NEW EXPECTATIONS
CITY MODELING IN THE INTERNET AGE

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Abstract

The first part of this paper tries to give an overview over the different aspects of city modeling. After a short history on city models the paper starts with a categorization of the different "types" of city models. We try to explain the various aspects involved in the creation of a city model and the problem of maintaining a city model. Then the paper shows the example of two computer models of parts of the same European city which have been created in two different ways. The first version of this computer model tries to use as many automatic or semi automatic procedures as possible to create the model. In the paper examples of these different procedures are given - from the automatic creation of the buildings itself, its roofs, and the surrounding terrain to the automatic cleaning of texture photos of the façade. The second version shows a model, which has been done with just a few automatic procedures and a lot of human effort (mainly students). The paper describes the limitation of both techniques and tries to give an outlook towards the combination of these methods. We will also show the importance of internet techniques in the use and presentation of computer city models.

Resumo

Este artigo descreve trabalhos anteriores feitos pelos autores em modelamento de cidades e tenta enfatizar os novos desenvolvimentos nesta área.A primeira parte deste artigo tenta fazer uma breve descrição sobre os diferentes aspectos de modelamento de cidades. Após uma pequena parte de introdução histórica sobre modelos de cidades, este artigo apresenta uma caracterização dos diferentes tipos de cidades modelos. Nós tentamos explicar os vários aspectos envolvidos na criação de um modelo de cidade e também o problema de manutenção do modelo. A seguir, o artigo mostra exemplos de dois modelos computacionais de partes de uma mesma cidade européia, os quais foram criados de duas formas diferentes. A primeira versão do modelo computacional de exemplo, tenta usar um número máximo de procedimentos automáticos ou semi-automáticos em sua criação. No artigo são dados exemplos desses diferentes procedimentos abrangendo a criação automática dos prédios em si, seus tetos, o terreno ao seu redor, até a limpeza automática de fotos texturais da fachada. A segunda versão mostra um modelo que foi criado com apenas alguns procedimentos automáticos e muito esforço humano (principalmente de alunos). Este artigo descreve as limitações de ambas as técnicas e tenta dar uma visão na direção da combinação destes dois métodos. Nós mostramos também a importância de técnicas de Internet para o uso e apresentação de modelos computacionais de cidades.

History and Expectations

As soon as CAD programs with the ability to draw in 3D were available and affordable the creation of 3D city models started to increase. Many of them were initiated at universities (e.g. Bath Model, Glasgow Model) for educational uses and they had to deal with the limitations of software and hardware at the time of their creation. The often mentioned CASA study (from the year 2000) identifies over 60 cases of virtual cities worldwide. But the main focus in city modeling is right now is shifting from static City Models to static models that can be browsed interactively towards interactive "Virtual Cities" or "Virtual Worlds".

A good example for this development are the original CASA Bath model, the later VRML versions of the Bath Model (V.Bourdakis) and the Virtual London project by CASA. The Virtual London model – as stated on the CASA website will be a "visualisation of all buildings within inner London through which users can navigate at street level as well as fly across in panoramic fashion. It will be possible to query the data within the model by simply pointing at and clicking on buildings and streets to reveal data concerning floorspace, land use, rents, traffic volumes etc. Users will also be able to make proposals and seek answers to "what if?" questions involving placement and visualization of new buildings, demolition, and changes to transport links". (figure 1)

Some of the aspects mentioned about the Virtual London project are also incorporated in the VRVis and Digcity Graz models.

Graz: Two Examples

Over the years some parts of the city of Graz have been modeled and visualized for different reasons in different qualities. There have been university projects (design and urban design) and commercial projects of the city. The most interesting commercial projects has been created because of major exhibitions about the history of the city and include an 3D – studio animation about historic Graz in the 17th century (G.Angerer – Sense2) and an interactive visualization of parts of the historic center using the "Unreal" game engine. (Bongfish, 2000) (figures 2-3)

