

## **Development of Geo-Historical Data Handling GIS and Realization of Digital Earth Concept**

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**ABSTRACT** Through the experience of developing GIS for disaster prevention [1][2][3] we noticed that requirements for GIS can be divided into at least 3 categories. The first type of GIS is for regional analysis and decision-making based on data integrating detailed geographical historical (temporal) information of a region to the maximum extent. This type of GIS can give solutions for federal or local government requirements. The second type of GIS is for general public use such as to use instead of paper map. Requirement of data is mainly positions of geographic objects which are subsets of the first type of GIS data and such as service information mainly as attributes which are gathered by unspecified people and system has to be simple. The third type of GIS is for special purposed GIS such as car navigation systems of which functional requirements are almost finalized. Compactness, efficiency, and cost are important.

We will propose a solution which satisfies a variety of requirements of GISs by combination of non-internet GIS and internet/web GIS related to realization of digital earth. Activities of ISO/TC204 WG3 (standardization of geographic data structure focusing on ITS) is also mentioned.

**KEY WORDS** Geo-historical data, GIS, Digital earth, Network

### **1. Building up of Geographical Information and Updating**

It is usually required for information systems to be built up, such that it is suitable for dealing with information and, meets its requirements. Though it is also similar in the case of the geographic information, the requirements of information are different according to the application field. The local governments need the most detail information, such as accurate geometric representation of road or the information about the associated facilities. The organizations, which control the local areas, such as local government, fire station and so on, need locations of each house and their corresponding information about habitants. Such geographic information is also useful for the habitants around the place. Though the information about the other places is also useful for such as planning

sightseeing, the priority of the required information is different from the one of the neighbor's, i.e., for planning sightseeing, location of each house is generally not important.

The measurement for gathering geographical information is done by local government and the national organization, because its cost is so high and it's impossible for private organization to do it because of regulation under law. If the process through measurement to building database can be made without any duplication, geographical information as a base may be controlled consistently. Moreover the information based on the measurement by public organizations can be shared.

On the other hand, the lot of search data is usually collected by private organization using the measurement data, so that information is not

always controlled consistently. But as those data can be considered as attribute data corresponding can be taken.

Sometimes local governments will refrain from combining together components of geographic data related to personal in terms of keeping privacy. However, in case of big earthquake, it may be useful for the rescue or recovery to gather information made by different organization and to put them together. Considering these situations, the information by each organization should be made by the structure and format that can be integrated with other information when it is necessary.

The real world always changes according to activities of human life and nature. For the local government, they need to record those changes of their regions. In figure 1 concept of spatial-temporal GIS and model of real world description is described. The local shopping center, habitants and public corporation needs the updated information although their requirements and priority of the information depends on each. For the distant area, its requirement is different from them.

## 2. Characteristics of Geographic Information

Generally speaking, geographic information is a description of object with shape data and attribute data combined together as shown in figure 2. These data, such as shape data obtained by surveying and some attribute data can be only obtained by a few authorized organizations. In contrast, lots of attribute data related to shape data are collected and managed by multiple organizations. In any region, the organizations that collect and open geographic information are much less than those who send general information, which is not treated as geographic information, via Internet.

By analogy with car navigation system and others, their characteristics are that the specified geographic information about region is used for a longer period than other general non-geographic information. Moreover, in the case of use of original paper map, it is frequent that many users are almost using same information for a region. To the application of development and planning for a specified region, the collected data in advance is also usual to use for a long time.

## 3. Data Sharing Method of Geographic Information

When digital earth is mentioned, it is clear that the share of information on the earth is very important to use such as the conservation of environment or prevention of disaster. However, the requirement to share the detailed information of a region is not practical, because detailed information is mainly

to the location of the common measurement data, consistency in location between different data set used only in the region. Even detailed information is available, summarized information according to each region is used often for analysis of wide area. When the wide area data is used to make a region analysis, it is required that all detailed information could be shared, but in fact, only a few limited resource of information has been processed, it is usually necessary to ask each region to supply their summarized data. Even when the analysis begins from the detailed information, to lead to the analytical results for a wide area will require that several phases be summarized.

