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Internet + maritime emergency management platform – a case study of the Liujiaxia reservoir area in Gansu Province, China

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Abstract

With the development of tourism in the inland waters, various types of accidents in the waters have posed a great threat to human life, property, and the environment. This has caused concern in all circles of society. According to water tourism safety issues, and relying on Internet technology, shipping safety, and public safety management theory, this paper has proposed the concept and design plan of an Internet + maritime emergency management platform. This platform includes functions such as the intelligent perception of a ship's navigation status, the scientific selection of a maritime emergency rescue site, the emergency rescue scene, the online dynamic management of maritime emergency resources, and the online production of a maritime emergency rescue plan. The design scheme has been used in the platform's development. This paper has taken the application of the Internet + maritime emergency management platform for the Liujiaxia reservoir in the Gansu Province of China as an example. The results showed that the design of the platform that has been proposed in this paper is reasonable and that it can provide scientific, fast and accurate decision information for emergency command in the Liujiaxia reservoir and improve the effective control of the accident site as well as the use of resources.

Introduction

In recent years, with the rapid development of the economy in China, water tourism in reservoirs and lakes has become one of the most popular tourist attractions. With the popularity of tourism rising, the reservoir's area and the lake's area have attracted many passenger ships. With the development of the local economy, the incidence of accidents has also been increasing sharply. This kind of accident poses a greater risk and will lead to a large number of deaths. Therefore, it is very important to ensure the safety of water traffic and reduce the damage caused by accidents.

Water traffic safety has captured a great amount of concern in the past decades (Montewka et al., 2014; Prabhu Gaonkar et al., 2011). The research into water traffic safety has included the normal navigation of ships as well as post-accident emergency response. For normal navigation, the Maritime University of Szczecin has developed a navigation decision support system (NAVDEC) for sea-going vessels, and this may contribute to the enhancement of navigational safety by the Intelligent Algorithm (Pietrzykowski, Borkowski & Wołejsza, 2012). The Internet of Vessels (IoV) was proposed to integrate advanced technologies into a platform to ensure that ships benefit from the Internet of Vessels to improve the efficiency and safety of shipping and promote the development of world transportation (Tian et al., 2017). For post-accident emergency response, domestic and foreign scholars have carried out extensive research into the water emergency management system. Emergency management, which is

also known as crisis management, refers to the government and other public institutions taking action. When emergency prevention is implemented, the authorities will take a series of measures to protect the public and property, including emergency response, the necessary coping mechanisms etc. Japan put forward the "Japan Disaster Countermeasures Basic Law", as protection against water disasters to form a comprehensive emergency management system, including prevention, emergency response and work summary (Gan, Xu & Zhang, 2010). Britain proposed the "Domestic Emergency Law" to improve water traffic safety. According to the bill, the British established a legal system aimed at water emergency management, as well as a complete emergency system platform (McEntire, 2003). The United States promulgated the "Federal Emergency Plan", intended to maximize the protection of human life, material resources and financial resources (Liu, 2014). The Canadian government established a set of emergency management systems with hierarchical management. This has made the whole emergency management system more complete and efficient (Liu, 2004). In addition to these theoretical studies, combining information technology with emergency management has become a hot topic in emergency management. Decision support systems (DSS) WITOIL are crucial when facing oil spills which could have severe impacts on the Mediterranean Basin and they also contribute effectively to the reduction of natural disaster risks (De Dominicis et al., 2013a, b). DSS Ocean-SAR (Coppini et al., 2016) supports search-and-rescue (SAR) operations following accidents and the Early Warning system manages alerts in case of extreme events by providing near-real-time information on weather and oceanographic conditions. The Vessel Traffic Services (VTS) System is provided by The Marine Department. With the VTS system, Vessel Traffic Service Operators are able to provide traffic information and advice to mariners by VHF communication (Gwiazda, 2006). Closed Circuit Television (CCTV) system cameras can be used in maritime management, providing real-time images to vessels to improve the maritime emergency response capability (Zhao, 2005). The maritime emergency management platform should be combined with the emergency management process, which includes the optimal layout of the emergency resource site, the alarm, the emergency response, and the selection of the emergency plan and emergency resource allocation and other comprehensive plans (Turoff et al., 2003). Researchers have established the emergency management system of the maritime emergency platform, such as an emergency command platform, an integrated information management platform, an emergency linkage command platform and so on. These maritime emergency platforms can play a unique role in the face of different obstacles (Wang, Liu & Li, 2011; Zhang et al., 2011; Pettersen & Asbjørnslett, 2016).

