Integrated Management of Geographic Data and Vehicular Images in Geographic Information Systems

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Abstract: In this paper, we design and implement an integrated management system for geographic data and vehicular images using a Geographic Information System (GIS). Integrated management of geographic data and vehicular images is very important to manage and to provide them to users effectively because of a large volume of vehicular images. To manipulate these data together, we consider a vehicular image as a polygon which is a type of popular geographic data types. The polygon represents a region in which spatial objects appear the vehicular image.

Keywords: Integrated Management, Vehicular Image, Geographic Information System

1. Introduction

With many requests about some systems which can search, display and manage more actual and realistic information like real images with related geographic information, Geographic Information Systems (GIS) are being extended to include special functions for processing and managing spatial images, such as aerial imagery, satellite imagery, or vehicular images [1].

Geographic Information Systems concerned with spatial images should have some additional modules to manage them with maps efficiently. Especially, in Geographic Information Systems related to vehicular images which are taken by some cameras attached to a vehicle, the efficient spatial image management module is more important since a very high number of the images.

Although several methods can be used to manage and to manipulate the vehicular image efficiently, the best strategy is to consider vehicular images as some geographic data, such as sets of line-strings, or polygons because we can manage these data using some integrated methods.

In this paper, we design and implement an integrated management system for geographic data and vehicular images using a Geographic Information System (GIS). To do this, we 1) introduce a concept about matching of geographic data and vehicular images, 2) suggest a method to present a vehicular image using a traditional geographic data type – polygon, and 3) design and implement the integrated management system to show effectiveness.

This paper is structured as followings. In chapter 2, we briefly explain the concept of integrated management of geographic data (maps) and vehicular images, and in chapter 3, we describe system architecture and user interfaces of the designed and implemented system. In chapter 4, we conclude this paper.

2. Integrated Management of Geographic Data and Vehicular Images

The concept of integrated management of geographic data and vehicular images is based on spatiality which both geographic data and vehicular images have. Because geographic data are represented as some coordinates values, and vehicular images obtained by some vehicles such as MMS (mobile mapping system)[2] are also spatial, that is, vehicular images have some spaces in themselves, these types – geographic data and vehicular images, although they are not similar, can be matched based on locations, or spatial they represents.

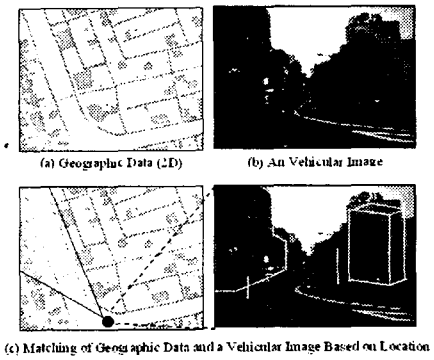

Figure 1. Matching of Map Data and a Vehicular Image

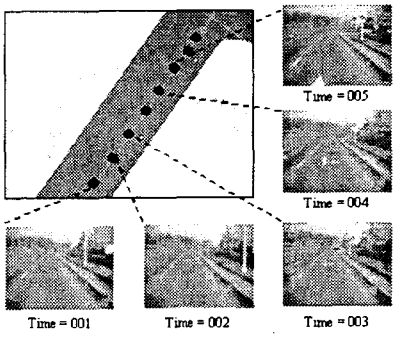

Figure 2. Matching of Map Data and Successive Vehicular Images

As figure 1, 2 shows, based on the location where the image was acquired, the geographic data and a vehicular image can be matched with each other. Using this location based matching, we can display, edit, and search geographic data through the medium of vehicular images, or visual spatial data, that is vehicular images, through 2D/3D geographic data. This matching also enables for us to manage the vehicular images as a kind of spatial data.

Some geographic information systems, such as image geographic information systems, or video geographic information systems[3], which can manipulate multimedia data such as images, should manage a large volume of multimedia data. In such a system, an integrated management functions or modules to provide realistic visual information to users are essential.

3. Design and Implementation of an Integrated Management System

1) Spatial Data Type for Vehicular Images

To provide integrated management of geographic data and vehicular images, that is, to manage the acquired vehicular images with geographic data, we consider the images as a kind of spatial data types - a polygon. A polygon of a vehicular image means the area or the region which spatial objects in appear on the images.

Because we can regard a vehicular image as a polygon, we can use all traditional spatial operations or relationship among spatial data types with vehicular images without major modifications. Therefore, when retrieving geographic objects appearing on a certain vehicular image, we can use normal spatial operator "contain" specially designed in SQL. Figure 3 shows the mapping of a vehicular image and a polygon which presents a region shown by the image. In figure 3, the shaded polygon in 2D map represents a region described by the vehicular image.

