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Application of Cloud Computing in the Early Warning Management of Chemical Water Pollution Accidents

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To study the application of cloud computing technology in the early warning management of chemical water pollution accidents, the early warning management platform of chemical water pollution accidents is built based on the cloud computing technology, modern information technology and communication technology. The platform combines the cloud and terminal and then analyzes the application of cloud computing in the early warning management of chemical water pollution accidents. The early warning management of chemical water pollution accidents designed in this paper can timely collect, process and transmit the information of chemical water pollution accidents and can timely feedback the information to relevant departments. This system can save the development cost of chemical enterprises and improve the efficiency and quality of the early warning management of chemical water pollution accidents, which is of certain application value.

1. Introduction

The rapid development of the chemical industry is accompanied by serious environmental pollution, including water pollution, solid waste pollution and air pollution. Among them, chemical water pollution accidents are mainly caused by factors such as climate, traffic accidents and inaccurate transport personnel, which account for the largest proportion of all chemical accidents. Once a chemical water pollution accident occurs, the surrounding ecological environment will suffer serious damage. The heavy metal components in the water body will flow downstream through rivers, exerting serious impact on the health of residents in the polluted area and increasing the economic loss in the area. In order to effectively reduce the incidence of chemical water pollution accidents, some chemical enterprises have already established the early warning management system for chemical water pollution accidents, but producing very little effect. At the same time, with the rapid development of information technology, the cloud computing technology have been generated and developed. At this stage, the cloud computing technology has been widely used in all walks of life in China and has achieved certain results. The application of cloud computing technology in the early warning management of chemical water pollution accidents can effectively improve the deficiency of the early warning management system for chemical water pollution accidents in enterprises, which is of great practical significance.
In order to thoroughly study the application of cloud computing technology in the early warning management of chemical water pollution accidents, this paper uses the cloud computing technology and refers to the needs of the transmission timeliness, internal management and early warning system of water pollution information. The early warning management platform of chemical water pollution accidents is built based on the cloud computing technology, modern information technology and communication technology. The platform combines the cloud and terminal and then analyzes the application of cloud computing in the early warning management of chemical water pollution accidents.

2. Literature review

Environment and development have always been a common concern in the world. Among the top ten environmental incidents that threaten humanity, two of them are related to chemical pollution. Since the 1960s, developed countries have gradually built chemical parks and gradually become the mainstream of international development. The study of sudden water pollution accidents in foreign countries has focused on

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the risk assessment of sudden water pollution incidents in the sea for a long period of time. However, there are few studies on the risk assessment, analysis and early warning theoretical system of sudden pollution accidents in non-sea areas.

The event decision network (EDN) is analyzed and evaluated. This method can accurately analyze the impact of oil spill on marine ecological environment (Lan et al., 2015). Through the analysis of coastal fixed and mobile risk sources, the impact of water pollution incidents caused by sudden oil spills on the ecological environment of the coast was analyzed and assessed (Zhang et al., 2015). Black developed a new oil spill impact model application package (SIMAP) based on the natural resource damage assessment (NRDA) model. This model can be applied to the assessment of the loss of natural ecological resources of various oil spill accidents. It has universal applicability (Black et al., 2014). The cumulative effects of the proliferation of hazardous substances and the potential threats to the environment from the spilled substances are considered. Based on this, the proliferation of dangerous chemicals was numerically simulated (Yao et al., 2016). Due to the dose-effect relationship of environmental pollution accident hazard assessment, it is currently difficult to determine the degree of damage to the ecosystem. The pollutant concentration value is used to indicate the magnitude of the hazard consequences. The risk grading scale method was used to assess the risk of environmental pollution accidents caused by inland river transport (Choi et al., 2014). Ding et al. developed an environmental risk management system that can depict the degree of impact of the spread of dangerous chemicals on human health, surface water, and soil resources. These four risk factors are integrated into a risk assessment system. The system can be applied to many fields such as transportation of dangerous chemicals, emergency rescue of hazardous areas in parks, and safety planning (Ding et al., 2017). For the study of risk assessment indicators, the "environmental accident index" method was proposed. This model is suitable for accidental dangerous chemical spills. First, the factors that affect the consequences are graded. Secondly, it is applied to the recognition of environmental impacts and the rapid semi-quantitative classification of dangerous chemical spills (Vélez et al., 2014). Statistics show that there has been an increase in pollution accidents in the water environment. For example, an explosion at the Sinopec Jilin Petrochemical Company's Shuangbang Plant caused serious pollution in the Songhua River. The data released by the National Bureau of Statistics shows that in recent years, the number of water environmental pollution accidents in China has been declining. However, the economic losses caused by water environmental pollution accidents have not been correspondingly reduced. It presents a fluctuating trend. The average economic loss of the accident has increased. The degree of harm and the scope of influence of a single water pollution accident are increasing. The harm intensity of water pollution accidents has increased.