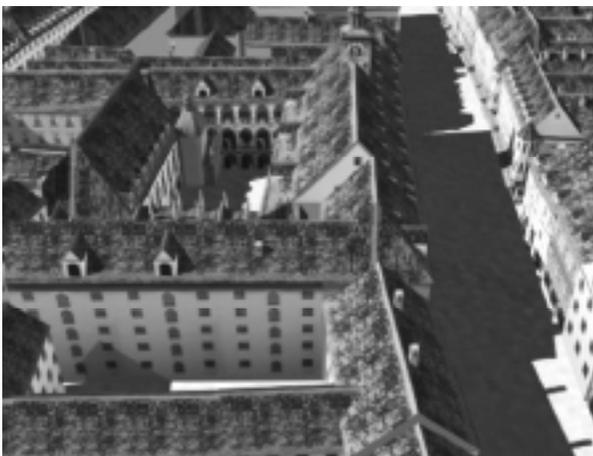*Fig 1 - Intended Virtual London model including example for Site manipulation (CASA)*

Fig 2 - Renderings from the animation of Graz 17th century (G.Angerer – Sense2)
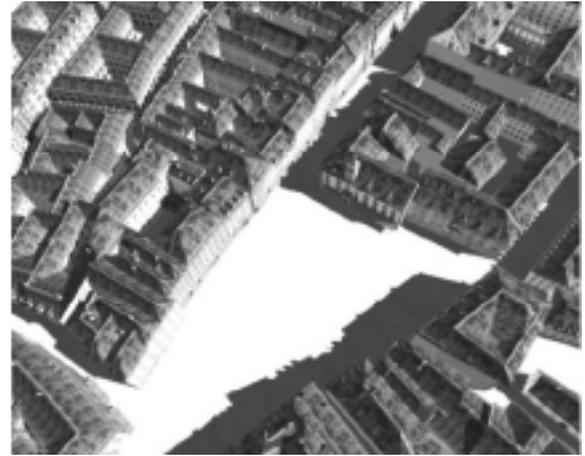

Fig. 3 - Renderings from the animation of Graz 17th century (G.Angerer – Sense2)

The most important thing was the decision of the municipality to invest in a 3D city model. The department of survey at the municipality started with several attempts to establish an automatically created city model out of their data sources. Even the "Digcity" project at Graz university of Technology started in the beginning with the intention to base our work on this 3D model and using our resources (mainly student's workforce) to refine this automatically created city model. But in the beginning all the attempts of the municipality failed and we found out that for our project it was even better to start with the basic data itself then to try to erase the mistakes of these early generated models. These experiences also forced the city of Graz to increase the quality of their basic data sets. Because of the facts that the old city of Graz is listed by the UNESCO as a World Heritage and will be Cultural Capital of Europe in 2003 there was the possibility for the city to spend some money on the project.

So now the city started to work together with the VRVis research center in Graz and Vienna, Austria, which is funded by an Austrian governmental research project called Kplus. (www.VRVis.at). In this project the intention is to use as many automatic or semi automatic procedures to create the city model as possible.

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The VRVis Model

Some of the methods used in the VRVis research project "Virtual Habitat" for their Graz model are indicated below (see also http://www.vrvis.at/ar2/city_model/city.html):

• Photorealistic 3D City Model

The project deals with the creation of a photorealistic 3D city model from existing 2 1/2 dimensional GIS data provided by the Municipality. The input data consists of roof lines, a 30m grid DEM (digital elevation model including break lines) and registered aerial images (for texturing) (figure 4).

Fig. 4 - Examples from the VRVIS Model (K Karner)

• Feature based Modeling of Facades

A system to extract 3D information from oriented digital facade images using various feature extraction/matching methods. The emphasize is on 2D feature extraction from digital images including contour chains, line segments and vanishing points. The extraction of 3D lines is based on line matching over multiple oriented views. The system is designed for the automatic extraction of 3D lines from facade images and is called MetropoGIS (see VRVis).

• Semi-automatic Georeferencing of Image Sequences

A system to augment a 3D block model of a real city with geo-referenced terrestrial images of the facades. The terrestrial images are taken by a hand-held digital consumer camera using short baselines. The relative orientation of the photographs is calculated automatically and fitted towards the 3D block model with minimized human input using vanishing points. The introduced city documentation system delivers a fully 3D geographic information data set.

