Research and Application of Emergency Plan in Dynamic Evolvement Simulation System Based on GIS

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***Abstract* — In order to satisfy the requirement of visual emergency plan compilation and revision, a new method plotting elements integrated with animation is presented based on static structure model and spatiotemporal data model. Emergency plan can be compiled by coordinating consultation and deduced cross-platform. Symbol library and animations are designed. Furthermore, plotting elements can be added remarks, video and audio, and remarks can be converted into audio. The system is developed and a case is provided to prove the methods of being scientific, rational and effective.**

Keywords - situation plotting; animation; deduction; consultation; spatiotemporal data model

I. INTRODUCTION

Unexpected various emergent events will inevitably arise in modern society, such as all kinds of criminal cases, natural disasters, man-made accidents, and these events usually cause serious casualties and property losses. Reasonable and effective emergency plan can convenient for decision-making when emergency events occur, the effects attenuated accordingly[1].

But emergency plan is generally static text, lack of intuitive display effect and poor operability. Therefore, many scholars propose dynamic deduction to show emergency rescue process by way of deduction. Emergency dynamic deduction is mainly to deduced and analysis the past, present and future events with change. Graphical symbols are situation deduction graphic language, and graphic symbols and text can illustrate emergency progress[2-5]. Situation information mainly express emergency power deployment, dispatched lines using symbols in geographical information system based on plotting, so that emergency personnel can clearly understand the situation by the way of human-computer interaction. However, the rescue situation map can only show the trend at a certain moment, which is static map. The development of rescue operation changes at any time, so the situation is bound to change. Therefore, emergency rescue urgent need to be able to display real-time emergency situation changes in the situation map, in order to make the correct decision-making.

Based on GIS, computer and multimedia technology, emergency plan dynamic deduction system is developed. the of. Emergency parties can work out and revise different plans with more guidance and maneuverability in the system based on B/S architecture

II. EMERGENCY PLAN DEDUCTION TECHNOLOGY

In order to achieve multi cross-platform and collaborative plans, several key technical issues need to address in the following aspects.

A. Situation Plotting

Situation plotting plot various composite graphic symbols on the map to express actual contents of the plan elements and position[6]. Plotting technology plays an important role in emergency rescue, city public safety emergency rescue, military and other fields[7-12].

In order to meet the needs of the plan deduction, this paper designed emergency plan plotting symbol library, as shown in Fig.1.

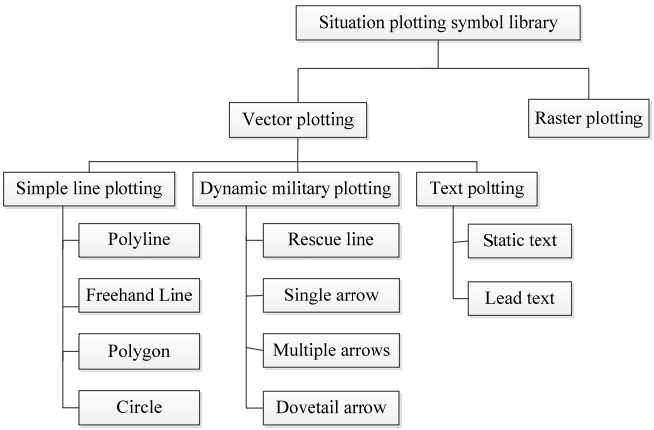

Figure.1 Symbol Library of Emergency Situation Plotting

(1) Raster plotting

Emergency rescue needs express rescue state and other information on the map, such as supplies, personnel, etc. Raster images are designed to express the information.

(2) Simple line plotting

Simple line plotting includes polyline, polygon, rectangle, circle, triangle and so on. Line symbols indicate instant information along a certain direction, such as the mass evacuation route. Polygon symbols mainly express in certain range of entities, such as people resettlement.

(3) Text poltting

Text plotting symbol is mainly some text, to express description of situation information.

(4) Dynamic military plotting

Dynamic military symbols refer to the change with the battlefield situation of military, with geographic scope and significance. Literatures[13-15] have described the implementation method, no longer to describe.

B. Collaborative Consultation

In order to realize coordinated development of contingency plans, consultation coordination needs to be solved. Collaborative content including text information, plotting, and file information collaboration. It is required to notify the rest of the parties to synchronize information, when any participant updates, adds and deletes information

The publish/subscribe model defines a one-to-more relationship, so that multiple subscribers can monitor a subject object simultaneously, which will notify all subscribers to update the information automatically when subject object itself changes. The publish / subscribe model enables system to have a better openness and more dynamic topology network characteristics, logical process of collaborative technology as shown in Fig.2.

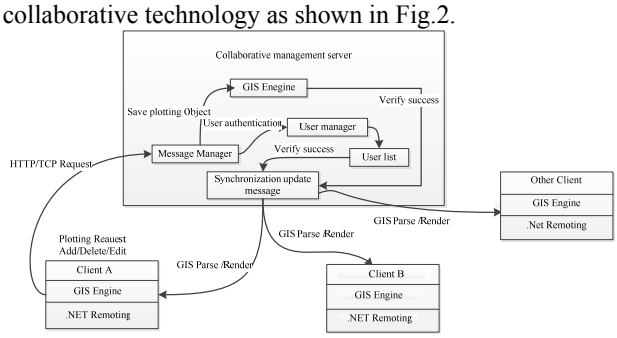

Figure.2 Logical Process of Collaboration Technology

C. Voice and Video

In order to enrich plan information, text description information in the plan can be converted into voice. In the .Net Framework System of System.Speech.Synthesis namespace, SpeechSynthesizer class provides a function of speech synthesis engine. The method can convert text into audio stream, and client can play. At the same time, we can add video to the elements, and the process of event can be shown to decision makers.

