FEATURE-BASED SPATIAL DATA MODELING FOR SEAMLESS MAP, HISTORY MANAGEMENT AND REAL-TIME UPDATING

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ABSTRACT: A demand on the spatial data management has been rapidly increased with the introduction and diffusion process of ITS, Telematics, and Wireless Sensor Network, and many different people use the digital map that offers various thematic spatial data. Spatial data for digital map can manage to tile-based and feature-based data. The existing tile-based digital map management systems have difficult problems of data construction, history management, and updating based on a spatial object. In order to solve these problems, this paper proposed the data model for the feature-based digital map management system that is designed for feature-based seamless map, history management, real-time updating of spatial data, and analyzed the validity and utility of the proposed model.

KEY WORDS: Feature-based, Digital map, Seamless, Spatial data, Data model

1. INTRODUCTION

A demand on the spatial data has been rapidly increased with the introduction and diffusion process of ITS, Telematics, and Wireless Sensor Network. Accordingly, several advanced nations have constructed or have studied on the research for offering the exact and up-to-date spatial data to users. Various people use digital map that offers various thematic spatial data. Therefore, the role of digital map management system that manages digital map systematically and offers a prompt updating and useful service is very important. Digital map is digitized for map that has graphics data, related attribute, and location configuration through aerial survey. Digital maps are widely used in GIS and Spatial database because various analysis and practical use are available [1].

Spatial data for digital map can be divided into tile-based data that manage dividing into fixed unit, and feature-based data that directly manage object without being limited to tile. The existing digital map management systems support spatial data of tile-based. Therefore, the tile-based digital map management systems have difficult problems of data construction, history management, and updating based on a spatial object [2].

In order to solve the problems, this paper proposed a data model for the feature-based digital map management system that is designed for seamless map of feature-based expression, history management, real-time updating of spatial data. Proposed data model is designed for feature-based data model through the analysis of digital map ver.2.0 and National framework data. Also, we analyzed the validity and utility of the proposed model.

This paper is organized as follows. We discuss related work in Section 2. We describe the feature-based digital map data model in Section 3. We verify validity of the feature-based seamless map, history management and updating to use proposed model in Section 4. Finally, we offer our conclusions in Section 5.

2. RELATED WORK

Several advanced nations have been studied for object management of feature unit [3,4]. Especially, Master Map of Great Britain Ordnance Survey, which is a continuous database that reflect real world, and it models real world in more detail using Topographic Identifiers (TOID). TOID has unique value by number that is no meaning 16 digits. Through this, there is characteristic that can express complex feature that several features should be used. Master Map designs using 6 kind of feature (class), and these each feature has geometry or topology attribute. Spatial data type is consisted of Point, Polygon, Polyline, MultiLine, Geometric Ring, Topological, and so on. In the case of update mode, Master Map has dual industrial structure that data updating and management achieved by tile unit, and data supplied to user achieves by feature unit. That is, the initial data creates database of tile-based after edits to existent tile unit data [5,6].

The American has been studying about representing ID definition for last feature ID through construction of National Map. Australian also has been constructed ID system similar to the American for object management of feature unit through ASDI (Australian Spatial Data Infrastructure). However, object-based updating and history management is achieved in Master Map until present [7].

There are a lot of studies about method that compose and keeps digital map and UFID in the Korea [2,8,9]. However, actuality being used UFID has characteristic

that are different with existing study. And, UFID structure of previous study is difficult to apply to feature-based digital map because of it is structure that applied to tile-based. Digital map which is constructed in the National Geographic Information Institute (NGI) can be divided into ver.1.0 and ver.2.0. Digital map ver.1.0 was difficult expression of topology structure because of production of feature expression putting first, and it is consisted of graphic information that separate attribute information does not exist. Digital map ver.2.0 modified logic and geometry errors of digital map ver.1.0, and supplemented graphic information, and has attribute information. However, Digital map ver.2.0 used until present is also digital map of tile-based. Therefore, this has condition that can not give UFID in principle, and duplicates can happen. That is, there is problem in methods that gives UFID for single object of several edge of map sheet [7].

