Design and Implementation of Video GIS for Web Applications

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Abstract: Recently as users' requests for geographic information systems are being more various, several new functions are being added to existing geographic information systems. One of them is linkage of spatial geographic data and video / image data to offer more realistic information of geographic objects to users. Geographic information systems implementing this function are called video geographic information system.

In this paper, we design and implement a video geographic information system for providing map data, video data and link information of them to web applications. We 1) design system architecture of a video geographic information system, 2) analyze some processes to construct link information of map data and video data, 3) design database schema to store map data, video data, and link information, and 4) design some XML/GML schema used to query and retrieve these data for web applications.

Keywords: Video Geographic Information System, GIS, Web Application

1. Introduction

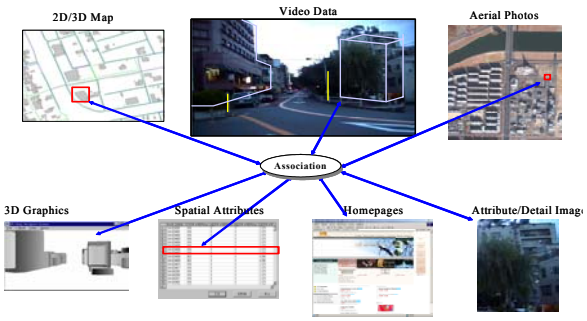
Recently, as geographic information systems which search, manage and analyze geographic data are used more widely, there are more requests of some systems which can search, display, support and manage more actual and realistic information of geographic objects[1, 2, 3]. As a response to the requests, video geographic information system which links video data with geographic data and represents geographic data as they are by displaying obtained video data is being more popular. To construct link information of video data and spatial geographic data for web applications, video geographic information systems should provide some methods or functions to search and retrieve the map data, video data, and link information of them.

The rest of this paper is structured as follows. In section 2, we explain the concept of the video geographic information systems and introduce some examples of implemented systems as related works. In section 3, we show the design and implementation of a video geographic information system. In section 4, we conclude the paper.

2. Overview of Video GIS

1) Concept of VideoGIS

Linking video data with geographic information means to make some additional information of map data and video data to enable referring one using the other. Besides these data, any type data can be used to be linked. Figure 1 shows the concept of such a video geographic information system. By linking video/image data and 2D/3D geographic information, we can use this visual information in some applications, such as facility management applications and disaster prevention systems, which require more accurate visual information of geographic data.



[Figure 1] Concept of the Video Geographic Information System.

2) Examples of Implemented Systems

■ Iwane Video GIS

Iwane Video GIS[4] is a series of video geographic information systems developed by Iwane Corporation. Road Video GIS, Railway Video GIS, Public Utilities Video GIS, River Video GIS, Sightseeing Video GIS are the members of Iwane Video GIS.

■ MediaMapper

MediaMapper™[5] is a software which operates on desktop PC environment and is developed by Red Hen Systems. MediaMapper™ connects image data, video data and geographic information and displays them together.

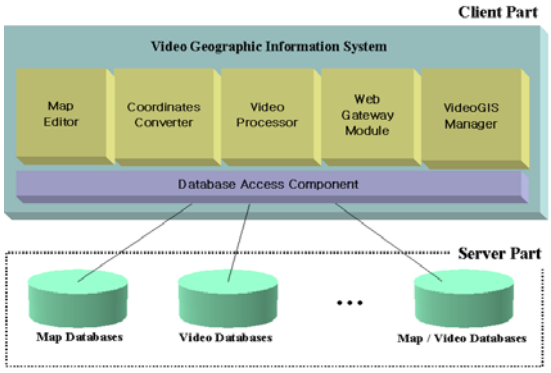
[Figure 2] Examples of Previously Implemented Systems

3. Design and Implementation of VideoGIS for Web Applications

1) System Architecture of VideoGIS

The designed video geographic information system in this paper is structured in client/server architecture as figure 3 shows. The server part of the system is composed of several databases which store video data, geographic information and connection information and the client part of the system is composed of a map viewer/editor component, a coordinate converter component, a video processor component, a web gateway component, a VideoGIS manager component and a database access component accessing the server part.

- Map Editor Component
  constructs, displays, edits, searches, and manages geographic data.
- Coordinate Converter Component
  converts coordinates in pixel coordinate system into coordinates in ground coordinate system, and vice versa.
- Video Processor Component
  displays, analyzes and manages video/image data.
- Web Gateway Component
  processes some queries for retrieving map, video, link data and sends the results to clients.
- VideoGIS Manager Component
  initializes and manages the system and the data.
- Database Access Component
  offers unique interface for accessing several databases in the server part

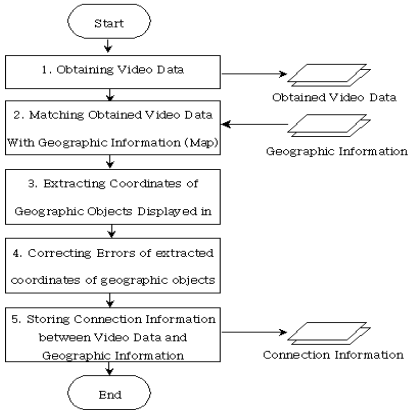


[Figure 3 The Designed System Architecture

2) Construction of link information among map data and video data

The processes to extract and to construct link information between video data and geographic data are composed of five steps as showed in Figure 4. The steps are 1) obtaining video data, 2) matching obtained video data with geographic data, 3) extracting coordinates of geographic objects appearing in video data, 4) correcting errors of extracted coordinates, 5) storing the extracted link information.

