CAMPUSGIS-3D ESTABLISHED WITH ESRI'S PRODUCT FAMILY

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Abstract

This paper presents recent improvements of the CampusGIS of the University of Cologne (http://www.campusgis.de). Set up as an *ArcIMS* based online GIS environment in 2005, this application provides general and spatial campus information by connecting several existing relational database systems of the University of Cologne with spatial data within an online GIS environment. The system is used for information, orientation, and routing; and functionalities for facility management are planned.

The CampusGIS is currently extended to the third dimension, which allows advanced orientation on campus. Official LIDAR data was used to generate a LoD1 city model in *ArcGIS*. This semiautomatic 3D-modeling was set up using *Spatial Analyst* and *3D Analyst* tools. An *ArcGIS Server 9.3* globe service is used to visualize the 3D-data which includes the LoD1 city model and a DEM which has been derived using radar data acquired by the German radar satellite TerraSAR-X. Additionally a geoprocessing service using *Network Analyst* is implemented to serve a routing application.

1. Introduction

The first release of the CampusGIS, designed by the GIS & remote sensing research group in the Department of Geography at the University of Cologne as an ArcIMS-based HTML- and Java Script-application, was established in the year 2005 and is operational since early 2006. Since there was a strong development in web-technology and web-based GIS applications the basic structure and design has changed and the prospects of the CampusGIS increased. A major improvement was the change of the HTML-, JavaScript- and PHP-script configuration to AJAX (Baaser et al. 2008). By now a secondary, basic change is realized by using a Java-environment with ArcGIS Server-technology.

Due to the fact that the existing campus information system is under continuous enhancement one current focus lies on the expansion from a 2D- to a 3D-information system and the integration of routing tools.

2. CampusGIS

The CampusGIS is established by using different sources of data which are organized in relational database systems and in ESRIs file geodatabase. In order to provide the implemented tools and the acquired data current web technology is used. A major task of the whole project is to couple data from different sources and to provide the information online.

2.1. Input data

A large amount of data has to be managed which are available in the information system. The data consists of (i) topographic geo data, (ii) surveyed line data of walkways and polygon data of building outlines (iii) alphanumerical data, (iv) CAD-drawings, and (v) elevation data (Baaser et al. 2006). A reasonable way to handle the varying data types is a relational database management system. Because topology is needed for routing purposes the geo data are stored as featureclasses of an ESRI file geodatabase. Raster based GIS data are stored separately in the geodatabase. Alphanumerical data like addresses of buildings and information about staff are stored in MySQL-databases and content management systems (CMS) hosted by different facilities of the University administration.

2.2. Technology

The latest version of the CampusGIS is running on ArcGIS Server 9.3 Java with the Network extension for the routing application as geoprocessing service and the 3D extension for the visualization of the 3D city model as a globe service, see chapter 3 (ESRI 2006). Besides the basic GIS-functions like zoomin, zoom-out, pan, and alphanumerical and spatial search- and information functions, the CampusGIS provides the calculation of footways: The user puts the starting point, optionally stopover and the destination by mouse-clicking on the map and the system answers after calculating based on a shortest-route-algorithm according to Dijkstra by drawing the best path and listing the directions (ESRI 2009).

3. 3D Modeling

Starting with the first concepts of Virtual Reality and 3D modeling in the 1960s digital, 3D models have now become an important tool in research, planning, and navigation. In the 1990s, the primary use for 3D city models in German cities was related to air pollution and noise emission analysis. In recent years an increasing number of cities and enterprises established digital models for visualization and navigation purposes. The models differ in their level of detail (LoD) depending on their intended use. Because of rising significance of 3D models the CampusGIS presently extended to the third dimension. The model enhances the system regarding visualization, navigation and facility management. The modeling has been carried out with ESRI's *ArcGIS 9.3*.

The 3D modeling is based on topographic and surveyed data out of the CampusGIS. Additionally LiDAR data from the land survey administration North Rhine-Westphalia have been taken to get height information about the buildings. A high accuracy digital terrain model (DTM) and digital surface model (DSM) was available for the test site of Cologne's Campus. In a first step a preprocessing and input into *ArcMap* as a feature layer has been run (see fig. 1). In order to get comprehensive data an *IDW* interpolation using the *Spatial Analyst* was mandatory for the DTM. A spatial join based on the building data has been carried out on the DSM. Thus a calculation of the mean height for every building was made possible by using ESRI's *Spatial Statistics* tools. Upon that a 3D block model could be generated with the *3D Analyst* in *ArcScene*.

