SUPERMAP GIS 6R: A REAL SPACE GIS

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ABSTRACT:

We present a novel GIS, Real Space GIS, which is a 2D & 3D integration GIS. Real Space GIS is based on Real Space which is 3D geographical space and 2D map space which is based on geographical sphere or ellipsoid comparing to Paper Space GIS which is based on traditional Paper Space based on paper map coordinates. Real Space GIS mainly integrates data structure, data model, data storage, data visualization, data analysis of 2D GIS and 3D GIS. Real Space GIS provides users with the advantages of 3D GIS while remaining the features of 2D GIS. Real Space GIS also is compatible with Paper Space GIS. SuperMap GIS 6R based on SuperMap Universal GIS Core (UGC) is a Real Space GIS. SuperMap GIS 6R is a technology system not a single product and has been applied to some applications and greatly reduces the cost of building a 3D GIS system based on an existing 2D GIS system.

1. INTRODUCTION

Studies have shown that 2D views are often used to set up precise relationships, while 3D views help in acquisition of qualitative understanding [1]. 2D GIS has proven to be the most sophisticated system that operates with the largest scope of objects (spatial and semantic), relationships and provides means to analyze them [2], however, 2D GIS analysis has encountered some limitations in some situations, e.g. noise prediction models (noise spreads out in three dimensions) [3], real estate market [4], water flood models, air pollution models, geological models [5]. Other disciplines which have met the need for 3D geo-information are: 3D urban planning, environmental monitoring, public rescue operations, telecommunications, landscape planning. The developments in the area of 3D GIS are pushed by a growing need for 3D information [6].

The study in 3D GIS is intensive and contains all aspects of acquisition, storage and analysis of real world phenomena. Among all, 3D analysis and other related issues (topological models, frameworks for representing spatial relationships, 3D visualization) are mainly in the focus of investigations. 3D GIS has been investigated for over one decade, while the breakthrough of 3D GIS seems to be go slow. Up to now the research in 3D GIS still has many difficulties and 3D GIS cannot provide the same functions of 2D GIS: (1) data capture, (2) data structuring, (3) data manipulation, (4) data analysis, and (5) data presentation [7]. Therefore now 3D GIS cannot adequately replace 2D GIS while 3D GIS has some advantages over 2D GIS.

We present a novel GIS, Real Space GIS, which integrates 2D GIS and 3D GIS and provides users with the advantages of a 3D GIS while still owning features of a 2D GIS.

2. BACKGROUND

2.1 2D GIS

Until recently most geographical information systems (GIS) only visualize information in two dimensions (2D GIS). 2D GIS is still widely used by geographic information professionals and most of the current research and development still lies in this traditional map-based approach. Although 2D GIS easily perform numerous spatial analyses and applications, visualization is generally limited to view either individual GIS layers or the results of GIS analyses [8]. Since the world we live in is three or more dimensions, focus has shifted towards the development of GIS in three dimensions.

2.2 3D GIS

3D GIS which attributes to pipelined 3D graphics and efficient terrain visualization algorithms and related techniques becomes a reality and many GIS have become available on the web. Such on-line GIS systems include Terrafly [9], GeoVR [10] and Terra VisionII a flyby global GIS [11]. Two special applications are GeoZui3D [12] and VGIS [13]. The first, GeoZui3D is a 3D marine GIS which supports real-time input and texture mapped imagery with a simple viewport control method which links multiple views. Moreover, VGIS is an integrated global GIS and visual simulation system which supports multi-resolution terrain elevation and dynamic 3D objects. There are many 3D GIS systems like VGIS. In public domain Google earth [14] becomes more and more popular and has been applied in environmental monitoring, public rescue operations and so on. NASA WorldWind [15] is a known open source 3D GIS system which helps users to quickly build a 3D GIS system. However, Google earth and NASA WorldWind focus on the visualization of massive global imagery and terrain and related data and refer to little functions of GIS. SkylineGlobe [16] is another well-known 3D GIS system which provides useful functions of 3D GIS. Nevertheless SkylineGlobe is just a 3D GIS system and integrating SkylineGlobe and 2D GIS systems provided by other vendors is still a problem.

2.3 2D/3D GIS

In the literature, a unique Geographical Information System (GIS) that seamlessly integrates 2D and 3D views of the same spatial and aspatial data is presented [17]. The system consists of two main visual data elements. The first is the 3D base-terrain which comprised of the topographic data that is initially read into the GIS. The second is the vertical layering system. The system is developed using OpenGL. However, this system only integrates 2D and 3D views of the spatial and aspatial data but not consider integrating 2D and 3D data model and structure as well as geo-DBMS and so on. SuperMap GIS 6R is a novel GIS which closely integrates 2D and 3D GIS considering these factors.

