Development of the Real-Time Monitoring System for Analysing the Aquatic Epidemics Tendency

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Abstract. Under the rapid development of globalization, the prevention and treatment of aquatic epidemics has caused widespread concern due to international trade exchanges frequently. Although the epidemic disease information is gathered and published by World Organization for Animal Health (OIE) in regular, some vital characteristics of such disease are not able to obtain directly. Therefore, this technical paper designs a real-time monitoring system jointed Geographic Information System (GIS) and view tables, which aims to help managers or scholars to analyse the aquatic epidemics tendency between the different species and districts. There are mainly three contributions in this paper: (i) the real-time monitoring system of aquatic epidemics researches is first developed from the worldwide perspective; (ii) system provides the superior visual results of statistical analysis on user interface based on the technical processing on data association and light or colour intensities presentations; (iii) Furthermore, the web service is constructed and extended on the separation framework contained web frontend and backend the purpose of which is to reach efficiency of exploitation and failure process.

1. INTRODUCTION

With the deepening of globalization and international interdependence, trade cooperation between various countries has become more and more frequent, especially in the field of import and export of aquatic products. Under the conditions presented, the risk of aquatic epidemics has also increased. More than 40.8-billion-yuan economic losses from aquaculture diseases, according to the 2020 Aquatic Animal Health in china reports [1]. Hence, it is necessary to build animal disease information system to monitor and predict dynamically the outbreak events such as Decapod Iridescent Virus 1 (DIV1) Infection, and Ostreid Herpesvirus-1 taking place, distribution, propagation.

There are presently few researches on the real-time monitoring of aquatic epidemics in worldwide. Comparatively, some studies have been carried out by Rhee [2] and Joseph [3] based on special species or water environments in other aspects. As informatization progresses in agriculture, various visual technologies and products are forcefully developing and introducing as well, like real-time sensing technology, Internet of Things and ArcGIS technologies. Therefore, this technical paper develops a real-time monitoring combined with Geographic Information System (GIS) to analyse the aquatic epidemics tendency with the intention of avoiding economic loss and human health. To reveal the aquatic epidemics tendency clearly, a comprehensive approach that includes GIS, visualization techniques and web crawler technology is put forward for addressing this issue. Additionally, four interactive interfaces
designed by associating diseases and species are developed to support the operates that displaying and querying spatial data.

The rest of this paper is organized as follows. In the next section, the design of monitoring system and data collection processing are introduced briefly. Subsequently, the detailed system function implementations, including the development environments and the system functions mainly, are given in section 3. In addition, we assess the correlation analysis functions in term of statistical analysis and some display modules of fisheries disease. Finally, section 4 concludes the article.

2. DESIGN OF MONITORING SYSTEM

2.1. Selection and adoptive technologies
In order to enhance the corresponding page speed and release the server-side resources timely, this monitoring system adopted the separation framework contained web frontend and backend. The system architecture diagram is described in Figure 1.

Figure 1. The monitoring system included frontend and backend Web separation technologies.

Just as in Figure 1, this framework is divided into two stages: the background provides data, and the frontend is responsible for display. Specifically, the fronted and backend have only server separately, which means they simplify the expression of communication between the client and the server through JSON, CSS, Http REST interfaces [4]. Compare with the integration framework, the proposed method has the vital advantage because of the processing that data management and implementing business logic are constructed separately.

2.2. Distributed data collection
The system mainly monitors and captures the latest epidemic report data published irregularly on the official website of the World Organization for Animal Health (OIE). All the data is then extracted, transformed, loaded by adjusting the cleaning processes and saved to the aquatic disease data warehouse. For purpose of describing clearly the data processing of server platform, the overall working flow of the system is summarized as shown in Figure 2.
As shown in Figure 2, the collection system comprises two main sub-module which includes original information collection module, data processing module. First, Raw data are collected by setting Slave nodes, DOM analysis with intention of processing OIE outburst data. Subsequently, the series of operations are performed to meet this requirement of business data like Master code operate, Hash code validation, etc.