Early warning and processing systems for water pollution accidents developed earlier in some economically developed countries. In addition, it has also developed in North America (the United States, Canada), Europe, Asia, Japan, and South Korea. Most of these countries' water quality early warning systems monitor pollutants after major water pollution incidents. They did not propose emergency treatment technologies for various types of pollutants. The following describes the early warning emergency response systems of various countries in the world. The Ohio river water quality early warning system monitored the water quality in the downstream areas of the mainstream and major tributaries of the Ohio river. Subsequently, the system was improved on the basis of the original, so that it has a more complete pollutant diffusion model, data collection and transmission system and network sharing system. It laid the foundation for better early warning and emergency response to sudden water pollution accidents. There are already more than 30 water quality monitoring stations on the Rhine and the world's largest system of biological indicators (including fish, algae, leech, shellfish and bacteria) III has been built. A water quality warning system including three water quality monitoring stations was established on the Severn river. The early warning system has been fully automated and can perform real-time online monitoring of a variety of water quality indicators. The French Water Group built a complete water quality early warning system. The system includes a number of monitoring stations with automatic analyzers and automatic detectors. The system can store historical data information. When a sudden accident occurs, it can make timely and accurate determination of the nature and characteristics of the event, and then compare it with history-related information to find the best solution. The monitoring and warning system also includes monitoring, automatic analysis and prediction model system. In Asia, South Korea inS00lee uses NSPLM. SPLM water environment mathematical model. Combined with the ArcView software of ESRI company, the change of water quality is predicted by determining the amount of pollutant discharge. The water environment management system of the basin has been developed. Korea also successfully developed water pollution warning systems using wicker fish and leeches. Using hydrodynamic models and arcobjects GIS component development techniques, the flood forecasting management system for the Caparo River Basin was developed (Hou et al., 2014). Japan has established the Yodogawa river water quality monitoring and early warning system. In general, the emergency warning and emergency response system for sudden water pollution accidents abroad has been quite mature.

To sum up, with the continuous development of urbanization and social economy, the sudden occurrence of water pollution accidents has caused great losses and threats to the national property and social security and the health of the people. Water environmental problems have become increasingly prominent. Sudden water pollution accidents have received increasing attention as an aspect of environmental issues. The sudden pollution of the water environment not only causes serious economic losses, but also threatens the health and life of the residents. It also affects social stability and ecological balance. As a result, it is difficult to restore the ecological environment, cause serious damage to the ecological environment, and seriously hinder the development of social economy. Therefore, effective prevention of water environmental pollution accidents is an urgent problem to be solved. In addition, China's chemical industrial park has a tendency of developing from east to west. Chemical accidents occur frequently, which makes water environmental pollution accidents more concerned. Based on the above research status, cloud computing is applied to the early warning management of chemical water pollution accidents.

3. Method

In the transaction management system, a large number of application examples have verified the possibility and advantage of introducing cloud computing technology into the transaction management system. In the scene of emergency water pollution accidents, the data of the accident information can directly access the cloud computing processing platform through the network for the processing and the results of computing process can be obtained on the mobile platform.

3.1 Construction of System Architecture

The early warning management system of emergency water pollution accidents consists of two parts: the client and the cloud. The client adopts the mobile platform architecture of the J2ME solution. The cloud adopts the cross-platform and highly stable technology as required. The cloud data storage platform adopts the Microsoft SQL Server 2012 to provide stable and secure services for data storage, transfer and visualization. The entire early warning management system of emergency water pollution accidents adopts the hierarchical design and its business structure is shown in Figure 1.

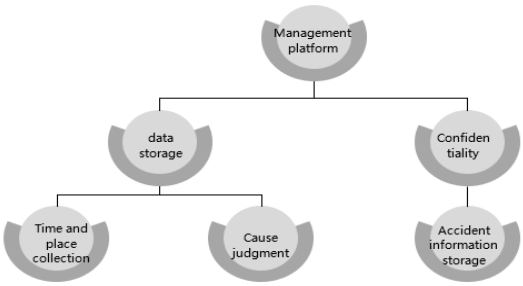

Figure 1: Schematic diagram of early warning management system for sudden water pollution accidents

The network architecture of the early warning management system of emergency water pollution accidents collects and accesses the accident data based on mobile network platform and mobile equipment and remotely operate the cloud through the mobile network. At present, in the mobile communication technology, the downlink speed of 4G technology can reach 100Mbps/s while the uplink speed can reach 30Mbps/s. The downlink speed of 3G technology can reach 30Mbps/s and the uplink speed can be 384Kbits/s. for the required data transmission of the system, the transmission speed of mobile communication technology can fully meet the system requirements. The network architecture of the early warning management system of emergency water pollution accidents is shown in Figure 2.