From the above research, it can be seen that a comprehensive emergency response system, based on the whole emergency response process, is lacking. So this paper has proposed the concept and design plan of the Internet + maritime emergency management platform. This platform includes functions such as the intelligent perception of a ship's navigation status, the scientific selection of a maritime emergency rescue site, an emergency rescue scene, the online dynamic management of maritime emergency resources, and the online production of the maritime emergency rescue plan.

Platform framework and functional design

Frame design

The emergency management process includes the optimal layout of the emergency resource site, the alarm, the emergency response, the selection of the emergency plan and emergency resource allocation and other comprehensive plans. This platform has summed up the experience of the entire emergency management process, and the platform's design framework has been shown in Figure 1. The construction plan of the platform has been shown in Figure 2.

The system's platform is composed of a data layer, a platform layer, and a function layer. The data layer is the basic guarantee provided to the platform. The platform layer is the core component of the whole platform, and the function layer is the technical display of the platform. The data layer is the blood of the platform, including ship information, rescue site information, meteorological information and rescue personnel information. The platform integrates information from different sources to realize data acquisition. The platform's layer is the heart of the platform, including data interfaces, process control, data management, role permissions, and portal management. The input data is processed by the core algorithm in the platform layer to realize the functions of the platform. Last is the function layer, which implements the functions, such as the intelligent perception of a ship's navigation status, a ship's risk prediction, scientific layout of the emergency rescue resource

