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# Design and Implementation of Ship Pollutant Emission Monitoring System based on AIS

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## Abstract

**With the continuous development of the shipping industry, the importance of water pollution treatment has become increasingly apparent. However, the problem of receiving and treating ship pollutants has not been effectively solved. It is common for all kinds of garbage and sewage to be discharged directly, and it not only affects the urban construction and development, but also brings an environmental security crisis to the public. In order to improve the ship water pollutant emission, a ship pollutant emission monitoring system based on Automatic identification system (AIS) is designed and implemented. This system is implemented based on the front-end and back-end separation mode, the back-end uses Spring Boot to realize business logic processing, and the front-end realizes data display based on Vue and Mapbox.**

## Keywords

**Ship Water Pollutants; AIS; Spring Boot; Vue; Mapbox.**

## 1. Introduction

At present, due to the one-sided pursuit of economic interests by some ship owners, the ineffective work of regulatory authorities and the weak environmental awareness of the public, some ships do not discharge pollutants in accordance with the regulations, which greatly exceeds the environmental load of the water area, and has a huge environmental impact on the rivers and lakes with a good environment. According to the characteristics of waterway transportation and the characteristics of ship pollutants, build a ship pollutant emission monitoring system. Starting from being conducive to environmental protection and convenient transportation, grasp the key links and prominent problems of the current ship pollutant transfer and disposal, cooperate with relevant departments to establish a full chain and closed-loop management mechanism from generation, reception, transfer to disposal, open up the information island between departments, promote the integration of information systems and realize the sharing of data resources, Improve the ability of joint supervision.

AIS is a digital navigation aid system composed of shore based and ship borne equipment, which realizes the navigation status and ship information interaction between ships and between ships and shore-based [1]. AIS data includes ship type, name, maritime mobile service identification (MMSI), arrival time, navigation speed, transit area and other information, which can be applied to ship identification, ship tracking, ship collision avoidance, maritime management, channel calculation, etc. With the continuous development of shipping industry, ship activities are becoming more and more frequent. Tracking ship trajectory information through visualization technology has important theoretical and practical significance for ship management, maritime supervision, trade analysis and so on [2].

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By AIS data and ship pollutant emission data, when ships enter the jurisdiction, when they discharge pollutants and when they leave the jurisdiction can be known. By AIS data, the whole process of ship pollutant emission can be known. For improving ship water pollutant emission, a ship pollutant monitoring system based on AIS data is implemented. The emission of ship pollutants and the location of the ship can be gotten in real-time.

## 2. Requirement Analysis

The electronic management of the whole process of receiving and transferring ship water pollutants based on AIS data is established, and the data exchange and sharing is realized between local maritime, port and shipping, ecological environment, housing and construction and other relevant units. The system is provided to the personnel of maritime system units, transportation system units, residential construction system units and ecological environment system units. Using the functions provided by the supervision workbench, the system can query, statistics and analyze the ship pollutants applied by the crew, and realize the whole chain supervision of ship water pollution application, reception, transfer and disposal. The main functional structure is shown in Figure 1.

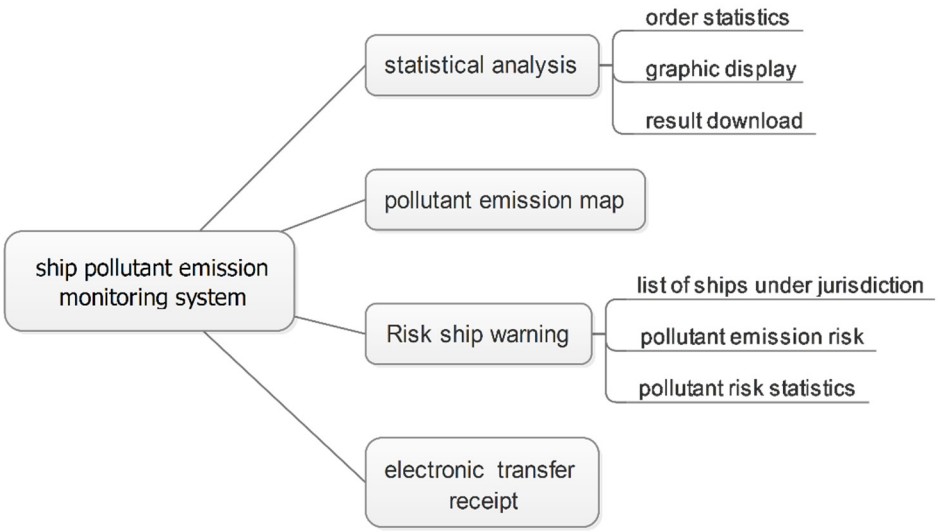


**Figure 1.** User requirements diagram

## 3. System Design and Implementation

The system adopts B / S architecture. According to the design idea of MVC and the development mode of separation of front and rear ends, the system is divided. The system mainly includes view layer, controller layer, business logic layer, persist layer and data storage layer [3]. For the data storage of inbound and outbound reports, Doris cluster is used for storage. The back-end uses the Spring Boot framework to accelerate the background development. The front-end uses the Vue cli scaffold to realize the rapid construction of the front-end Vue framework. At the same time, the front-end UI (user interaction interface) uses the element UI in the Vue CLI ecology to provide users with a good interactive experience. The overall architecture is shown in Figure 2.

