Exploration of Urban Intelligent Bus Management System based on Big Data

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Abstract. To discuss urban intelligent bus management system based on big data, an intelligent urban public transport management system is designed and developed around the traditional urban public transport management business. The system has the functions of intelligent bus dispatching, passenger travel service, and data statistical analysis, and has important value for fully mining the value of bus data and improving the level of intelligent bus management. Based on the analysis of the operation and management requirements of urban public transport industry in China, the overall framework of urban intelligent public transport management system based on big data is designed. The framework is built around the collection, transmission, storage, analysis and display of bus data, covering the functions of intelligent bus dispatching, arrival time prediction, and passenger flow prediction.

Keywords: big data; urban intelligent bus; bus management; management system.

1. Introduction

Urban development promotes the increase of population and vehicles, resulting in traffic congestion and road congestion, and eventually a certain probability of traffic accidents. These problems affect people's normal life and should be solved in time. For the effective control of vehicles, besides adding roads and planning, in order to ensure the safety and smoothness of roads, a series of traffic safety facilities, such as signal, road signs and so on, can be constructed, and a traffic command center can be set up. Through these schemes, traffic flow can be improved and traffic congestion can be alleviated [1-3]. However, from the perspective of urban development, traffic demand is continuously increasing, and its system environment is becoming more and more complex. It is difficult to solve the traffic problem fundamentally if only considering vehicles or roads [4,5]. Therefore, the road, vehicle and other transportation elements should be considered together to form a whole. Only by using information and communication technology, electronic technology and other technologies can the intelligent transportation system of traffic emerge [6,7].

Intelligent transportation is an important part of urban traffic planning. Transportation information and intelligent technology are important contents of establishing comprehensive transportation system. From the macro perspective, the emergence of this development and transportation system is an important stage of urban development, which can enhance the overall advantages of the city from the actual function. From the micro-level analysis, this development situation can improve the comprehensive transport capacity of the urban transportation system, improve the efficiency and service quality of the transportation industry, reduce traffic consumables, pollution, reduce traffic safety accidents and so on, and provide high-quality traffic services for various regions of the city, forming a green and smooth traffic system [8].

2. Big Data Technology and Jeesite Technology

According to the definition, it can be seen that the concept of big data is similar to the concept of "massive data", which is gradually changing from the information age to the data age. There are some differences between the big data in intelligent transport system and the "massive data" before. This kind of big data is not only facing the increase of the total data, but also considering the problems that the conventional data acquisition, storage and analysis technology cannot solve. Because the goal of big data technology is to use distributed technology to process various forms of massive data, and to analyze and mine them. With the increasing data size, valuable information can be obtained. The

following is the ecosphere schematic diagram for big data reference and the structure diagram of HDFS (Hadoop Distributed File System).

