

Platform Design for Web Publishing of Virtual Urban Landscape

Changlin Yin^{1,2}, Qingming Zhan¹, Wenqiang Xu², Honghui Zhang³

1. School of Urban Design, Wuhan University, Wuhan 430072, China

2. Planning information service center, Changsha planning management bureau, Changsha, China

3. School of Info-Physics and Geomatics Engineering, Central South University, Changsha, China
ycl@hnup.com, qmzhan@whu.edu.cn, xuwenqiang_114@163.com, zhhgis@163.com

Abstract: The web publishing of virtual city landscape is an important component to build urban public service information platform. This paper analyses the implementation process of urban landscape web publishing and design briefs, realizes web publishing of three-dimension model and model interactions by Web 3D technology in combination with VRML and Java Applet, and achieves unified query on map and 3D scene. The browsing scene is simplified by dynamic scheduling. A number of experimental applications on web publishing of two-dimensional and three-dimensional virtual urban landscape are presented.

Keywords: 3D model, WebGIS, Virtual landscape, Web publishing

1. Introduction

In recent years, with the continuous deepening the digital urban construction and the application, the traditional two-dimensional (2D) digital city system has turned to be lack in visual performance. It is unable to present three-dimensional (3D) spatial information. As a result, its application is constrained to broader and deeper extent, especially for areas with special requirements of visual effects, such as urban planning, landscape design and underground pipe network construction requesting for 3D simulation function. On the other hand, as the government information platform changes from the managerial to the service-oriented, more public participation are required. For example, urban planning department needs to display the planning proposals in the 3D form to users, so that users can browse virtual planning landscape model via the network, and give comments and suggestions on the proposed planning. Such a service model requires not only a 3D platform, but also a Web-based one.

With the development of technologies such as virtual reality, internet services and distributed spatial database, it is possible to realize the 3D visualization of urban spatial information in the network environment, and it brings a chance in building a public-oriented, easy-operated and visual city information services platform to the public. Under such circumstances, a platform for virtual city landscape web publishing is developed.

When web publishing system of virtual urban landscape realizes the three-dimension model publishing, it

should retain features of traditional GIS systems in the database construction, information services, etc. Thus it is a WebGIS system that contains Web3D technology essentially, the implementation of which is a systematic project. Scholars have carried out research on Web 3D topographical visualization and network Virtual Geographic Environment (VGE), etc., and has published several papers^[1-5], Some software products has been expanded from 2D to 3D in network environment^[6-8], which are mainly applied to 3D topography but seldom in urban landscapes publishing.

To meet the demand for public participation in urban planning decision-making, based on analyzes on the web publishing process of virtual urban landscape, we studies the key technology of each level to establish a virtual urban landscape information service platform system, an open and shared system capable of both two-dimension and three-dimension.

2. Implementation flow of virtual urban landscape web publishing

In addition to web-supported 3D model, virtual urban landscape publishing in network environment needs architecture environment for web services, to develop web services, and design platform for clients and servers. The implementation workflow of virtual urban landscape web publishing is shown in Figure 1.

3D model making of urban landscape is the fundamental work, complicated and time-consuming. Digital elevation models are generally applied in digital topography, with sophisticated algorithms. Surface features are modeled with the assistance of professional 3D modeling software packages. The displays and real-time interactive

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responses of 3D dynamic data require large amounts of data transfer and model transformation. The huge amount of topography and surface features data require enormous memory and computing resource. Therefore it is necessary to simplify the scene. 3D models established by conventional software usually cannot be used directly in web publishing. It must be aided by Web3D technologies, which will be described below. Network environment construction is the core project of the system building, including design of clients and servers. The detailed designs are very much related to Web3D technology. As a Web GIS system, spatial database organization of servers and GIS services implementation are vital important to the system development.