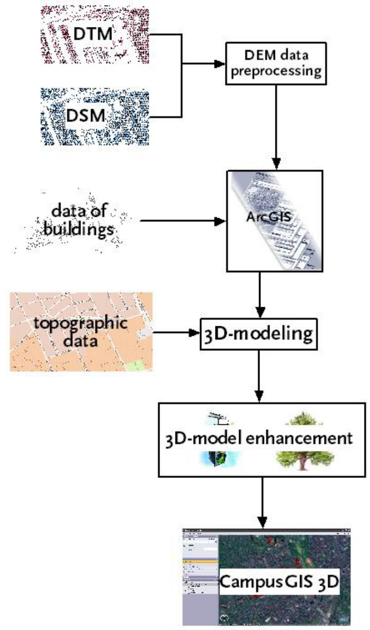

Figure 1. Workflow of 3D modeling

ArcGIS provides several tools for 3D model enhancement and visualization. Texturing the features subject to the attributes is only one tool which was used for the model enhancement. Additional layers with on campus features (e.g. trees and streetcar stops) have been added to get a more realistic impression of the model.

4. Results

4.1. The 3D-model

With the available digital elevation data a reasonable 3D modeling could be carried out using ESRI's *ArcGIS 9.3* product. A semiautomatic, cost- and time-saving approach was chosen. According to the specification of the *Special Interest Group 3D* (SIG 3D) of the *Initiative Geodata Infrastructure North Rhine-Westphalia* (GDI NRW) the output model is classified as a LoD 1 city model (see fig. 2). With additional features aside from the buildings an enhanced 3D-model of the campus is available for the CampusGIS.

Figure 2. 3D campus model in *ArcScene*

4.2. CampusGIS-3D

An integration of features in the third dimension is possible in the CampusGIS by setting up a globe service in ArcGIS Server. Consequently the service is available for access via ArcGlobe, ArcGIS Explorer or ArcReader (see fig. 3).

Aerial photographs and other remote sensing data like data from the German radar satellite TerraSAR-X is added for visualization and interpretation purposes.

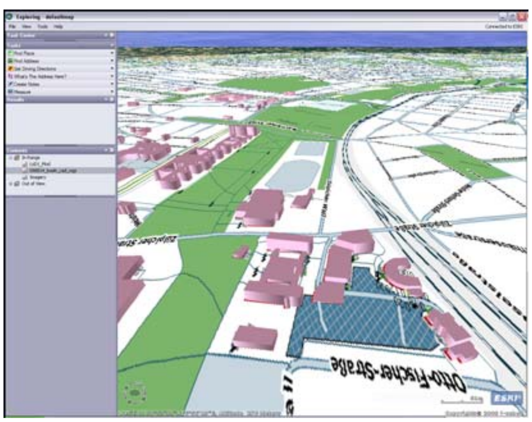

Figure 3. CampusGIS-3D visualized in ArcGIS Explorer

5. Conclusions and outlook

The 3D data integration enhanced the capabilities of the CampusGIS considerably. Navigation in combination with 3D data is much more user-friendly as it comes closer to the perception of the real world. With handheld devices like mobile phones or personal digital assistants (PDA), 3D data for navigation by means of location-based services (LBS) will be a commonly used application in the near future. Beyond navigation, further 3D analysis functionality could be added, e.g. for architectural planning tasks, facility management and studies on solar roof potential (Kassner et al. 2008). For these purposes terrestrial laser scan data are conceivable.

An integration of the 3D data into the existing CampusGIS architecture would result in a benefit for the client.

More detailed input data and data from different sources could enhance the scope of the described system. Acquisitions of buildings with a terrestrial laser scanner have been made and an implementation of a 3D model with higher LoD is under construction. An integration of other remote sensing data has been tested using an orthorectified image (ORI) of TerraSAR-X. Especially in regions where no high accuracy and high resolution aerial photograph are available or other SAR applications are planned, an integration of radar data like TerraSAR-X data into a similar system would highly enhance the usage.

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