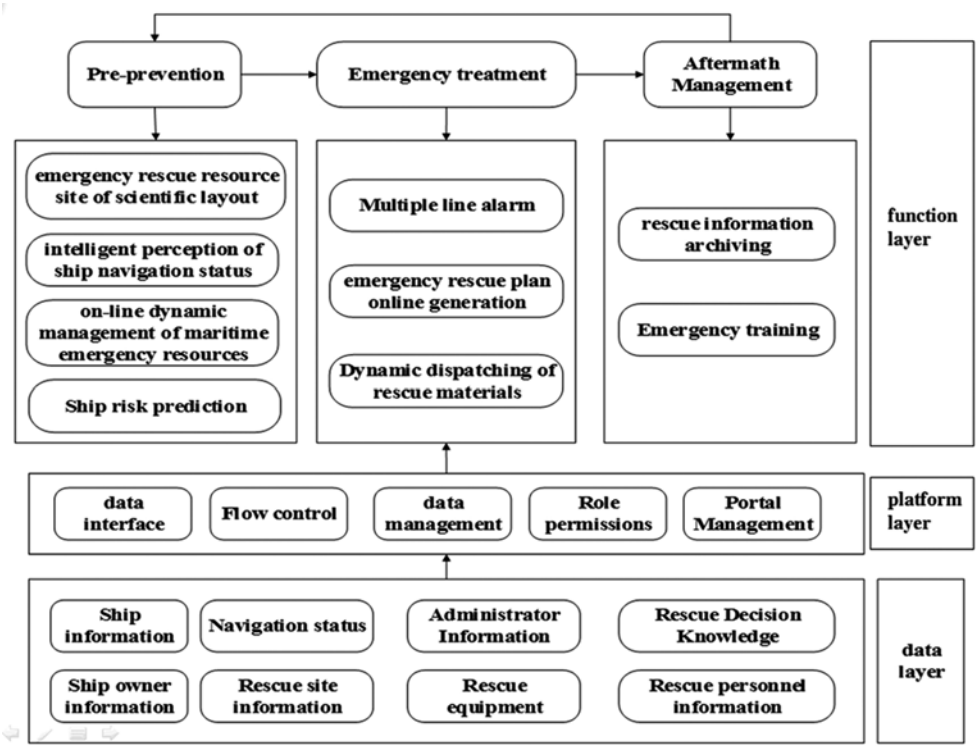

Figure 1. The platform's design framework

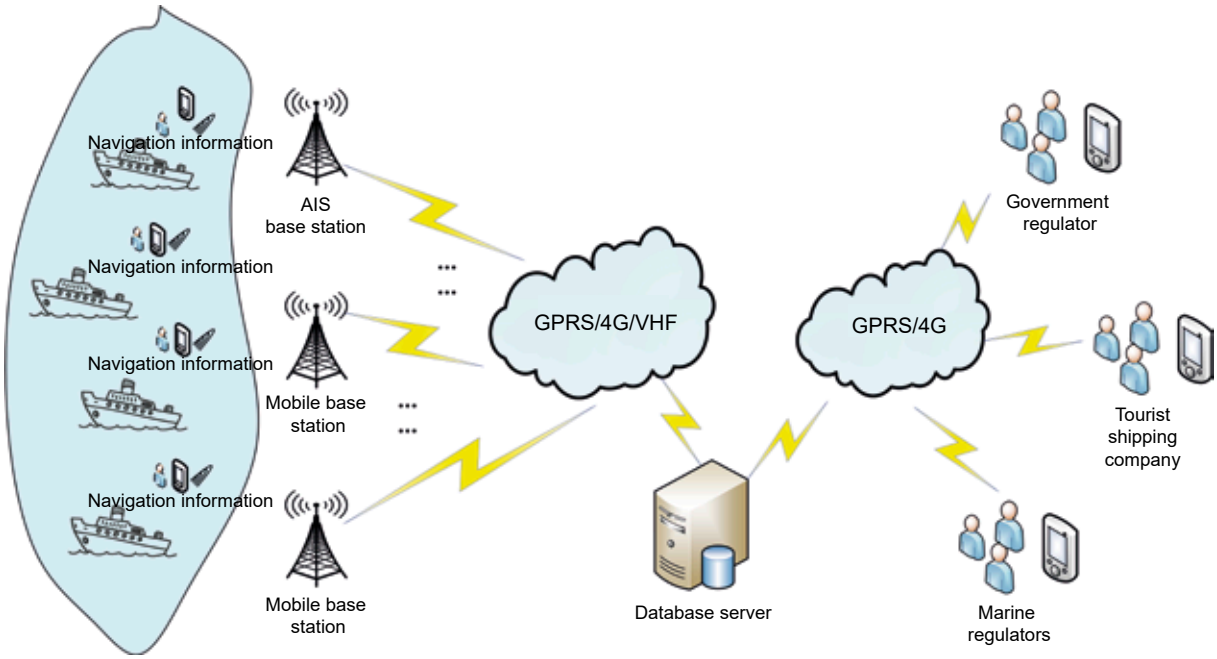

Figure 2. The construction plan of the platform

site, online dynamic management of maritime emergency resources, online generation of the emergency rescue plan, and rescue information archiving, etc.

Internet+ emergency management system

Intelligent perception of a ship's navigation status

This system obtains a ship's position information through a smart mobile phone. According to a plurality of a ship's location information in a short time, the ship's location, real-time status information, and the speed of the ship can be obtained. The above dynamic information is integrated with the static information of the ship to compose the completed virtual ship AIS information. Through the mobile network or Very High Frequency (VHF) radio waves, the information interaction between the ship and another ship, and the ship and the system

platform can be realized. At this point, the system platform can be used as a virtual VTS to monitor the status of a tourist ship and provide a guarantee for the safety of the ship's navigation.

