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Research about Earthquake Emergency based on GIS Building Real Time Dynamic Plotting System

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Abstract

Earthquake is one of the natural phenomena which is one of the natural phenomena, which is one of the more powerful 、sudden and destructive. It happened that the violent movement of the earth's crust and the destructive power of the earth's interior, the earthquake is inevitable, but the post earthquake emergency rescue work can be reduced to a minimum.In this paper, we first analyze the post earthquake relief work, ti can be concluded that establishing an effective and orderly rescue work is so necessarily and urgencily. Therefore, this paper establishes a *GIS* dynamic mapping system, according to the characteristics and the prototype method to carry out the overall design of dynamic mapping system,it can solve the problem of how to arrange the earthquake emergency measures. A linear fitting model was established, and the survival rate of the buried personnel was obtained. Then establish the network topology model of the rescue team rescue ability. At the end ,we give the earthquake emergency rescue command work to propose an effective solution.

Keywords: *GIS* Real Time Dynamic System;Bee Network Topology;Emergency Rescue

1. Introduction

Earthquake is one of the more common natural disasters, because of the violent movement of the earth's crust has a very strong sudden disaster. The earthquake is up to avoid, because it is one of the earth's motion situation. With the rapid development of economy, the population and property in the city is over concentrated, the lifeline system is more vulnerable, and the earthquake occurs, it will be a huge impact on the loss of life and property, social and psychological.

China has a vast land area, about eighty percent of the live in the earthquake zone. The earthquake occurred in high frequency, large population density, the building is concentrated, if there is an earthquake, the country's huge loss. How to reduce the loss caused by the earthquake has become a problem of concern.

In recent years, the domestic and foreign take earthquakes frequently, along with numerous casualties and huge economic losses, the earthquake has caused the attention of the government and people from all walks of life. China's national policy adjustment in the national planning to increase the earthquake disaster reduction, before the introduction of advanced construction technology to ensure that meet the structural seismic design, earthquake disaster relief work.Earthquake relief work has always been an important research content of disaster prevention and reduction, but because of various factors, the impact of the earthquake relief work has become a very complicated process. With the development of computer network technology, the post earthquake rescue efficiency also has a great breakthrough. This paper makes a global consideration of disaster scene rescue. By evaluating the safety performance of hazardous substances and rescue structure, we can determine the rescue force deployment, search and rescue, search and rescue priority. Improve the rescue efficiency, has practical significance.

2. Real Time Dynamic Plotting System of GIS

2.1Overall Technical Route Design

The GIS technical route is: first, in the understanding of some seismic data under the premise, to earthquake disaster statistics, according to the statistical results, painting a renderings of all kinds of disaster, along with the time development has more information about the earthquake, dynamic monitoring in real time. Second, through the statistics of the injured rate and the number of buildings. Fitting the survival rate function image, the need of the various moments of the relief pressure.

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2.2Model establishment based on linear fitting for pressure

Through the analysis of spatial information, the distribution of the need to rescue workers in the disaster area is used to establish the model of the I unit.

Different types of buildings to accommodate the number of people.Buildings can accommodate many people, the need to consider the seismic moment, construction and population density. Classification of buildings in accordance with purpose. So the building is divided into four categories, as follows:

Table 1 Number of different building types

The first	Class of Hospital Room	Full time nursery class	Three workshop
Second	Office	Buildings	school
Third	Residential	Quarters	Hotel
Fourth	Business services and entertainment architecture	Hotel	Two workshop

At the same time, it is also a different time, working day or holiday, this paper establishes the dynamic model of t as the independent variable according to different time points. This paper takes Wenchuan County as an example, from the Chinese database search data, to find out the need of data modeling and solving.

Among them, a is the total number of mobile workers, b is the total number of resident personnel, t for the occurrence of the earthquake time points, $N(t)$ is the number of buildings.