• Multiresolution Textures

A method to automatically calculate texture maps for a given 3-dimensional object out of a sequence of images. This is an interesting aspect for the creation of the textures for a city model. Very often it is not possible to make photos of a building without elements in the foreground (e.g. persons, vehicles, vegetation) which block the view and have to be removed from the texture when it's used for the building (figure 5).
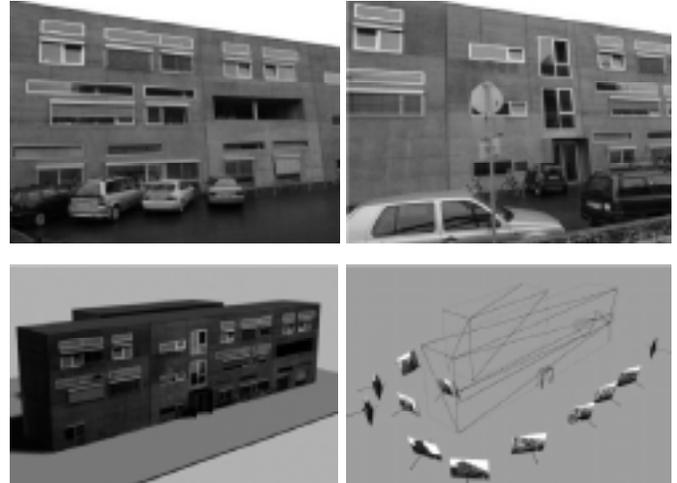

Fig. 5 - Examples from the VRVIS Model (Bauer)

The positive aspects of automatic generated models with digital photogrametrical methods are efficiency and speed. The most problematic part in the automatic creation of a 3D model is the (until now) limited possibility of segmentation and grouping of the generated model. This notion is an important part in the maintenance of the model – it is essential to be able to directly address certain parts of the model (e.g. a single building) to update the model.

This aspect is also very important for the possible interaction between our "Digcity" project and the VRVis city model. We are currently discussing with the Municipality of Graz the possibility to exchange certain objects in the oracle database with more refined versions when they are available. So in future time we plan to shift the focus of our project towards producing more sophisticated and detailed models to be used in the automatically generated model.

The "Digcity" Model

The **"Digcity"** project at Graz University of Technology has been presented in detail already in previous papers and presentations at conferences in this field (Dokonal et.al., 2000 and 2001). To bring back to your memory some of the aspects involved in this project a few catchwords of the project are listed here: (figure 6)

Main goals:

   • The creation of a 3-D City Model of Graz with the support of the students in the study fields of Architecture and Urban Design
   • The educational aspects involved in the work on the model
   • The idea is learning to use and understand all aspects of the city model - like spatial aspects, constructional details, reliability of sources - by being involved in the creation

Fig. 6 - Examples from the Graz "Digcity" model

Starting point of the project:
- The wish to create "sustainable" computer models of the city (sharing and reusing of work done at our university)
- Therefore bring "added value" for students (and teachers)
- Use the potential of mass university (no money but many students)
- Use the need for 3D-city models in architectural education (a lot of students design projects are situated in the city therefore there is a lot of interest in getting digital data)
- Bundle and coordinate all these needs and efforts

Principle project structure:
- The city model is based on models of individual buildings
- Every single building is a (autocad) drawing with a predefined layer structure
- Every source of information and every modification of the data sources has to be documented on a data sheet which is an essential component of the project

Main data sources:
- Photogrammetrical evaluation of aerial pictures
- Aerial pictures
- Terrestrial survey
- Site analysis
- Available detailed computer models of special buildings

Levels of detail (lod's):
- Girding surfaces of every individual building (lod 1)
- Additional information from aerial pictures (lod 2) (dormers of roofs, chimneys)
- Space defining elements of the facade (lod 3) (balcony, bays ...)
- Detailed computer models of special buildings (lod 4) (if available)

We are currently working on a web interface to download and compile our data files to make our basic data sets more easily available. This interface will be finished in November 2002. The next step in the project is depending on the development of the VRVis city model for the municipality - we will try to use the automatic generated model and refine it with detailed models from our database. This is "work in progress" right now and because of the above mentioned limited possibilities of segmentation and grouping in the automatic generated model we are still discussing this point.

References

Please use the Cumincad database (http://cumincad.scix.net) with the keyword: 3D City Modeling.

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