Online management of rescue sites and rescue resources

The system platform has adopted the improved P-median location model to optimize the location of the emergency resource site in the water. The P-Median (Zhang et al., 2016) base model is used to locate the P emergency rescue site, the sum of the shortest distance (minimum time) of all emergency resource requirements to the P emergency resource site is then minimized. In addition to the shortest distance, the security risk of the emergency demand point is also considered. The risk is the safety risk weight (the safety risk weight is determined using the Analytic Hierarchy Process (AHP)) of the emergency rescue site to the emergency demand point and the nearest emergency rescue point distance product (called risk-weighted distance).

After the establishment of the resource site, the rescue resources in each site ask for online management and classification. On-line resource management can handle the distribution of emergency resources in real time. When an accident occurs, the platform will find the largest number of emergency resource sites according to the location of the accident. At the same time, the deployment of the emergency resource situation will also be displayed in real time on the system platform.

Generating an online plan for the emergency rescue

The platform will realize the digitalization and standardization of the emergency plan, as well as establish an optimal emergency system and the standardization of operational procedures. According to the actual accident type, accident grade, accident location, and other information, a targeted emergency plan is then generated. This relies on the accumulation of large amounts of data and a successful emergency program.

Emergency rescue dynamic scheduling

The dynamic dispatching of emergency rescue is the next part of the emergency work of the online generation of a maritime emergency rescue plan. According to the emergency rescue plan, it is convenient to achieve dynamic resource scheduling and real-time emergency resource allocation adjustment. The scientific and reasonable dynamic scheduling of emergency resources is then realized in the shortest possible time.

Hardware and software systems

The whole platform is composed of a hardware system and a software system. The platform's