Figure 2: Schematic diagram of the network structure of early warning management system for sudden water pollution accidents

3.2 Application Platform

In order to improve the user's response to incidents, the early warning management system of emergency water pollution accidents will be applied on the mobile platform and the terminal configuration is portable mobile devices such as smart phones, tablet computers and laptops. Currently, J2ME is the best solution for embedded devices and intelligent electronic devices. Sun defines the J2ME as a highly optimized JAVA operating environment targeting a wide range of consumer products. This solution can be easily achieve the cross-platform application implemented across platforms and this solution can be compatible with the Android and Windows operating systems for smart phones in the mobile terminal.

The introduction of portable mobile devices in the early warning management system of emergency water pollution accidents can effectively enhance the timeliness of some basic data collection for emergency accidents. The widely used mobile smart mobile platform can obtain GPS information to determine the location of the accident while the camera with high pixels can capture high-resolution images of the accident scene (see Figure 3). The dominant frequency of the mobile phone processing cores satisfies the pre-judgment of the accident data and it is simple and quick to send and receive the accident data and information.

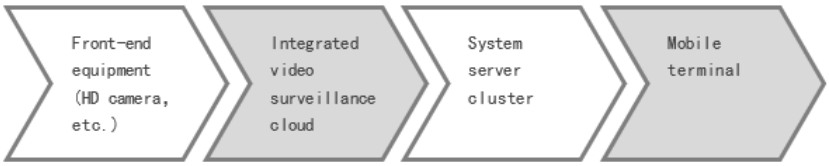

Figure 3: Basic flow of environmental video surveillance system in cloud mode

4. Results and Discussion

The early warning management system of emergency water pollution accidents focuses on solving practical problems in information collection, information uploading and downloading, data information processing, data analysis and other practical application problems. Based on the principle of information construction, this system follows the design concepts cross-platform, hierarchical design, component type and multi-interface mode.

The emergency water pollution accidents often occur in the field or areas where basic monitoring facilities are weak, so the immediate collection of accident information is responsible by mobile terminals in the early warning management system of emergency water pollution accidents. The mobile terminals can collect the information such as accident location, accident scene images, accident time, climate conditions and pollution state videos to provide basic data support for the query of data, images and videos, statistical analysis and advanced treatment of information for users of the system. At the same time, the mobile terminals can meet the requirements of all-weather, all-terrain and timeliness in the collection of information on emergency water pollution accidents. As long as the field staff has mobile terminals, they can conduct the information collection required by the accident handling whenever and wherever possible at earlier stage, as is shown in Figure 4.

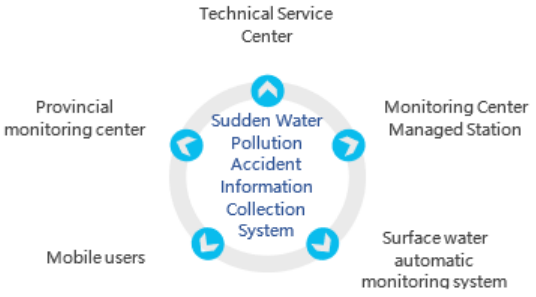

Figure 4: Construction of an Information Acquisition Platform for Sudden Water Pollution Accidents

While the mobile terminal collects the basic information, the terminal's built-in application program of the early warning management system of emergency water pollution accidents can perform preliminary classification, judgment and processing of the accident information. The application program can determine the type, pollution level and possible damage of accidents based on the built-in small information database and mark

the alert level of the accident information, enabling decision makers to deal with the accidents quickly, accurately, and effectively. At the same time, the application program can provide the step prompt of guidance pattern for information collection and the system is responsible for the determination of the information collection content, collection order and whether the collection is complete required by the accident processing. The operator can collect basic information for the system without professional knowledge. In addition, the built-in early warning management system application program of the mobile terminal can compress and encrypt the collected information and data according to the requirements so as to increase the speed and security of information transmission. According to the configuration of the mobile terminal, the data volume of the collected image and video will place great pressure on the currently widely used mobile communication network transmission rate. For example, the data volume of a single image captured by an 800-megapixel camera is about 1.8 Mbps and the data volume of the collected video is bout 30Mbps per minute. The compression ratio after the compression can reach 50% - 90%, which can effectively improve the information transmission rate.

