carry out effective coordination and integration in it. This systematic requirement makes the integrity and coordination of traffic mechanical and electrical engineering as the key considerations in the design and construction process, so as to ensure the effective and stable operation of the entire engineering system.

2. Application value of big data in performance evaluation of traffic mechanical and electrical engineering

The application value of big data in the performance evaluation of traffic mechanical and electrical engineering has become increasingly prominent, and its application depth and breadth have a far-reaching impact on the optimization and development of traffic mechanical and electrical engineering.

First of all, big data provides reliable technical support for traffic mechanical and electrical engineering performance evaluation, so that its performance evaluation work can obtain sufficient data resources. The traditional performance evaluation is often limited by the lack of data, and it is difficult to reflect the performance of traffic mechanical and electrical engineering comprehensively and accurately, which affects the effectiveness[3] of engineering optimization. The application of big data technology can collect a variety of data, including traffic

flow, equipment operating status, failure frequency, etc., which provides more abundant and comprehensive information for performance evaluation.

Secondly, the application of big data technology is also helpful to realize the real-time monitoring and prediction of traffic mechanical and electrical engineering performance. Through real-time analysis of big data, relevant staff can find potential problems in the project in time, predict possible failures, and take corresponding measures to prevent or repair. This not only improves the reliability and safety of the operation of the transportation system, but also reduces maintenance costs, making the operational efficiency of the entire transportation system significantly improved.

In addition, big data can also help optimize the design scheme of traffic mechanical and electrical engineering. Through the analysis of historical data, designers can understand the performance of the project under different operating conditions, and then identify the shortcomings of the current project and propose targeted improvement plans[4]. This kind of optimization design based on big data can make the traffic mechanical and electrical engineering more in line with the actual situation, and further meet the public's transportation needs.

3. Performance evaluation of traffic mechanical and electrical engineering based on big data

3.1 Demand analysis of traffic mechanical and electrical engineering performance evaluation

Monitoring engineering: the monitoring engineering as a whole can be divided into two parts: outfield monitoring facilities and monitoring center. The monitoring information collected by outfield monitoring facilities in real time will be used for calculation and processing, so as to determine the traffic control strategy according to the results of multi-source data processing and analysis, and complete the purpose[5] of traffic control and guidance. Therefore, the realization of the main function of the monitoring system is to ensure the monitoring accuracy of the monitoring facility and the coverage of the detector, so in the performance evaluation needs of the monitoring project, it is necessary to focus on the evaluation of these two aspects.

Communication engineering: Traffic mechanical and electrical engineering is divided into a number of different sub-projects and systems according to functional requirements, and the correlation between each project and system is realized through communication engineering. Communication engineering is responsible for the transmission of all data content such as traffic operating state, equipment operating state, highway toll data, etc. With the further development of China's transportation industry, The data type of transmission is also in the original pure data based on the addition of images, voice and other information[6]. This needs to ensure the efficient, stable and safe operation of the communication system, so the performance evaluation of the communication project based on big data is carried out around this aspect, the specific evaluation content includes the degree of optical fiber, the fluency of various types of data transmission, transmission reliability, scalability, the degree of business diversification and so on.

Toll engineering: the toll engineering of traffic mechanical and electrical engineering is mainly put into application in the expressway, and with the increasingly extensive application of ETC, the evaluation of the engineering performance of ETC has become an important reference basis for optimizing the toll engineering of traffic mechanical and electrical engineering. With the continuous growth of the scale of the road network, the complexity of China's highway path is also increasing, from the original one-to-one path selection into a one-to-many path selection, so the split of highway tolls needs to ensure that the real sense of reasonable, fair and accurate, which is another urgent requirement[7] for the performance evaluation of traffic mechanical and electrical engineering toll engineering.

3.2 Implementation of performance evaluation of traffic monitoring engineering based on big data

In order to evaluate the performance of the monitoring engineering in the traffic mechanical and electrical engineering based on big data, it is necessary to first determine the specific evaluation objectives according to the main role of the monitoring engineering, and determine the appropriate performance evaluation indicators

according to the objectives. As far as the function of the current monitoring project is concerned, its main role is to reduce the incidence of traffic accidents, improve traffic efficiency, and optimize the use of equipment on this basis, so the specific evaluation indicators should be selected equipment failure rate, data clarity and transmission speed.

