Study of Map Symbol Design Sub-System in Geostar Software

CHENG Peng-gen[1, 2] GONG Jian-ya[1] WANG Yan-dong[1]

(*National Key Lab for Information Engineering in Surveying, Mapping and Remote Sensing, Wuhan Technical University of surveying and Mapping, Wuhan , 430079；*

pgcheng@21cn.com

2.Surveying Department, East China Geological Institute, Linchuan, Jiangxi, 344000)

KEY WORDS: Map Symbol, Design, System, Geographic Information System, Object-Oriented

ABSTARCT: In this paper, we introduce mainly application problems of object-oriented technology in the course of design and developing map symbol design subsystem in Geostar software. Under the technology of object-oriented, symbol classification and organization, graphical element classification and symbol base structures have been designed, and the symbol design subsystem and dynamic link library of spatial information symbolization have been developed.

1. INTRODUCTION

No matter Geographic Information System (GIS) or cartography system, the map symbol design is one of the basic functions. Generally, the needs of symbol system are different according to the application fields of GIS. In order to improve the adaptability of GIS, a GIS system should provide the modal of map symbol design and mapping.

Making a comprehensive view of the popular CADs and GISs. There are four kinds of methods to implement symbol design. The first is text editor, such as the “shp” file of AutoCAD. The second is the user developing language, for example, the MDL language of MGE. The third is the graphics editor of the system itself, such as “Block” file of AutoCAD. The last is the symbol design modal, e.g. the Line Style Editor of MGE. In a word, a good GIS should provide a map symbol design Modal.

As a good map symbol design system, it should satisfy the needs as below: (1) the graphical elements of constructing map symbol must satisfy the need of design system. (2) User can view the symbol real time when designing map symbols. (3) The design system has friendly interface, convenient and agile operation. (4) The designed symbols must have a special precision. (5) The design system should have good encapsulation, maintainability and adaptability. The key to solve the above problems is adapting object-oriented technology in developing the map symbol design system.

This paper is organized as follows: Section 2 analyses map symbol characteristic and designs the graphic element of symbols based on object-oriented method; Section 3 designs the symbol library; Section 4 introduces the system design of our system and section 5 the design of symbolization dynamic library of spatial entity; Section 6 is the conclusion of this paper.

2 MAP SYMBOL CHARACTERISTIC AND GRAPGICAL ELEMENTAL DESIGN

2. 1 Map Symbol Characteristic Analysis

The maps of describing real world usually are topography map and thematic map although the shapes of real world thing are different and protean. They are considered symbol aggregate, and the symbols of describing feature are classified into point symbol, line symbol, surface symbol and thematic symbol in geometry. In fact, point symbol, line symbol and surface symbol have the respective characteristic of themselves and the commonness. The differences of them are their respective basal graphical element, while the sameness is their drawing parameters, such as symbol code, drawing handle, pen color, brush color, and the operation method such as drawing and delete function. On the view of the object-oriented, we can define three symbol object classes, i.e. point symbol class (CPointSymbol), line symbol class (CLineSymbol) and surface symbol class (CSurfaceSymbol), and encapsulate data members (attribute) and function member (operation method) in each object class in order that each class object has relative independence. In the interest of reducing data and program code redundance, we can generalize supper class, namely CSymbol, which is based on the above three object classes

2.2 Graphical Element Design

Symbol is the aggregate of graphical element and the design of graphical element is the core of symbol design system. In general, we can design the different graphical element of point symbol, line symbol and surface symbol, according to their respective characteristics, and classified the basic graphical elements into graphical element objects. Thus a symbol is a complex object aggregate different graphical element objects. To these object classes, which have the some data member and the accordant operation method, we can abstract a supper-class of high level.

