

# RESEARCH AND DESIGN OF DYNAMIC SYMBOL IN GIS

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## ABSTRACT:

In this paper, firstly the dynamic visual variables are discussed. The dynamic variables of symbol include duration, change rate, change order and rhythm. Then, how to study and design the dynamic symbol is researched, the object-oriented method is used to implement the design of dynamic symbol. When designing dynamic symbol, the time frame is used to control the procedure of symbol animation by setting start time and end time. Not only the dynamic variables but also the static visual variables are introduced to show the dynamic representative form of symbol. Finally, the extensive application of dynamic symbol in visualizing map is discussed. The dynamic symbol can represent spatial position, attribute character, tense change of spatial position and attribute character in visualizing map.

## 1. INTRODUCTION

Dynamic map, a new type of maps with animated and interactive functions, arises from the development of information technology and is becoming more efficient than static paper maps. Dynamic map adds the time dimension on the basis of traditional 2D or 3D map, which can gain the time-order animation effect of contents related with time, and reflect the dynamic change course of map features with the time (MIAO lei, 2004). It is a kind of map that makes the users gain the dynamic visual sense of map features which moves in the different spatial position and its attribute changes continually.

Introducing time into the dynamic map promotes the development of cartography and makes great progress in the visualization of electronic map. At the same time, it puts forward the new challenge of dynamic map visualization. As map language, a kind of new symbol—dynamic symbol is provoked by the development of dynamic map on the basis of traditional map symbol. The dynamic symbol need refer to some new research problems based on the origin map symbol. For instance, how to introduce time dimension into designing the symbol, and how to show the map be means of dynamic symbol in order to meet the effect of dynamic map visualization.

In this paper, firstly the dynamic visual variables are discussed. Then, how to study and design the dynamic symbol is proposed on the basis of researching the symbol dynamic variables, the object-oriented method is used to implement the design of dynamic symbol, and the extensive application of dynamic symbol in visualizing map is given at last.

## 2. DYNAMIC VISUAL VARIABLES

Dynamic visual variables can be applied to the representation of point symbol, line symbol and area symbol on map, which can represent the dynamic character of symbol with the change of time. Koussoulakou And Kraak (1992) introduce dynamic visual variables (time variables) into describing the dynamic character of object in GIS, and they points out that time

variables include three variables such as order, duration and change rate. In 1994, MacEachren added frequency, display time and synchronization to the dynamic variables. At the same time, AI Tinghua (1998) pointed out that dynamic visual variables include duration, change rate, order and rhythm. Of all others, rhythm is one complex variable that is made up of the variables such as change rate, duration and frequency so on.

From the research above, we can learn that the dynamic variables include seven variables: duration, display time (moment), frequency, order, rate of change, synchronization, rhythm. The dynamic variables need be represented by using the static visual variables (Bertin, J. 1967).

### 2.1 Duration

The duration is the time course from the symbol appearance to the symbol disappearance. Duration can be divided into a smaller time unit which corresponds to the frame in multimedia technology. In cartography, duration is mainly used to represent the continued course of dynamic phenomena and reflect the time extension of object (see Fig. 1).

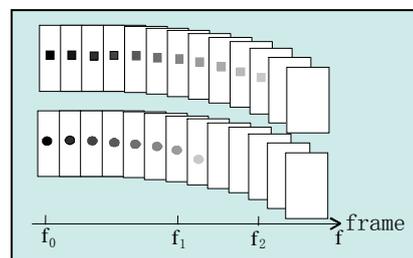


Figure 1. Duration

### 2.2 Display Time

This is the time at which some display change is initiated. In Figure 2(1) this is the moment a symbol appears in the map, In Figure 2(2) this is illustrated by the moment which takes changes.

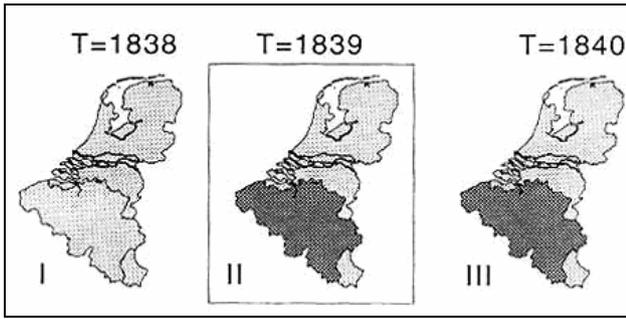


Figure 2. Display time

### 2.3 Change Rate

It is the ratio of symbol change (m) and duration(d). Change rate describes the change speed of symbol situation. It need use the static visual variables such as size, colour and direction to represent the symbol change. It can represent the change speed of direction, colour, size, spatial position of map features (see Fig. 3).