3. REAL SPACE GIS

3.1 Definition

Before GIS exists, map is represented on paper. Therefore map has to be projected from spherical space or ellipsoidal space to planar space. Moreover, the early geographical information comes from the digitization of map. Thus 2D GIS is based on Paper Space. Paper Space is the space after projection which based on paper coordinates. However, there are some disadvantages of 2D GIS based on Paper Space. Firstly map after projection is deformed and has an influence on the results of kinds of measure. In order to meet different needs, many map projections were created. For example, distance measure on the map based on equal distance projection is precise and area measure on the map based on equal area projection is accurate. Not one of them can meet all needs of different applications. Such many map projections greatly increase the difficulty of integrating different geographical data and the complexity of GIS. What's more, map projections are very difficult to non-professionals and have a negative impact on applications of GIS in IT.

With the development of Computer Graphics (CG) and Virtual Reality (VR) technology and the falling cost of collecting 3D information, 3D GIS has been developed rapidly. 3D GIS is based on 3D geographical space and the data of 2D GIS is not directly applied in 3D GIS. The incompatibility of data of 2D GIS and 3D GIS results in much redundant data. Although 2D GIS has a nature defect, 2D GIS is very sophisticated and has some advantages over 3D GIS. 2D GIS owns much more useful data than 3D GIS. The cost of collecting data of 2D GIS is lower than 3D GIS. 2D GIS represents spatial relationships more clear than 3D. The functions of data model, data analysis of 2D GIS are more mature than 3D GIS. Moreover, 2D GIS is broadly applied in different domains and many applications. So 2D GIS is still necessary now.

In order to meet need for 2D and 3D information, neither a pure 3D GIS system nor a 2D GIS system with a 3D GIS system are not enough. Because the data of 2D GIS and 3D GIS is incompatible, there is much redundant data in a 2D GIS system with a 3D GIS system. In addition the integration the functions of a 2D GIS system and a 3D GIS system is also very hard and this solution is just a transition.

Real Space GIS which is a 2D & 3D GIS and not just a 3D GIS efficiently solves such problems. Real Space GIS closely integrates 2D GIS and 3D GIS and is based on Real Space. Real Space corresponding to Paper Space is based on 3D geographical space and 2D map space which is based on geographical sphere or ellipsoid. Once there is no paper output, map projection is not necessary. The process of the development of Real Space GIS is shown in Fig. 1.

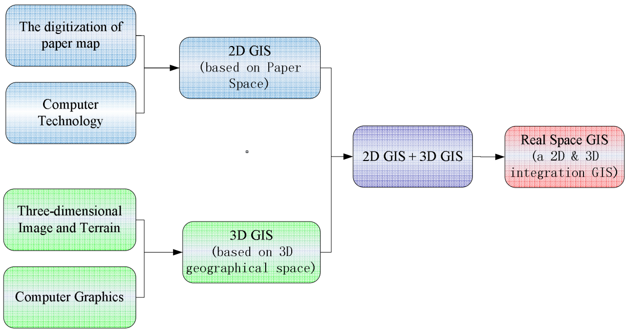

Fig.1 The process of the development of Real Space GIS

3.2 2D & 3D integration

Data model and structure integration is a part of 2D & 3D integration of Real Space GIS. The data of 2D GIS can be directly shown in the scene of 3D GIS without conversion and the data of 3D GIS can be directly shown in the scene of 2D GIS without conversion. Especially for massive 2D data the fundament data structure must be altered to adapt the visualization in the scene of 3D GIS.

Data storage and management integration is a part of 2D & 3D integration of Real Space. Real Space GIS can support storing 2D and 3D data in the same geo-DBMS. The geo-DBMS provides same functions to get access to 2D and 3D spatial data.

Visualization integration is a part of 2D & 3D integration of Real Space GIS. The visualization integration consists of two important elements. The first is theme integration, the data of 2D GIS can be used to create a 3D theme and the data of 3D GIS also can be used to create a 2D theme. The interfaces of 2D theme and 3D theme keep consistent. The second is symbol integration, 2D symbol can be applied in the scene of 3D GIS and 3D symbol can be also applied in the scene of 2D GIS. The unified management of 2D and 3D symbol facilitate maintaining the symbol library.

