Design of emergency materials dispatching system based on banker algorithm

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ABSTRACT

Taking emergency materials scheduling as the research object, this paper puts forward the problem that deadlock is easy to occur in the scheduling process of emergency materials after various major events. Since Banker algorithm can effectively avoid deadlock in resource scheduling process, an emergency materials scheduling system based on Banker algorithm is designed.Through the design and implementation of the module functions of system management, emergency materials management and scheduling, and information sharing, the efficiency of emergency materials scheduling is improved, the real-time monitoring of the whole process of emergency resource application and scheduling is realized, and the information level of emergency resource management is enhanced.

Keywords: Emergency supplies, banker's algorithm, dispatching system

1. INTRODUCTION

In recent years, we have experienced several major emergencies such as SARS, avian influenza and African swine fever, especially the novel coronavirus pneumonia epidemic that lasted for three years. Now, people are still worried about it, and many people are still struggling to decide whether COVID-19 is cured or COVID-19 is reinfected.Emergencies often have an impact on individuals, families and even countries.Taking the national control of the epidemic as an example, people have a huge demand for emergency supplies such as antipyretic medicine, and often insufficient material reserves, which leads to a lack of supplies.When the rescue materials received from "eight parties", there were problems such as uneven distribution, which caused social instability and trapped residents.Therefore, when an emergency occurs, how to use scientific and reasonable methods to dispatch materials is particularly important.

The banker algorithm is one of the most representative algorithms to avoid deadlock.The emergency materials supply management center is regarded as the banker, and emergency materials are regarded as the funds managed by the banker. Multiple resident processes request the community material supply management center to allocate various types of emergency materials, which is equivalent to multiple processes applying for multiple resources from the system[1].

2. PROBLEM ANALYSIS

In early 2023, local headlines read:"Due to the infection of medical staff has led to the increasingly serious reduction, the gap is large, the current major hospitals have entered the most tight, the most critical threshold[2-4], the municipal health Commission to the city's medical and health professionals issued an initiative, hoping that the medical staff with medical education background or medical institution experience retired in the past five years, Medical college students with medical education background waiting for employment, etc., join the main battlefield of medical and epidemic prevention voluntary service queue." Under the initiative of not going to the hospital for non-severe cases, how to meet the demand for emergency drugs, test agents and other emergency materials in various residential communities, and how to make overall arrangements and scientific deployment of emergency materials within a limited time are the centers of all work.

2.1 Causes of deadlock in emergency materials dispatch

Reasons for life and death lock in the emergency material scheduling process: First, emergency materials are insufficient system resources. When the sum of resources required by multiple resident processes is greater than the resources provided by the system, residents may be locked due to competition for non-preemptive resources.The second is the improper promotion sequence of each process in the system, that is, joint promotion in this order can make all the materials applied

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for by residents can be applied for normally, while joint promotion in another order will lead to two or more residents occupying part of the resources and applying for other blocking resources occupied by residents, resulting in multiple residents in deadlock. It seriously affects the security and reliability of the system and causes the illegality of the advancing sequence of resource allocation.The third is the randomness of the resources requested by each concurrent process of the system, including the type and quantity of resources requested

2.2 The necessary conditions for emergency material scheduling to produce deadlock

In the case of multi-resident processes concurrently scheduling resources, there are four necessary conditions for process deadlock:

(1) Mutually exclusive condition. Each resource is not shareable, that is, the obtained resources are used exclusively, and a resource is occupied by only one process at any time.

(2) Request and maintain conditions. A process does not release the resources allocated to it when it is blocked waiting for a resource request.

(3) No preemption (no deprivation) condition. The resources obtained by a process cannot be preempted until they are used up. They can only be released by the process that obtained the resources.

(4) Cyclic waiting conditions. Several processes (two or more) form a circular waiting chain, where each process in the chain waits for resources occupied by the next process in the chain.

When a deadlock occurs, the above four waiting conditions must exist at the same time.If one does not exist, the deadlock cannot exist.

