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Smart Maritime Services: Optimizing Ship Traffic Management

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Abstract:

In the development of an intelligent maritime infrastructure, establishing a maritime smart service is crucial for enhancing the efficiency of ships' port entry and exit, thereby minimizing the waiting time for loading and unloading goods. This study provides the foundational functionality for querying ship arrival and departure reports and visually presents this data through thorough analysis. By examining the ship arrival and departure reports, the study investigates the interprovincial maritime traffic and analyzes historical freight data to create preliminary profiles of ships. This analysis aims to understand the dependence of various provinces on goods and their roles within the industrial supply chain.The system's back-end architecture is built using the Spring Boot framework, while the front-end is developed with the Vue framework, enabling a clear separation of front-end and back-end development processes. For the storage and visualization of port entry and exit report data, the system employs a Doris database cluster to manage historical data efficiently. Visualization tasks are handled using the open-source Echarts library, facilitating the initial development and exploration of a data analysis system for ship entry and exit reports.

Keywords:

Doris; Echarts; Big Data; Ship Arrival and Departure Report; Vue; Data Visualization.

1. Introduction

China has a dense river network and a developed waterway transportation industry, which is an important support for the national economy. It plays an irreplaceable role in modern cargo transportation [1]. In recent years, with the growth of national economy and the support of national policies, China's waterway transportation industry has developed rapidly. According to the data, as of November 2021, China's waterway cargo transportation volume was 7485.81 million tons, an increase of 8.5% year-on-year from January to November 2020. However, due to the impact of the epidemic, the ships arriving at the port cannot complete the loading and unloading tasks in time, and many ships are waiting in line outside the port, resulting in the congestion of the port. The ship cannot complete the operation in time in the port, and the waiting time for the berth is long, which puts great pressure on the ships in and out of the port.

On August 5, 2021, in order to further standardize the reporting system for ships arrival and departure the port, and strengthen the reporting management for ships entering and leaving the port, the maritime safety administration of the Ministry of transport issued the measures for the management of reports on ships entering and leaving the port (hereinafter referred to as the measures). It has made comprehensive and systematic provisions on the circumstances, contents, time limit and other contents that need to be reported; The measures for the first time realize the full spatial coverage of the management of ship arrival and departure reports, and all ships in the waters are required to carry out the ship arrival and departure reports.

Through the analysis of the ship entry and exit report data, it is helpful for the maritime department to master the operation status of the port and improve the entry and exit efficiency

of the port. By analyzing the trend of port freight transport, we can have a macro understandingof the development of port cities. Analyze all kinds of ship information, realize the preliminary study of ship portraits, strengthen the supervision of ships, improve the level of maritime supervision, and ensure the safety of water navigation.

2. System Architecture

2.1. Functional Module

As shown in Figure 1, the ship arrival and departure report data analysis system is mainly composed of three parts: large screen display of arrival and departure data, ship arrival and departure information query, and overview of arrival and departure report data. The large screen display of departure data includes the top ten statistics of each province, cargo type statistics, ship type statistics, etc. Arrival and departure information query includes ship basic information query, historical ship arrival and departure report information, map of main provinces to and from which ships travel, etc. The overview of port entry and exit report data includes national port flow statistics, national port monthly throughput, cargo demand statistics, etc.