2.2.1 Graphical Element Design of Point Symbol

A point symbol is composed of fourteen kinds graphical elements, such as point, poly-line, polygon, text, bitmap, and so on. So we can defined fourteen kinds of graphical element object, for instance, point class, line class, poly-line class, polygon class, curve-line class, curve-polygon class, arc class, ellipse class, triangle class, rectangle class, asterisk class, text class, bitmap class and sub symbol class. According to change the attribute value of the graphical element class we can get different graphic element. For example, polygon can be classed hollow and solid, hollow polygon has the cases of overlay and disoverlay, and the solid polygon can be divided into solid fill and bitmap fill. Because of the rectangle, ellipse, text and bitmap have the same operation process and the some location data member thereby we can abstract a supperclass CBox. The polyline, polygon and curveline can be abstract a supperclass CCPLine. Furthermore, we can abstract the highest graphical element supperclass CElement, which has the common data member and operation method of the entire graphical element object consist point symbol. The relationship among graphical element object classes of point symbol is show in figure 1.

2.2.2 Graphical Element Design of Line Symbol

In general, combining draw method is adopted in line symbol drawing. A Line symbol can be regarded as the combination of the line graphical element, which has the single characteristic. For instance, fence symbol is consisted of dash line, continuous point symbol and continuous cross line symbol. According to line symbol of

topography map specification of china, we can design thirteen kinds of basic line style, i.e. solid line, dash line, dot line, double dash line, double solid, continuous point symbol, located point symbol, lead link, lead point symbol, cross line, change width solid line, change width dash line, band hatch. We can design the above basic line style into 13 kinds of graphical element object classes. Because of different line graphical element object has different characteristics, therefore we can design the data members for different line graphic element object, for example, located point symbol data member is point symbol code, point symbol scale, whether drawing point symbol at the extreme point, whether the point symbol point at north, etc.

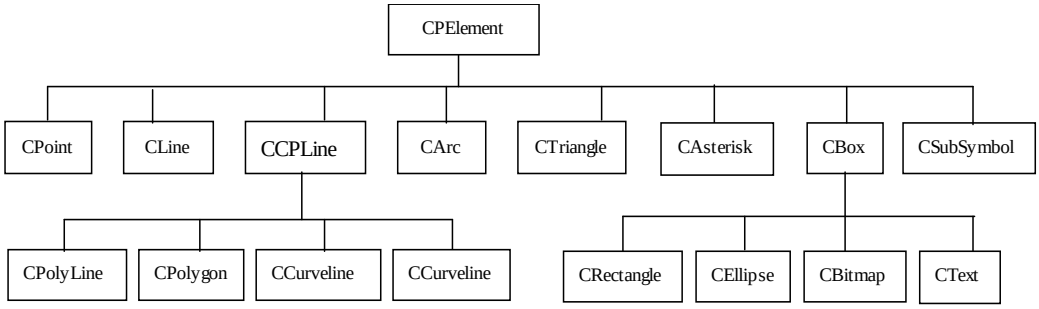

Figure 1. Relationship among graphical element object classes of point symbol

2.2.3 Graphical Element Design of Surface Symbol

It is not difficult to find that there are four kinds of method of drawing surface symbol. They are color fill, hatch fill, point symbol fill and bitmap fill. We can design them into four graphic element object classes. The data members of color fill class are fill color and fill type. The data members of hatch fill class are oblique angle, line width, distance among hatches, hatch color, start point coordinate (x, y), offset value (dx, dy), real length and empty length. The data members of point symbol fill class are row and column offset of the first point symbol, row and column distance between two adjacent symbol, point symbol code, point symbol scale, rotate angle, rotate angle form (fixed, random), point symbol seed form. The data members of bitmap fill class are width and height of bitmap, bitmap, whether mask fill, mask color, whether maintain the ratio of horizontal to vertical.

3 SYMBOL BASE STRUCTURE DESIGN

3.1 Design System Symbol Library Structure

Design system symbol library is oriented to symbol design Symbol. Symbol is the assembling of symbol describing information. No matter what point symbol, line symbol or surface symbol, they are the complex objects, gathering graphical element instance object of themselves. In order to save memory, we only store graphical element object identity and the describe parameter consisted of a symbol in the symbol library. As far as symbol library is concerned, it is not suitable only to store the data files of symbol describing information, and we must build up index mechanism of symbol. There are two kinds of methods to build up it. The first is to store index and data in the same file. In this case the index is stored in front of the data file, namely, symbol library is divided into index and data area. The second is to store index and data apart, namely storing index in one file, while storing data in the other file. The characteristic of the former is that there is only one file in a library, thus it is easy to manager, while it is not easy to add symbols. Therefore the method is always used to output symbol library organization of symbol designing system. The latter is consisted of two files in a same symbol library. For the sake of management conveniently, we can organize symbol library by using the method of which filename is

same and while suffix is different.