The first type of buildings in summer one curve as follows:

$$N(t)=\begin{cases} 0.9a\sin\left(\dfrac{t-7}{2}\right)\cdot\pi+b & (7\le t\le 8)\\ 0.9a+b & (8\le t\le 11)\\ 0.1a\cos\left(\dfrac{t-11}{3}\right)\cdot 2\pi+b+0.8a & (11\le t\le 14)\\ 0.9a+b & (14\le t\le 17)\\ 0.9a\sin\left[\left(\dfrac{t-17}{4}\right)\cdot\pi+\dfrac{\pi}{2}\right]+b & (17\le t\le 19)\\ b & (19\le t\le 24 \ \ and \ \ 0\le t\le 7) \end{cases}$$

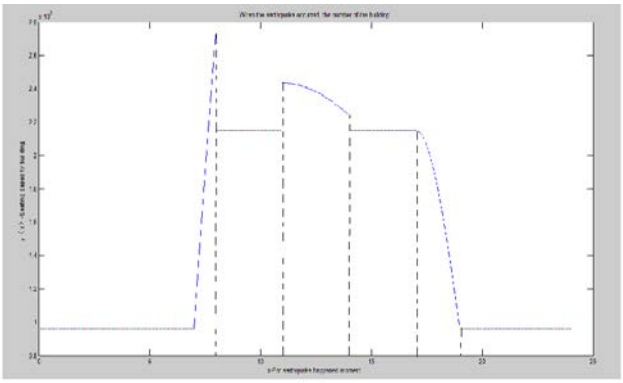

Figure 1 The line of the first building contain peoples in summer

Among them, a is the total number of mobile workers, b is the total number of resident personnel, t for the occurrence of the earthquake time points, $N(t)$ is the number of buildings.

The second type of buildings in summer one curve as follows:

$$N(t)=\begin{cases} 0.9a\sin\left(\dfrac{t-7}{2}\right)\cdot\pi+b & (7\le t\le 8)\\ 0.9a+b & (8\le t\le 11)\\ 0.1a\cos\left(\dfrac{t-11}{3}\right)\cdot 2\pi+b+0.8a & (11\le t\le 14)\\ 0.9a+b & (14\le t\le 17)\\ 0.9a\sin\left[\left(\dfrac{t-17}{4}\right)\cdot\pi+\dfrac{\pi}{2}\right]+b & (17\le t\le 19)\\ b & (19\le t\le 24 \ \ and \ \ 0\le t\le 7) \end{cases}$$

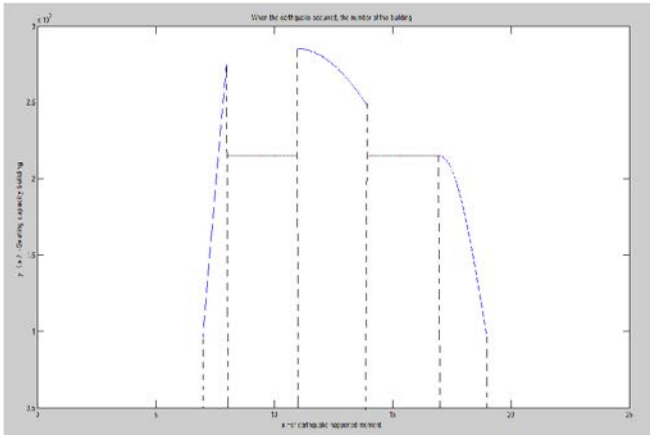

Figure 2 The line of the second building contain peoples in summer

The third type of buildings in summer one curve as follows:

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$$N(t)=\begin{cases}0.9a\sin\left[\left(\dfrac{t-6}{4}\right)\cdot\pi+\dfrac{\pi}{2}\right]+b & (6\le t\le 8)\\ b & (8\le t\le 11)\\ 0.7a\sin\left(\dfrac{t-11}{3}\right)\cdot\pi+b & (11\le t\le 14)\\ b & (14\le t\le 17)\\ 0.9a\sin\left(\dfrac{t-17}{4}\right)\cdot\pi+b & (17\le t\le 19)\\ 0.9a+b & (19\le t\le 24 \ and \ 0\le t\le 6)\end{cases}$$