Framework data is wide as geographic information that is basis frame in construction and application of National Geographic Information System (NGIS) , and various user need, and geographic information that offer positional or contents reference system to integrate several geographic information [2,9]. Framework data is consisted of reference data that are referred when expressing other data, data set that become position standard, and UFID that mean unique identifier of feature and data model that describe relationships and structure of each data items. In addition, framework data is consisted of relationships of spatial data model and non-spatial data model. It is classified in kernel feature class, and feature class that have common attribute. Unique Geospatial Identifier (UGID) does function that connects feature class and spatial object class.

3. FEATURE-BASED DATA MODELING

The goal of digital map management system is to raise authenticity and utilization of spatial information through smooth supply about user. For this, digital map management system must have characteristics of currentness, seamlessness and consistency. Feature-based digital map management system can raise authenticity and utilization more than tile-based digital map management system in this goal because it manages information by feature unit.

3.1 Modelling of UFID

UFID is used in feature-based digital map must have three conditions. First, UFID must reflect the most recent state of feature (currentness). Second, UFID must have one seamless object without distinguished like existing tile-based digital map (seamlessness). Finally, it should always keep equal features (consistency). Constructing of seamless digital map is necessary condition that UFID has unique value, and composition of object type data is sufficient condition to grant UFID clarifying object. Grant system of UFID that consider all such condition is proposed that "Technology Development of Digital Mapping for Next Generation" by project. In this paper, we designed UFID structure to use proposed method. Figure 1 shows grant system of UFID.

UFID is classified as three elements of code left. First, feature code includes information that compared layer code of digital map ver.2.0 and standard code of digital map ver.1.0. Serial number means serial numbers of relevant feature which is constructed consecutively. It can use total 7 digits number and handle more than nine million objects of equal type. Also, this grant system presents UFID structure by 16 digits including parity bit of 1 digit for error confirmation. Extendable ID part is variable area that has been defined at management agency. This area can be utilized by area for information interchange or ID confirmation between agencies.

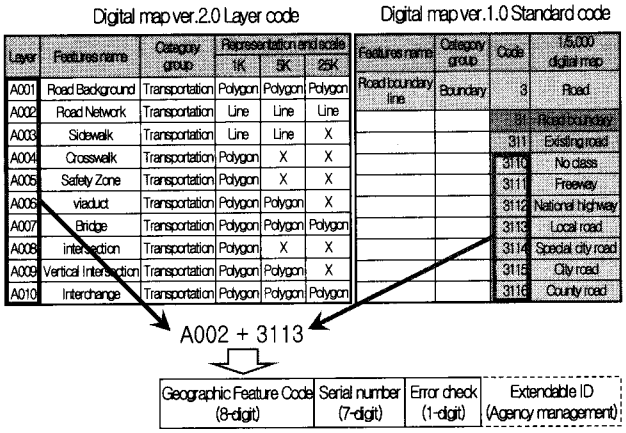

Figure 1. Modelling of UFID

3.2 Database design considering object consistency

Database that design in this paper designed based on data model of framework data. Figure 2 is conceptual model of designed whole data.

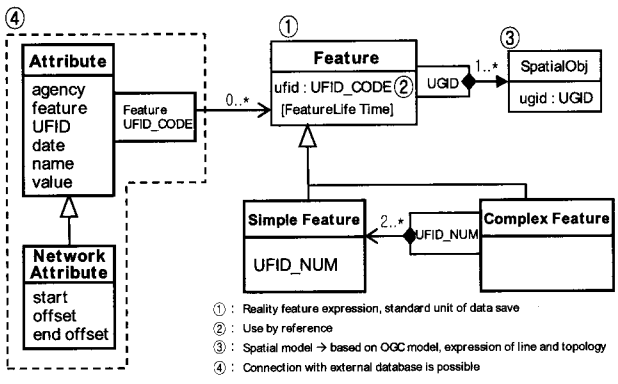

Figure 2. Conceptual model of whole data

Existing UFID model is replaced by UFID_CODE of 8 digits that is given newly in feature. Simple feature and complex feature gave serial numbers called UFID_NUM. UFID can be expressed through the union of UFID_CODE and UFID_NUM. Through this, UFID can have one unique value. Designed data model removed

unnecessary existing attribute information, and minimised duplicate or insignificant part. Figure 3 shows example of UFID that is applied in one feature.