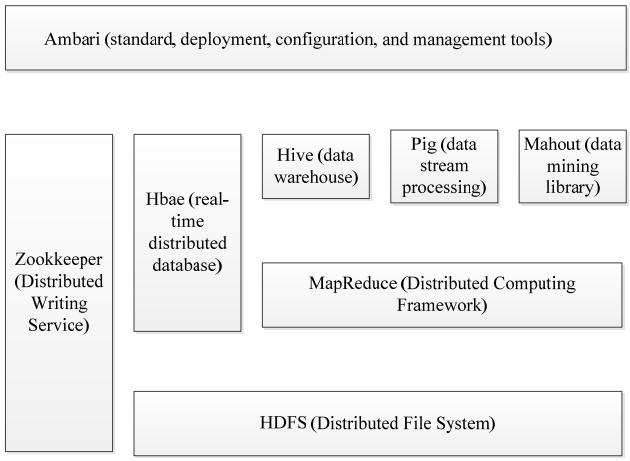

Fig. 1 Hadoop ecosystem

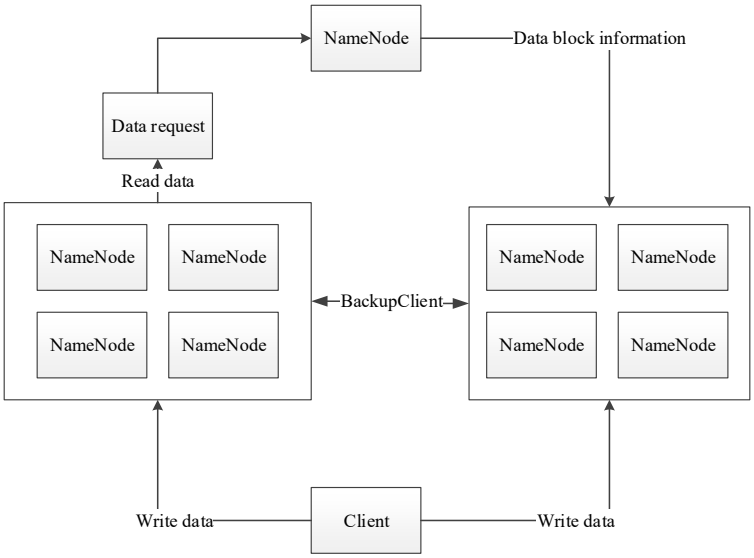

Fig. 2 HDFS structure diagram

JeeSite technology is introduced. JeeSite2n is an open source JavaEE rapid development platform based on many excellent open source projects, highly integrated and encapsulated. Its framework adopts the most classic and optimal combination in the Java industry, namely Spring Framework as the backstage core container, Spring MVC as the model view controller, and MyBatis or Hibermate as the data access layer. JeeSite also improves programmers' development efficiency by introducing a series of development components and code generation tools, such as system permission components, data permission components, data dictionary components, core tool components, view operation components, workflow components, code generation etc.

3. Algorithms and Function Design of Urban Intelligent Bus Management System based on Big Data

3.1 Big Data Source and Analysis of Urban Bus

Table.1 The main data used by the system and its source

Data name	Data source	Data type	Data size
Vehicle trajectory data	Vehicle-borne GPS device	Dynamics: Semi-structured/unstructured	TB level
Site information	System	Static: Structured	MB level
Line information	System	Static: Structured	MB level
Bus	System	Static: Structured	MB level
IC card swiping record	IC card swiping device for on-board bus	Dynamics: Semi-structured/unstructured	TB level
IC card information	System	Static: Structured	GB level
Weather data	Weather station or network	Dynamics: Semi-structured/unstructured	MB level
Video data	Vehicle/platform camera	Dynamics: Semi-structured/unstructured	PB level

3.2 Summary of Data Processing Algorithms based on Big Data

Traditional data processing algorithms should use a single computer node to obtain information and then process data. When dealing with massive data tasks, the computer processor will decompose the whole computer into several sub-tasks, and according to the COU (Central Operation Unit) execution time, draw the flow chart. The specific content is shown in Figure 3.

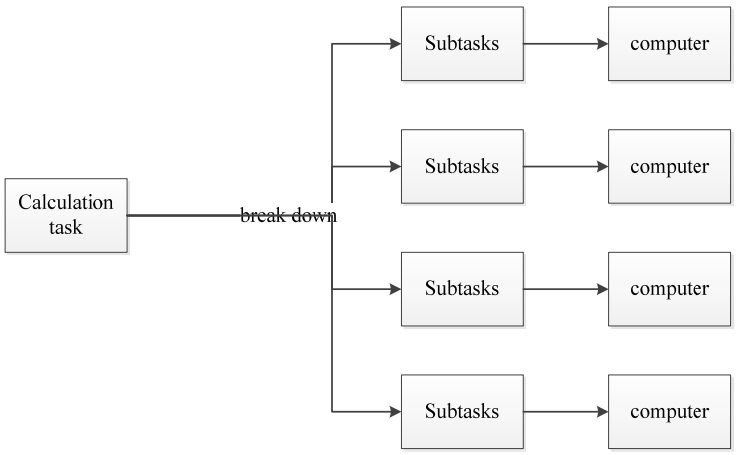

Fig. 3 Parallel computing model

As can be seen from the figure above, this data processing method is often limited by the resources of CPU (Central Processing Unit), memory and so on. It will consume a lot of time, and in the actual task calculation, it is difficult to complete the analysis task of big data within the specified time. Therefore, in view of the big data requirement of intelligent system, a new data processing algorithm should be selected to process the bus management system.

As a parallel computing model, MapReduce mainly divides large computing tasks into a series of Map and Reduce tasks running on Hadoop cluster. At the same time, the data stored in HDFS is segmented, and each task is only responsible for one of the specified data blocks, so as to solve the load balancing problem of the whole computing cluster. Map tasks are usually responsible for loading, parsing, transforming and filtering data, and outputting intermediate result data for Reduce processing. Reduce then groups or aggregates the intermediate result data according to the specific needs of users.

Therefore, MapReduce's input end is a series of file sets stored on HDFS, and the output end is the calculation results needed.