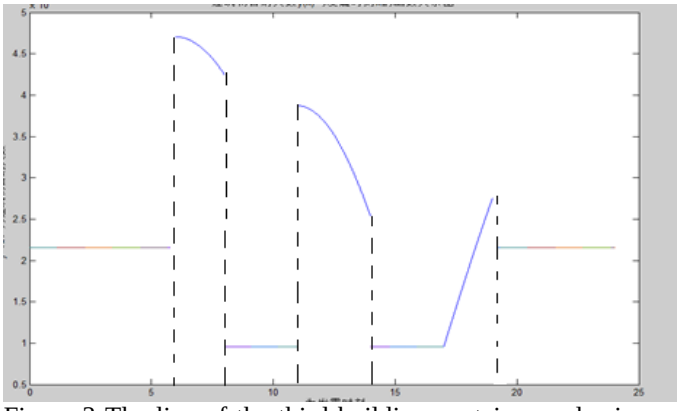

Figure 3 The line of the third building contain peoples in summer

The forth type of buildings in summer one curve as follows:

$$N(t)=\begin{cases}a\sin\left(\dfrac{t-8}{4}\right)\cdot\pi+b & (8\le t\le 10)\\ 0.1a\cos\left(\dfrac{t-10}{3}\right)\cdot\pi+b+0.9a & (10\le t\le 16)\\ 0.1a\cos\left(\dfrac{t-16}{2}\right)\cdot\pi+b+0.9a & (16\le t\le 20)\\ a\sin\left[\left(\dfrac{t-20}{4}\right)\cdot\pi+\dfrac{\pi}{2}\right]+b & (20\le t\le 22)\\ \dfrac{1}{10}b & (22\le t\le 24 \ and \ 0\le t\le 8)\end{cases}$$

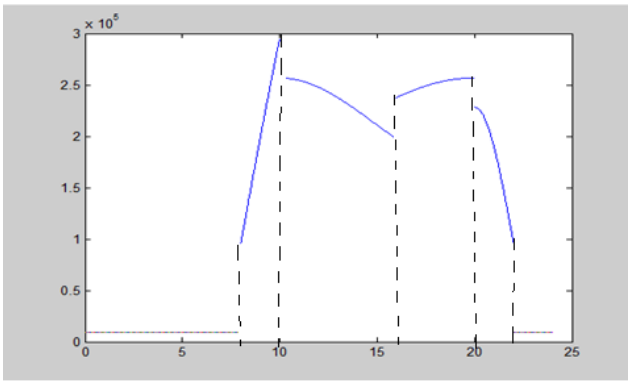

Figure 4 the line of the forthbuilding contain peoples in summer

The Wenchuan earthquake occurred in the time of the curve, we found the total number of buildings inside the earthquake moment, including the total number of 154683 people.

Parameter setting of personnel injury.Combined with the time of the Wenchuan earthquake, and the strong degree of the building of Wenchuan, using the method of earthquake casualties, the fitting curve equation is given in this paper: During the day take place earthquake:

$$W = 0.008829e^{0.5(I-7)} \bullet (\frac{3}{4}D+\frac{3}{5}F) \qquad (1)$$

Among them, I is the earthquake intensity, F is severe damage rate, W is the rate of injury, D is the collapse rate.

Parameter setting for the survival rate of the press.After the earthquake and a golden rescue period, generally within 72 hours, the survival of life is most, more than this time almost no chance of survival, in 24 hours after the earthquake occurred almost all the people were rescued, second days, the survival rate was 50%-60%; third days, the survival rate in 20%-30%. So international relief is the most effective rescue time in 72 hours.

