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Construction and Key Technology of a Rapid Response Platform for Emergency Decision-Making under the Background of Big Data

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Abstract: The development and implementation of big data has provided people with many conveniences. Due to the endless emergence of various emergencies in our lives, the establishment of a rapid response platform for emergency decision-making will help prevent and reduce the impact of natural disasters, public health incidents and social security accidents. Therefore, this article focuses on the construction of a rapid response platform and key technologies for emergency decision-making in the context of big data. This article analyzes and gives examples of the key technologies of the rapid response platform for emergency decision-making, and reveals the application methods of this technology. This paper starts from the needs of emergency decision-making, and designs the key functional modules of the platform. In order to verify the feasibility and reliability of the system, this paper has completed the functional test and non-functional test of the system. The test results show that the response time of the system function is less than 3s, and the CPU utilization rate and memory occupancy rate are between 20% and 52%. It can be seen that the system basically meets the design requirements.

1. Introduction

Human living standards continue to improve with the development of science and technology, and at the same time, emergencies caused by various natural or man-made factors also continue to occur [1-2]. The occurrence of emergencies brings hidden dangers to human life safety and causes economic and life and property losses [3-4]. The development and application of big data provides new technical support for the practice of emergency decision-making in our country, and also puts forward new development requirements for emergency decision-making in China [5-6].

Regarding the research on emergencies and emergency management, many scholars at home and abroad have conducted multi-angle and in-depth discussions on them. For example, Shanlin researched and designed an emergency Internet comprehensive information platform [7]; Yefeng used big data to improve China's emergency response the center's knowledge management and decision-making capabilities are the subject of research [8]; Wang investigates and analyzes the big data of emergency communication networks [9]; Li F conducts research on emergency actions and big data applications for floor management [10]. It can be seen that the research on emergencies and emergency management has always attracted much attention. The advent of the era of big data is of great significance to the construction of a rapid response platform for emergency decision-making.

Based on the background of big data, this paper studies the construction of a rapid response platform and key technologies for emergency decision-making. This article first analyzes in detail the key technology of the rapid response platform for emergency decision-making, and reveals the application method of this technology. Then, starting from the needs of emergency decision-making for emergencies, the key functional modules of the platform are explained in detail. Finally, this article has completed the functional test and non-functional test of the system.

2. Construction of a Rapid Response Platform and Research on Key Technologies for Emergency Decision-Making in the Context of Big Data

2.1. Analysis of Key Technologies

(1) Emergency communication technology

The communication of the system to the upper level is achieved through remote access to the media, using satellite communication that supports bandwidth data communication, shortwave communication that supports voice and low-level messages, or 3G communication under the availability of mobile networks [11-12]. Downlink communication is mainly used for cluster communication for on-site command and dispatch and wireless video transmission that can provide point-to-point video transmission.

At the scene of emergencies, the system transmits information through media such as the Internet, VPN, satellite communications, and portable mobile collection terminals on the scene can also use 4G/5G networks as mobile communication means.

(2) XML-based data exchange technology

This system uses XML-based data exchange technology in the data reporting interface. The first step is to predefine and structure the data that needs to be exchanged; the second step is to standardize the extraction and mapping of data elements and aggregated data sources from top to bottom according to the business process, and create a corresponding XML model; the third step is to use the UML model to describe the business model and the information model in detail, explain the roles involved in the business activities and the sequence of data exchange, and form an information model with several interrelated categories. Among them, the data exchange calculation method for uncertain XML is as follows:

To complete the data exchange, the algorithm needs N_s switching matrix, which means N_s configuration states. The switch matrix for configuration status is shown in formula (1):

$$P_n = \{P_{ij}^{(n)}\}(N_s \geq n \geq 1) \quad (1)$$

In the formula, $P_n = 1$ means that a connection is established between the input stage i and the output stage j. Each switching matrix P_n has a corresponding weight of ϕ_n, and ϕ_n represents the number of time slots that need to be sustained in the reconfiguration state P_n during the packet switching process. Note that one packet can be exchanged in one slot. Among them, the calculation method of the total data exchange routing time T of the system is shown in formula (2):

$$T = \sigma + \tau + \Omega \quad (2)$$

In the formula, σ represents the total reconfiguration overhead, τ represents the total time maintained by the N_s switching matrixes, and Ω represents the total path cost.