After clear the performance evaluation indicators under the premise, the use of big data technology to widely collect all kinds of monitoring mechanical and electrical engineering data in the evaluation area, including equipment running time and operating stability, monitoring data quality, traffic flow data, etc., and then through cloud computing and other technologies to collect all the data screening and sorting, excluding errors, duplication and invalid data, To ensure the reliability and scientificity of data evaluation. After data screening, the remaining correct data are integrated and sorted into a unified format data set[8].

Finally, the data in the data set is analyzed and mined, and statistical methods are used to analyze and describe the data content, and the distribution and change trend of the data are confirmed. After confirmation, it is necessary to apply association rule mining, cluster analysis and other data mining technologies to clarify the potential laws and patterns of data formation, and combine the actual operating conditions of traffic monitoring mechanical and electrical engineering, reasonably interpret the data analysis results, extract valuable information, and comprehensively evaluate the performance of traffic monitoring mechanical and electrical engineering combined with information. Point out the existing problems and shortcomings, so as to complete the complete performance evaluation process.

In the whole performance evaluation process, it is necessary to pay attention to the whole process from collection to the formation of evaluation results to ensure the security and privacy of data, and adopt specific management measures to avoid data leakage and abuse; In addition, it is combined with the actual operation of traffic monitoring mechanical and electrical engineering, carefully select evaluation methods and evaluation tools to ensure the accuracy and reliability[9] of performance evaluation results.

3.3 Implementation of performance evaluation of traffic communication electromechanical engineering based on big data

On the whole, the performance evaluation of traffic communication mechanical and electrical engineering based on big data has certain similarities with the performance evaluation of monitoring engineering in the general process, which needs to go through several processes of determining indicators, data collection, data processing and analysis, performance evaluation and result visualization. However, since the data complexity of traffic communication mechanical and electrical engineering is obviously more than that of traffic monitoring mechanical and electrical engineering, in order to ensure the effectiveness of performance evaluation, it is necessary to add as much as possible in the specific implementation process of model building, model training and other contents, and realize the performance evaluation of traffic communication mechanical and electrical engineering with the help of big data models, so as to improve the comprehensiveness and reliability of performance evaluation.

At the beginning, it is still necessary to clarify the specific evaluation objectives, combined with the role of traffic communication mechanical and electrical engineering and operation mode, the specific evaluation objectives need to be formulated[10] around the communication efficiency, communication failure rate and network coverage degree. On the basis of determining these objectives, specific performance evaluation indicators can be obtained, that is, the data transmission rate, packet loss rate, equipment online rate and so on, of which the packet loss rate adopts the reverse evaluation index, that is, the lower the packet loss rate, the better the performance of the communication mechanical and electrical engineering.

After determining the specific evaluation indicators, it is necessary to collect and integrate the data of communication electromechanical engineering around the evaluation indicators. The collection content includes

various different types of data generated in the communication electromechanical engineering. In addition to the network traffic data and user behavior data, it is also necessary to collect the real-time operating status data of communication equipment at different periods. For the collected data, it is necessary to use distributed storage and computing and other big data technology for effective storage and management, but before putting the data into storage management, it is necessary to clean all the data, remove the error and duplicate data and convert the data into a unified format, after which the data can be stored to the database or data set[11].

In the collection of communication electrical engineering data at the same time, it is necessary to synchronize the establishment and training of digital models to meet the needs of communication electrical data processing, model categories can be selected machine learning model or statistical model, such as neural network, decision tree or regression model, after selection to adjust it to form a performance evaluation model. After the model is established, part of the cleaned data can be put into the model for training, and the model is gradually optimized and adjusted according to the training results until the model can give complete feedback on the performance evaluation results.

After the model function is perfect and can effectively evaluate the performance of traffic communication electromechanical engineering, the trained model can be applied to evaluate the performance of traffic communication electromechanical engineering. Put the data stored in the database/data set into the model, and conduct real-time evaluation or historical performance analysis of the project according to the performance evaluation requirements. After the evaluation results are formed, the results need to be visually transformed, that is, the results are converted into intuitive reports, charts and other content, so as to reduce the difficulty of the evaluation personnel and engineering personnel to recognize and understand the performance evaluation results, so as to effectively apply the evaluation results to optimize the communication mechanical and electrical engineering[12]. The complete process is shown in FIG. 1 below.

