CyberCity Modeler: Automatic Texturing of 3D City Models
TerrainView-Web: 3D Web-VRGIS

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ABSTRACT

Cybercity Modeler is a sophisticated and proved tool for 3D-city model generation from aerial-and satellite imagery and LIDAR data. Further developments ensure the continousity of the data flow and optimize ongoing the data capturing and continuation. A new development was performed for the automatic texturing of facades from aerial and/or oblique images. Another important development was the integration into ArcGIS (ESRI). With the application www.map2day.at which was performed within a common project with Forest Mapping Management (FMM), Salzburg and ViewTec, Zurich a powerful and unique web-based 3D-GIS was created. For this development CyberCity AG - which is an ESRI business partner development, got an award for best software integration at the ESRI user conference 2004 in SanDiego in partnership with ViewTec and FMM.

1   INTRODUCTION

Large-area 3D city models generated by means of photogrammetry or laserscanning are predominantly used in urban planning, architecture and marketing (e.g. tourism, real estate promotion). Additionally they are requested as basic data for the gaming and entertainment industry.

CyberCity generates 3D city models semi-automatically from stereo aerial images or laserscanner data and developed the specialized software *CyberCity-Modeler (CC-Modeler™)*. Besides the easy to use texturing of facades with terrestrial images, a new and efficient technology was integrated for the automatic texturing of facades and roofs from (oblique) aerial images (*CC-AutoTex*).

Recently *CyberCity-Modeler* was extended by the new tool CC-VisualStar which was developed as a photogrammetric workstation with special functionality for data continuation and 3D measurement. An efficient updating can be managed by comparing existing 3D city models with new aerial photographic information.

The 3D data can be managed in a commercial database using ArcSDE (ESRI) and be used for further analysis in ArcGIS (ESRI).

For real-time visualization, the 3D city models can be exported in Open Flight format (FLT) including level-of-detail (LOD) for geometry and textures. The professional visualization tool TerrainView™ (ViewTec AG) supports level-of-details and includes sophisticated functions for the real-time visualization of a huge 3D scenery including functionality for combining, moving and deleting objects in different formats. Web-streaming of landscape and city models allows TerrainView to view large data sets with high speed.

In cooperation between CyberCity, ViewTec and FMM Salzburg an application www.Map2day.at was developed, which makes use of the above mentioned developments. The Web solution allows companies, product and service suppliers to present their offer on the Web. Actually www.Map2day.at is the combination of GIS technology with high quality 3D-city model data and high speed real-time visualization on the internet.

2   GENERATION AND UPDATE OF 3D-CITY MODELS

CC-Modeler is a software tool for generation of 3D-city models. It was described in several papers (see www.cybercity.tv) and presented e.g. at Corp 2003 and Corp 2004. Data source is either aerial/satellite imagery or LIDAR. Generation and continuation of the data can be performed perfectly by using the CyberCity-Modeler module *CC-VisualStar*, a photogrammetric workstation. Following points are important for actualization:

- Comparison between existing 3D-city models and actual status shown in the actual stereo model.
- Deletion of objects which do not exist anymore
- Editing of objects which have changed between the different status
- Add new objects by direct modeling
- Management of the actual city model in a GIS database (incl. attributes)

CC-VisualStar requires a PC with a stereo-capable graphic card and monitor. With a shutter glass the stereo viewing is performed. VisualStar also has standard photogrammetric features like stereo-model orientation, automatic and semi-automatic measurement of aerial triangulation, DTM and DSM, orthophoto computation including mosaicking. A new tool for automatic generation of True Orthophoto is available since 2005.

To improve the geometric quality, *CC-Edit* was developed. *CC-Edit* is a CAD system specified for 3D city models and is used for improving the geometry of the models. Numerous functions for fulfilling geometric requirements like planar faces, parallel lines etc. can be applied and overlappings between adjacent buildings can be cleaned. Building footprints can be combined with the roof structure to get realistic overhanging roofs.

