

The Organization of Multimedia Information in Electronic Map

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ABSTRACT On the basis of an electronic map-based hypermedia data model (EMBHDM), this paper makes a study on the technologies of nonlinear storage, organization, management and browsing of information as well as organization of data on the basis of the relationship between multimedia information of electronic maps.

This paper first analyzes some features of electronic maps and hypermedia technology, and then illustrates the creation of EMBHDM with some examples. The tests show that this model can efficiently organize and express multimedia data.

1 Introduction

As a new type of carrier of spatial information, electronic map possesses many features: dynamic, interactive, multimedia integration, etc. Multimedia electronic map combines several kinds of media such as graphs, images, texts, charts, sounds, animations, videos etc., and can express spatial information directly, visually and vividly via human perceptions like vision, hearing, sense of touch.

An electronic map-based hypermedia data model (EMBHDM), which is based on electronic maps and hypermedia technology, is studied in this paper. In this model, geographical and spatial entities connecting multimedia information are defined as nodes of information; spatial relationships between objects of geographical entities are taken as links; and mutual associated relationships between nodes and links constitutes a complicated information network. Accordingly, visualization of geographical objects and such functions as inquiry of spatial information, spatial search, spatial analysis can be realized. Adopting graph and image processing, technology of spatial database management, layered information management model and user-oriented interface design, EMBHDM offers convenient and flexible graph editing, view display, data processing, self-definition of node and link information, abundant information link connections and expressive forms.

2 The definition of hypermedia

Hypertext is a kind of computer technology involving nonlinear storage, organization, management and browsing of information in accordance with relationships between information. The distinction between hypertext and traditional computer

technology lies in the following aspects.

1) Hypertext attaches great importance not only to information needed to be managed but also to creation and expression of relationships between information.

2) Hypertext creates and expresses various knowledge and systems in the real world by means of relationships between information. Therefore, hypertext provides a new way of communication between computer and human beings, which is conforms more to people's habits.

Hypertext technology combines natural language text and computer's ability to interactively shift and dynamically display linear text. Its essence and basic feature is to establish relationship inside a text as well as between texts. It is the relationship that provides a non-linear organization for texts. In other words, hypertext is composed of nodes which store information and links which describe relationships between information. A node is a natural data unit related to some theme in hypertext system. A link is an entity in hypertext system showing relationships between information. Links hide behind information and is recorded in application systems. If no marks are intentionally made for these links, the users will feel the existence of links only when they shift from one node to another. It is with links that hypertext becomes nonlinear. Only with the help of links can users find related information along relative links.

Information network is thus formed with nodes and links. Different from traditional information technology, users' operation of checking up information in hypertext is carried out according to relationships between information (that is links). From application, browse is an activity that users undertake at their will. Whether browsing may fulfill its goal or not and whether efficiency of browsing is high are closely related to the design of hypertext system.

Hypertext technology is adopted to manage multimedia information such as graphs, images, texts, sounds, videos, animations etc.

3 The features of electronic map

Through digits, digital map shows spatial informa-

tion which is traditionally represented in traditional paper map by means of graph, symbol, color, annotation, etc. With the help of computer, under the support of spatial data management of GIS and processing software, digital map can fulfill some processing activities of spatial information. Thanks to combination of digital map and highly efficient and accurate processing function of computer, it is very easy and flexible for digital maps to produce all kinds of models of new products satisfying different demands.

Maps of digital form become more abundant and variable in content. Its main expression in introduction of three dimensional information and dynamic information can be found. Digital technology should make it possible for integration of graphs and images, vertical connection of the different scales maps and horizontal seamless connection of the same scales maps about city, province, country and world.

Multimedia revolution makes computers not only process digits, texts etc. , but also begin to store and show multimedia information such as text, photo, sound, animation and video, etc. On the basis of spatial reference provided by visual digital map of different details for users, computers can represent spatial distribution of various spatial entities and connection through information with multimedia information, so they offer users more vivid and direct information for displaying object.

On the basis of cartographic database, stored in outer memorizer of computer in the form of digits, electronic map (also called screen map or instantaneous map) is a visual map. Electronic map technology is a combination of many modern technologies: GIS technology, digital cartography technology, multimedia technology and virtual reality technology etc. Taking a kind of visual electronic map as background, with the aid of multimedia information as expressive means to display whole appearance of city, enterprise and tour scenic spots, multimedia electronic map is a product of modern information. It may be stored in outer memorizer of computer, spread by means of CR-ROM, networks etc. , and offer users in the form of desktop computer or touch screen computer.