(3) Tomcat server

Tomcat server is a free and open source, lightweight Web application server, widely used in small and medium-sized systems and occasions where concurrent access requirements are not very high, and it supports Servlet and JSP specifications.

(4) Geographic analysis service technology

The platform adopts the geographic analysis service technology released by GIS Server. The system pre-determines the calculation processing flow, the user only needs to input some necessary parameters, the background will automatically complete the complex calculation according to the pre-customized processing flow, and return the calculation result to the caller. This technology is needed in the analysis of spatial data such as roads, networks, and demographic statistics in the emergency resource management module.

2.2. Design of Key Functional Modules of the Rapid Response Platform for Emergency Decision-Making

(1) Emergency warning module

The early warning function plays an important role in the pre-prevention and preparation phase of emergency response data. Through the screening and analysis of massive data, various emergencies can be predicted. The function of the emergency early warning module is to design, prepare, manage, maintain and count the emergency plan before an emergency event occurs. The functional police module includes four sub-modules: new emergency plan, emergency plan query, emergency plan management, and emergency plan statistics.

(2) Emergency response module

The main function of this module is the management of early warning announcements and accident alarms, including modification, query, editing and deletion of announcement numbers, release time, announcement content, emergency handling, emergency watchkeeping, etc. At the same time, the system needs to provide management of the accident unit situation, accident situation, accident overview and accident personnel situation, including the modification, query, editing, and deletion of the unit name, unit code, safety assessment classification, accident province, accident situation, etc.

(3) Intelligent generation module of emergency plan

This module includes three sub-modules: plan generation, plan execution, and plan revision. The plan generation module compares the emergency plans in the emergency plan library and emergency case library according to the types of emergencies, on-site environmental conditions and the analysis results of front-line emergency personnel, and quickly generates a scientific rescue plan that is consistent with the current situation.

(4) Emergency resource management module

The emergency resource management module includes four sub-modules: emergency material management, emergency knowledge management, and emergency plan management.

Emergency material management is mainly for all kinds of health emergency resources, statistical analysis of collected information, including emergency material reserves, emergency material standards and other parts. The reserve of emergency materials is dispatched and distributed according to the storage of various types of materials, and various information is collected and analyzed to obtain detailed and feasible resource data for emergency decision-making.

Emergency knowledge management includes multiple categories. Taking infectious disease knowledge as an example, the name of the infectious disease, the cause of the infectious disease, clinical manifestations, disease, treatment principles, and post-occurrence control and treatment measures need to be entered into the system. You can query, edit, delete, add, and other operations on this type of information later.

The management of emergency plans and regulations includes laws and regulations, technical plans, and emergency documents. Laws and regulations are mainly responsible for various emergency emergencies that institutions are responsible for, and provide important analysis reports for subsequent decision-making and other work.

2.3. Operational Strategy of Rapid Response Platform for Emergency Decision-Making in the Context of Big Data

(1) Establish a big data strategic thinking and change the concept of emergency management

The basis of the smooth operation of the rapid response platform for emergency decision-making in the context of big data is to establish a correct awareness of big data. Only by establishing advanced big data awareness, the government can optimize emergency decision-making in emergencies and continuously increase the speed of management innovation. Therefore, the Chinese government must attach importance to big data management. Through propaganda to cultivate the big data awareness of government officials and the public, establish big data strategic thinking, change the concept of emergency management, and improve the capabilities of relevant departments and staff.

(2) Formulate a big data open policy and establish a shared database

In modern society, emergency management of emergencies is not only a matter for the government, but also concerns all people in society, and requires the participation and cooperation of social organizations and the public. Therefore, the government should reasonably open data resources on the basis of protecting confidential data from being leaked to meet the public's service demand for government data. However, realizing the sharing of data and information and ensuring the confidentiality of necessary confidentiality is still part of the government's efforts. Big data management is fundamentally different from traditional data management. The noise and low density of data are not conducive to data management. The government should standardize data processing. One must ensure the confidentiality of necessary confidentiality, and the other must ensure that open data can meet the requirements.