In order to handle conveniently, we adopt the stored form of which data and index are apart in symbol design system, and the stored form of which index and data are in the same file in the symbol library of design system output. Because of different symbol characteristic of point symbol, line symbol and surface symbol, their index structures are different. However, they all include the following fields in the three kinds of symbol index structure: symbol name, symbol code, pointer of point at describing data and the size of describing data. For instance, point symbol library index file record structure is symbol name, symbol code, pointer of pointing at describing data, size of describing data, symbol type and location style.

3.2 Applying System Symbol Library Structure

Applying system symbol library is the symbol library that oriented to applying system (spatial entity symbolization dynamic library). In order that GIS system manages the symbol library of many scales series and many forms, we need adopt a special index mechanism to achieve it. We design a symbol library index file, namely symIndex.tab, to manage symbol library. A record of index file has a symbol library correspondingly, and there is a record to be added in index file when system design generates a new symbol library. The record structure of symbol library index file is following: Number of symbol library, type of symbol library (point symbol, line symbol or surface symbol), name and the description information of symbol library.

The target of introduce symbol library serial number is to gain a certain symbol describing information quickly, because we adopt the method, symbol library serial number * 10000 + symbol serial number, to build up symbol index in the dynamic library. We can gain a symbol describing information after search twice when drawing a symbol, thus the speed of drawing symbol is increased greatly. Once the symbol library index file was built, the client can design the different symbol library having different scale and type, thereby it is convenient greatly to output multi-scales serial map in GIS environment.

4 SYMBOL DESIGN SYSTEM DESIGN

4.1 Function Design

The symbol design system should have the function of designing point symbol, line symbol and surface. Owing to the difference of point symbol, line symbol and surface symbol characteristic, we do not adopt completely identical method, but a flexible method. However real-time display is the basis of symbol design. This system is organized with the ideal of combining parameter with. Point symbol adopts graphical interface form to design, while line and surface symbol parameter form and display the designed symbol real-time. The symbol design system has the function of editing, modifying, storing, deleting, browsing, and integrating system library. It mainly includes: symbol library, symbol edit, parameter set, and help.

Symbol library: its main function is to handle symbol library file, including setting up a new symbol library, opening a existing library, closing symbol library, browsing the symbols of library, cleaning off the deleted symbols in symbol library, transfer design symbol library to applying system symbol library, merging the two symbol library in the same type, and exiting symbol design system.

Symbol edit: this function is to be aimed at a symbol to handle, including building up a new symbol, quitting a designing symbol, storing the designed symbol, deleting the symbol in symbol library, choosing a symbol in symbol library, and redrawing the design window. As far as point symbol design is concerned, it should have the function of deleting, moving, rotating and handling the front and behind cover.

Parameter set: it is designed to have the function of changing design unit, showing and closing grid point for the sake of improving symbol design precision.

Figure 2 is an interactive interface of surface symbol design.