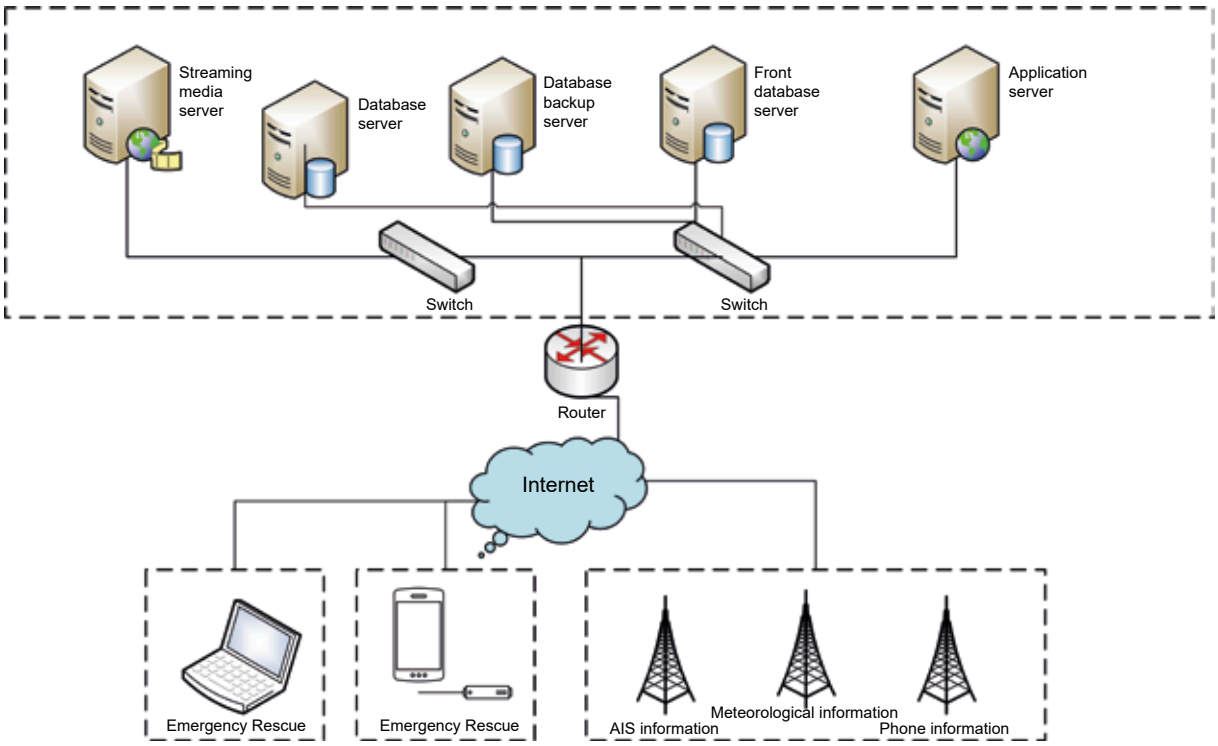

Figure 3. Hardware system composition

hardware mainly includes a splicing display, a computer, a stitching processor, a splicing cable, a server, a mobile phone and so on (Figure 3). The hardware is the carrier of the software system. The server is the carrier of the whole platform, and the server and the computer are connected through the Internet. The information is displayed on the computer screen and projected onto a large screen.

The software system processes the navigation information collected by the smartphone and the environmental information received by the sensors, and it involves the core algorithm, which realizes the function of the whole platform. The Internet + the maritime emergency management platform (APP) is installed on smart mobile phones, providing a new mode of an office whenever and wherever possible.

Application example

Application fields

Gansu Province is located in the northwest of China and belongs to the Inland area. With the development of water tourism in Gansu Province, the shipping routes in the Liujiaxia Reservoir Area have become busier. However, there are some problems in the Liujiaxia reservoir area, such as a large water area and an insufficient allocation of rescue forces. When an accident occurs, it will cause great losses. Therefore, in order to protect the safety of tourism, this paper has applied the design scheme of the Internet + maritime emergency management platform to the Liujiaxia reservoir area.

Application of the design scheme of the Liujiaxia reservoir products

Liujiaxia reservoir maritime emergency rescue involves the Gansu Waterway Bureau, the Linxia maritime bureau, and the relevant county area maritime bureau. How to implement the emergency rescue work of the specific prevention and management decisions is the key problem to solve. Therefore, as shown in Figure 4, the construction of three levels of maritime emergency management platform, provincial, state and county can solve the above problems.

The user of the platform is part of the maritime affairs department of the province, prefecture, and