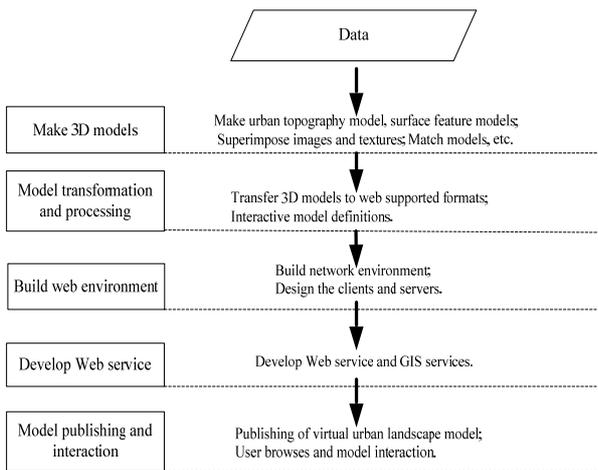


Figure 1. Implementation workflow of web publishing of Virtual urban landscape

3. The virtual urban landscape key technologies for web publishing

The virtual urban landscape publishing platform is internet-based, with the typical three-layer structure, B/S model. Considering the system support for publishing and GIS mapping service, it is different from the conventional Web systems in terms of the implementation technologies. The following are design briefs for each tier of the system: 1) User Layer: the browser of the layer supports 3D model browsing and model interactions, as well as offers 2D map browsing and querying. 2) Service : the layer realizes the function modules of the system and the applications. This system is aimed at both traditional Web services and GIS services. 3) Data Layer: this layer should play effective role in spatial data management of the Web GIS. The following are the key technologies of each layer mentioned above.

3.1 Web3D technology implementation based on virtual reality modeling language

The paper uses Autodesk 3DMAX to create precise models of buildings, but the models can not be directly used for web publishing. They have to be transformed into models that are acceptable in a network environment. We take Virtual Reality Modeling Language (VRML) which has some unique advantages^[9-11] in realization of Web3D and is the Web language standard for the 3D publishing.

To meet the demand of user interacting with 3D models in a virtual urban landscape, Java scripting capabilities provided by Script node in VRML is applied. At the same time, the External Authoring Interface (EAI) is used to communicate between Java programs and the VRML scene. The process for the realization of interaction with models is shown in Figure 2.

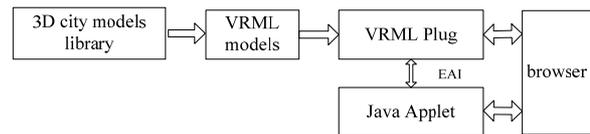


Figure 2. Implementation flow of virtual urban landscape browsing and interaction based on web and VRML

EAI defines a set of Java classes of VRML browser. The external programs, such as Java Applet nested with the VRML browser in the same Web page, are used to control and manipulate the VRML nodes. The browser class which encapsulated in `vrml.external` package is called by the Java Applet program to communicate with the VRML browser. Then the `getEventOut()` and `getEventIn()` interactive events are called by the browser class to capture the input and output instances. The following is a part of Java code which is use to translate the models in VRML scene:

```

... ..
Browser browser = new browser (this);
Node mover = browser.getNode("transform");
EventSFVec3f translation = (EventSFVec3f)
mover.getEventIn("set_translation");
float value[3] = new float[3];
value[0] =100.0f; value[1] = 0.0f; value[2] =
50.0f;
translation.setValue(value);
... ..

```

In above codes, *transform* is pre-defined transformation node. EAI first obtains a reference to this node and then access the node's input events to change the virtual scene.

3.2 Implementation of WebGIS service based on ArcIMS

In order to integrate publishing of maps and virtual urban landscape in the web environment, a WebGIS technology based on ArcIMS is introduced. Supported by WebGIS service, users can browse the corresponding map of the city. The system is designed to achieve the interactive browsing and querying between maps and 3D models. Implementation flow based on ArcIMS is shown in Figure 3.

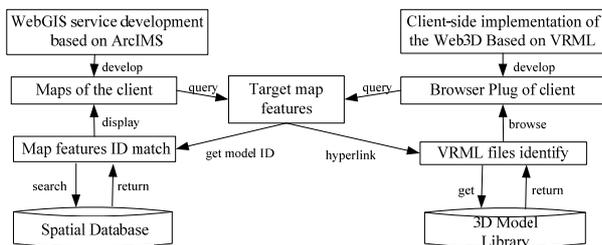


Figure 3. Implementation flow of interactive querying between maps and 3D Scenes based on ArcIMS

ArcIMS provides hyperlink function to enter virtual scene or display building models according to the query results from the map. The hyperlink function can be realized by modifying the ArcIMSparams.js file in ArcIMS. The settings in the file are modified as follows: useHyperLink = "true", hyperLinkLayers[0] = "Museums", hyperLinkLayers[1] = "WebSite". The 3D model ID is used to match the feature on the map, so we can query the feature information from virtual scene to the map.