The features of electronic map are listed as follows:

- a carrier of spatial information
- complicated heterogeneous data and data relationship

Electronic map is the carrier of spatial entity whose features can be represented in two aspects: spatial character and non-spatial character. Their corresponding data types are spatial data and property data. The former can be divided into vector data and raster data according to the way that data are organized. For instance, digital map belongs to vector data while remote sensing images belong to raster data. Property data is classified into structural data and nonstructural data according to organization of data structure. For example, property based on RDBMS is mainly structured data, while photo, sound, video are usually non-structural data. Spatial entities do not exist in isolation. There are many complicated spatial or non-spatial relationships between entities. In addition, complicated relationships between entities can be also shown by the relationship between non-spatial information (i. e. relationship between semantic information). Complicated data type and data relationship result in many troubles in data storage and management.

- rich and various information content

Map is a symbol of spatial cognition. The specific objects that map represents are point features, line features, area features of man-made or natural spatial entity, which can be tangible or intangible, visible or invisible. The contents that maps convey can be synthetic or thematic. The scope of the object may be local or global.

Owing to the limit of scale, map scope and capacity etc. , the amount of information that paper maps can reflect is limited. The properties of features are reflected only by using structures of map symbols, colors and sizes. However, the amount of information which electronic maps can reflect is much larger. Besides all kinds of map symbols, it can cooperate with external database. Management of larger amount of information can be achieved by adopting compress technology of data, stratified technology, open window technique, visual technol-

ogy etc.

- complicated information relationship

Maps should not only express such features of the geographic object as geometrical (positional) feature, property feature and time feature, but also reflect the special relationship and property relationship between different geographic objects. In addition, geographic objects include simple ones and complex ones. Thus the information relationships are complicated.

- share of information

After maps are digitalized, they can be easily copied and disseminated and thus achieve information sharing. Accordingly, electronic maps can be copied in great amount without any damage and spread through computer network.

Advantages of hypermedia technology are demonstrated as follows:

- flexible and convenient management of complicated heterogeneous data,
- capability to manage complicated relationships between information,
- simple, convenient and visual operation by users,
- abundant expressive ways,
- convenience in data sharing with other application thanks to the open hypertext technology,
- convenience in integration and enlargement of the system by the aid of hypertext technology.

Accordingly, hypermedia technology can better express multimedia information on the basis of electronic maps.

4 EMBHDM

EMBHDM employs hypermedia technology to organize and manage complicated map objects and relationships between objects.

In a system which contains large amounts of information, it is difficult to cover all the information with one or two maps. In this case, several maps may be used. These maps are connected by certain logical relationships. Their connections may be horizontal and vertical. Vertical connection is demonstrated by the connection of the maps which cover the same area in various scales. For instance, the

world map, national maps, or provincial maps, maps of all cities and towns in China can constitute a multi-scale map system. The maps at lower layer are amplifications of certain parts of the maps at their upper layer.

Maps of different areas are connected automatically by certain standards such as a unified geographical coordinate system.

4.1 Node

A node is a natural data unit related with certain theme in the hypermedia system. For users' convenience, certain forms of marks are made on nodes in the hypermedia system, indicating the existence of links. These marks are given different names in different systems such as button, hot region, anchor and so on. They have similar basic function in spite of their different names and realizing mechanism. For instance, in WWW system, these marks are made by using HTML.

According to features of electronic map, in EMBHDM, nodes are classified by its geometrical features into seven types:

- 1) Point node, items which cover small areas, can not be scaled, but should be located,
- 2) Arc node, which has no significant meaning and can be connected with point node to form direction line node,
- 3) Line node, items on the earth surface which are line-shaped or belt-shaped, such as roads, rivers, frontier lines,
- 4) Rout node, items on the earth surface which are line-shaped or belt-shaped, and have directions, such as traffic net, tube-net-system, mainly used for net construction,
- 5) Area node, items which are located in areas which can be classified into circle, square and polygon, such as blocks, lakes and forests,
- 6) Complex node, which are composed of two or more nodes mentioned above, such as bus route with stations and path,
- 7) Text node, which is defined by the marks (annotations) on the map, such as names of places or units.

Nodes are classified into three kinds according to their functions: system node, map node and theme

node.

1) System node is the node connected with system function. It mainly executes certain function in the system and accomplishes certain function. In EMBHDM, system nodes can be further classified into 5 types, i. e. file node, view node, media node, search node and analysis node.

