A NEW APPROACH OF MAP REPRESENTATION FOR REALISTIC EXPRESSION OF THREE DIMENSIONAL SPACE

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Abstract

New approach to realistic expression of three dimensional space has been investigated in the Geographical Survey Institute of Japan. This trial is carried out as one of the research for next generation map. We are studying about data producing method, three dimensional model generation method and trial of making realistic landscape images so as to consider the data contents of next generation map. This paper reports the process of creation of three dimensional landscape view and their results.

1 Introduction

In conventional topographic maps printed on paper, real three dimensional world is projected vertically onto two dimensional plane with symbolization of ground objects. To read maps in this expression demands some knowledge and skills. It also has some problems especially in representing urban area where many elevated roads and underground passages exist.

Therefore, we are studying new representation method for three dimensional space, according to human custom and ability concerning 3-D space recognition. Digital cartographic data opened up possibility of completely new expression for maps. By utilizing computer graphics technology, landscape image seen from arbitrary viewpoint can be generated. Animation of the scene following movement of viewpoint is also possible. The expression makes it easy for general users to recognize three dimensional space.

There are two research items in this study. One is to study the method to create as realistic landscape image as possible from digital cartographic data. The other is to examine data contents of digital cartographic data required for such representation.

Cartographic data corresponding to 1:25,000 Topographic Maps published by the Geographical Survey Institute(GSI) are used as the first target because they are the largest scale maps covering all over Japan. In terms of data items, digital elevation data(DEM) and main road data of 1:25,000 scale topographic maps produced and published by the GSI and house and field boundary data picked up with a digitizer are used.

2 Data preparation

This section deals with the data collection and editing method and whole processes. We tried to study the ability of 1:25,000 scale level map data contents to represent landscape realistically. We have 1:25,000 scale topographic maps covering all over Japan. There are about 4,400 map sheets in all of them.

2.1 50m mesh DEM

GSI have been producing digital elevation model(DEM) in the whole country. These are about 250m grid interval mesh DEM and about 50m grid interval mesh DEM. We used this 50m grid interval DEM to make terrain model.

2.2 road data(main road)

GSI also produce digital road data. However, Only main road data administrated by the national government and so on are available at the moment.

2.3 Houses and buildings

GSI does not produce digital cartographic data of houses and buildings corresponding to medium scale maps. They have to be collected with a digitizer from medium scale topographic maps manually.

2.4 Vegetation boundary

Vegetation boundary is the most important data to express realistic landscape images. However, GSI have not produced vegetation boundary digital data of medium scale maps. We have to get digital data by using the same method as houses and buildings data collection.

2.5 Water boundary

Water boundary is also collected by digitizing with a digitizer from 1:25,000 scale topographic map.

3 Generation of 3-dimensional model

Next step is to generate three dimensional model from digital cartographic data.

First of all, we have to create polygon data from all vegetation boundary data and water boundary data. After this, These polygons must be divided to small triangles for next process. Each triangle are lifted by using the height of 50m DEM. The grid interval of these 50m mesh DEM is too rough to express the realistic landscape. These data have to be interpolated. Road data are modeled according to their

road widths and lifted by the same method as vegetation boundaries. House models are generated by adding some parameters such as width, depth and height. The shape of roof can be selected from some kinds of roof shapes which are prepared in advance. Road models and house models have to be lifted by using DEM.

The process of map representation for realistic expression of three dimensional space is shown in Figure 1.

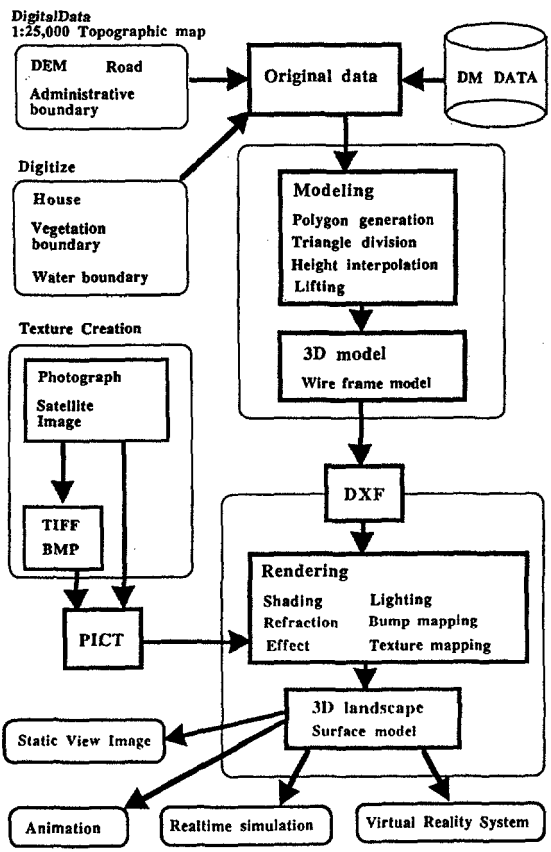

Figure 1: Flow of map representation for realistic expression of three dimensional space

4 Visualization of three dimensional space

After creating three dimensional model, we have to paint color to each polygon structuring three dimensional model. Each polygon has identity number according to its kind, and each polygon can get identical color by using computer graphics method and technology. First of all, the surface model are created from three dimensional space model, shadow and lighting are calculated to make surface model. After this, to make more realistic view, texture is mapped onto surface of 3-D model. Texture can be created from photographs scanned with a scanner and a personal computer. Behind landscape, we can put an image of clouds made from a photo. We can also use bump map method to express surface of model. Bump mapping is effective to express rough surface. Figure 2 is a landscape of Mt. Tsukuba, which is a small mountain in Kanto plain but it is famous in JAPAN. We can also express a variety of landscape images by changing the textures. For example, if we use a picture of snowing, scenery of winter can be expressed. Figure 3 is Mt. Tsukuba viewing from above mountain top with fog effect.

5 Generation of Animation

Animation of landscape can be created by connecting some sequential static view images. Animation can give us realistic experience as if we fly over the three dimensional space like a bird. However, it is rather difficult to create animation in real time. That is why, we have to prepare sequential image in advance. These animations are enough to recognize three dimensional space with ease. The image data of animation will be so large if long animation is made that we need special hardware such as an optical disk to save the huge data.

6 Results and problems

By the above method, realistic image can be created rather easily, if we have a computer graphics system. The most difficult problem in this process is to prepare some kind of digital map data. The GSI have been trying to produce a variety of digital map data, but it is not enough to make a three dimensional model. In particular digital data of medium scale map are not perfect at present.

7 Conclusions

This new method for map expression brings a lot of capability and information for us. Therefore, we can expect that this method can be used for many purposes, for instance, environment assessment, development planning in regional scale and countrywide scale, city planning, landscape analysis, and so on.