In the early warning management system of emergency water pollution accidents, the mobile terminal is responsible for uploading the collected accident information and preliminary processed data to the cloud through the mobile communication network. The mobile terminal uses the currently widely used 3G or 4G technology for the mobile network communication to quickly upload accident information and data. Assume that the accident information includes 10 high-definition images, 1 minute of voiced video, text and digital data. The data volume after compression is 12 Mbps. Theoretically, it only takes 30 seconds through the 3G technology network and 0.4 seconds through the 4G technology. It can be seen that the mobile communication network can fully meet the data transmission requirements of the early warning management system of emergency water pollution accidents and effectively meet the timeliness of the information.

The cloud in the structure of the early warning management system of emergency water pollution accidents is responsible for the advanced treatment such as computational simulation, storage and data analysis of the data and information received. The cloud provides all the hardware configuration requirements of service programs, data query reduction and application terminal required in the early warning management system of emergency water pollution accidents and meets the high-level resource requirement of large-scale data processing. Firstly, the data storage server in the cloud is mainly responsible for the classification and storage of accident data, including field data, data forwarded by other departments and data in the accident processing, which can provide data basis for accident impact prediction, accident scale simulation and accident handling. At the same time, the decision database in the cloud's storage server can provide stable, efficient and secure accident handling support program for decision makers. Secondly, the cloud's application server is mainly responsible for the computing services of pollution diffusion, pollution scope, pollution capacity and data visualization, including the theoretical calculation of the diffusion scope of pollutants, the location that can be reached by pollutants at various time points, the time of natural degradation or decomposition of pollutants without taking any measures, impact scale of the pollution incident (including the number of people, administrative divisions and public opinion, etc.) and provision of visual data for relevant departments. Thirdly, the cloud releases the accident information in public under the conditions of the constraint of security protocols and the authorization of decision makers and manages the user rights, which is to grant different level of system operation authority to users with different confidentiality level to reduce the incidence of misoperation and data missing. At the same time, the cloud server manages the emergency water pollution accidents at the global level, effectively helps the definition of responsibility of personnel in the accident treatment and satisfies the condition that the each decision and treatment measure has the signature of each responsible person. The cloud storage, analysis and release system flow are shown in Figure 5.

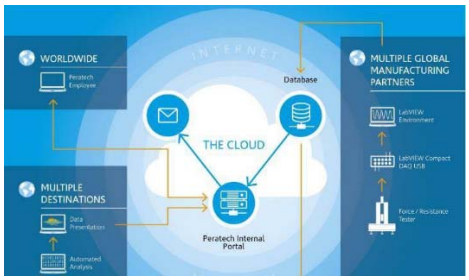

Figure 5: Cloud Storage, Analysis and Publishing System Process

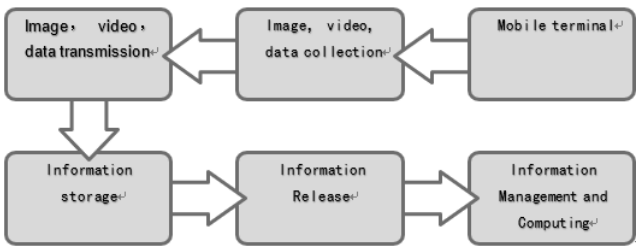

Figure 6: Schematic diagram of data flow for early warning management system of sudden water pollution accidents

The mobile terminal of the early warning management system of emergency water pollution accidents can remotely access the cloud and perform the query of accident information and data. Users can access the cloud at any place and any time through the mobile communication network to obtain the instant information of emergency water pollution accidents, which will not be bound to a fixed PC terminal and increase the flexibility of system application.

The operation of the early warning management system of emergency water pollution accidents is coordinated by the mobile terminal and the cloud and the data flows and stays between the mobile terminal and the cloud. The early warning management system of emergency water pollution accidents is shown in Figure 6.

5. Conclusion

To thoroughly study the application of cloud computing technology in the early warning management of chemical water pollution accidents, this paper refers to the needs of the transmission timeliness, internal management and early warning system of water pollution information and builds the early warning management platform of chemical water pollution accidents based on the cloud computing technology, modern information technology and communication technology. The platform combines the cloud and terminal and then analyzes the application of cloud computing in the early warning management of chemical water pollution accidents. The research results show that the early warning management of chemical water pollution accidents designed in this paper can timely collect, process and transmit the information of chemical water pollution accidents and can timely feedback the information to relevant departments. Also, this system can save the development cost of chemical enterprises and improve the efficiency and quality of the early warning management of chemical water pollution accidents, which is of certain application value.

In the research of this paper, the application of cloud computing technology in 4G network and 3G network is mainly used in the early warning management of chemical water pollution accidents. At present, relevant departments in China have stated that they are going to build a 5G mobile network. Therefore, in the future summary of research work, it is necessary to enhance the application of cloud computing technology in the early warning management of chemical water pollution accidents in 5G network.

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