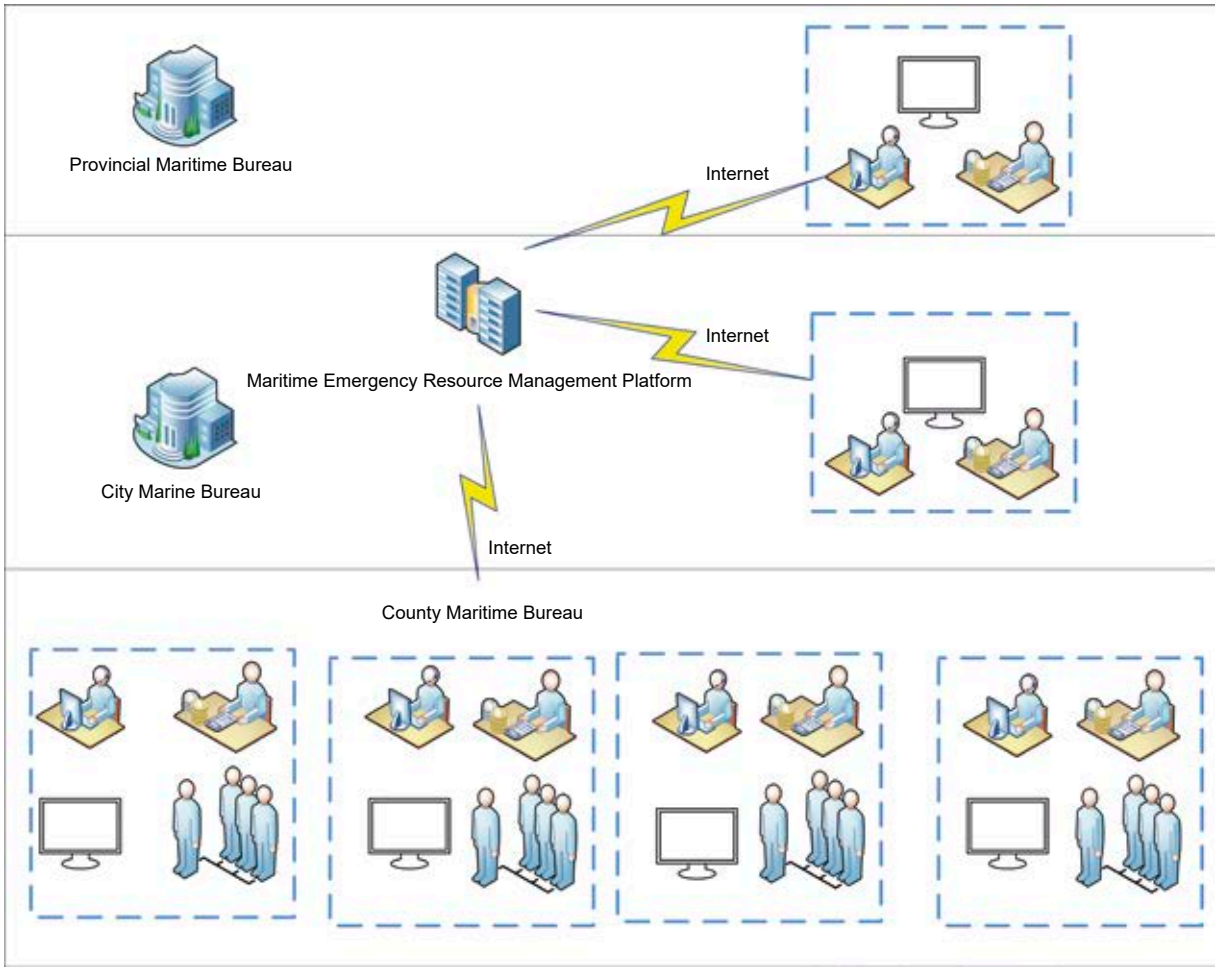

Figure 4. The platform's organization framework

county. The goal of the platform is to achieve its purpose based on GIS, and the platform can view the emergency rescue site, equipment, material, personnel, and other information. The Liujiaxia reservoir emergency rescue should include emergency resource management, rescue process management, training management, accident analysis etc. The function of the whole platform needs to meet the needs of the various applications.

Function of the platform in the Liujiaxia reservoir area

The Liujiaxia reservoir maritime emergency management platform exchanges data by virtual AIS to realize the sharing of resources. The platform combines big data and Internet technology, and can rapidly analyze the emergency resources, navigation information, hydrological data, and meteorological data, and integrate the best scientific rescue program to improve the efficiency and success rate of a rescue. The functions of the system include system management, rescue power management, accident warning, emergency rescue process management, rescue results management, etc, which are defined as follows:

(1) System management

This function includes the functions of organization structure management, user management, role distribution, standard code management and so on.

(2) Rescue power management

This function refers to the system's management of rescue personnel, rescue ships, rescue resources, and energy information. In the event of an accident, this function can dynamically coordinate rescue power.

(3) Accident warning

This function is to predict the occurrence of accidents by monitoring the waters and ships and to avoid accidents as much as possible.

(4) Emergency training management

This mainly includes management of the training plan, training log, training personnel, training place, training effect analysis, current training stage, etc.

(5) Emergency rescue process management

This includes an emergency rescue plan, rescue process information display, and leading rescue group information view, accident scene GIS display and other management functions.

(6) Rescue results management

This function refers to the analysis of the cause of an accident, archiving rescue results, archiving information queries and so on.

Product display

The emergency rescue management platform for maritime application was tailored for Gansu's Liujiaxia reservoir, which is known as the "Internet + maritime emergency management platform for the Liujiaxia reservoir". In the past year, the construction of the platform has received high praise from users.

There have been many application examples, such as in Figure 5 for the home page of the system and in Figure 6 for the system's pages. Figure 7 has shown the mobile client application interface, the basic design of the functions is similar to the web page.