Because the earthquake magnitude and the 1976 Tangshan earthquake magnitude similar, so according to the victims of the districts and counties of Tangshan earthquake survival analysis, survival rate as a function of expression can be fitted by the least square method, is:

$$f(\tau)=0.0892\tau^2-0.286\tau+100 \qquad (2)$$

Among them, the survival rate of the pressure is $f(\tau)$, the time of being buried is τ . Any moment of the earthquake victims can survive by the fitting curve figure 3-5 said:

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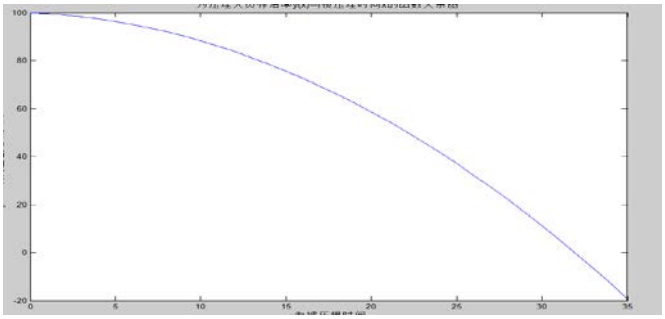

Figure5 Function expression of the time of pressure buried but alive

The total time of the pressure, including the occurrence of the earthquake to search and rescue operations, there is a formula:

$$\tau = t_0 + t_\tau + t_s \quad (3)$$

The pressure of the total time is τ , the earthquake occurred is t_0 , the rescue team travel time is t_τ , the time ofcarry out search and rescue operations is t_s

The time is equal to the distance divided by the speed, so:

$$t_r = \frac{L}{v_c} \quad (4)$$

Among them,the distance of rescue team running is L , the speed of the rescue team is v_c .

Model establishment based on cellular topology search time:For the problem of searching the optimization problem is similar to the problem of finding the maximum search efficiency in the shortest time, this paper constructs the theory of cellular coverage to get the maximum search efficiency, that is, the minimum coverage principle. Through the analysis, a circular inscribed hexagon can not only achieve full coverage, but also ensure the efficiency of the maximum coverage.

In practical problems, the search team is generally divided into several groups, each group is responsible for a small area. In this paper, we discuss the group as a unit, with a rectangle for the task assigned to a group to consider, while the search group within the personnel can not be too scattered. Assume that each search team are in the walkie talkie within the radius of the region to search, each team lined up, the overall translation scanning forward line search. The target area is grid, so the full coverage path planning algorithm based on grid map is used to solve the target area. In Figure 3-6, the effect of the regular hexagonal cellular topology of a rectangular area is assumed, and the length of a rescue zone is a , and the width is b .

