STUDY ON SPATIO-TEMPORAL DATA MODEL AND VISUALIZATION TECHNIQUE

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Commission II, WG II/1

KEY WORDS: Spatio-temporal data model Temporal database Spatio-temporal database. Visualization

ABSTRACT:

3D data model is the better model at present, but it can't describe the temporal and changes, can not describe the dynamic characteristic. So, we need introduce time to the model, integrate time with spatial data. It has a brief discussion to spatio-temporal data model and visualization of data model in this paper.

1. INTRODUCTION

In the real world, when the character of non-spatial of entity has changed, perhaps its spatial character (position or shape) has a change. Some simple objects, even some objects, example building or gear, having little more complicated shape, are immobile and isolated; they can be described using mathematic formulas. But to the scenes and the other complicated objects, example organism and society, they are mobile, growing and variational[2]. There is an example: we need the city size 10 years ago to calculate the development speed of the city. But now, no a perfect data model supports the function. Only current data are stored in database, no historical data[7].

3D spatial data model is the base of visualization of spatio-temporal data. But virtual reality scenes based on the model are static, only the snapshot of the real world. So the spatio-temporal c is very important, we need a perfect spatio-temporal model.

2. GENERAL OF SPATIO-TEMPORAL DATA MODEL

We introduce time in space data model to form spatio-temporal data model, Construct the integrated space-time data model. The model can organize and manage temporal geographic information model effectively[1]. Geographic phenomenon is composed of space, time attribution and topological relations. It can be represented as a formal[1,6] $E = f(S, T, A, TO)$,
Where, E is the geographic entity; S is the space relation of geographic entity , which is composed of spatial scale, spatial coordinate and spatial relation; T is the temporal; A is the attribution of geographic entity; TO is the relation between geographic entities.

Spatio-temporal data model includes spatio and temporal. The core question is how to integrate the space dimension and temporal dimension effectively. There are two solutions: first, extend the temporal dimension based on space data model; second, extend the space dimension based on temporal dimension. Space data model may mainly divide into vector data model and raster data model. So, Adding time dimension the model also is that we combine the temporal to vector-based data model or raster-based data model. Then , space data model may divide into position-based (raster) spatio-temporal model,

object-based (vector) spatio-temporal model and time-based (event) spatio-temporal model.

At present, the main spatio-temporal data model includes the space-time cube model, sequent snap shots model, base state with amendments model and space-time composite model.

3. SPATIO-TEMPORAL DATABASE.

Spatio-temporal database is a database system including temporal and space factor. Its establishment relies on the expression of time. The expression of time is not the goal of geographic information, but using spatial analysis tools and techniques to stimulate the dynamic process, explore and mine the information concealed in spatio-temporal data. The establishment method of normal spatio-temporal data model is also in exploration.

3.1 Temporal database

Temporal database's importance is that it make the database become the real resource order, and can provide rich data for dynamic monitor and analysis. Common database have not saved old and obsolete data, but temporal database include historical data ,it make database become a complete electronic information records depository for every department. Temporal database provide the current and historical data. Compare and analysis the history and currency, predict the future. Then service for the forecast system, decision-support system and other system. Temporal database is the real database because of the character: dynamic and completeness.

Temporal database has many kinds of classifications. According to the ability of handling time, temporal database has historical database, rollback database and bitetemporal database; according to the time data stored in the database , temporal database has historical database, real-time database and forecasting database; according to the structure of database, temporal database has linearity database, offshoot database and period database.

3.2 Spatio-temporal database

Add the temporal to spatial database, get 3D or 4D database, this is spatio-temporal database. The temporal dimension enrich

database. Not only it increases the difficulty of managing the database, but also the sea volume data provide the facility for spatial and temporal analysis. There are two kinds of spatio-temporal database: spatio-temporal data model based on vector and spatio-temporal based on raster. They are deprived from vector database model and raster data model. These two models all can handle six change type of spatial and temporal: attribute changes, static spatial distribution, static temporal changes, dynamic spatial changes, mutation of process and movement of an entity.

Typical vector spatio-temporal database model is Space Time Composite (STC) and Spatio Temporal Object(STO). STC is a way of handling time in GIS that preserves topology by sub-dividing space into a small set of areas that can then be re-aggregated into the arrangement that existed at different dates. The changes of attribute of the STC are stored as a history for each other. Worboys (1994) extend the space-time composites to spatiotemporal objects. The STO at different times are treated differently even if they are identical geographically. The spatio-temporal object model dose not need to be reconfigured when the new temporal information is introduced, however, it will repeat unchanged data[8]

Typical raster spatio-temporal database model is Event-based Spatio-temporal Data Model(ESDTM) and Object Oriented Temporal Change Object. (OO-TCObject). ESDTM stores the list of events ordered by time sequence instead of time intervals in the snapshot model. It overcomes the redundancy in the data records when there are no changes since the model records only changes when the event happens. But it may require the interpolation when the requested time does not exist in the system[8]. OO-TCObject mainly builds the model from the data, it can describe the changes of temporal when the data change with time.

4. VISUALIZATION OF SPATIO-TEMPORAL DATA MODEL

Visualization of spatio-temporal data model is the visualization of multi-dimension information. The temporal dimension is special, it is a abstract reference of geographic information development, is the dynamic simulation of geographic information process. We need interpolation during two sample temporal. Dynamic technology is important character of computer visualization. It permits multi-angle vision, and can present the process. Fig 1 is the flow of visualization display.
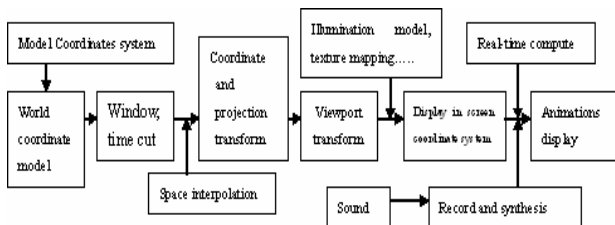

Fig1. Visualization flow

Follow is an experiment. There are three population data for some region according to three different years, build sequent snap shots model, then the population change can display dynamically. From the animation, we can get the population distributing, tendency and degree of population growth.

Fig2 population change with time

5. CONCLUSION

The study to Spatio-temporal data model is at the fundamental research stage, still needed to make the further breakthrough. Because of influence of traditional relational database, we always want to add the temporal to the relational database, try to integrate spatio and temporal. But it is difficult to extend the time dimension simply, a lot of questions must be solved. Object Oriented Temporal Change Object is becoming the hot point[1]. Visualization of spatio-temporal database model need animation , multi-media, virtual reality and other computer techniques. It will have the widespread application prospect.

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