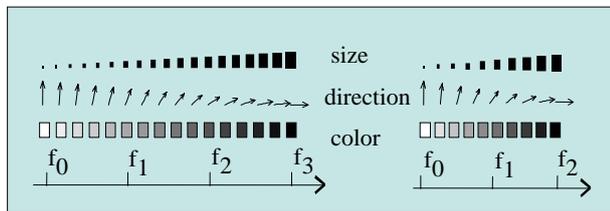


Figure 3. Change rate

### 2.4 Frequency

Frequency is linked with duration. Either can be defined in terms of the other. It is worth treating it as a separate dynamic variable because humans react to frequency as if it were an independent variable.

### 2.5 Order

Time is order. Order represents the visual order of every frame context. By separating the change course of symbol situation into every frame according to the time order, change order is to show every frame by order to represent the change. It can be used to represent the visualization order of map features. For example, colour change from grey to blue can represent the weather change from bad to fine.

### 2.6 Synchronization

Synchronization refers to the temporal correspondence of two or more time series. It can apply to matching chronological data of two or more data sets precisely. If natural patterns are out of phase (such as rainfall and vegetation growth), adjusting their synchronization at the display stage may uncover causal links that would not be apparent if chronological dates are closely adhered to.

### 2.7 Rhythm

Rhythm represents the periodical change of symbol. It is a kind of complex variable that is made up of the variables such as change rate and duration, and it represents the special visualization effect. The rhythm change can be represented by the periodical function (see Fig. 4). It describes the tense character and the repeated character of periodical change phenomena(ZHU Guorui, 2004).

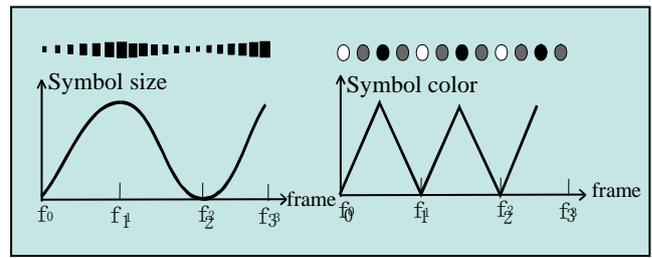


Figure 4. Rhythm

## 3. DESIGN OF DYNAMIC SYMBOL

On the basis of traditional map symbol, the dynamic effect of basic graphic elements is set to implement the dynamic representation of map symbol. The usual animation styles are blinking, jump and others. Symbol blinking can simplify the problems of symbol size, shape and symbol overlay in order to highlight the symbol directly and quickly in view. Symbol jump, as well as position change and movement along certain direction, can simplify the line width and shape design of symbol and improve the load of map (ZHANG Junhai,2001).

### 3.1 Data Structure of Dynamic Symbol

When designing the dynamic symbols, not only the dynamic visual variables are considered, but also the static visual variables are considered so as to represent the dynamic styles of symbol together. The basic variables of dynamic symbol include duration, animation style, color change, size change, direction change, change rhythm, change rate and others. Every animation style has its own character, and it is made up of different variables and different representative form. The data structure of dynamic symbol is as follows (see Fig 5).

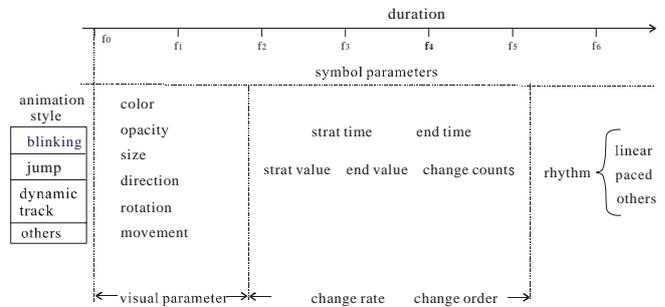


Figure 5. Data structure of dynamic symbol

From the figure 5, we can learn much information as follows. Duration: it specifies the time of symbol animation from start to end.