For working with 3D-models existing data is imported from a GIS database or file system and is displayed together with the aerial stereo model. This means that the older city model is overlaid with the new image information and differences and changes are

visible immediately. Buildings, which do not exist anymore, can be deleted from the database. New buildings can be recognized because they are visible in the stereo model and not yet represented by the necessary vectors. These buildings can be measured and modeled directly. The modeling is performed automatically after measurement of the polygons defined by the boundary points and the inner points of the roof. The operator just measures points, the lines and vectors are created automatically. The modeling is performed without knowing about the roof structure. E.g. it is not necessary to tell the program if it is a saddle-, tent- or other roof.

The 3D-data can be managed in commercial databases with ArcGIS, ArcSDE (ESRI) or Topobase (C-Plan).
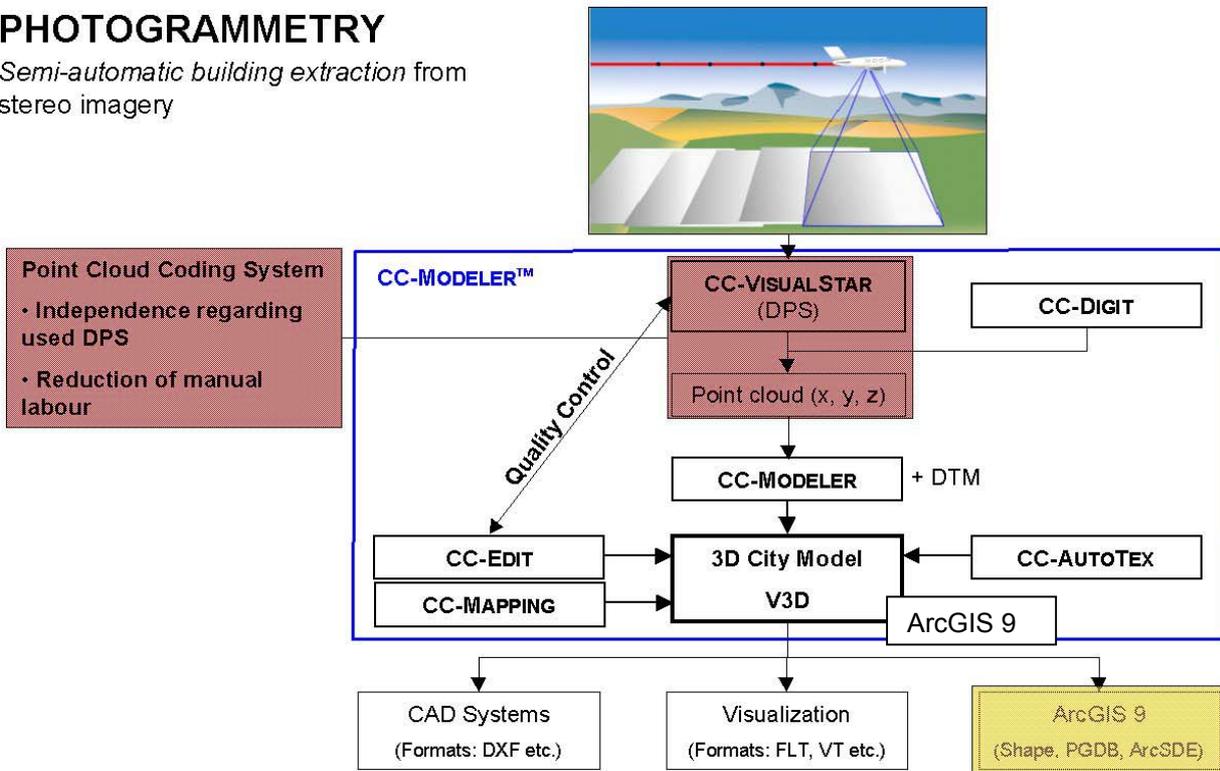

Figure 1: Workflow for Updating of 3D-city models in CyberCity processes and the management with ESRI Arc products

For more details we refer to www.cybercity.tv.