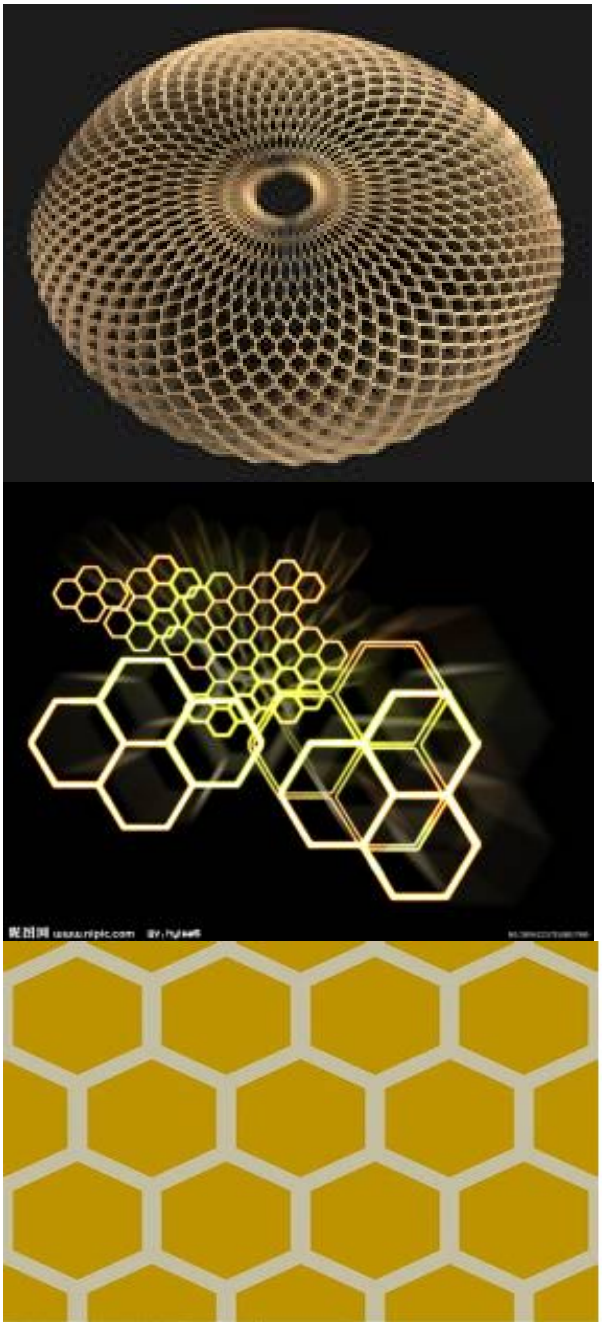

Figure6 Cellular topology evolution

According to each member's effective search radius r_s ,we can find out the rescue team, as shown in Figure 7.

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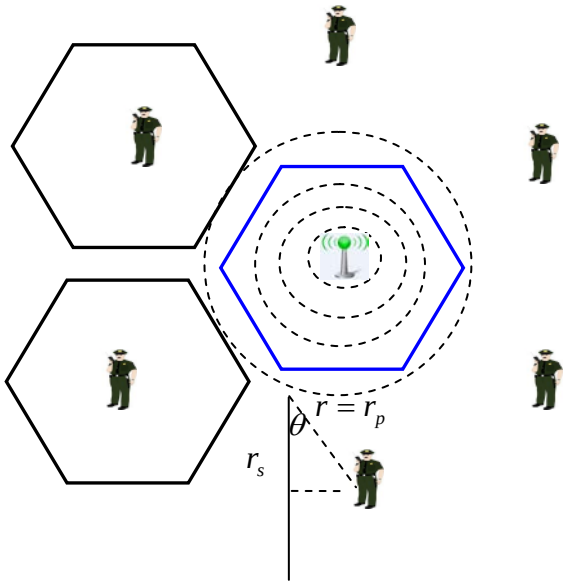

Figure 7 Search and rescue team actual search radius

$$r_s = r\cos\theta = r\cos 30^\circ = \frac{\sqrt{3}}{2}r \tag{5}$$

The number of people who have a rescue team to search for

$$G_s = \left[\frac{b}{r_s}\right] \tag{6}$$

A rescue with a group of people at the same time to search the required time for:

$$t_s = \left[\frac{a}{2r_s}\right] \circ t = \left[\frac{a}{\sqrt{3}r}\right] \circ t \tag{7}$$

Among them, the time required for the search of the unit, each rescue team search and rescue speed is different, this paper uses the average rescue speed. $[\ ]$ is Rounding up.

At t time of Building domestic demand relief workers are as follows：

$$F_a = N(t) \cdot W \cdot f(\tau) \tag{8}$$

Need to save the number of people in the expression:

$$\begin{cases} F_a = N(t) \cdot W \cdot f(\tau) \\ \tau = t_0 + \dfrac{L}{v_c} + \left[\dfrac{a}{\sqrt{3}r}\right] \circ t \end{cases} \tag{9}$$

Through the analysis, the establishment of the GIS space system can be known, we can simulate the entire disaster area that need to relief pressure buried personnel distribution.Then we can predict the most effective search and rescue plan after the earthquake.

3. Conclusions

By establishing mathematical modeling, combined with seismic GIS spatial analysis to simulate the disaster relief of the entire disaster area, this paper has an advantage of combining the Wenchuan earthquake example, the results of this paper are accurate and the results obtained by this method are basically consistent with the results obtained by the Wenchuan earthquake. And then consider the building capacity of the number of parameters. According to the earthquake is likely to occur in the different time, place, type of building considering, Wenchuan County as an example using MATLAB draw all kinds of buildings one day tolerate the curve, provide the most intuitive information for rescue workers at the scene.

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