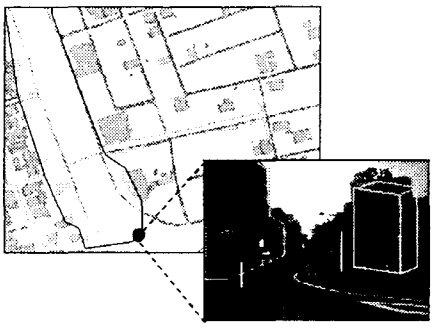

Figure 3. a Vehicular Image and its Polygon

2) System Architecture

Figure 4 shows system architecture of a geographic information system which manages geographic data and vehicular images as integrated data.

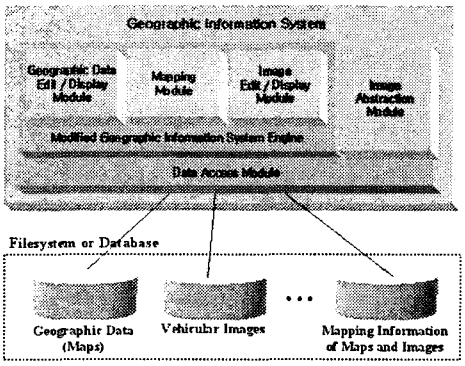

Figure 4. The Designed System Architecture

The designed system has been designed based on a traditional geographic information system engine with some modification. The modified geographic information system engine has special functions to manipulate and to manage particular polygons representing vehicular images in different context. In addition to existing functions or modules in a traditional geographic information system, the design system has several special modules such as a mapping module, an image edit/display module an image abstraction module as shown in figure 4.

The mapping module converts some spatial attributes such as pixel coordinate values which mean a specific point in 3D space to ground coordinate values in geographic data, and vice versa. The image edit/display module let users to edit vehicular images, or display the vehicular images realistically using spatial matching provided by the mapping module. The image abstraction module extracts polygons from vehicular images. To extract more exact polygons, the image abstraction module refers geographic data with locations where the vehicular images was acquired. Polygons extracted from vehicular images are imported into the modified geographic information system engine. The imported polygons are manipulated and managed just as they are vehicular images.

We implemented the designed system on Windows XP platform. As test data, we used a geographic data of Daejeon Korea, in shape format, and a large volume of vehicular images, about 20,000 images, taken by our mobile mapping system called 4S-Van [4].

3) User Interface

User Interface of the designed and implemented system are showed in figure 5. As shown in the figure, the system consists of five main windows.

Two windows on the left side in figure 5 provide some functions related to attributes of a specific spatial objects or a specified spatial object group in tabular form. Users can search or edit some properties of spatial objects using these windows. Other two windows on the right side in figure 5 offer some functions related to vehicular images acquired on some roads. Vehicular images can be shown in stereo mode or single image mode.

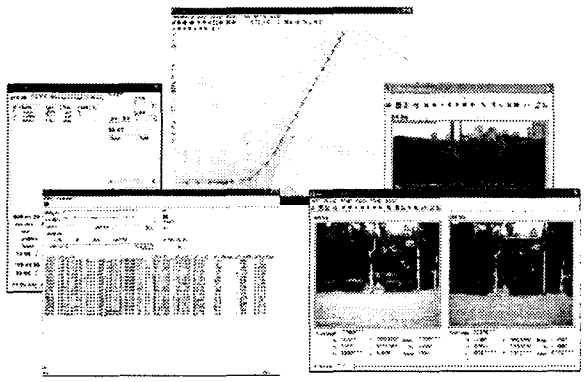

Figure 5. User Interface of the Designed System

These windows are connected with an image edit/display module internally. Some attributes of spatial objects from map viewing windows can be displayed on these vehicular images.

The central window in figure 5 is a map viewer which displays geographic data in 2D/3D fashions, or browses vehicular images appearing in certain regions. This main window connects the windows on the left side with them on the right side in figure 5. Through this window, some properties of spatial objects and spatial attributes of vehicular images can be exchanged.

4. Conclusions

In some geographic information systems such as image geographic information systems which have specialized functions handling images or video, efficient vehicular image management is very important because of images size and affinity with geographic data - spatiality.

In this paper, to manipulate these data together, we considered a vehicular image as a polygon which is a type of popular geographic data types, and modified a traditional geographic information system. Finally, we designed and implemented an integrated management system of geographic data and vehicular images.

References

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