The map publishing service and website are developed in the map service implementation environment provided by the ArcIMS Manager. We use the web service customization function of ArcIMS to create a new map service, which is associated with the map data, and then adds the service to the new website. The page layout and map tools of the website are also designed in the integrated implementation environment of ArcIMS.

3.3 Scene simplification based on dynamic scheduling

In a virtual urban scene, the amount of topography data accounts for a significant proportion of the entire scene. When a user roams in a virtual scene of a large site or a complex topography, the processing speed will be slow down, because of data size. In order to simplify the 3D topography data, a scene dynamic scheduling technology is used.

First, a VRML file of the entire scene is defined, the file just includes some information about the background, view point and some other overall effects of the scene.

The "Inline" node of VRML is used to add the partial scene of the file. The following is the example:

```
#VRML V2.0 utf8
Background{ groundColor[...]; skyColor[...]; }
Group{ Children{ Inline(url"scene_1");
              Inline(url"scene_2");
              ... ..}
}
```

The visibility rang in the scene is determined by the position of the current view point, the largest distance between the front and the back, and the horizontal viewing angle while roaming in the scene. Then corresponding files except for the scene beyond the visible area are loaded dynamically for display.

4. Design and implementation of virtual urban landscape publishing platform

4.1 Function structure of target system

The goal of the system is to provide the public a shared platform in urban 3D information visualization as well as a network window for citizens to make suggestions and comments on urban planning and development. The function architecture is shown in Figure 4.

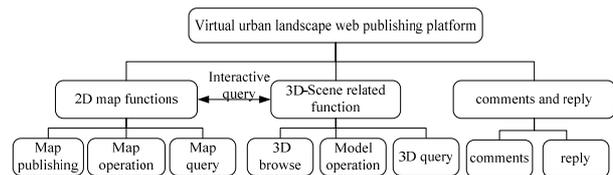


Figure 4. Function architecture of the target system

4.2 Architecture of the target system

In accordance with studies on design briefs and key technologies of each system layer, combining the requirements of target system function design, the system architecture is presented as Figure 5.

The data layer consists of data servers storing a variety of spatial data, 3D model data, resources and archival data, etc. System data layer uses ArcSDE + Oracle database system, with powerful spatial data management capabilities of ArcSDE to achieve unified management of spatial data and non-spatial data. Service layer develops the map service with Arc IMS, takes Apache HTTP server 2.0.55 as the Web container, Apache Tomcat 5.5.25 as the Servlet container, to build Web application framework. User layer installs BS Contact VRML/X3D browser in order to support VRML model display. Figure 6 shows a screen caption of the 3D virtual scene.

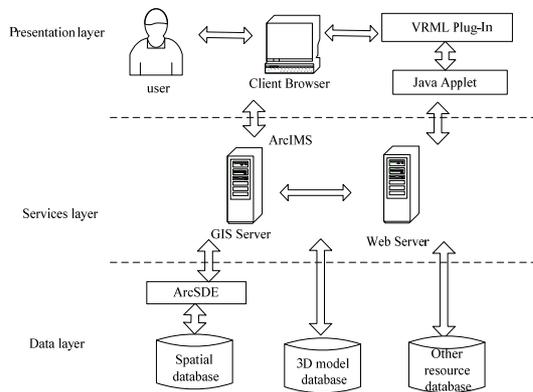


Figure 5. Architecture of the target system



Figure 6. A virtual scene published by the system

5. Conclusions

It is of great significance to establish Web-based virtual urban landscape model publishing platform for digital urban development and urban planning information services. The paper analyses the implementation process of virtual urban landscape web publishing, considering the design briefs of each target system layer and conducts core research on key technologies to system implementation. The Web 3D method with VRML, Java Applet, EAI method has been used to realize web publishing of 3D models and model interactive control. ArcIMS technology is used for realization of map publishing and 2D/3D literal query based on Web service. The paper has proposed a dynamic scheduling method on the base of VRML scene segmentation, which could improve the speed of the scene browsing.

There are many technological points referring to 3D urban publishing based on spatial data. In the current network environment, real-time scheduling of large topography and massive data, and multi-source data organization based on GeoDatabase data model are needed for further research.

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