(3) Build an emergency decision support system supported by big data

In the rapid response platform for emergency decision-making with big data analysis technology, the departments responsible for management such as the transportation department, the medical department, the police department, and the municipal infrastructure management department must carry out information transmission and communication in a timely manner in order to when an incident occurs, it can provide human, material resources and navigation information, to prevent and reduce the loss caused by the emergency in time.

3. Platform Function and Performance Test

3.1. Test Range

The functional test of the platform mainly includes system login, emergency early warning management, emergency plan query, emergency response and emergency material management test; non-functional test mainly includes the test of system stability, fluency and safety test, and the result of test record Including the response time, CPU utilization and memory occupancy rate of each functional module.

3.2. Test Environment Configuration

The rapid response platform for emergency decision-making is based on the Java enterprise application-level SSM (Spring +Spring-MVC+ Mybatis) development framework, the system Web application server uses Tomcat, and the background uses Mysql database management system data.

3.3. Non-Functional Module Test

The tool used in this experiment is Loadrunner, which simulates 1000 users to access the server at the same time with the same action on Loadrunner to realize the performance test of the platform.

The experiment process is: record user login platform, browse interface, search data access behavior, create a script of user request behavior; according to the actual situation, set 1000 concurrent users, and access the system at the same time according to the script. After the simulation is completed, it will generate CPU including CPU Test report of utilization, memory occupancy rate, response time and other information.

4. Analysis of Experimental Results

4.1. Analysis of System Function Test Results

This experiment simulates a concurrent test of 1000 users, and records the system's response time to related functions. The test results of specific functions are shown in Table 1: the average of system login, emergency plan management, emergency case management, emergency response, and emergency resource management the response time is 1.0s, 2.4s, 2.9s, 2.1s, 2.3s; the maximum response time is 1.5s, 2.9s, 3.2s, 2.8s, 2.7s.

Table 1: System function response time (s)

Operate	Average response time	Maximum response time
System login	1.0	1.5
Emergency warning management	2.4	2.9
Contingency plan query	2.9	3.2
Emergency Response	2.1	2.8
Emergency supplies management	2.3	2.7

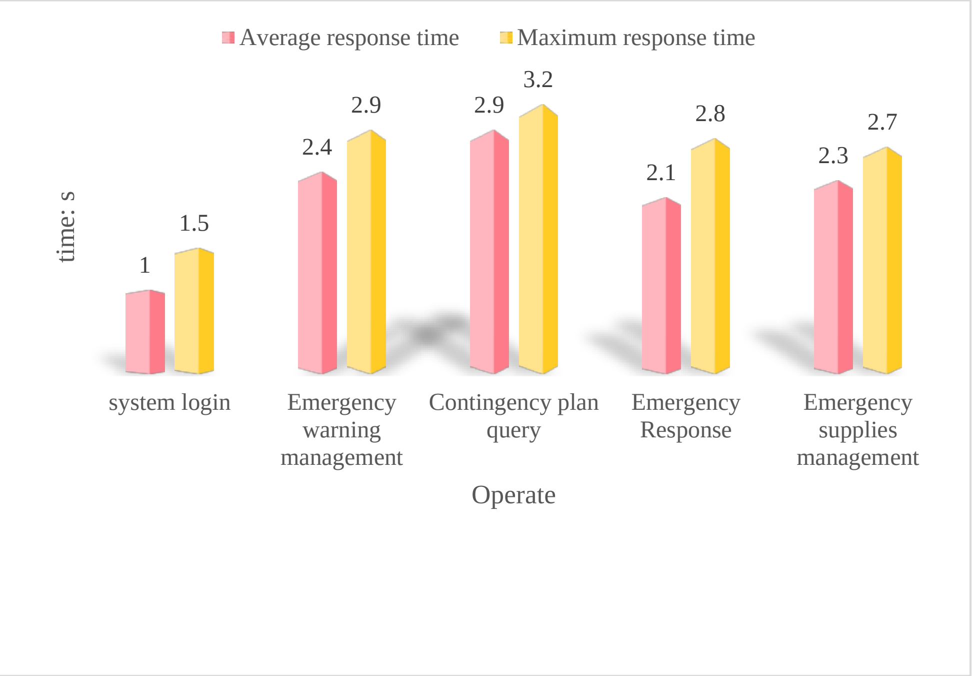

Figure 1: System function response time (s)

It can be seen from Figure 1 that under the concurrent test of 1000 users, the response time of each function of the system is between 1 and 3.2s, and the average response time can be controlled below 3s, which meets the performance requirements of the system. It can be seen that the system has good operating performance and can be put into practical use.