UFID_CODE	UFID_NUM	SETOF_UGID	STARTURFID	ENDURFID	DIRECTION	NUM	KIND
A0023116	50007292	573776	A02P32105145981	A02P32105145991	TWO_WAY	0	County road
A0023116	50007303	573777	A02P32105146005	A02P32105146016	TWO_WAY	0	County road
A0023116	50007314	573778	A02P32105146005	A02P32105146027	TWO_WAY	0	County road
A0023113	50007325	573948	A02P32105013334	A02P32105013345	TWO_WAY	594	Local road
A0023116	50007336	573452	A02P32105144238	A02P32105144249	TWO_WAY	0	County road
A0023116	50007347	573453	A02P32105013356	A02P32105144251	TWO_WAY	0	County road
A0023113	50007358	573949		A02P32105013356	TWO_WAY	594	Local road
A0023116	50007369	573454		A02P32105144262	TWO_WAY	0	County road

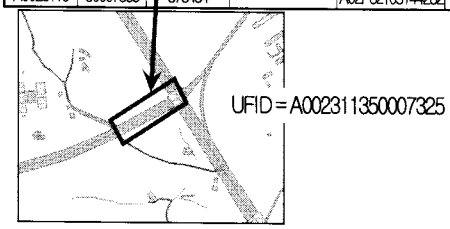

Figure 3. Example about applying UFID

First, feature-based digital map constructs data of tile unit depending on spatial database of schema. It divided by tile unit physically but seamless data process can be enabled by feature unit using operator. In case of storing object to database, spatial data that consisted of tile unit has UFID_CODE equally, feature information is agreed. That is, one feature can construct seamless data logically using this feature code. Therefore, these models have easy updating and history management of feature unit.

3.3 Updating and history management

Digital map data must include time and status information along with spatial information for updating and history management. Therefore, we added time attribute that can trace history about alteration information in database schema, and added state attribute that can confirm updating availability through comparison with existing data. Also, all alteration data follow in "Append-Only" policy for history preservation. That is, physical delete of data does not happen, and when delete, logical delete that transaction time end happens. Therefore, once created data is not deleted actually, and history tracing is possible because it is always remained to database. Figure 4 displays conceptional flow of updating and history management.

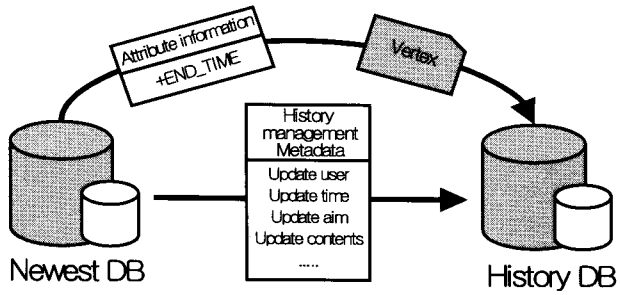

Figure 4. Conceptional flow of history management

For example, when updating of simple feature is included in several tiles, read data as much as relevant area using UFID_CODE. This data updates feature by tile of newest database through JOIN operation with UFID_NUM that is simple feature identifier, and Backup is stored to past database relevant area.

These methods can become very efficient method that can improve efficiency about storage space and speed, because updating is achieved about more relevant feature than method that update all feature

4. VALIDITY ANALYSIS OF PROTOTYPE

Aims to analyze validity chose framework data of scale 1:5,000 of Cheongju city area, and spatial data composed database about transportation section. Transportation section can apply easily proposed model to other feature because transportation model is complex than other feature, and updating often occurs. Updating extent does by tile-based and limit so that updating through file. Abstraction and examination algorithm of updating data used method which studied in existing.

4.1 Seamlessness of objects

We tested possibility of seamless feature search to use model which proposed newly and UFID classification code about transportation section.

```
SELECT   *
FROM     UNIT_ROAD as R1 JOIN ROAD as R2
WHERE    R1.NUM = '594' AND R1.UFID_NUM =
         R2.UFID_NUM
```

Above SQL searches the seamless object of "No.594 local road", and Figure 5 shows result about the query. Conformable data can see which abstracted through JOIN operation with "local road".