2.3 Solve deadlock measures in emergency materials dispatching

In general, if no loop exists in the resource allocation diagram, the system will not be in a deadlock state, otherwise the system may be in a deadlock state.In order to prevent deadlock in the system, the common measures to solve the deadlock are as follows:

(1) Deadlock prevention. Prevent deadlocks by breaking the last three of the four conditions necessary for a deadlock to occur.

(2) Avoidance of deadlock. With Banker's algorithm, in the process of dynamic resource allocation, the system must be able to determine whether the system is still safe after allocating resources to a process, and allocate only when it is safe.

(3) Deadlock detection and removal. The detection mechanism of the system detects whether the deadlock occurs in time, and if it is identified as occurring, the system is freed from the deadlock state by using the deadlock release algorithm.

(4) Ostrich algorithm. The simplest solution to a deadlock is to ignore or ignore it. When deadlock is rare in a computer, there is no need to expend energy to solve it, and it can be ignored in an ostrich-like way.

3. THE BANKER ALGORITHM WAS USED TO DISPATCH EMERGENCY MATERIALS

The Banker's algorithm, proposed by E.W. Djkstra in 1965, allows processes to dynamically request resources, and the system calculates the security of resource allocation before each implementation. If resources are allocated safely, the system allocates resources to processes.That is, after resources are allocated, the system allocates resources to each process in a certain order, and each process can run smoothly until the end. Otherwise, resources are not allocated and the application process is blocked.

3.1 Data structure in Banker's algorithm

In order to implement the Banker algorithm, four data structures must be set up in the system to describe the resources available in the system, the maximum demand for resources by all processes, the allocation of resources in the system, and how many resources are needed by all processes.

Table 1. Data structure Table.

Data structure	Description	Instructions
Available	Available resource vector	Indicates the number of available resources in the system， $Available[j]=k$ ， Indicates that the number of existing class R_j resources in the system is k.
Max	Maximum demand matrix	n processes in the system. Each process has the maximum demand for m resources.Such as: $Max[i][j]=k$ ， Indicates that process P_i requires k class R_j resources.
Allocation	Distribution matrix	Indicates the number of resources occupied by each process in the system.Such as: $Available[i][j]=k$ ， Indicates that process P_i has obtained k class R_j resources.
Need	Demand matrix	Represents the number of types of resources that are still required for each process.Such as: $Need[i][j]=k$ ， Indicates that process P_i still needs to allocate k class R_j resources to complete the execution.

3.2 Banker's algorithm

3.2.1 Determine the security of the system status. The work vector in the security algorithm executed by the system can be described as shown in Table 2 below.

Table 2. Two vectors of the security algorithm

Work vector	Vector initialization	Instructions
Work	Work = Available	It represents the number of various types of resources that the system can provide to the process to continue running, and it contains m elements.
Finish	Finish[i] = false	It indicates whether the system has enough resources allocated to the process for it to finish running.

Start with Finish[i] = false; When enough resources are allocated to the process, Finish[i] = true. The specific implementation process is shown in Figure 1:

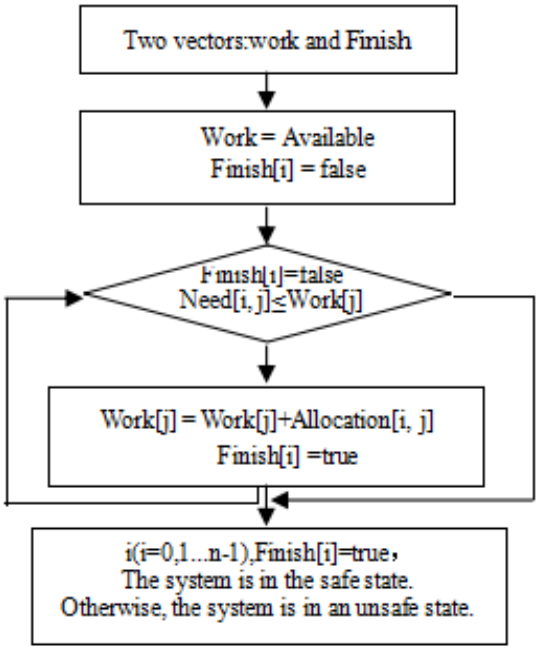

Figure 1. Security algorithm flow.