Herein, the requirement to share information is viewed from the point of collecting information from objected region. As the data about individual privacy is involved in the citizen's information used in local government, this will become a disadvantage if all geographic information is shared.

The data sharing method can be break down into 3 categories, based on characteristics of the geographic information as shown in figure 3.

(1)Data sharing method for like the case of inside in the local government

Intra-net is suitable to share common geographic information, which make exchanging and sharing updated data possible with keeping securities of individual attribute data. Geographic information has to manage as spatial temporal data to keep consistency in relationship between objects and attributes. Update data can be used in different division soon after the change has made at the division where responsible to data maintenance.

(2)Data sharing method for utilizes unspecified user

Internet is suitable to exchange geographic information that is opened to public. Here, treatment of geographic information of basis that is made based on surveying and attached attribute data has to be differentiated. Update has to be done more carefully with basis information than attached attribute data. Objects or features described as geographic information of basis has to manage as spatial temporal data to allow combining attribute data with keeping consistency.

(3)Data sharing method for specific purposes such as a car navigation system

Geographic information suitable to the application is combined together into a unit and stored in such as CD-ROM or DVD. These data are provided with application system or can be purchased at a store, similar to music CD. Update data can be provided as log data of changes by telecommunication or

Internet. Latest information such as point of interest can be also distributed same way. Spatial temporal data management is also necessary to allow combining additional data or deleting data.

#### 4. Sharing Data Via Network

Network is effectively applicable for geographical information to share information. However it is needed to meet the characteristic of geographical information and its purpose. For the basic data of geographical information, the specific data is normally used repeatedly and for long period. Therefore it can increase its usability by capturing and storing the data previously into user's information systems.

The updated data and attribute information as required is obtained via Internet, thereby it requires for the data to be capable of location matching. Relating the representative points represented by the location of topological space with respective information, it will be possible to make relationship with information. In that case, it is expected to enhance the accuracy of locating by using the same basic data. It is essential to be capable of time matching by relating it with respective information. So it is needed to keep the information using the location of spatial temporal information which is integrated with the location of, topological space and time. For the location of time, it is important to keep the information whether the target object exists or not. The criteria of the accuracy as a location information of topological space are basically to be within allowable deviation. In considering homogeneous polygon, it makes it easier to decide whether it exists within the allowable range on the corresponding lines and points, so it can avoid making uncertain decision.

It is rather needed for shared geographical data to be stored in each system than to download from servers very often. In this case, the data exchange should be made in the specified standard open format. In terms of its efficiency, it is better to convert the data into original format only when it's necessary. If this open format is suitable enough for execution, it can be used for application program directly without modification. It also makes it possible to realize the structure easier for open format data such that has been considered at the ISO/TC211.

#### 5. Activities of ISO/TC204

We have been discussed over the standardization for the data structure of geographical data especially focusing on Car Navigation System. We also have considered to apply it for the ITS related data structure. The proposed data structure as a standard is evaluated to use it for some products. It's reported that it could obtain better performance by the Car Navigation System provided with the proposed data structure than by the conventional one. Considering that the technology of makers are reflected to the proposed data structure, this can be well applicable for target application. It is originally designed for general-purpose applications. It is expected to expand the application field by fully described geographical data and the required extension.

#### 6. Proposal for Digital Earth

Building the network system for the data exchange based on feasible open geographical data format as standard, it will be possible to enhance the usability of data and systems. It is desirable to develop the original system based on this geographical data structure by joint development. As a result, it can be expected to reduce the workload of developing application system and send the application system developers to it.

On all those grounds, I would like to propose of international joint development for standardization of geographical data format, common basic software, and common application software. I would like to move toward sharing geographical data and reducing the workload of system development, so it is necessary to organize an international project, which takes advantage of the results discussed at both of ISO/TC211 and ISO/TC204.