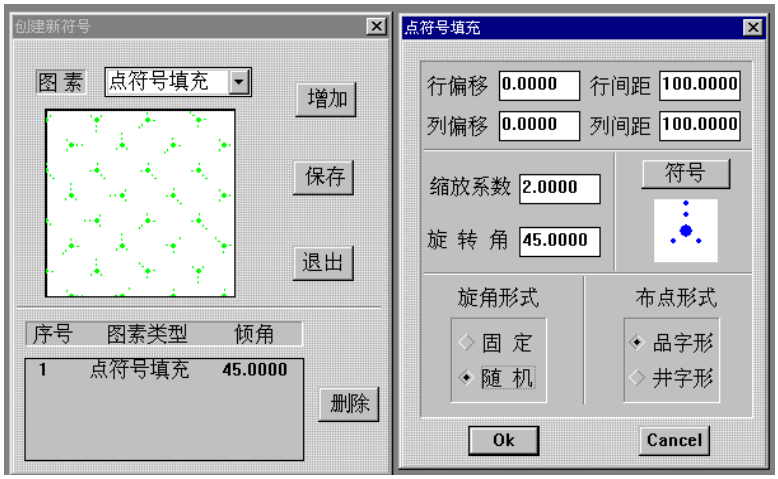

Figure 2. Interface of Surface Symbol Design

4.2 Program Design

Program design is adopted the method of the object-oriented. As far as symbol is concerned, different graphical element need be designed in the form of independent class, such as basis algorithm class, symbol class, point symbol class, line symbol class, surface symbol class and symbol browsing class. Moreover various kinds of windows and dialog box are designed into classes. Because class has the features of information encapsulation and inherence, it is easy to design and maintain the program. The relation among classes can be built by adopting class inheritance and instance object.

The relation between graphical element class and point symbol, line symbol and surface symbol class can be built by using instance object, but the relation among the basis algorithm class, graphical element, symbol class and point symbol, line symbol, surface symbol class can be maintained by the method of class inheritance. The relationship among the object classes of point surface design module is showed in Figure 3.

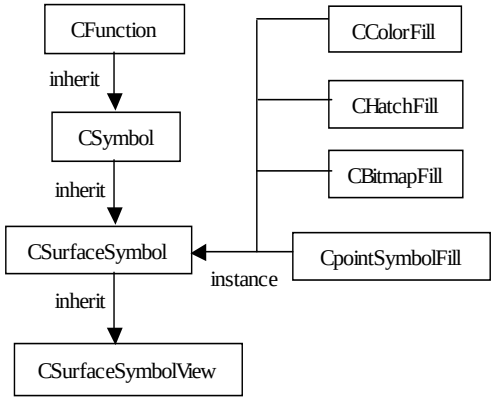

Figure 3. Relationship Among Object Classes of Surface Symbol Design Module

5 DYNAMIC LIBRARY DESIGNOF SPATIAL ENTITY SYMBOLIZATION

The target of symbol design is to build up symbol library for GIS system. In order that GIS use the designed symbol library and symbolize spatial entities, a spatial entity symbolization dynamic library is necessary in GIS. The process of spatial entity symbolization in GIS is follow: firstly configuring symbol for all sorts of objects, and then symbolizing according to the parameters of geometry coordinate, symbol description information of spatial entity, etc.

Because of symbol design system adopted object-oriented method, so we can use the source code and maintain the relationship among the object classes of symbol design system. In addition dynamic library should supply the interface of display, choosing, drawing for symbol library. So we should designed some new classes, such as symbol choosing dialog class. The relationship among the object classes in dynamic library is showed in Figure 4.

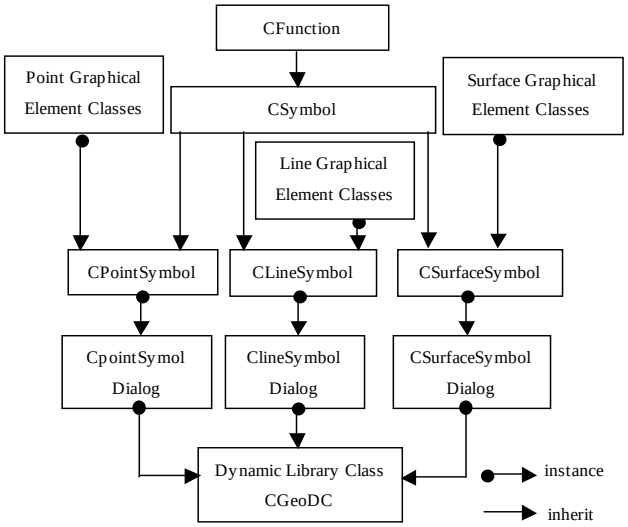

Figure 4. Relationship Among Object Classes in Dynamic Library

The dynamic library interface class is designed and named CGeoDC in order that other module of GIS can call it. The part functions definition of CGeoDC class are as following:

public: //function member
int selPointSymbol(); //select point symbol
int selLineSymbol(); //select line symbol
int selSurfaceSymbol(); //select surface symbol
void DrawPointSymbol(POINT pt, UINT Index, COLORREF color, double unit,double scales=1.0,double angle =0.0); //drawing point symbol
void DrawLineSymbol(POINT *pt, int n, UINT Index, COLORREF color, double unit); //drawing line symbol
void DrawSurfaceSymbol(POINT *pt, int n, UINT Index, COLORREF color, double unit); //drawing surface symbol
BOOL CraeteSymbolBrush(UINT Index, CBrush *abrush); //create a brush according symbol index