In step 1, we obtain video data using camera attached a car and attaching a GPS signal receiver. By using a GPS signal receiver, we can know where the video data were obtained. In step 2, we load geographic data of a region in which the video data are obtained and make basic links between video data and loaded geographic data. In step 3, we extract pixel coordinates and ground coordinates of geographic objects appearing in the obtained video data by referring camera position values, ground coordinates of the region in which video data are obtained and so on. Because it is possible that there are some errors in extracting pixel coordinates and ground coordinates of geographic objects, in step 4, we adjust and correct the errors manually. In step 5, we store obtained information, such as the location of geographic objects in the video data in pixel coordinates and ground coordinates, as link information.



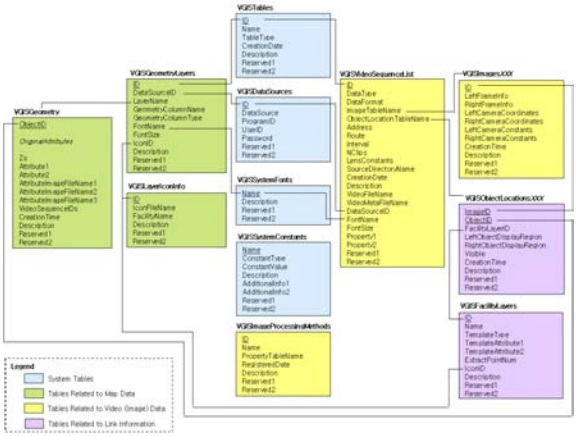
[Figure 4] Processes to Construct Link Information in the Video Geographic Information System

3) Database Schema Design

Data stored in several databases mainly consist of 1) spatial geographic data, 2) video / image data and their attributes, 3) some information related to system management, and 4) link information of spatial geographic data and video/image data. “VGISGeometry“, “VGISLayerIconInfo“, “VGISGeometryLayers“ tables store spatial geographic data and their attributes. “VGISVideoSequenceList“, “VGISImage“, “VGISImageProcessingMethods“ tables store video data and their attributes. “VGISTables“, “VGISDatabaseSources“, “VGISSystemFonts“, “VGISSystemConstants“ tables contain system management information. “VGISObjectLocations“, “VGISFacilityLayers“ tables store the link information of map data and video data. The database schema , its tables, and their relationships designed to store these data are shown in figure 5.

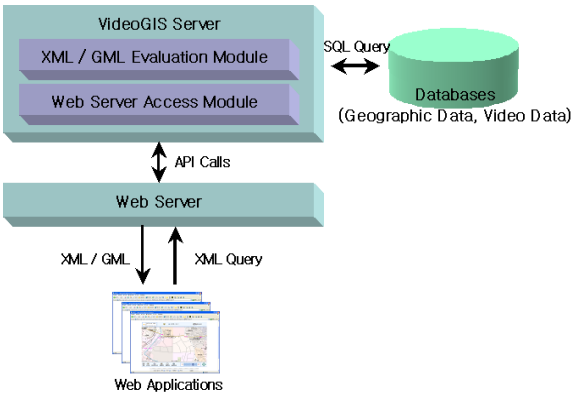
4) VideoGIS Data Retrieval

Retrieval of map, video, link data from the video geographic information system is shown in figure 6. Web



[Figure 5] The Designed Database Schema

browsers and some web applications which require to obtain VideoGIS data send requests to the video geographic information system using XML / GML query formats. The web gateway component in the VideoGIS system converts XML / GML queries to SQL queries which can be understood by several VideoGIS databases. As shown in figure 6, the web gateway component consists of two modules – XML / GML evaluation module and web server access module. The web server access module provides a unique interface to access the video geographic information system and XML / GML evaluation module parses the requests and converts XML / GML queries to SQL queries and vice versa.



[Figure 6] Retrieval of the VideoGIS Data

The XML / GML queries sent by clients can be classified into two groups. A group is “VideoGIS specified queries” and the other group is “general queries”. The VideoGIS specified queries are some queries used to retrieve system information of the VideoGIS system and link information of map data and video data. The general queries are some queries used to access all type of data existing in the VideoGIS system. The VideoGIS specified query is a subset of general query. Figure 7 shows the formats of the VideoGIS specified query and the general query.

```
<VGISGeometry>
  <ObjectID> Value </ObjectID>
  [<Zs> Values </Zs>]
  [<CreateTime op="Operations"> Values </CreateTime>]
  [<Description"> Value </ Description>]
</VGISGeometry>
```

(a) VideoGIS Specified Query Format

```
<VGISQuery type="SQL">
  <ResultFormat>
    XML Fragment
  </ResultFormat>
  <SQLQuery>
    SQL query statement
  </SQLQuery>
</VGISQuery>
```

(b) General Query Format

```
<VGISQuery type="SQL">
  <ResultFormat>
    <RESULT>
      <ID> $1 </ID>
      <NAME> $2 </NAME>
      <TYPE> $3 </TYPE>
    </RESULT>
  </ResultFormat>
  <SQLQuery>
    Select ID=$1, Name=$2, TableType=$3 From VGISTable
  </SQLQuery>
</VGISQuery>
```

(c) A Sample General Query

[Figure 7] Query Formats for Retrieving the VideoGIS Data.

4. Conclusions

In this paper, we designed and implemented a video geographic information system for providing map data, video data and link information of them to web applications. We 1) designed system architecture of a video geographic information system, 2) analyzed some processes to construct link information of map data and video data, 3) designed database schema to store map data, video data, and link information, and 4) designed some XML/GML schema used to query and retrieve these data for web applications.

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[5] http://www.mediamapper.com