D. Situation Deduction

The essence of the plan situation information is around the event, which consists of temporal dimension, spatial dimension and stage dimension. Temporal dimension refers to the time information recorded, which illustrates the development of the event from the time perspective. Spatial dimension is the position information of the plan, including location of the event and so on. It shows the trend of the event from the space perspective. Stage dimension is a key stage of the event evolution, including latency, outbreak period, diffusion and recession, it shows event development and change from quantitative to qualitative perspective. The situation deduction is designed to show plan information along the time axis on the map based on computer, GIS, Database, multimedia technology and plotting technology.

III. METHOD OF DYNAMIC DEDUCTION

The components in emergency plan are expressed by symbol mark. Furthermore, symbol animations are added to simulate dynamic components change over the time.

Symbol animations for action include moving, deformation, blink, zoom, show and hide, attribute changes, graphic symbol changes. Each action has start time and finish time. The main parameters for the action of symbols are shown in Tab.1.

TABLE I. SYMBOL ACTIONS AND THEIR PARAMETERS

Animation type	Parameters
Moving	Point,time
Deformation	Coordinates of point
Blink	Blink cycle and type
Zoom	Zoom times, cycle and initial orientation
Show and hide	State type
Property change	Property
Symbol change	Symbol code

In the situation deduction process, with the passage of time, position of some entities will be changed over time, such as the rescue team. This position change can be represented as moving of symbols. In Moving trajectory points (X_1, Y_1, T_1), (X_2, Y_2, T_2) ... (X_n, Y_n, T_n), X, Y are the coordinate of point, T as the time object moving to movement to the point (X, Y). Route and route length can be determined by the trajectory points, the length of route:

$$S = \sum S_i (i = 1, 2, \cdots, n-1) \tag{1}$$

Where

$$S_i = \sqrt{(X_{i+1} - X_i)^2 + (Y_{i+1} - Y_i)^2} \tag{2}$$

the position (X, Y) at time T:

$$X = X_i + \frac{S_T - S_{\text{summation}}}{S_i} \times (X_{i+1} - X_i) \tag{3}$$

$$Y = Y_i + \frac{S_T - S_{\text{summation}}}{S_i} \times (Y_{i+1} - Y_i) \tag{4}$$

Where, S_t is motion distance at the time T in the section; (T_1, T_2) is the period in the trajectory, and T located in the period.

$$S_T = (T - T_1)(T_2 - T_1) \times S \tag{5}$$

$S_{\text{summation}}$ is additive along the length of route till:

$$S_{\text{summation}} < S_T \text{ AND } S_{\text{summation}} + S_i \geq S_T \tag{6}$$

Then the symbol location (X, Y) is on the line segment (X_i, Y_i) and (X_{i+1}, Y_{i+1}). The azimuth adjustment of (X_i, Y_i) is arctg(Y_{i+1}-Y_i, X_{i+1}-X_i).

Deformation animation is mainly to show the development trend of entity through shape change. Linear deformation action can indicate army offensive posture. Planar deformation action is mainly used for regional expansion or contraction. The deformation action mainly controls coordinates (X_1, Y_1), (X_2, Y_2), ... , (X_n, Y_n) to change the entity.

Blink is used for outstanding performance of important entities. The event situation is complicated and changeable. Some of these entities relatively important, need to set the flash action to highlight the importance of it.

Zoom action is mainly used to highlight entities through cycle of enlarge and shrink.

The show and hide action can be used to show an entity or a hidden entity at a particular time or at a time.

Attribute change is mainly to change the color of the graphic symbol or the line type to show the changes of the properties.

Symbol change action is mainly used to change the symbol at a certain time.

IV. CASE STUDY

The author uses the B/S architecture to design and implement the emergency plan deduction system. The client based on Silverlight technology has a better user experience.

In this paper, we take for instance forest fire to simulate the plan, main process as follows: a forest park catch fire ,and the region is located; fire event is reported to the emergency office ,and firefighting group, material group, fire evacuation group are founded; firefighting group is responsible for forest fire fighting; the material group is responsible for the distribution of materials and equipment; evacuation group is responsible for the evacuation of tourists; fire brigades rush to the park; medical teams are responsible for medical treatment; fire spreads, and the traffic is controlled, the full process as shown in Fig. 4.

(1) fire broke out and the region is located

(2) rescue teams are founded

(3) rescue teams organized to rescue

(4) fire brigades rush to the park

(5) medical teams are responsible for medical treatment

(6) fire spreads, and the traffic is controlled

Figure.4 Simulation of the Emergency Plan

V. CONCLUSION

In this paper, we construct a static object model for the unified expression of plan elements. The system does not depend on the specific map platform, which can be integrated with ArcGIS, Google, SuperMap, MapGIS and so on. This plan only contains time dimension information, without considering spatial dimension information and stage dimension information.

Constitute the program of emergency and deduction based on the plan are one of the most important parts of the emergency response. Based on GIS, computer, multimedia technology, emergency plan dynamic deduction system is designed, which provides consultation environment and plans visualization. Plan information includes graphics, text, animation, audio, video and other information.

This plan only contains time dimension information, without considering spatial dimension information and stage dimension information. We will combine spatial dimension and phase dimension information with the plan next step

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