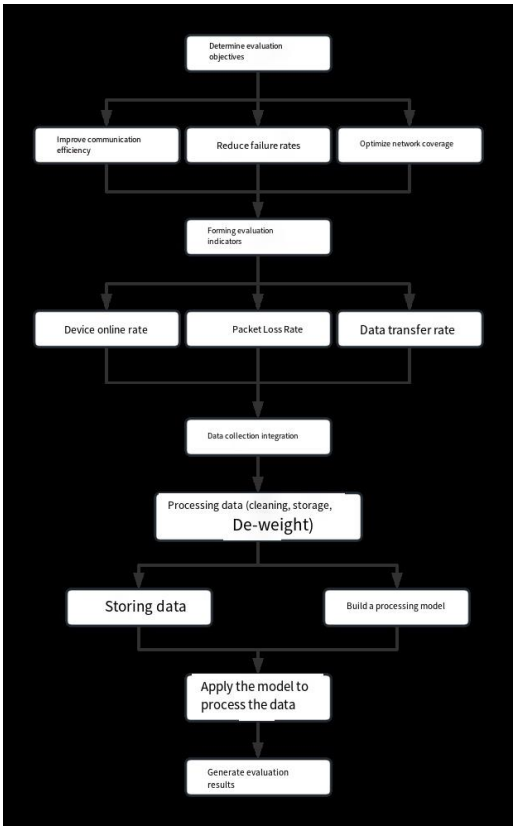

Figure 1 Complete process of performance evaluation of traffic information electromechanical engineering based on big data

3.4 Performance evaluation of traffic toll mechanical and electrical engineering based on big data

The performance evaluation of traffic toll mechanical and electrical engineering based on big data is to use big data technology and methods to conduct a comprehensive evaluation of the operation, equipment status and performance indicators of the traffic toll system. The purpose is to combine the evaluation results to obtain optimization measures for engineering performance, so as to improve the reliability of toll mechanical and electrical engineering and meet the specific needs of today's society in this respect.

The whole process includes the steps of data collection, data cleaning, data analysis, model establishment and performance evaluation. The beginning stage also needs to clarify the performance evaluation objectives of the toll mechanical and electrical engineering, combined with the operating status of the above toll mechanical and electrical engineering, its evaluation objectives should be determined around the ETC and path selection planning level, while including how to improve the toll efficiency, equipment operating stability, ETC., which also needs to add the response time evaluation for ETC to ensure the integrity of the performance evaluation.

After the completion of the evaluation purpose and the determination of indicators, it is necessary to conduct data collection. Can be installed sensors and monitoring equipment to real-time monitoring equipment operating status, traffic flow, charging and other data, the premise is to reasonably determine the scope and object of data collection, combined with performance evaluation indicators clearly need to collect the type of data, as well as the specific source of data equipment. The data collection process involves the deployment of collection equipment, so it is necessary to pay attention to the deployment of collection equipment can not affect the normal operation of the project, and can fully ensure the transmission efficiency of the collected data.

After data collection, it is necessary to carry out data cleaning and conversion. The key of data cleaning is to deal with outliers and noise, and it is also necessary to effectively identify and deal with missing values. Among them, the outlier refers to the data content that is obviously different from other data, mostly due to the acquisition or transmission error, sensor failure, etc., generally by deleting the outlier or replacing it with the average/median; Noise is the random formation of information in the exponential data flow, which is not related to the system, and is usually processed by wavelet transform or smoothing filter; Missing values are very common in data preprocessing, mostly due to sensor faults or data transmission errors, and are similar to outliers in processing methods. Data conversion includes data switching, scaling and normalization, which aims to process data values into data of the same type and with certain statistical characteristics.

After that, the data can be divided into training sets and test sets, and the data modeling work can be carried out simultaneously. Data modeling is to build a data model through the application of regression analysis, classification analysis, etc. After the completion of modeling, the data training set is put into the model to test the performance of the model, and the model is adjusted and optimized according to the results. After adjustment and optimization, the model needs to be deployed in the production environment (such as cloud computing platform, containerization technology or mobile devices), and then the performance evaluation of traffic toll mechanical and electrical engineering is formally carried out and the evaluation results are obtained. Finally, the evaluation results are presented visually, so that the evaluation results are more intuitive and easy to understand, and provide scientific basis for management decisions.