3.2.2 Invoking the system state security algorithm. Let Requesti be the request vector for process Pi,If Requesti[j]=K, Indicates that process Pi requires K Rj resources.After the Pi sends a resource request, the system checks the request according to the following process[4].

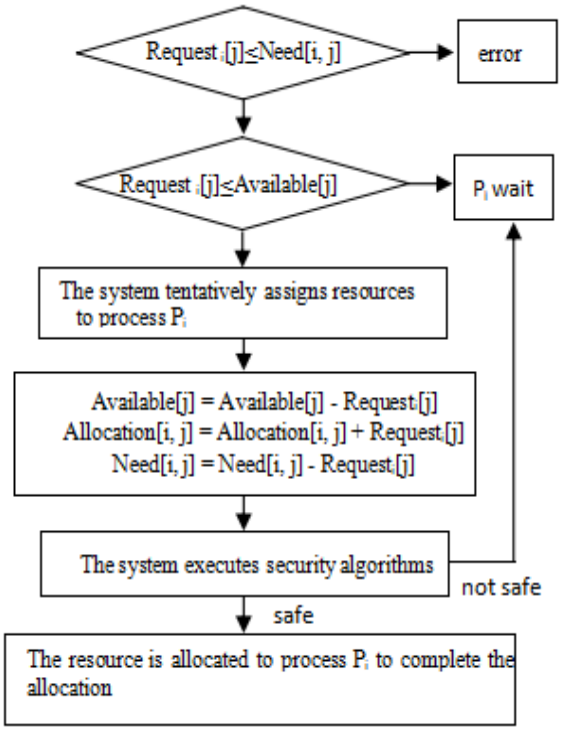

Figure 2. Banker algorithm flow.

4. EMERGENCY MATERIALS SCHEDULING STRATEGY AND SCHEDULING SYSTEM DESIGN

4.1. Emergency materials scheduling strategy based on banker algorithm

The banker algorithm calculates the security of the resources allocated before the resources are allocated.When emergencies occur, the supply and demand relationship of emergency materials is often in short supply, and the demand for emergency materials at various disaster sites is different. How to scientifically deploy the limited emergency materials to the hands of residents in the short term is of great significance for improving the accuracy of emergency rescue work[5].Therefore, the author proposed the emergency materials scheduling network structure based on the banker algorithm, as shown in Figure 3.

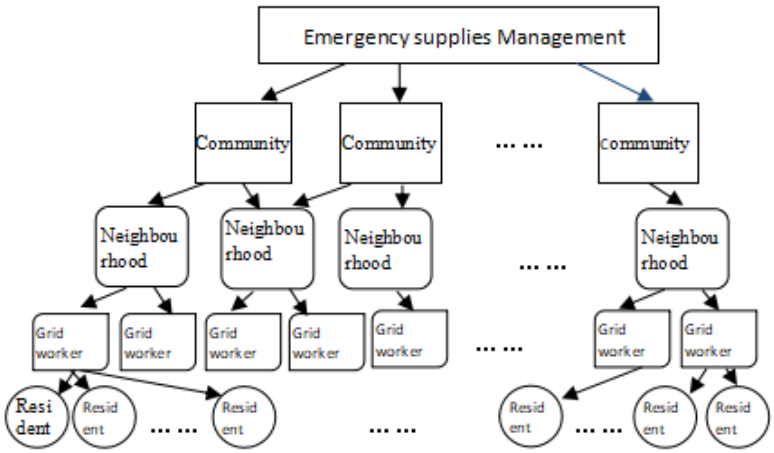

Figure 3. Structure diagram of emergency materials dispatching network.