2.3. Database construction
PostgreSQL is selected as the backend database of system due to its advantages: owning strong stability, strong pressure resistance and compatible with GIS technologies [5]. The system mainly includes three stages: data crawler, data standard warehousing and data overlay analysis. According to the function of the database design, system is divided into the original database and the business database. The original database directly stores the data information returned to OIE, mainly including the original web pages, and business database is composed of a variety fishery disease data sheets so as to mobilize expediently for background administrator. The ER diagram of disease as shown in Figure 3.

It can be from Figure 3, several database tables are decomposed and cleaned based on data attributes from the OIE original data, for example, the control measure table is obtained by means of extracting the descriptive information of weekly reports. Furthermore, knows about differences in data semantics and types that also is crucial to success structure system database. Ultimately, these entity table being broken up are associated with disease, time, and regions, etc., which greatly provides the efficiency of data storage.
3. SYSTEM FUNCTION IMPLEMENTATION

3.1. Development environment setup
To achieve real-time monitoring effect and meet the high concurrency requirements, the development environment of the system is shown in Table 1.

| Element                  | Configurations                                      |
|--------------------------|-----------------------------------------------------|
| Data storage             | PostgreSQL9.6                                       |
| Client operation         | Web Browser (chrome)                                |
| Caching technique        | Redis                                               |
| Language                 | JAVA, PHP                                            |
| Development tools        | Vue, Echarts, GIS                                    |
| Operating system         | Linux (ubuntu16.0 or above)                         |
| Web server               | Tomcat8                                              |

3.2. Assessment of system functions

3.2.1. Main functional module
In this section, we first analyze that OIE data from different perspectives in order to come up with a best design of user interfaces for global aquatic epidemics monitoring. The system divides into four modules according to data characters of diseases: time dimension display module, diseases dimension display module, region dimension display module and search request module. The main functional modules are illustrated in Figure 4 as below.
As shown in the Figure 4, the main functional modules contain three areas, the real-time monitoring area in centre, the latest epidemic outbursts area on the left and the species information on the right. The monitoring information regarding the number of outbreaks and areal distribution is real time displayed on list and geographical map based on GIS and web spider technologies. Meanwhile, the detailed data of every bursting point are displayed by means of clicking on map or in left-side list. During the monitoring management, the diverse diseases and the infected species are arranged according to amount on the right side of interface.

It is important to point out that there is a cross correlation between aquatic species and infectious diseases, i.e., one species may be infected by different types of epidemic or a disease may affect more than one species. Under the conditions presented, the statistical rankings in term of diseases, species and regions are given respectively so as to alert the risk for businessman and policy manager.

3.2.2. Correlation analysis functions

It is widely known that the feature of aquaculture disease normally lies in localization and timeliness. In this sub-section, two analysis referring to unique disease and region are presented to reveal the trend in throughout the world. The regional features are depicted in Figure 5.

As seen in Figure 5, the changing trends in term of concern disease such as the outbreak amount, affected regions amount, and the infected species are described in right with statistics or imagery form. Presented in the interface left is data analysis that involves ranking regions and infected species via selecting a specific disease. Depending on the application filter, the diversity from different epidemic can be recorded at a spatial map clearly. what's more, the overall information of disease is integrated into the spatial position, which is linked to tabular data to improve the analysis efficiency. Finally, we also develop the search function for offering the personalized service of original report delivery.
4. CONCLUSION

In this study, we develop the real-time monitoring system in accordance with web separation and GIS technologies for analysing the aquatic epidemics tendency in throughout the world. The key benefit of this system is that it provides overall management of the aquaculture disease and deliverables, thus improving the probability of prevention early. This platform is mainly composed of four blocks: the home page, the disease page, the district page, and the search page. Compare with the data capture and visual design generally, this monitoring system has a vital procedure that data are captured and transformed through the ER database table.

With respect to the functions of platform, statistics and visual graph around diseases are presented directly to describe the variation trend to some extent. In summary, the system indeed is promising to improve the possibility success of preventing aquatic epidemic outbreaks and it can also be extended to third-party services.

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