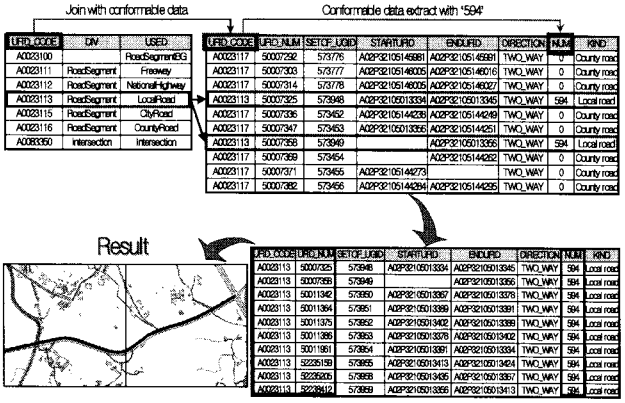

Figure 5. Expression example of Seamless feature

4.2 Real-time updating

When updated occur by feature unit, we did to confirm including state attribute that updating had occurred. Updating and history executed regarding updating occurs when state attribute is 1. Figure 6 shows process which processed when updating occurred comparing existing data with input data. When updating of data occurred, updating availability

conclude by comparing with the relevant data in newest database. Changed data fixed state attribute by 1, and correct relevant data and stores to newest database. Past data stores information of data which is changed by unit of time interval for history management when store to past database.

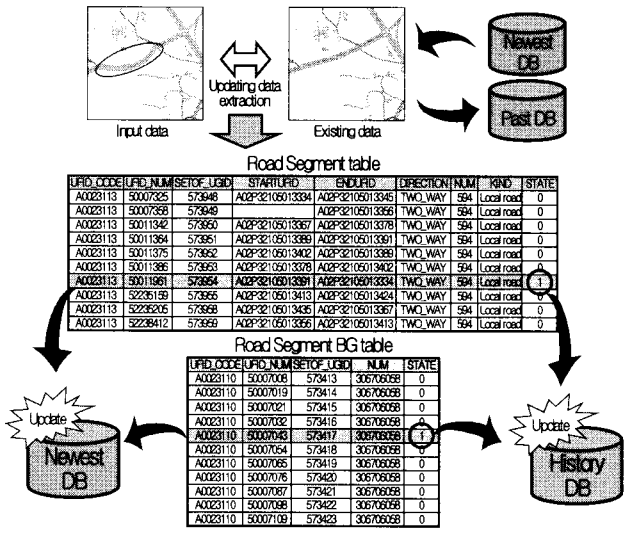

Figure 6. Flow of real-time updating

4.3 History management

The existing history management deletes previous data, and stores updated data because of key constraint among integrity constraint. For that reason, history did not manage, when and who revalidated data. But, data model that proposed in this paper does not violate key constraint because it uses UFID and S_TIME attributes to compound key, and can store and manage changed history by intervals of time unit whenever a feature is updated. Schema of history management database is shown in Figure 7. Figure 8 is history information of when updated "No. 594 local road" 3 times as feature-based history management's example.

History (UFID, Data_type, Tabl_name, Update_Method, Update_User, Update_Purpose, State, S_TIME, END_TIME

Figure 7. Schema of history management database

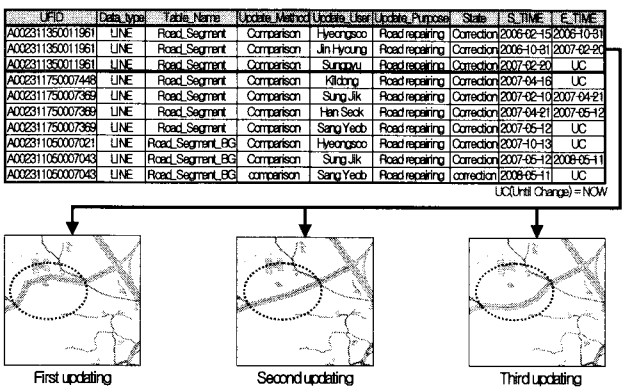

Figure 8. Feature-based history management

5. CONCLUSION

The importance and utilization of geospatial data and digital map in field of spatial information technology has been increased. Especially, objects' seamless expression of digital map and updating or history management policy to mange validity data are important requirements to implement feature-based spatial database. However, expression for feature is difficult, and validity of data depreciates because existing digital map management system is tile-based system. Also, it has problem in updating and history management.

In order to solve these problems, this paper proposed feature-based data model for digital maps which is used most widely. In addition, proposed model used real spatial data and verified validity based on the model.

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