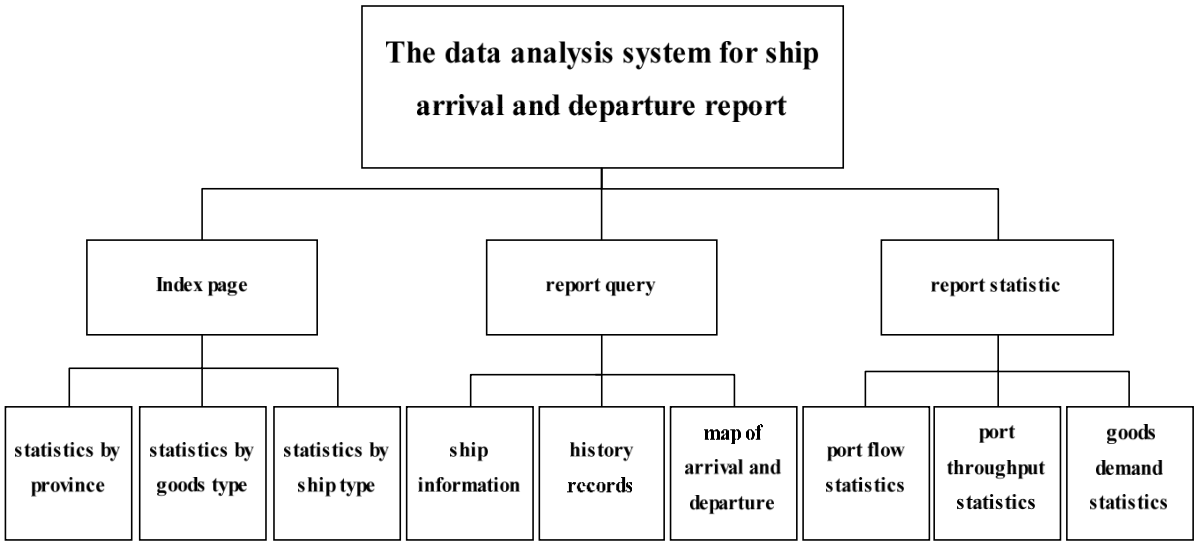

Figure 1. The functional module diagrams

2.2. Architecture Designment of Development

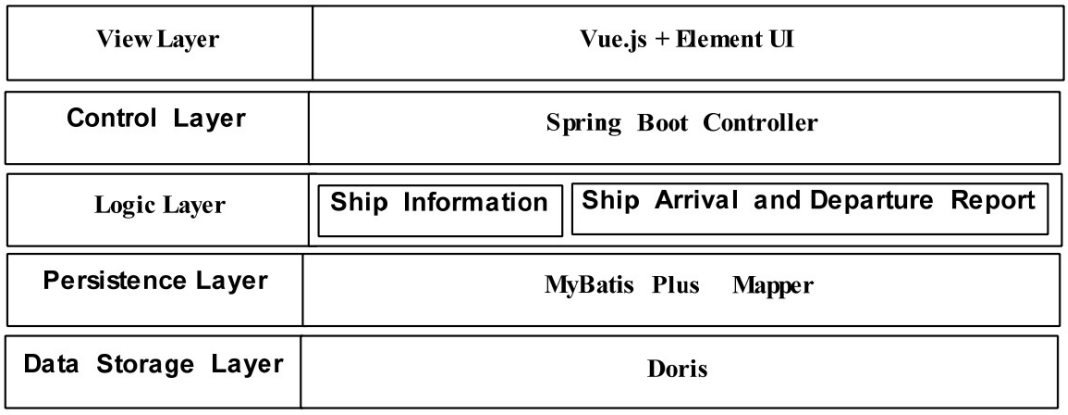

Figure 2. The architecture designment of development diagram

The system adopts b/s architecture and the development mode of front-end and back-end separation. The system is divided according to the design idea of MVC. The system mainly

includes view layer, controller layer, service layer and mapper layer. Doris cluster is used for data storage of arrival and departure reports. The back-end uses the Spring Boot framework to accelerate the background development. The front-end uses the Vue cli scaffold to quickly build the front-end Vue framework [2-3]. The front-end UI uses the element UI in the Vue ecology to provide users with a good interactive experience [4]. The system development architecture is shown in Figure 2.

2.3. Architecture of Data Storage

The traditional database is more suitable for data transactional operation, while the system is mainly used to query massive arrival and departure report data, so the system uses Doris database. The database is an SQL analytical database system based on MPP technology, which can provide millisecond query response performance for arrival and departure reports [5]. The system uses 11 servers to build Doris database cluster. The cluster structure is shown in Figure3.