2) Map node is the node connected with maps, that is, to fulfill the connecting of maps. In EMBHDM, maps includes cover, group, main map, map, sub-map, control map, super-map, multi-scale map.

3) Theme node is a root node, which is not connected with other nodes. It can be used for inquiry and display of the multimedia information of the objects such as graph, photos, charts, sounds, animation, video, text, etc.

4.2 Link

Link is the entity used in hypermedia system to display the relationship among information. It is the key to represent spatial features of hypermedia. Links freely set by the author can display the relationships among information to the greatest degree and reveal the true color of present system. Incorporating different ideas into one system can not only avoid digital redundancy but also satisfy different requirements of different users. For instance, information can be organized according to information types, contents, creation time, information clues and so on. Consequently, customers can get different information according to their own points of view. As the nodes (except systematic node) and links can be set freely, EMBHDM offers great freedom in creation of multimedia electronic maps and can meet varied demands. Thus they can produce all kinds of multimedia electronic maps. In EMBHDM, five basic modes of connection are realized, which are the connection between covers and their group, the connection between groups and their main maps, the connection between maps, the connection among maps and sub-maps, and the multimedia connection between main maps or maps or sub-maps and nodes.

4.3 Data model

The hypermedia data model based on electronic

map is a three-layer structure data model. The layers are the layer of customers' interface, logic layer and physics layer.

4.3.1 The layer of interfaces

The layer of interfaces is a displaying layer, which is used for display of hypermedia. It supplies the customer with the definition, edit, dealing with nodes and the tool to operate information network structure. In this layer customers communicate with

hypermedia by the tools provided by the system. This layer is the interface for the interaction between users and the hypermedia system. Interface layer supports the semantic connection from various media to nodes, as well as the semantic connection from tables and fields to various media. In EMBHDM, the authors have developed a software authoring electronic map, which is named as Atlas2000, shown in Fig. 1.

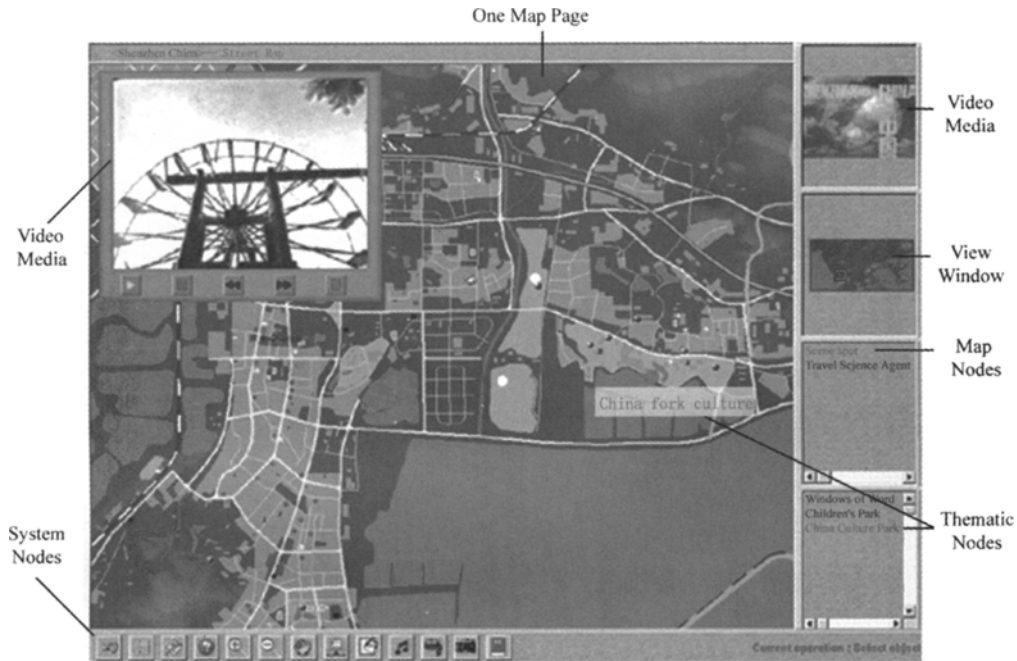


Fig. 1 One page created by EMBHDM

In the layer of interfaces of Atlas2000, the following functions can be completed:

- rich edit functions for spatial data,
- convenient operations for users to define nodes such as point, line, area, text, etc. and set up corresponding links,
- management and display of the spatial data made up of vector data and raster data,
- inquiry of spatial information and spatial analysis based on electronic map,
- connection between spatial data and feature data with ODBC technique,
- making and displaying 3D map,
- displaying, zooming, roaming multi-scales map,
- management and display of several maps covering large range.