3 AUTOMATIC GENERATION OF FACADE TEXTURE

A software tool was especially defined to optimize texturing of facades. The goal was to reach a high degree of efficiency for big city areas. With CC-TLSAutotex or CC-Autotex, facade textures, which are taken from aerial images, can be put automatically on wall facades. This software module is an addition to CC-Mapping, where manually taken terrestrial pictures are handled or pictures within a library are used as generic texture.

In the meantime the ancient city of Salzburg was photographed from a helicopter using medium format cameras producing oblique images. More than 500 aerial oblique images were taken, each of them including about 30 to 60 facades. The image with the best quality for the individual facade was selected automatically by CC-Autotex. Facades of objects, which still were fully or partly hidden by obstacles, have been edited manually. Using this procedure the cost of texturing could be reduced drastically.
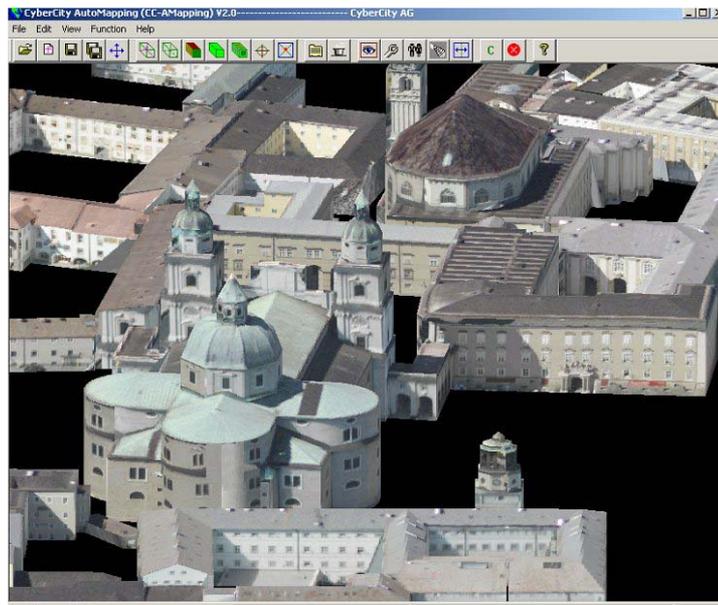
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Figure 2: CC-AutoTex results of Salzburg

4 VISUALIZATION WITH TERRAINVIEW-WEB

The **TerrainView-Web** application is a state of the art Virtual Reality based software solution that facilitates the interactive visualization of high-resolution 3D-terrain data over the **Intranet**. Due to ViewTec's advanced software technology and innovative data management concepts, large amounts of data may be processed in real-time. Digital elevation models, high resolution orthophotos, satellite images, 3D-buildings and vector data provide the real time application with the information to display excellent high quality representations of complex terrains and landscapes. It was described in several papers (see www.viewtec.ch).
Spatial planning, works premises and city visualization, TerrainView-Web gives benefit by visualizing present or future building projects in a most attractive way. TerrainView-Web can include the corresponding information into the terrain model of your site, to visualize any preferred number of textured buildings. Optimization of production sites, marketing and public relation strategy can now be improved.

Main features of TerrainView/TerrainView-Web are:

- Web streaming support
- Import of 3D-models of different formats
- Manipulate objects
- Various modes of navigation
- Points of interest editor
- Advanced flight path editing
- Terrain paging
- Weather visualization
- Arbitrary resolution screenshots
- Stereo support
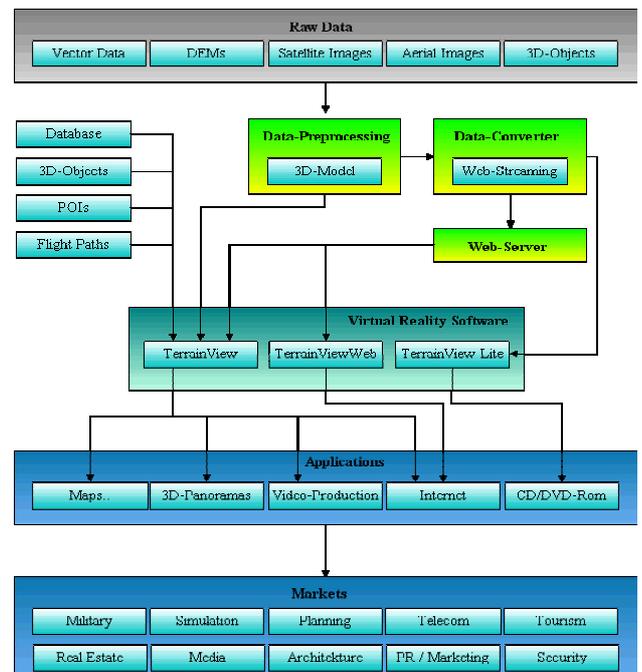- Generation of digital video
- Information tree