Spatial analysis and query integration is a part of 2D & 3D integration of Real Space GIS. The spatial analysis and query of 2D GIS can be directly applied and showed in the scene of 3D GIS. For 3D spatial analysis, Real Space GIS should provide advanced 3D analysis including Boolean operations of 3D objects, 3D topological operations, 3D spatial query, 3D buffer analysis, 3D network analysis. The result of 3D spatial analysis and query can be shown in the scene of 2D GIS.
Besides 2D & 3D integration of Real Space GIS, Real Space GIS should integrate the surface, the above, the under of the earth. For example, Real Space Real should provide the ability to manage the real 3D geological data in the under of the earth and the atmosphere in the above of the earth and the terrain on the surface of the earth. In addition Real Space GIS should take a unified workspace, layer, legend for 2D and 3D data of GIS. Finally Real Space GIS should adequately compatible with the data in Paper Space.

3.3 Limitation

There are some limitations for Real Space GIS. Firstly Real Space GIS is not a product but a technological system. This system is incorporated in kinds of product such as Desktop GIS, Objects GIS, and Service GIS and so on. Real Space GIS like geo-DBMS is not appropriate to be designed as an independent product. Secondly the Space which Real Space GIS is based on is not an absolute space but a relative space. The Real Space based on Sphere or ellipsoid is a model for absolute space and is more realistic than Paper Space. Thirdly Real Space GIS is not a key to all problems when it begins to appear. It will take several years to develop and perfect itself. Although Real Space GIS can solve some problems which cannot be solved by previous GIS, it isn't reasonable to pay too much attention to Real Space GIS. Maybe the early Real Space GIS isn't as good as Virtual Reality Systems or 3D Systems on visual effect and 3D analysis of Real Space GIS is premature, but Real Space GIS will be more and more perfect and useful.

4. SUPERMAP GIS 6R

4.1 Implementation of SuperMap GIS 6R

SuperMap UGC 6R which is based on SuperMap Universal GIS Core (UGC) and is independent on platforms is developed independently by SuperMap company and its property right is completely owned by SuperMap company. Two kinds of SuperMap Objects GIS, SuperMap Objects Java 6R and SuperMap Objects .NET 6R, are based on SuperMap UGC 6R. Three kinds of SuperMap Desktop GIS, SuperMap Viewer 6R, SuperMap Express 6R and SuperMap Deskpro 6R, are based on SuperMap Objects GIS. In addition Service GIS, SuperMap iServer 6R, are also based on SuperMap Objects GIS. All SuperMap GIS products including Service GIS, Objects GIS and Desktop GIS are 2D & 3D integration products and provide the functions of 2D and 3D GIS. The architecture of SuperMap GIS 6R is shown in Fig.2. SuperMap Corporation will release the new generation GIS products Based on SuperMap GIS 6R including Objects GIS, Desktop GIS, and Service GIS in a short time. The products based on SuperMap GIS 6R is shown in Fig.3.