4. Optimization measures of traffic electromechanical engineering based on big data

4.1 Strengthen the monitoring of accident black spots and congested sections

According to the performance evaluation results of traffic monitoring mechanical and electrical engineering, it can be determined that the accident black spots in traffic engineering are concentrated in large flow/large curvature sections, Bridges, tunnels and other areas, so it is necessary to combine the results to clarify the monitoring camera layout and use effect of these points, and appropriately increase the layout density of monitoring and information release facilities according to the specific circumstances. To avoid this kind of accident black spots appear two

accidents, to achieve timely discovery, timely diversion of highway governance goals. Taking the distribution control of large traffic sections as an example, the distribution control of the vehicle inspection device should be shown in Figure 2 below.

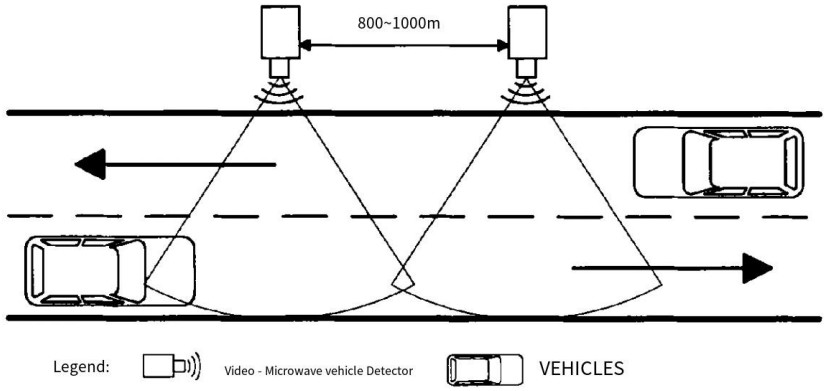

FIG. 2 Schematic diagram of large-flow section layout control

4.2 In-depth optimization of communication electromechanical engineering

In the evaluation results of traffic communication mechanical and electrical engineering, it is found that the security risks of the communication system are concentrated in the trunk ADM equipment, integrated access network, optical cable and other levels, the specific problems are old corresponding equipment, low transmission efficiency, lack of compatibility (optical cable is manifested as insufficient spare capacity of the whole fiber cable and serious attenuation). Therefore, it is necessary to carry out in-depth optimization for communication mechanical and electrical engineering. The first optimization strategy is to match PTN equipment for the road access network. This equipment can not only retain the original high availability, reliability, scalability, security and convenient management, but also lower the overall use cost, so it is necessary to gradually replace the old access network equipment (trunk ADM equipment) with this equipment. The second optimization strategy is to establish a communication resource management system to manage the distribution, opening and utilization of communication equipment resources in a unified manner. The system should be realized from the two aspects of network management hardware and software equipment and management system.

4.3 Optimize toll mechanical and electrical engineering with targeted measures

The problems of toll mechanical and electrical engineering lie in two aspects: toll passing rate and ambiguous path recognition. The problems of the former are slow traffic speed and serious interference of following vehicles/adjacent lanes, which are largely caused by fixed ETC communication area; The problem of the latter is that only the principle of the shortest path is used to charge, and only the location of the entrance and exit toll station is identified, and the specific driving path of the vehicle cannot be identified. For the problems existing in the toll passing rate of ETC, it is recommended to use phased array ETC antenna to optimize it and deploy it on the side of the highway to determine the specific driving path of the vehicle. For the ambiguous path recognition problem, the available technical routes include vehicle license plate recognition system, parking sign station scheme and non-parking sign station. Among them, the efficiency of parking sign station is not ideal and the later operation and management cost is high, so it is not considered. The overall change cost of the vehicle license plate recognition system is small, but the stability is slightly poor; Non-stopping sign station has the advantages of accurate path identification, strong anti-interference and no need to stop, but the overall cost is high and the need to replace the existing pass card, coupled with the technology has been significantly developed in recent years, in compatibility and stability still need to be verified, so it is necessary to combine the local economic development situation reasonably adopt the appropriate type of technology.

Conclusion

This study is mainly around the traffic mechanical and electrical engineering monitoring, communication, charging three important systems to carry out, through the analysis of the performance evaluation of the above three systems based on big data implementation strategy, respectively given three different optimization measures of the system. With the further application and potential development of big data technology, the technology is bound to provide more perfect functional support for traffic mechanical and electrical engineering, and then promote the development of this field.

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