The back-end is based on the Spring Boot architecture and it is composed of data layer, data logic layer and business logic layer [4]. The data layer mainly includes the AIS data and ship water pollutant emission data. The data is stored in Doris database. The business logic layer is mainly responsible for the operation of the data layer and the logical processing of the data business, including the control module and the service module. The system responds to the

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corresponding JSON data according to the request of the front-end user. For example, when requesting business for the number of ships, the service module marks the class with the @service annotation, marking that the current class is a service class. Adding this annotation will automatically inject it into the spring container, so it is not necessary to use the @service annotation in the application Define beans in the XML configuration file. Then bind Dao components by labeling @autowritten. The labeled member variables need to be configured in the XML file, and the corresponding setter and getter methods need to be removed from the program.

| | |
|---|---|
| View Layer | Vue.js+ Element UI |
| Control Layer | Spring Boot Controller |
| Business Logic Layer | Model+Busniess Object |
| Persist Layer | MyBatis plus |
| Data storage Layer | Doris + Redis + MySQL |

**Figure 2.** System architecture

The front-end is based on MVVM mode and implemented by Vue architecture. The front-end consists of model, view and ViewModel [5]. The model layer represents the water pollution data model, and the view represents the UI component. It is responsible for transforming the data model into UI display, including map display, list query, chart display, etc. ViewModel is an object that synchronizes the view and model. The ship dynamic map module displays the ship pollutant emission information and its location in the form of map. The map results are shown in Figure 3.

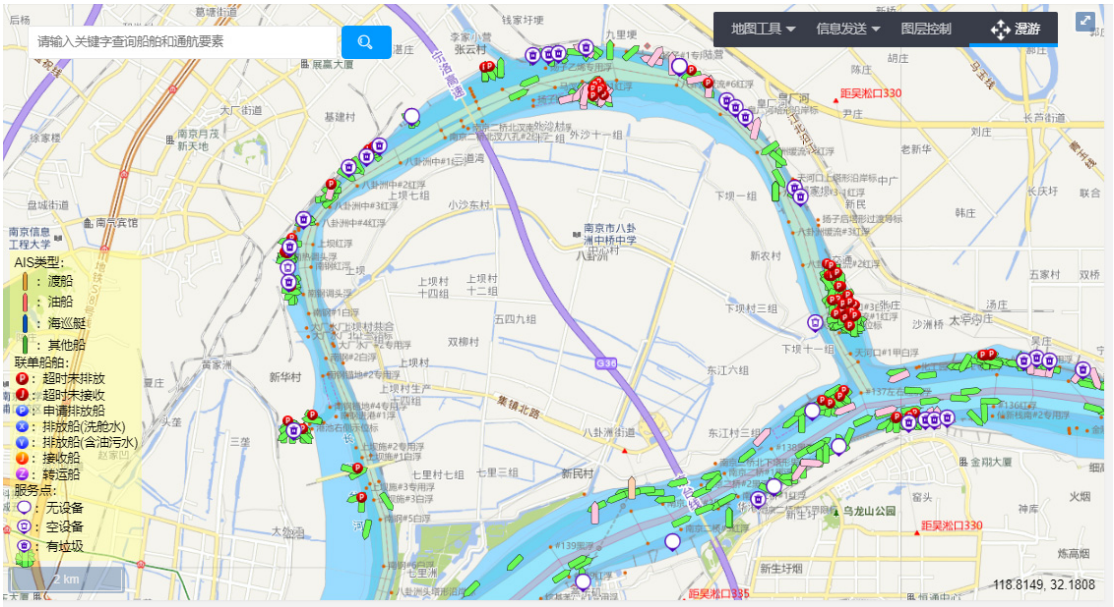


**Figure 3.** Ship water pollution monitoring interface

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The electronic navigation map shows all ships that have not been discharged after timeout, and the mark is a round red background with P in the middle icon. The user clicks the words "timeout not discharged" to pop up a list of all timeout not discharged ships in the jurisdiction, showing the specific information of timeout not discharged ships, ship name, ship type, latest discharge time, nationality, ship owner and contact number. The list can be queried according to the time-out area of the ship or the time-out area of the ship that has not been sent to the lower level, or the list can be queried according to the name of the ship that has not been sent to the lower level.

## 4. Conclusion

According to the characteristics of waterway transportation, combined with the characteristics of ship pollutants, from the perspective of environmental protection and convenient transportation, grasp the key links and prominent problems of ship pollution disposal, establish a whole chain closed-loop management mechanism from generation, reception, transfer and disposal with relevant departments, open up the information island between various departments, and promote the integration, sharing and collaborative supervision of information systems. Based on AIS data, master the ship emission dynamics in real time, build a ship water pollutant real-time monitoring system, use Doris to store massive AIS and ship pollutant emission data, obtain the data through spring booth, display the data through Vue framework, and display the map in Mapbox. The system is tested in the real environment, and the results show that the system scheme is feasible.

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