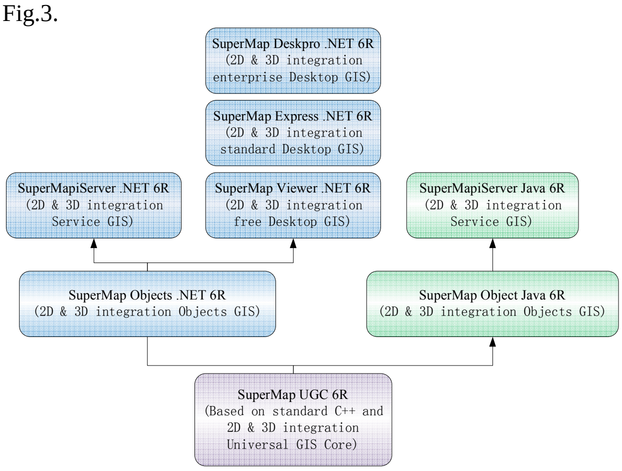

Fig. 2 Architecture of SuperMap GIS 6R

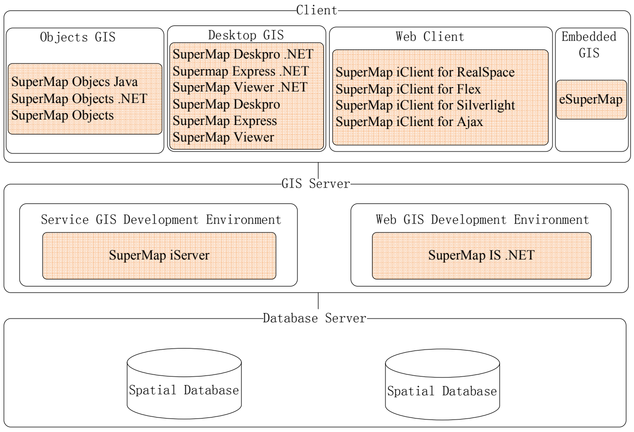

Fig. 3 SuperMap products based on SuperMap GIS 6R

4.2 Applications of SuperMap GIS 6R

SuperMap GIS 6R has been applied to several applications. For example, in national "A Map" project based on SuperMap GIS and large relational database which is organized by the second time the national land investigate the Leading Group Office and implemented by Beijing Zenith Land company, there is 45 TB spatial data in all. The 2D GIS system of this project was checked and accepted by professionals January, 21st, 2009. Later the 45 TB spatial data without extra data conversion was directly used in a 3D GIS system using SuperMap GIS 6R with SuperMap SDX+. Two snapshots of the 3D GIS system are shown in Fig.4 and Fig.5. SuperMap GIS 6R is also used to emergency command systems. The 2D symbol for the emergency command 2D GIS system being applied in the 3D GIS system is shown in Fig. 6.

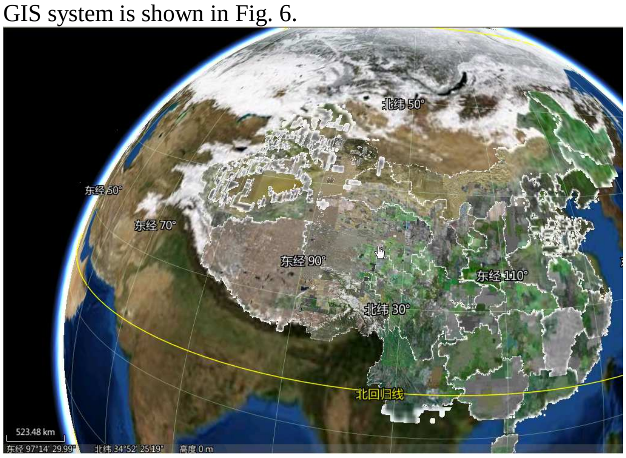

Fig. 4 China image about 40TB is shown in the 3D GIS system

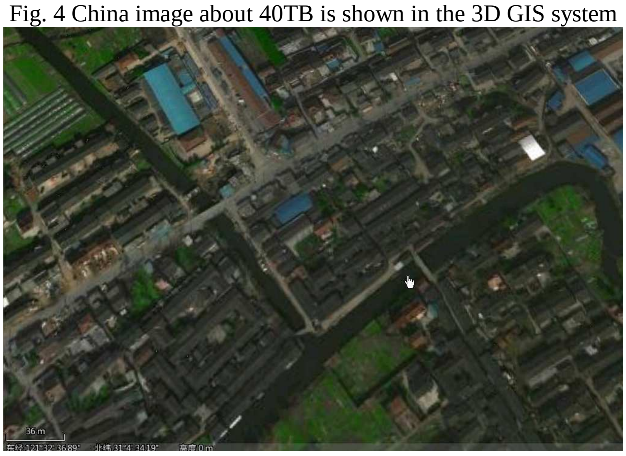

Fig.5 High resolution China image

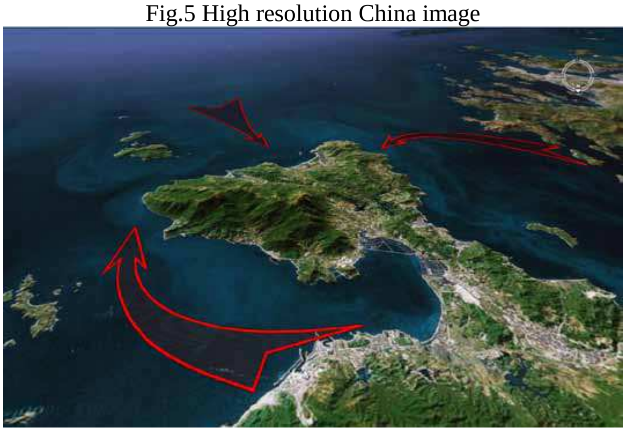

Fig.6 The 2D symbol for the emergency command 2D GIS system is applied in the 3D GIS system

5. CONCLUSION

We present a novel GIS, Real Space GIS, comparing to traditional Paper Space GIS. Real Space GIS is a 2D & 3D integration GIS. Real Space GIS doesn't loosely combine 2D GIS and 3D GIS but closely integrates 2D GIS and 3D GIS. Real Space GIS combines the advantages of 2D and 3D GIS and avoids data redundancy. SuperMap GIS 6R is a Real Space GIS developed by SuperMap corporation and SuperMap GIS 6R has been successfully applied in several applications. There are many avenues for further research. Although SuperMap GIS 6R is a Real Space GIS, it is not a mature GIS. We would like to refine the functions of Real Space GIS. We would like to do research on advanced 3D spatial analysis. We would like to strength the effect of visualization of 3D GIS and try to apply SuperMap GIS 6R to more and more applications.

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