4.3.2 Logic layer

According to the idea of Hybrid Model, spatial data

and non-spatial data are managed respectively. By adopting OOP technique, spatial data are managed through spatial data model. However, the non-spatial data are managed through RDBMS technique. Both are connected together by a unified identification (ID).

In EMBHDM, the data are abstractly described as cover, group, main-map, map, layer, geometry object (include point, arc, line, route, area, annotation, complex object). The layer structure is from top to bottom, cover → group → main-map → map (include sub-map, control map, super-map, multi-scale map) → layer → geometry object, which is shown in Fig. 2.

4.3.3 Physics layer

In EMBHDM, the group is regarded as a unit. Adopting structure of directory and file, the map data and media data are stored separately. In this way, it

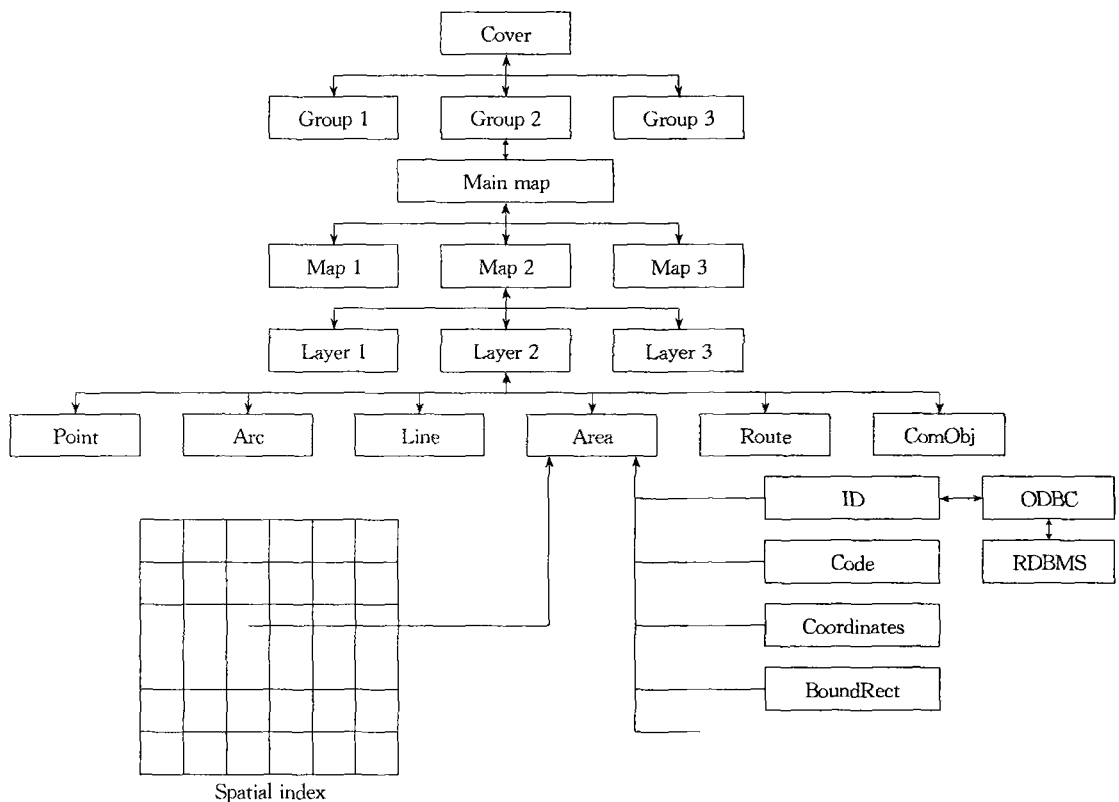


Fig.2 The logical structure of EMBHDM

will be propitious data share and to avoid data redundancy, and it can satisfy different requirements of different users as well.

5 Conclusion

On the basis of the features of electronic map and hypermedia, this paper makes a study on the techniques of nonlinear storage, organization, management and browsing of information as well as organization of data based on the relationship between multimedia information of electronic maps. Atlas2000, a software authoring electronic map, can efficiently organize and express multimedia data. The tests prove that an electronic map-based hypermedia data model can better express multimedia information based on electronic maps.

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