Colour: it represents the colour change of the objects from one colour to another during a specified time interval for a certain number of iterations. The colour animation can be used to highlight objects of interest on a map.

Opacity: it represents the animation visibility, in other words, the transparency of the objects from one degree of transparency to another during a specified time interval. The typical usages of the opacity animation are blinking to draw attention, fade-in to make objects progressively appear, and fade-out to make objects progressively disappear.

Size: it represents the size modifications of the objects during a specified time interval.

Direction: it represents the direction change of the objects from a starting angle to an ending angle during a specified time interval. Objects may be modified with direction change in terms of a position point. The direction animation is used to represent the symbols with the obvious arrow or direction.

Rotation: it represents the rotation of the objects from a starting angle to an ending angle during a specified time interval. Objects are rotated using its centroid as the center of rotation. The rotation animation can be used to show object directions changes, but not change the object content itself.

Movement: it is the movement distance of object during a specified time interval.

Animation style includes many types, such as blinking, jump, dynamic track and soon. Blinking can be used to show symbols with brightness change in order to draw attention. Jump is the way to show the dynamic representation of symbols by changing the symbol size, colour or direction. Dynamic track can be used to show maps symbols moving on the path of linear objects. A typical usage of this animation is to show vehicles moving along the path of a road.

Animation rhythm represents the regular change of symbol variable. It includes linear change, paced change and others. Linear change: this mode applies a simple linear interpolation between the start value and the end value. Paced change: This mode defines an even pace of change across the animation's start value and end value. This is only supported for values that define a linear numeric range, and for which some notion of "distance" between points can be calculated.

### 3.2 Procedure of Designing Dynamic Symbol

When designing dynamic symbol, the time frame is used to control the procedure of symbol animation by setting start time and end time. The key time on which symbol attribute takes changed is called as the key frame. At the same time, start time and end time is called as the key frame.

As for every visual variable, different attribute value is set in the time frame. Then the interpolation function is used to compute the change value between start value and end value during the time frame. The different attribute value is used to visualize the different symbol styles that are played by animation way of every frame. The principle is to decompose the animation action of the continuous key frame, and visualize the different context of every frame on the time axis, and play every frame continuously to form animation. The animation of every frame is very flexible, and it can represent any context if you want, and it adapts to reflect the exquisite animation just like the play mode of film.

But we must pay attention that no more attribute variables are used to represent the symbol animation once when designing one dynamic symbol, for fear effecting the integral representation of dynamic symbol.

The design interface of dynamic symbol includes all kinds of symbol variables. Fig.6 is the dialog interface of dynamic variable. Fig.7 is the dialog interface of colour variable. By setting the parameters, it can implement the various representative styles of dynamic symbol.

