

THE STUDY OF SPATIO-TEMPORAL DATA MODEL IN LAND USE DYNAMIC MONITORING

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ABSTRACT:

Spatio-temporal database is an application base of Temporal GIS, meanwhile, its basic theory is spatio-temporal data model. Traditional GIS, often was called Static GIS, generally not keep the history variety or reserve the overall situation state snapshot sequence of some typical models time dot. But the Temporal GIS not only emphasize the space feature descriptions and the attribute feature descriptions of the geography entity, and emphasizes the description of the entity time feature more than traditional geography data model. Currently the normalization spatio-temporal data model still is in the quest stage. This paper will analysis the feature of land use dynamic monitoring, and the same time, study several representative spatio-temporal data models. Finally, from these spatio-temporal data models find a proper model for land use dynamic monitoring for user to conveniently manage the spatio-temporal information.

1. PREFACE

Nearly ten years with the urgent requirement of the applied realm of GIS extended and mankind develop nature, understand nature, put forward the higher request to the processing of the geography information data, it can be saved and also manage history data effectively, in order to recur history, follow the transformation and predict the future, such GIS is called the Temporal GIS (the Temporal GIS, brief name TGIS). The TGIS is a kind of GIS which language is more abundant, more accurate to describe the realistic world, which can process the space dimension, attribute dimension and time dimension. The organized core of the TGIS is space time database, the foundation of the space time database is the space time data model. The time-space data model is good or bad, which not only decide the vivid and efficacy of the TGIS operating system, and also influence and restrict researches and developments of other aspects. Therefore, each countries scholars carried on a great deal of researches in succession, and put forward various time-space data model. This text commence on a few time-space data models which exist currently, combining the characteristics of the time-space data in the land use dynamic monitor, and find a kind of suited the space time data model that the land made use of the model adapt to the land use dynamic monitor which can carry out the TGIS function.

2. SPACE TIME DATA MODEL

2.1 Sequence snapshot models (sequent snapshots)

The sequence snapshot is composed of a series of time slice. Each slice corresponds to different time state layer respectively. Some GIS approach to the time-space characteristic with that method. The snapshot method towards to the most important constitute for expressing geography time transformation, which express effect is not direct. If want to gain the dissimilarity (change namely) of two time states, it must carry on thoroughly compare to two snapshots. It summarized that the main blemish of the model: 1) hidden type structure to transformation; 2) not have ability of examine errors; 3) the data redundancy is big. Saving memory space and advancing operate

efficiency are the two most important targets of TGIS. Because TGIS is compared with SGIS on the data quantity is big. But SGIS has already made the ability of calculator system bear the huge pressure. So the sequence snapshot model is similar to simulate GIS (analog GIS) within the GIS classification, is just a kind of conceptual model and it doesn't have the practical development value.

2.2 base state with amendments model

In order to avoid that continuous snapshot model note the characteristic of each no change parts again, firstly, base state revise model confirm the initial state of the geography phenomena, sampling on the time slot setup beforehand, the data state (call the ground state) of only saving a certain time, then note the characteristics of occur transformation [7-8] on certain time slot, pass through add change contents every time, can get the current state (snapshot).

2.3 Space-time composite models (space-time composite)

The method is brought forward by Chrisman to the vector model in 1983. The initial point of the model is a basis chart, which express the initial entity condition. The renewal period of each database will produce an overlay. Once the layer gets the approbation through the mistake check, it will pass through fold operate and merger to the system, the new crunode and new arc form a polygon which is different from adjacent polygon in attribute. Each attribute history of entity use a line in sequence to express. A record include a attribute volume and time that reflect its effective period. That model make space changes and attribute changes both mapped as space changes, and lead to new entity produce, is a compromised model of the sequence snapshot and the basis chart. Its biggest weakness lies in polygon broken and depend on related database excessively.

2.4 Space-time cube model

At the earliest stage Hagerstrand put forward the space-time cube model in 1970. This cube of three dimensions is composed of the space of two dimensions and the time of one dimension, which describe the evolutive process of two dimensions along

the third dimension. The evolutive track of the thing of two dimensions became a mode similar to "helminth". Any space entity's evolutive history is all an entity in the space-time cube. The model make use of geometry characteristics of time dimension visually and directly, which expressing the concept of a space time entity ,the description to the change of geometry is briefness and be easy to accept. The difficulty that model in a specific way to carry out lies in the expression of three dimensions.

2.5 Event based model

In the space time model based on affairs, the state change of the space time object is sprung by geography things. Passing through import affairs table, putting attributes or space change record in the each module of the same affair, showing, giving the describe method of time in sequence, which can build up the relation of object state and geography thing, In order to provide the foundation of the tense operation for high level. The space time model based on the affairs is very fit to the query of this question as " What happened in some times and in some areas", and also have good consistency in data and less fraction redundancy degree of the data.

2.6 Object oriented spatial temporal data model

This model organize geography space time with the object oriented idea. Among them object is the independent pack which is a concept entity have only one marking. Each geography space time object encapsulate the tense characteristic,attribute characteristic ,related behavior operation and the relation with other objects. Worboy put forward the model of object space time based on space time character of three dimensions in 1992 .Its basic thought is the space object(only consider the plane dimension), add the information of the time axis, then constitute a intact space time object of three dimensions. The data structure of space time model that object oriented is simple, which make use of object oriented software technique fully, and be advantageous to the expand of space time data model and tense operate, but currently the pure object oriented GIS is less, which model still have many theoretical problems haven't been resolved[3].