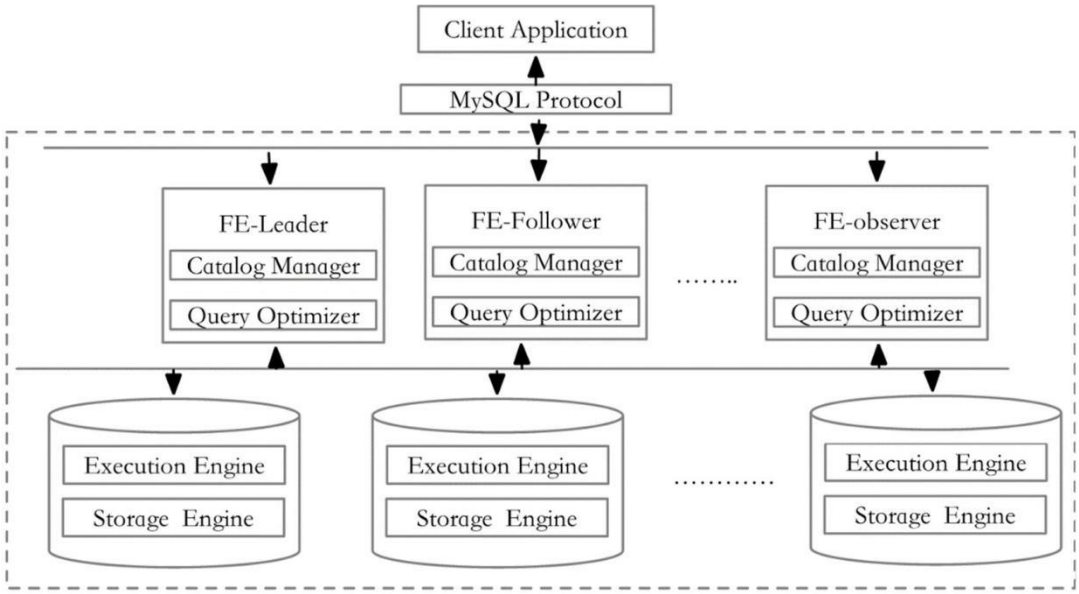

Figure 3. The Doris Cluster

3. System Implementation

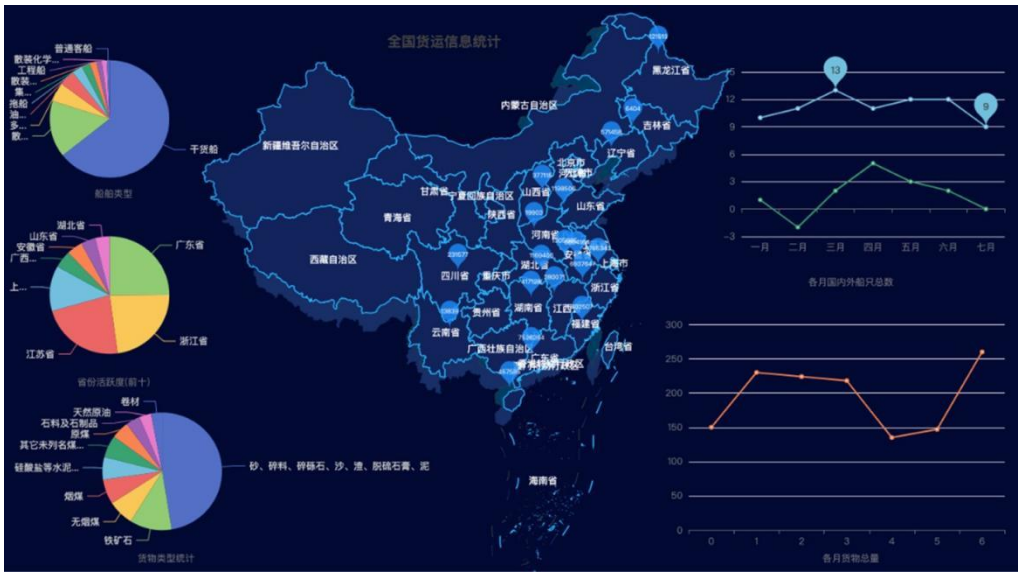

Figure 4. The display effect of index page

The index page summarizes and displays the information of the arrival and departure reports of the current year, including: Statistics of the total cargo transport volume and types of ships in each province, ranking of the port transport activity in each province, proportion of cargo transport types, line chart of the total number of domestic and foreign ships in each month, line chart of the total transport volume in each month, etc. The specific effect is shown in Figure 4.

After Vue initialization, the page makes a get request to the back end through Axios. After the back end responds successfully within the set time, it calls the Echarts method. If the response times out, the front end will give an error prompt.

On the ship display page, enter the name of the search ship and click the query button to obtain the background data information through the get request. During the query, the query button adds the query animation and the status under query to improve the interactivity of the front- end UI. If the response times out or fails, the front end will give a timeout warning, restore the normal state, and assign the data to the corresponding Vue object. After receiving the front-end data, the latest port entry and exit report information of the ship and the status of the ship at the port will be displayed. Display the ship's cargo status, such as cargo type and container quantity. And display the proportion of cargo types carried by vessels in previous years, as to analyze the main types of cargo carried by vessels. Analyze the main entry and exit cities of ships, and obtain relevant information such as the main service areas of ships. The effect is showin Figure 5.

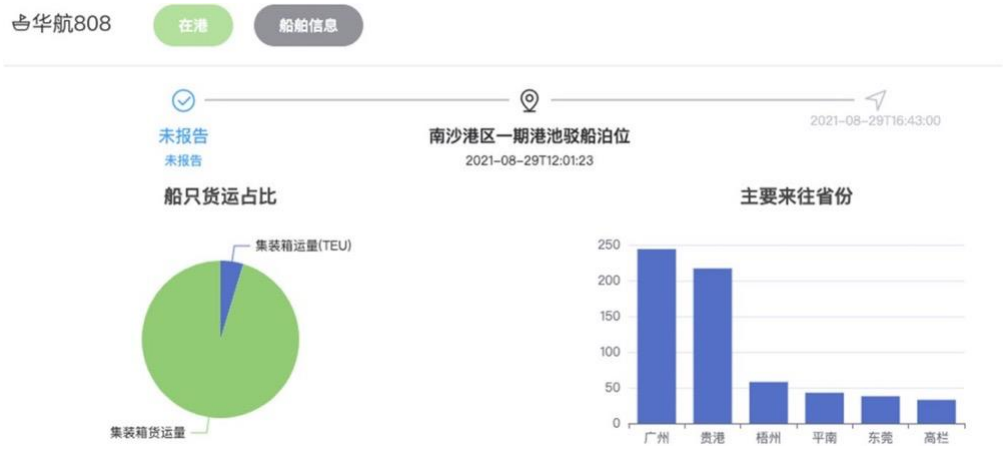

Figure 5. The ship information page

4. Conclusion

The report data of ship arrival and departure not only plays an important role in the marine supervision of ships, but also can explore the status of regional macroeconomic development, material exchange between provinces and the relationship between material supply and demand. The system has preliminarily completed the analysis of the ship arrival and departure report data, roughly analyzed the arrival and departure report data, proposed the overall architecture of the system, analyzed, and retrieved the data using Doris database, introduced the characteristics of spring boot framework, Vue framework and related ecological components, and applied them reasonably in this system.

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