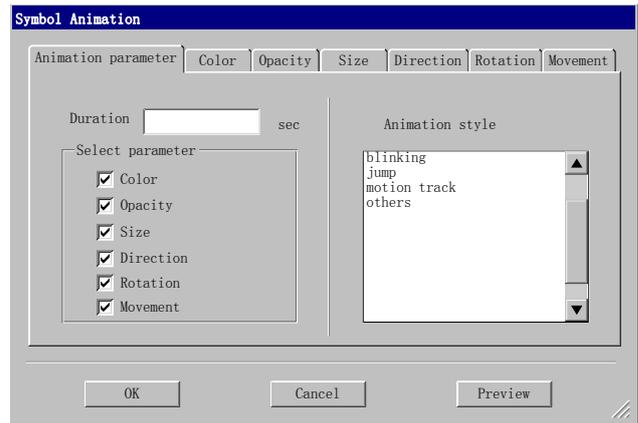


Figure 6. Property page of animation variable

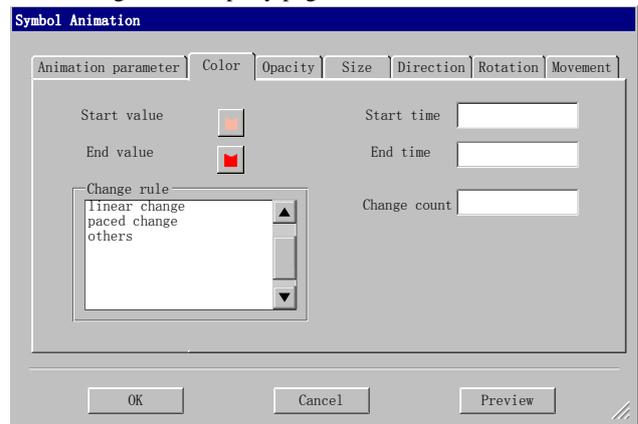


Figure 7. Property page of colour variable

## 4. APPLICATION OF DYNAMIC SYMBOL IN VISUALIZATING MAP

The animation of map symbol can enhance the attraction of map by means of representing the quantity and quality character of symbol by using animation. The animation type of symbol is classified into two kinds. One is connected with the actual time and tense, and it reflects the change procedure of object with the change of time. The other is to generate the continual animation effect in order to attract the people's attention. It is not connected with the actual time and tense (Alan M. MacEachren,1994).

In summary, dynamic symbols can not only represent the time and tense change of map features, but also represent the non-tense characters of map features such as quality difference, quantity classification, different importance and so on. In visualizing map, the dynamic symbol can represent three information contents: attribute character, spatial position, tense dynamic change of spatial position and attribute character. The former two are the static characters of map feature, which is not connected with the time and tense, and it just enhances the visual sense of static characters and information by using animation technology. The latter is the true application of dynamic character of symbol in visualizing map.

### 4.1 Representation of Attribute Character

It mainly refers to the static attribute characters which are not related to the time, such as quality difference, quantity classification and others. They can be represented by visual

way of dynamic symbol. For example, we can represent the direction of vehicle flow by means of the change of symbol rhythm which can cause the track of movement, and use the change of symbol size to reflect the classification of vehicle flow quantity, and use the change of symbol color to reflect the difference of population quantity in certain region.

#### 4.2 Representation of Spatial Position

Because people pay more attention to dynamic things than static things, the spatial position of features can be highlighted in the way of blinking, jump and others. Therefore, we can use the dynamic symbol to represent the important feature and special object in order to make the users attentive and gain the spatial position of object in the short time. The changes of colour, brightness and texture are used to describe the spatial position. What's more, when highlighting the spatial position of object, the change rate can be increased in order to attract the peoples' attention more easily.

For example, we can use the blinking of symbol to represent the spatial position of earthquake centre in the earthquake country. In querying the best route when going out, we can use the dynamic trace to describe the route of cars and visualize the result.

#### 4.3 Representation of Tense Dynamic Change

It is the most direct method that the dynamic symbol is used to represent the dynamic change procedure of map features. The mapping relation between the actual change character and dynamic variable of symbol is built up according to the time and tense. Then the tense character and change rule of map features can be represented by the dynamic variables of symbol. For instance, duration is used to represent the continued course of dynamic phenomena, and the change rate of symbol is used to represent the position movement, the change speed of attribute and so on. Dynamic symbol can be used to represent the reappearance of historical change course, the track and watch of synchronous course in time, and other functions. We can use the colour variable of symbol to represent the population change of one region with the change of time, and use the dynamic track to represent the real-time moving position of car in navigation and position change of object with the time (see fig 8).

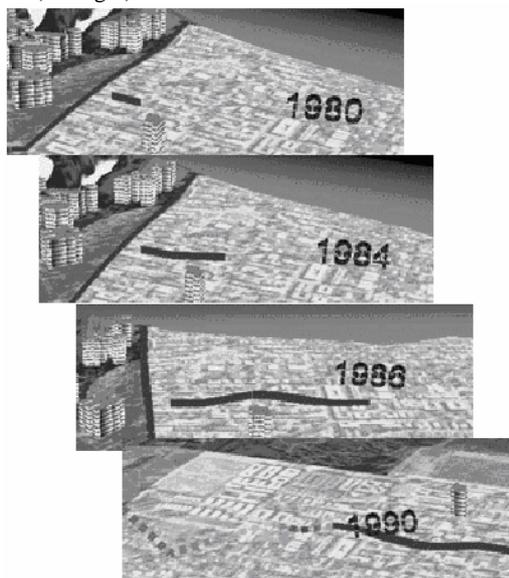


Figure 8. Change of line with the time

## 5. CONCLUSION

Dynamic symbol, as a new tool of map language, exploits the new field for the visual application of map, and provokes the new development of map visualization and representation. It helps to enhance the visual sense of people and services for all kinds of fields. At the same time, the research of dynamic symbol is just at its beginning presently, so there is still a long way to go to implementing a perfect dynamic symbol system. Therefore more research in dynamic symbol is needed to be done in the future.

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