3. A SPACE TIME DATA MODEL FACE TO LAND USE DYNAMIC MONITOR

Our country land use scope is wide, change speed is fast, the data renewal of land use dynamic monitor is a frequent process, the time dimension plays a very important role. If want to explain and comprehend the current state of land use, it must study the transformation history of the land use, therefore it can make an forecast to the variety in the future. Seen from this angle, the information system of land use dynamic monitor should be a TGIS. Because of the foundation model of the TGIS still not mature, and have no a flat type TGIS to publish now. But to the particular applied purpose, combining some mature techniques of SGIS and the study of existing TGIS carry on exploitation ,which also can attain the function of TGIS. This text aims at some characteristics that the land makes use of the dynamic state monitor, will face to the space time data model and ground states of the object to revise the space time database that the model combines together to study to design a basic in keeping with land to make use of the dynamic state monitor.

3.1 Structure of space time object model in land use dynamic monitor

The three main factors of land use unit(Unit)are spatial information(Spatial Information), time information(Time)and attribute information(Attribute).So the structure of the space time object model in this model is:< OBJ :{O-ID, Attr(t), Spatial(t), Temporal(Tv, Td), Actions}>.Among them, the O-ID means the marking of the object, which can confirm an object one and only; Attr(t) is a description of non- space attribute with time change in the object; Spatial(t) is a description of the space attribute with time change in the object; Temporal(Tv, Td) is the tense description of the object, which reflect the produce of the object, the change of the state and the life process of the perish. Another important part of the object namely actions is the behavior operation part for describe the object.

3.2 Memory ways of the space time data

In the research of the space time data structure, people have already discussed many memory ways of space time data, but all of them are not very perfect.This text on the foundation of predecessors' researches, adopt dynamic multilevel index method based on " the base state amending method" called base state amending memory method . The amending method of several kinds to base state have been indeed showed in figure1

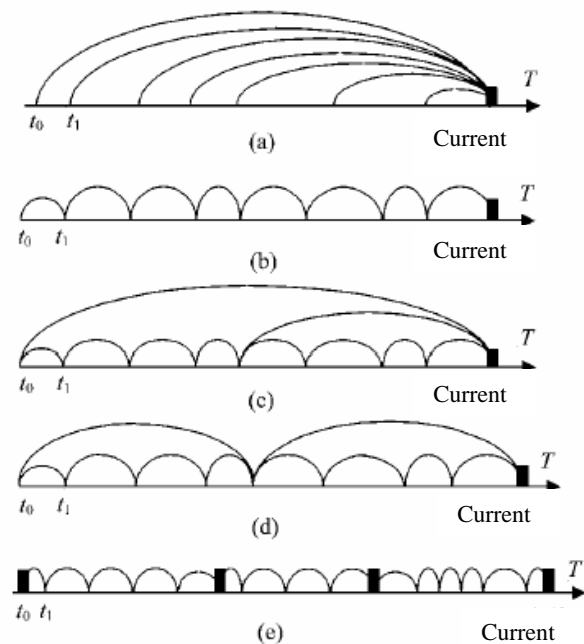


Fig. 1 Base state amending methods

The way a is make each history state as a amending which opposite to current state. When this kind of method have recorded the history state longer ago in the database, then renew the base state each time, all modify all bad documents, this is not realistic.

The way b avoid the blemish of the way a, so Langran [8] chose the way b ,however carry on index to the state long before, the way b carry on the reading operation to almost whole history state, also is not ideal all the same.

The way c, d are 2 kinds of improvement methods that Zhang zuxun lodged[9], compensate the shortage of the way a and b, but when the history is far for a long time, the problem in the way a and b also existing. Dynamic multilevel index method of this text adoption like way e.

At the whole history state dynamic establishes several base states, bad document number among the base states can be called the base state distance. It can confirm the base state distance according to the concrete application by customer or system, in the system, inserting along with the object history state, amending, and the index frequent degree to history period, then dynamic found the base state. Namely when the new change state add continuously, the distance of bad documents among the base states bigger than a certain value, it will establish the new base state automatically; when customer index frequently in some times, specially for the space time process with continuously change, it will spend more time on deduce process of amount of attributes that change continuously in renew of bad documents, by the method of dynamic establish bad document and base state, which can alleviate this problem. Compared with the way a to dynamic multilevel index method have elevation on the efficiency of data save and get, but be free from the history influence. However an important and the key of need master neatly among those is to confirm the value of the base state distance, it will waste the space if the value is too small, and it will take more time if the value is too big, therefore, confirming the value of the base state distance must according to the concrete circumstance to choice.

3.3 Space time search function

Based on the above space time database system, which can carry out research to land use condition on the space and on the time, a typical kind model of search can be described as: "All piece of terra that can manifest some area at a certain moment and satisfy certain condition". For this, the system will check to find time satisfied terra in attribute database, then carry on conditional filter to the terra attribute have been found, getting the marking code of these terra, and select the space data that have been picked in the space database. When not indicate attribute condition, the research result will be the layer of that region at a certain time. Another typical search can be described as: "Which croplands reduced in the year of A". The system will lookup attribute records of all entity year A and year A+1 in the database, finding out the marking code of the entity which as farmland in the year A but not in the year A+1, and then pick up the corresponding space data. Make use of the space time search function, which can fix the first dimension expediently, control the second dimension, carry on the search to the third dimension, thus carrying on the analysis of farmland decrease and land use type conversion etc, which is the SGIS can't complete.

4. CONCLUSION

The TGIS is the advanced research of the GIS. The sequence snapshot method does not have the further applied foreground in the existing model of TGIS, other models have the merit and blemish respectively, which can carry on the selection to the applied characteristics with different purpose. Aimed at the land use dynamic monitor work, the database system according to the base state amending model based on object oriented to develop have good space-time search function. The TGIS calls the emergence of the new data model and mathematic model. In the current stage the method of realize function of TGIS is to

reasonable use TGIS technique aim at the applied purpose in SGIS.

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