According to the structure in the figure above, the following assumptions are made about the network structure of emergency materials dispatching:

(1)Residents timely reflect the quantity of urgently needed materials, and community grid personnel collect statistics in real time, so that the demand for goods can be dynamically obtained.

(2) The community grid personnel check the quantity of materials and report to the community on time, and the grid personnel record detailed data for the long-term residents of each building in advance, that is, the number of residents in the community is known[6-8].

(3) After calculating the needs of each community, the community dispatches and distributes the allocated emergency materials.

(4) Do not consider the impact of transportation, climate, and workers in the distribution process.

4.2 Design of emergency materials dispatching system based on banker algorithm

The emergency materials dispatching system based on banker algorithm designed by the author is suitable for the emergency materials management center in a certain area, which includes several communities, and each community includes several communities.In this system, there are three major functional modules: system administrator, emergency materials and information sharing. Under the system administrator, there are modules for system login, system registration, material situation and material statistics; under the emergency materials module, there are materials management and material scheduling; information sharing includes modules for management messages and material announcements; detailed functional modules are shown in Figure 4 below.

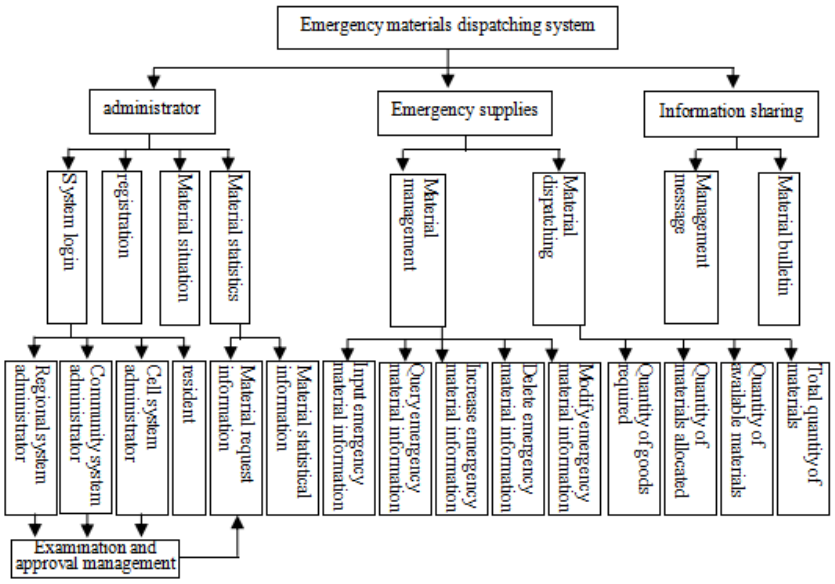

Figure 4. Functional diagram of emergency materials dispatching system.

5. CONCLUSION

The banker algorithm is used to make overall arrangement and scheduling of emergency materials, and all emergency materials in the system are compared to banker's funds. Every time emergency materials are allocated, the banker should accurately calculate the security of the distribution plan based on the current resource allocation situation.After security algorithm verification, if it is safe, one or several security distribution sequences are given, indicating that there are enough emergency materials to be allocated to lower-level applicants.Such as communities, emergency supplies can be distributed to each community, and the community will be distributed to residents in the same way. Otherwise, the system is in an insecure state.Therefore, each allocation must calculate security, and if the system is secure, the banker algorithm is executed.In the Banker algorithm, the emergency materials scheduling system must first check whether the two conditions are established, then carry out a tentative emergency materials Allocation, and modify the three values of Available, allocation and Need. Then the system executes the security algorithm again. If it is safe, the emergency materials will be formally allocated. Otherwise, the tentative distribution will be invalid and the original state of emergency materials distribution will be restored.The application of emergency materials dispatching system to emergency event materials dispatching and processing is conducive to improving the efficiency of emergency materials dispatching, realizing real-time information sharing, realizing the transparency, justice and openness of emergency materials application and dispatching, and achieving the purpose of promoting justice with openness and protecting public with transparency .

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