Figure 5: Workflow of Visualization

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Web Streaming Support

With ViewTec's TerrainView-Web you are able to connect 3D-terrain databases through Internet. Cities like Munich and Berlin with more than 500'000 buildings can be streamed. The 3D-terrain data size is only limited by the available disk space. TerrainView-Web runs in conjunction with proxy servers and firewalls. All data streams are compressed and heavily encrypted. A standard Web Server e.g. Apache, IIS, and many others delivers and manages the 3D-terrain data over the Internet or private computer networks. While using standard server technology, the user has access to large sized databases that can be viewed over low-bandwidth networks in real-time.

A 3D scene for TerrainView-Web can be generated as a service by ViewTec.

ViewTec's data preprocessor supports all the well-known GIS data formats:

- Vector (NDA DFAD (all levels),USGS DLG,USGS LULC,NIMA VPF ESRI Shape (import/export) IHO S57 (NOAA ENC))
- Imagery (GeoTiff, TIFF, Arc Info World,GIF, BMP, JPEG, ECW, JPEG2000, NITF CIB
- Elevation(NIMA DTED (levels 0,1,2), USGS DEM, Arc Info BIL, ESRI Grid ASCII, ESRI Grid Float, Japanese MEM, Spanish ASCII, GeoTIFF (16 bit), Bitmap (8 bit), IGN DB ALTI, X,Y,Z (non-grided), Contour lines
- 3D-Objects (OpenFlight)

ViewTec includes the service to generate complex 3-D buildings from vector source data without any external modeling required. Buildings are generated rapidly and automatically based on the attribution of vector data and simple user-controlled parameters. Buildings produced with default or user-defined textures are properly oriented and integrated with the underlying terrain. ViewTec makes the creation of complex terrain features easy. 2-D linear and areal features can be automatically constructed through user-defined parameters. ViewTec supports automated feature generators construct cultural features with a high level of detail to user specifications.

The generated scenery can be interactively visualized by TerrainView.

Additional 3D models such as buildings, billboards, and cars can be imported to enhance the realism of the generated terrain. Currently the supported data formats are:

- Autodesk 3ds
- VRML 2
- Design Workshop dw
- Alias/Wavefront obj
- NewTek LightWave 3D lwo.

A TerrainView 3D scene can be exported to the internet using the TerrainView-Web Export option. The free TerrainView-Web plugin enables the Microsoft Internet Explorer to visualize the scenery over the internet. The number of additional objects for Web export is unlimited.

More details are described at www.cybercity.tv under publications and www.viewtec.ch .

5   WEB-SOLUTION – WWW.MAP2DAY.AT

Map2day.at is a web-based 3D GIS service with interaction between a 2D city map and 3D visualization. It is used as a marketing tool to allow organizations to present their services and products via the internet and shows their location in 2D and 3D.
Map2day.at is realized by cooperation amongst CyberCity AG, ViewTec AG and Forest Mapping Management (FMM) GmbH. It uses ArcIMS (ESRI) and interfaces to TerrainView-Web (ViewTec AG).
The query of the informative GIS database in the background is based on location, categories (e.g. tourism, public health etc.) and groups (e.g. hotels, golf courses etc.). Areas and distances can be measured easily and results are shown instantaneously. The application supports 12 languages and the appearance can be customized, allowing the selection of different color schemes.