Under the Geostar environment, the interface of calling select line symbol function selLineSymbol of spatial entity symbolization dynamic library, and the background is the symbolization result of spatial entities by using spatial entity symbolization dynamic library are showed in Figure 5.

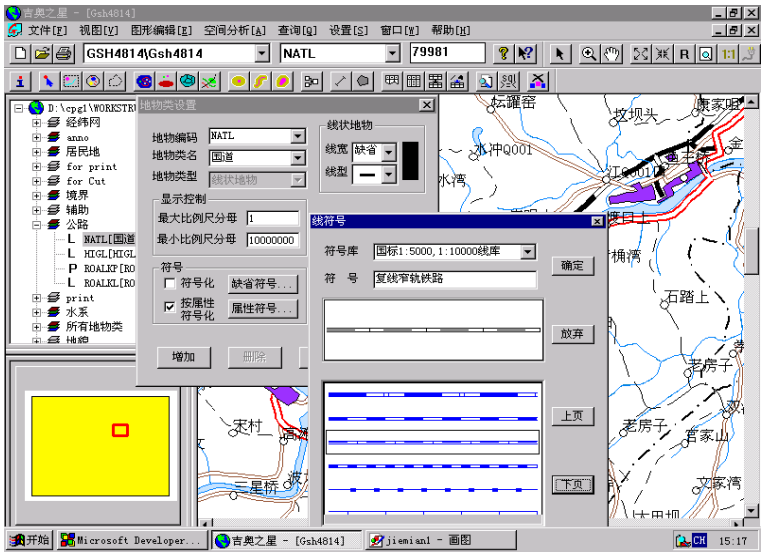

Figure 5. Relationship Among Object Classes in Dynamic Library

6 CONCLUTION

The authors design and develop map symbol design subsystem for GIS software GEOSTAR according to the technology described in this paper. The develop experience and result indicate that three are some advantages by adopting object-oriented technology to develop map symbol design software, such as correct logicality, convenient for developing software,

the software has good encapsulation, and it is convenient to maintain and expand the software. By using the symbol design subsystem and the symbolization dynamic library, we designed a series of symbol libraries of Chinese standard specification for cartographic symbols and they can meet the need of production.

Reference

1.CHEN Shun-qing. Design of map symbol library[J].ACAT GEODAETICA et CARTOGRAPHICA SINICA，1993,22(1):56-63.

2.WEN Hong-jie,etc. Software of Generating Graphical Element[J]. Journal of Computer Aid Design and Graphics，1992,4(1):41-45.

3.XU Qing-rong, etc. Foundation of Computer Cartographic [M].Wuhan: WTUSM Publish Company,1993.

4.TANG Rong-xi, etc. Tutorial of Computer Graphics [M].Beijing：Science Publish Company，1990.

5.GU Xing-sheng. New Edition of Object-Oriented Method and C++ Language[M].Xian：Xian JiaoTong University Publish Company，1992.

6.CHENG Peng-gen,etc. Design and Implement of Map Symbol Design System[J]. Journal of Image and Graphics,2000,5(12):1006-1111.

7. CHENG Peng-gen. Design and Organization of Vector-Based Symbol Base in GIS[A]..In:Archives of ISPRS Commission[C]. Wuhan: Wuhan technical university of surveying and mapping, 1994,30(6): 23-28

8. Frank,A.U. and Engenhofer,M.J. Computer Cartography for GIS: An Object-Oriented View on Display Transformation[J]. Computer & Geosciences,1992, 18 (8): 975-987