4.2. CPU Utilization and Memory Occupancy

In this experiment, under the same experimental environment, a concurrent test of 1000 users was simulated, and a total of 8 times were performed. The CPU utilization rate and memory occupancy rate of the system in the use of related functions were recorded, and the test results were averaged, as shown in Table 2: the CPU utilization rate of system login, emergency plan management, emergency case management, emergency response, and emergency resource management functions are 21%, 39%, 40%, 43%, and 52% respectively; the memory occupancy rate is 27%, 34%, 41%, 46%, 51%.

Table 2: CPU utilization and memory occupancy rate (%)

Operate	Average CPU utilization	Average memory occupancy
System login	21	27
Emergency warning management	39	34
Contingency plan query	40	41
Emergency Response	43	46
Emergency supplies management	52	51

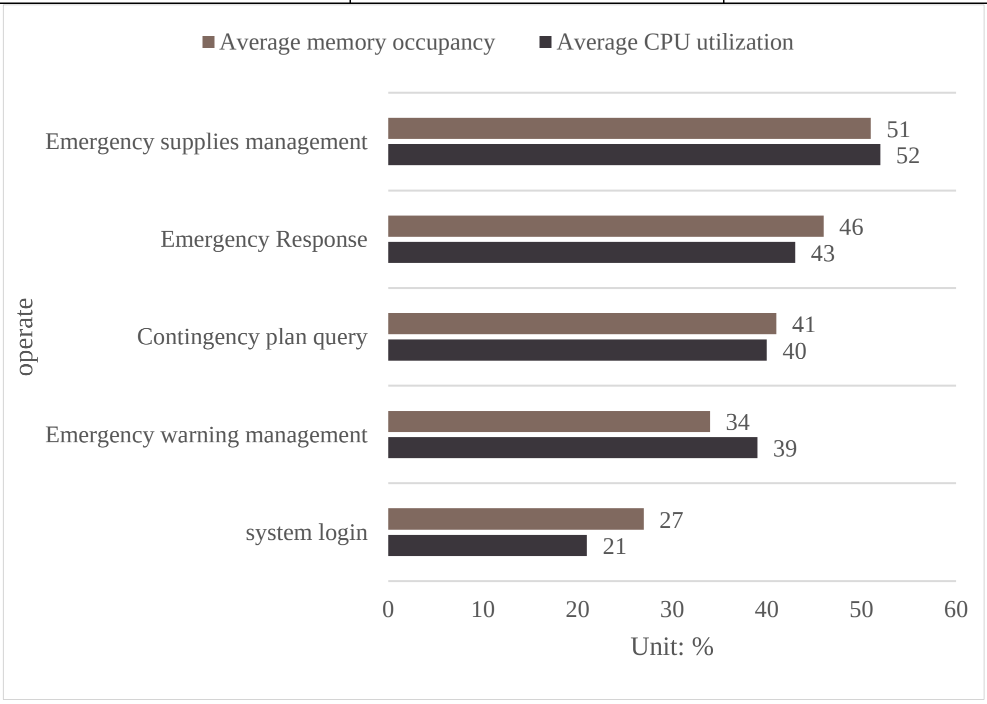

Figure 2: CPU utilization and memory occupancy rate (%)

It can be seen from Figure 2 that the average CPU utilization rate of the system is 52% at the maximum and 21% at the minimum; the average memory occupancy rate is between 27% and 51%. It can be seen that the platform functions and system operations are normal, the performance meets the requirements, and the test passes.

5. Conclusion

Using big data-related technologies to build a rapid response platform for emergency decision-making is conducive to solving the problems of poor prevention in emergency decision-making, untimely emergency response, unsatisfactory decision-making and processing, and improving the timeliness and effectiveness of emergency decision-making. Improve the ability to respond quickly to emergencies and resist risks. Through system research, this paper has completed the following tasks: detailed description of the key technologies of the rapid response platform for emergency decision-making in the context of big data; specific design of the key functional modules of the platform; completion of the system's function and performance testing, the test results verify the reliability and feasibility of the system operation.

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