The user can dynamically change between the 2D map and the 3D visualization that supports free navigation in the selected region. By selecting the location from the GIS query in the 2D map, the 3D window automatically navigates to the corresponding area in the 3D scenery. Hyperlinks to web pages or multimedia information can be accessed by integrated and defined icons.
Reality-based 3D city models by CyberCity AG and trees are combined with the 3D environment (DTM and orthophoto) and are web-streamed and optimized for the performance via Internet (see Figure 6).

The client (e.g. hotel or restaurant) can access their online administration page by using their username and password. They can manage entries (e.g. hyperlinks, promotion etc.) and keep the company data current, which makes this web-solution a powerful enterprise tool for tourism and marketing.
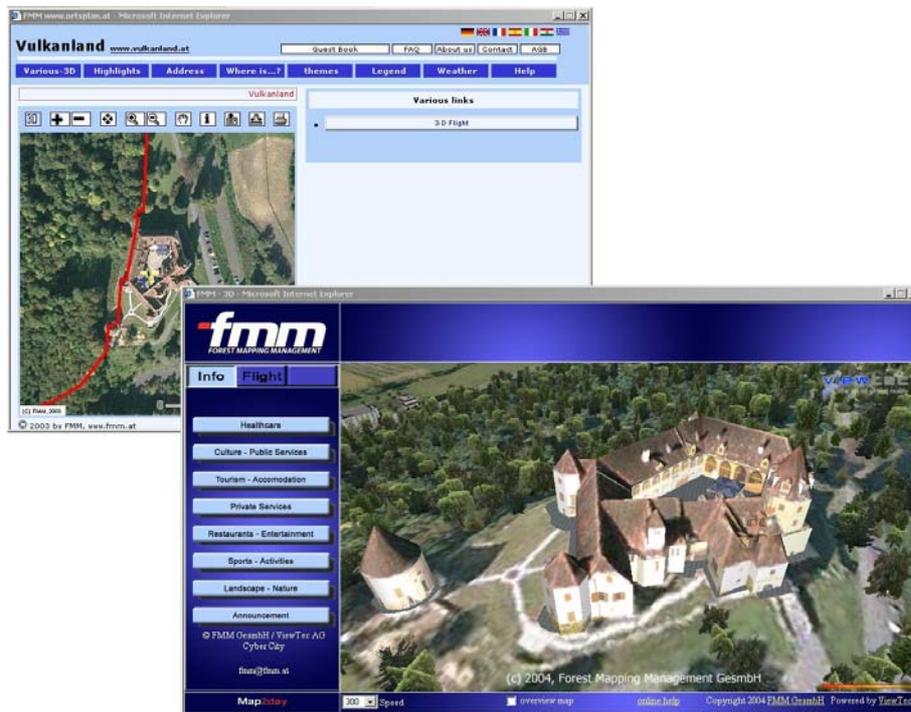

Figure 4: www.Map2day.at, a GIS solution with CyberCity's automatic textured buildings and realtime visualization with TerrainView-Web

6   CONCLUSION

CyberCity and ViewTec offer together new modules needed for updating and high-end visualization through the Internet. CyberCity's CC-VisualStar allows online updating and editing, CC-AutoTex the efficient texturing of facades with high quality and low cost. TerrainView now allows interactive modification of 3D-objects and permits the visualization of complex landscape and 3D-city models. Flight paths can be generated in a very sophisticated manner. CyberCity Modeler and TerrainView together are highly developed tools for most ambitious 3D-model applications.

7   REFERENCES

Publications, references and detailed information may be found on

www.cybercity.tv

www.viewtec.ch

CyberCity

The company CyberCity AG was established in April 2000 as a spin-off company of the ETH Zurich and offers software and services for the generation, management, editing and visualization of 3D city- and facility models. In the meantime CyberCity operates a branch office in Los Angeles (CyberCity LLC).

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