An Elevator Early Warning System Based on Big Data Technology

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Abstract. The paper introduced the design and framework of the elevator early warning system platform, and analyzed the relating function models of the system. The theory of using big data technology to process elevator devices is elaborated. Some key parameters the early warning system involved are also analyzed. Through the elevator early warning system, the necessary early warning measures can be put forward before the elevator failures occur, and the safety level of the elevator can be improved.

Introduction

Elevator is an important special equipment, with the development of economy and society, the use of elevators is increasing. Elevator safety is an important part of people’s travel safety. In recent years, information technology especially big data technology has been widely used. The construction of integrated early warning information platform for urban intelligent elevators is becoming more and more mature in technology. Using the latest big data technology to supervise elevator safety and realize early warning and continuous monitoring of its faults has become an important research task[1]. Through the long-term and continuous collection of elevator fault data, some abnormal characteristics of elevator operation status can be found through specific big data analysis technology. Furthermore, through scientific calculation and analysis, the early warning of elevator faults can be realized, so that relevant units can take measures in advance to avoid possible safety problems.

The Framework Design of Early Warning System

The framework of elevator early warning system is divided into three layers: the data collection layer, the data processing and analyzing layer and the data output layer, its framework is shown in Figure 1. The data collection layer includes elevator maintenance unit, various special equipment inspection and testing institutes, elevator manufacturers and other relating institutions, it also includes data collected from the Internet using web tools such as crawlers. The data processing and analyzing layer has a complex structure which includes Hadoop distributed infrastructure[2]. The distributed infrastructure includes HDFS and corresponding tools and data analysis platform that can improve data process speed with MapReduce. The data analysis layer contains the corresponding hardware infrastructure, these include servers, storage and virtualization, resource pools, cloud management elements, and storage resource virtualization facilities. The data analysis layer also includes infrastructure management platform supporting facilities and communication equipment for early warning system information service platform, the supporting hardware facilities for data analysis and application center, data processing center, data sharing and exchange center, etc.[3] The data output layer is also called data output unit, it mainly includes elevator users, elevator maintenance units, various special equipment inspection and testing institutes and elevator and related equipment manufacturers, among them, elevator maintenance units, various special equipment inspection and
testing institutes and elevator and related equipment manufacturers are not only relevant data providers, but also beneficiaries of data analysis and processing.

Figure 1. The framework of elevator early warning System.

The Function Design of Early Warning System

The function of elevator early warning system is divided into five functional modules: data collection module, data integration module, data preprocessing module, data filtering analysis module and data output module, as shown in Figure 2. Data collection module provides two kinds of interfaces: one is for elevator equipment related institutions, and the other is for network tools such as crawlers. At present, there is no uniform standard for data provided by elevator agencies, therefore the data format of the interface of elevator equipment data is flexible, and it can satisfy various data input formats. The data retrieved from the Internet by crawler tools are also in various forms, and there is no uniform specification, so the format requirements of the interface are relatively broad, the only difference from the previous interface is that the number of data entry items for the interface is fixed [4]. The function of data integration module is to format and standardize the data obtained by data collection module, it can merge the data obtained from the two interfaces of the acquisition module are and remove the duplicate data is eliminated by the module, too. The data preprocessing module mainly uses Hadoop to preprocess a large amount of data in a distributed way, this is done in a more reliable, efficient and scalable manner. This module uses HDFS to store files distributed, add or delete files and other routine operations. Data filtering and analyzing module is to process and analyze the data which come from preprocessing module, this module uses MapRduce technology. MapReduce is a technology for processing and analyzing huge amounts of data, it is a parallel programming model and methodology. With the help of the design idea of functional programming language, it provides a simple parallel programming method. It uses Map and Reduce function to realize basic parallel computing tasks, it also provides abstract operations and parallel programming interfaces. In this way, the purpose of programming and computing large-scale data is achieved simply and conveniently [5]. After analyzing and processing the related data MapReduce forms the target data. Then according to the daily usage of institutional users and elevator users, the special algorithm is adopted to form the result data which is ready to be output to users. The last module is the data output module which is divided into two parts: one for institutional users and the other for ordinary elevator users. Institutional users refer to elevator maintenance units, various special equipment inspection and testing institutes and elevator and related equipment manufacturers [6]. The data output to institutional users include some professional and elevator equipment parameters related data. The data exported to ordinary elevator users are mainly some basic data and early warning data of daily elevators.
Data Filtering and Analyzing

Data filtering and analyzing is the key link in elevator early warning system. Whether the function of the early warning system can accurately meet the predetermined standards is closely related to data analysis and the design of key parameters in the filtering process. There are two specific operation processes involved in the stage: one is to generate target data by MapReduce technology, the other is to generate the result data by calculating the target data through the characteristic arithmetic model, and then present the result data to the end user through the data output module [6]. MapReduce takes relevant analysis methods to check the elevator and related equipment by extracting key words such as "device code", "device brand", "first commissioning date", "years of device failure start" and "duration of failure", "device life expectancy" and "average failure rate" that can be queried, then the analysis results are stored in the target data set and stored through HDFS. The main algorithm models for target data are Deep Feed-Forward neural network model (DFF) and Hopfield Network model (HN). When training target data with DFF, the algorithm only transmits a small amount of error information to the upper layer. The data required by the model is part of the specific data in advance from the target data set, as shown in Table 1. Considering the limitation of computing time, the algorithm does not stack many levels when processing target data, which sometimes leads to inaccurate accuracy of early warning, this is the result of a comprehensive trade-off with time factors [7]. When using HN to train target data of elevator and related equipment, each batch of samples is used as one input sample, it is hidden during the training process and the original state is restored after the training, then it will be output as the result data.

| Brand Identification | Life Expectancy (h) | Fault Interval | Time Used (h) | Data Type |
|----------------------|---------------------|----------------|--------------|-----------|
| 20001                | 100000              | 1500           | 60000        | 1         |
| 20002                | 50000               | 406            | 35000        | 0         |
| 20003                | 75000               | 370            | 43022        | 0         |
| 20004                | 60000               | 100            | 21125        | 0         |
| 20005                | 65000               | 360            | 10220        | 1         |

Summary

The elevator early warning system involves all aspects of the elevator system, and the data of the relevant institutions is interrelated and different. It often happens that the same parameter has different descriptions in different institutions. In addition, some elevator equipment manufacturers are reluctant to disclose sensitive data, which adversely affects the precise forecast of early warning
system. Therefore, in the future, accurate acquisition of valuable data such as elevator operation parameters and environmental parameters, fault type, frequency, fault degree and operation life can provide more scientific and complete data analysis method for further improvement of elevator early warning system, it also lays a solid foundation for the further development of elevator fault risk early warning system based on big data technology.

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