#### References

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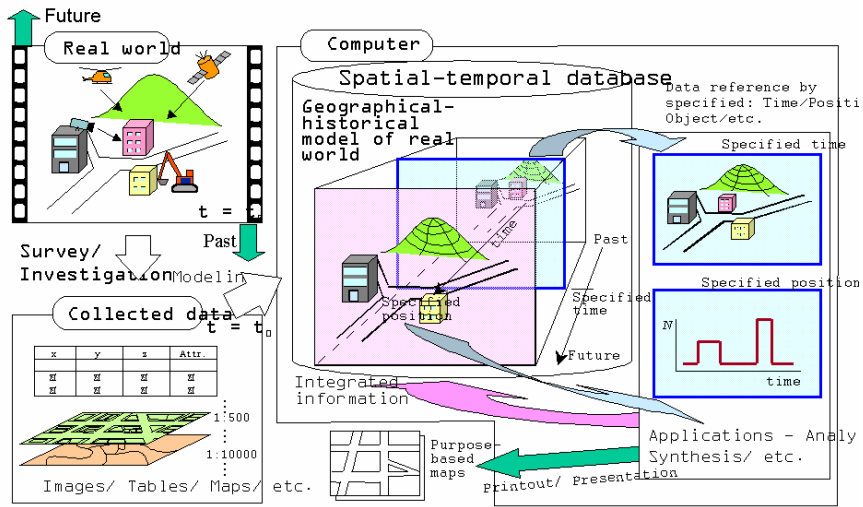


Figure 1 Overall concept of spatial-temporal GIS

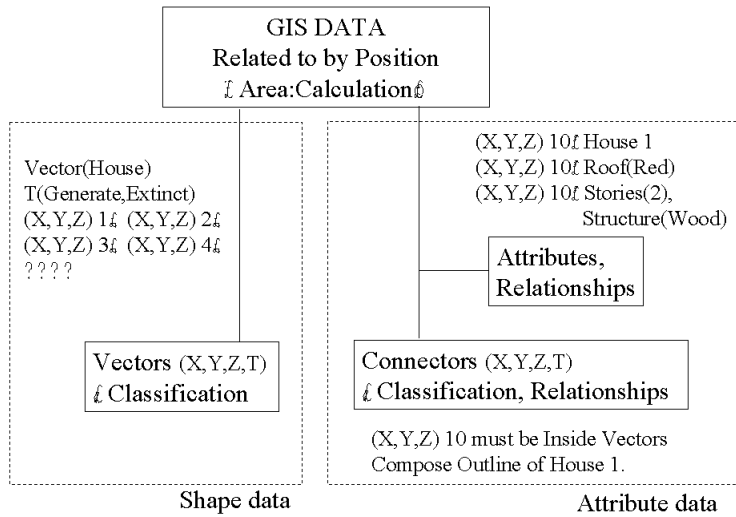


Figure 2 Data description with shape data and attribute data

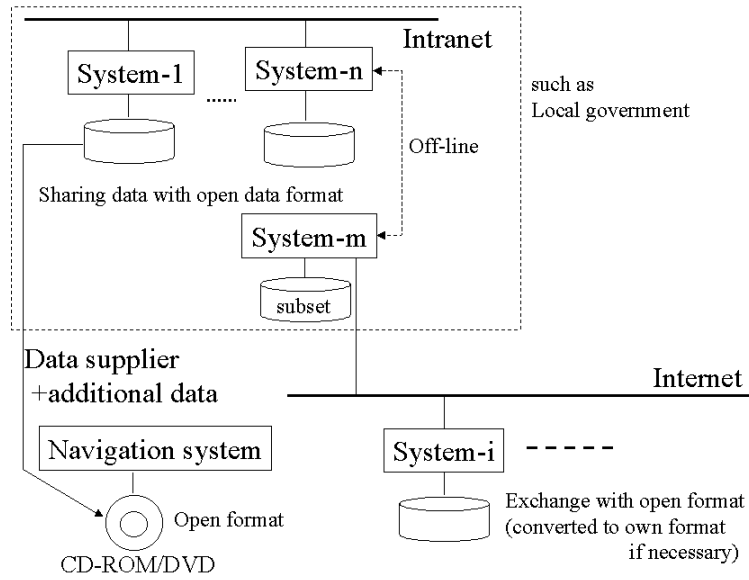


Figure 3 Data sharing with open format data