4. Function Design of Urban Intelligent Bus Management System based on Big Data

4.1 Determination of Departure Interval

For the urban bus network, the most critical issue in compiling the traffic plan is to determine the departure interval, and the departure time on the line is very important. If the departure starts too frequently, although it meets the passenger demand, it actually increases the unnecessary cost and the operation cost of the bus network; and if the departure is too few to meet the passenger's travel needs, it is necessary to set up the intelligent bus network and ensure the accuracy of the departure interval of each line.

$$F_{1j} = \max\left(\frac{P_{mj}}{d_{oj}}, F_{mj}\right), \mathrm{j} = 1,2 \ldots \ldots, \mathrm{q}$$

$$P_{md} = \max_{i \in S} \sum_{j=1}^{q} P_{ij} = \sum_{j=1}^{q} P_{ij}$$

$$P_{mdj} = P_{ij}$$

In the formula, P_{mj}: the minimum expected departure frequency in period j;
q: number of time intervals;
d_{oj}: the expected congestion of the vehicle in period j;
S: the collection of all stations i of the line, but excludes the terminal station;
i: the maximum daily passenger flow site;
P_{ij}: Statistical indicators of the total number of passengers carried by all vehicles leaving station i in time period j;
P_{mdj}: observed daily passenger flow at the largest passenger flow station in the period j;
P_{md}: the total passenger flow of the largest passenger flow station in the period j;
P_{mj}: the maximum passenger flow observed in the period j (for all sites).

4.2 Arrangement of Traffic Planning

According to the analysis of bus environment, its service mode has its particularity. Its vehicles need to travel along fixed lines, then stop at fixed stations. If there are no prior instructions, they cannot dump stations, cross lines and turn around in advance. From the service mode, buses and trains are similar, but ordinary buses do not have dedicated sections or dedicated intersection signals. At present, the goal of bus operation is to formulate a reasonable driving plan, and then quickly complete the driving plan.

Buses mainly provide convenient, fast and inexpensive means of travel for the fixed population, and they are carried out under a stable driving plan. When formulating or revising the plan, the maximum allowable departure interval and passenger flow should be taken into account. Large station express train interval, line support or passenger flow distribution are dispatching lines that need to be referred to when making rules. The emergent dispatch due to the change of passenger flow is less, so it is more necessary to maintain stability and seriousness. When operational problems occur, emergency measures should be taken in time to collect as much operational information as possible and constantly revise the driving plan, so as to know the future operation and production. Therefore, the real-time degree of collecting information on the way of vehicles does not need to be particularly strong.

5. Application and Test of Urban Intelligent Bus Management System based on Big Data

Performance test is to test the system performance requirements proposed in the software requirements specification. According to the non-functional requirement analysis of the system software mentioned above, the urban intelligent bus management system will be tested from two aspects of security and stability.

5.1 Security Test

Security test is to test whether existing security means or measures of software can effectively deal with potential security threats. The security test of this system is shown in the table below.

Table. 2 Security test case

Test case	Security test
Use case description	Users who do not have access to the page are forced to access the actual URL (Unified Resource Location) address; After the user logs in, there is no operation in 10 minutes.
Output specification	Check whether to jump to the login interface automatically
Conclusion	Passed

The test results show that when a user without page access authority enters the actual URL address of a page in the address bar, the system can detect that the user is not logged in or has no relevant access rights, then the system will automatically jump to the login interface by default to ensure system security; after the user logs in to the system, if there is no page operation after 10 minutes, the system will record the status meter as invalid, and automatically jump to the login interface, to prevent others from using it fraudulently.

5.2 Stability Test

After two months of multi-user simultaneous access stress test, the test results show that the system has stable performance and low error rate during the test period, and the system can also run stably while satisfying many users' access, with CPU occupancy under 65% and network occupancy under 15%. Therefore, through the performance test, it can be seen that the urban intelligent bus management system designed has stable performance and system security, and meets the needs of the system.

6. Conclusion

In order to illustrate and demonstrate the functions of the system, the actual operation of the system is elaborated from two aspects: system construction and deployment, and actual operation effect.

Because the urban intelligent bus system is too large, it is not conducive to research and experiment in the laboratory environment. In consequence, according to the functional requirements of the system designed, a prototype system of urban intelligent bus based on big data is designed. By setting up the system running environment in the laboratory server and simulating the application scenario of the actual bus enterprise, users with different rights can access the system through the common Web browser to realize the operation of their own business needs.

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