Figure 5. Liujiaxia reservoir area emergency management system home page

Figure 6. Liujiaxia reservoir area emergency management system function display

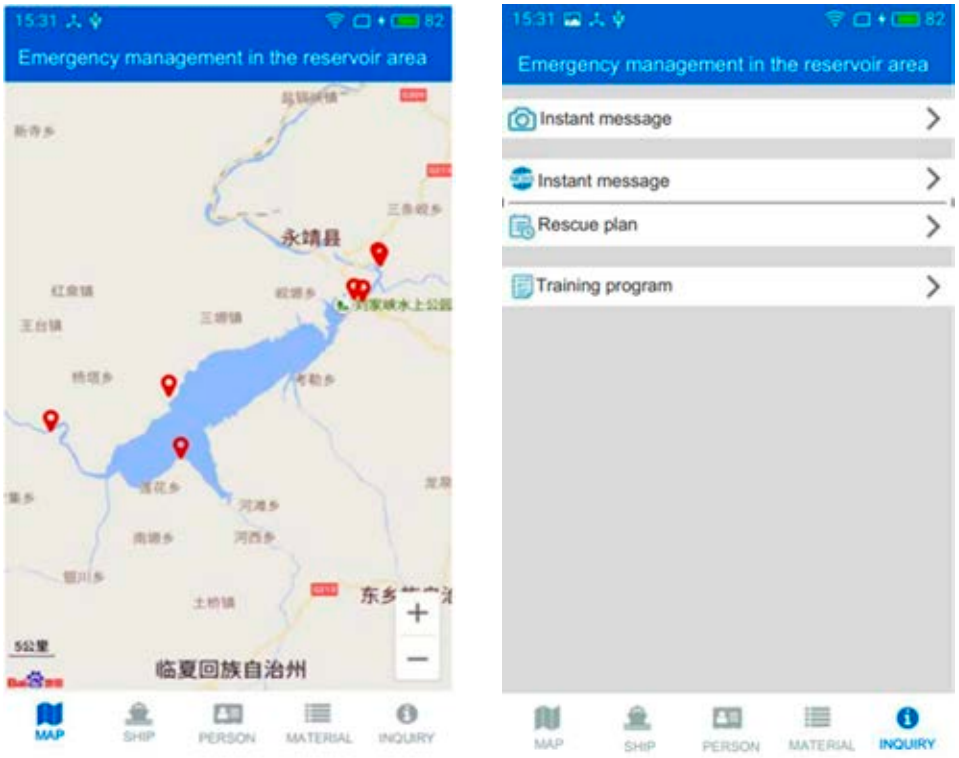

Figure 7. Mobile application interface

Conclusions

The framework and algorithm to form the Internet + maritime emergency management platform have been designed in this paper. This platform is the first professional maritime emergency platform in China. The platform has achieved intelligent perception of a ship's navigation status, the scientific choice of maritime emergency rescue sites, the online dynamic management of maritime emergency resources, the online generation of the maritime emergency rescue program and other functions. The platform has provided technical support for the supervision of traveling ships, ship risk warning, and emergency rescue. After one year's operation in the Liujiaxia reservoir, when it has faced emergencies on the water, through emergency rescue information sharing, this platform was able to provide scientific, fast and accurate decision-making information and dispatch all kinds of resources in a timely and effective manner for emergency command. The implementation of dangerous control and rescue work has aimed to reduce the

threat to ships, increase the safety of people as well as the water environment, achieve the most effective control with the least resources and ensure any loss is within the smallest range. In addition to the Liujiaxia reservoir area, the platform was further promoted and has been applied in Liangzi Lake, and good user feedback was obtained from there.

However, Mobile networks do not cover areas far from the shore, so the communication of this system will be limited in these areas. Currently, the system can only be applied to inland waters. Besides, due to the lack of sufficient rescue data, the system cannot use big data for intelligent, accurate and real-time online emergency response at this stage. In future research, big data analysis and artificial intelligence deep learning algorithms will be combined to build a more efficient emergency management platform.

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