Abstract

Innovative information systems based on 3D city models play a major role in application areas such as tourism, cultural heritage, city planning, traffic management and knowledge transfer. The commercially available geographic information systems (GIS) do not consider these developments sufficiently. The department of Graphic Information Systems of the Fraunhofer Institute for Computer Graphics Research IGD is carrying out numerous projects in which the spatial processing of three-dimensional data using GIS is a core component. With the help of self-developed solutions, large city and landscape models can be analysed and visualised in real time. This makes it possible to set up location-based services (LBS) as well as Virtual and Augmented Reality (VR/AR) systems, visualisations of reconstructed sites, 3D routing or to use the data as a basis for further analysis. This article presents the current level of development of the CityServer3D technology, which offers the possibility of three- and four-dimensional geodata held in an object-relational spatial database to be distributed over the Internet to different client software.

Approach

Nowadays, neither the storage nor the processing of three-dimensional data represent unsolvable problems. Beside standards already established in the geodata world, database solutions for the storage of the data are also present on the market. In addition, the simple linkage of geometry and presentation data will further develop already existing data. Many efforts, for example the working groups of the initiative for geodata infrastructures of North Rhine-Westphalia (GID NRW), bring the conversion, management and visualisation of the data up for discussion in order to support the application of these systems. The CityServer3D technology is one of these systems and extends these concepts. Besides a geodata server for three-dimensional city models, it also makes mechanisms available which not only support management and visualisation, but also provide a simple integration of analysis and dynamic data. This, in particular, permits the development of systems extending the possibilities from mere (simple) visualisations and static data management to systems with various application possibilities.

Technology

Besides the GeoBase21 database, the technology of CityServer3D consists of a server component and clients which fulfil different tasks. Apart from the geometry, the database also stores the thematic and spatial classification of the data sets. Further attribute data sets
can be held. Besides objects on the earth’s surface, the digital elevation model can be stored in different levels of detail and queried, whereas it is managed in different common models, so that both an optimised GRID and TINs (optionally with breaklines) can be stored. Thematic and spatial attributes of the objects are assigned to presentations which contain optional symbol presentations or the colour representation of the objects and object groups.

A central role within CityServer3D is played by the server component, which makes the data stored in the database accessible over different interfaces. The architecture makes it possible to query not only the data stored in its own database but also additional data sources. These can be other databases or files loaded using import components. In order to achieve this, CityServer3D uses a meta-model. The data transferred into this model can be processed in various ways within the server’s functional unit and, afterwards, transmitted over different interfaces and in 2D and/or 3D formats to clients or other servers. In this way, the interoperability of the server is ensured. Since the server has components for authentications and recordings of transactions, it can be used as a fundamental technology for eCommerce.

The server component consists of different modules. The interaction of the different modules is steered via the control unit. It enables the processes to be defined, so that, for example, a web mapping service (WMS) based on orthophotos can be set up quickly and simply. This mechanism can be generally used and also serves for the integration of more complex modules. In this way, objects from data sources can also be dynamically manipulated depending on the actual situation. The WebViewer of CityServer3D forms the interface between the user and the database. The WebViewer is based on standard technologies of the World Wide Web and can be called up using any Java-capable Browser.

With the help of the 2D component of the WebViewer, the user can define a polygon to select the area of interest on the map. By a mouse-click, the user gets a three-dimensional visualisation of the selected area in the WebViewer, which uses Java3D technology. In a virtual universe, the user can freely navigate through the areas and objects. One can, for example, select buildings to get further information. The user interface is configured by XML files and is available in several languages (e.g. English and German).

For the management of the database as well as for importing and exporting the geo data, a special client is provided for content administration. This tool uses the visualisation and navigation functionalities of the WebViewer as well as special data filters for data administration.

The main functionality of the Administration Tool, however, consists in the import and export of geo data of different formats. In order to support different formats, the Administration Tool contains components which make conversion of external data to the internal format possible. Since these converters are tied up as independent libraries to the server (an extension for upcoming geo data standards and formats), the adaptation effort is minimised. Currently, the exchange of SVG, SHP, VRML, raster-based, AutoCAD and GML3 files is achieved. For the import, the Administration Tool offers the possibility of accomplishing global manipulations of the geodata. The necessity for such a feature shows up already with the import of VRML files due to different coordinate systems. The definition of an offset for the point of origin of the visualised scene graph is also possible.
Application

CityServer3D serves as an enabling technology for several application areas such as tourism, traffic, risk management or site planning and marketing. The WebViewer of CityServer allows the provider to serve the user with models from a site. These can be actual situations as well as differing planning phases and possibilities. The user is able to navigate inside the models using free navigation or by flying or walking in the model.

By analogy with the WebViewer used for stationary systems, the MobileViewer serves as an interface between the database and the user of a mobile device, expanding CityServer3D with location-based service (LBS) functionality. The Java-based MobileViewer enables the user to navigate inside lower-detailed three-dimensional dynamic maps as well as highly-detailed 3D building models on newer mobile devices supporting 3D-rendering.

Different fields of application can thus profit from CityServer3D: as a dynamic tourist guide, the MobileViewer presents, for example, a visitor to a town with the shortest way from his position to the nearest restaurant by providing a 3D map with his destination position highlighted. Objects of special interest, such as historic buildings, are presented in a highly detailed way, allowing the user to walk virtually through the building. As different representations of the same object can be offered, the historical development of a building and its surroundings can be watched right on the spot and compared with the actual, real view.

The MobileViewer also serves as a supporting tool in site planning and marketing. Construction managers can examine various designs of a building in the planning phase while physically present at the construction site and can base their decisions on the virtual model and the vicinity in the real world. While the building is still in construction, CityServer3D can provide potential investors and the public with three-dimensional models of the building, allowing them to navigate through and examine it on their mobile devices.

Jörg Haist, Daniel Holweg

Fraunhofer IGD, Darmstadt, Germany

Email: joerg.haist@igd.fraunhofer.de, daniel.holweg@igd.fraunhofer.de