Focus for 3D city models should be on interoperability

not verisimilarity!

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FOCUS FOR 3D CITY MODELS SHOULD BE ON INTEROPERABILITY; NOT VERISIMILARITY!

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ABSTRACT

3D city models have become a very popular commodity for cities in general. The politicians and/or the administrative management have in the last few years been very active when it comes to investments in dimensionality, and the models come in many different forms and for many specific or non-specific purposes. The trend until now has shown that municipalities and developers in most cases have given high priority to the visual impact of these models. It has been more important for the cities to obtain a model that gave a high degree of verisimilarity in contrast to a model that had a high degree of interoperability. Verisimilarity would in this case mean a 3D model with close resemblance to reality and based on modelling principles from CAD and scenes from this, build with focus on photorealism. Interoperability would mean a 3D model that included semantics in form of an object model and an ontology that would make it useful for other purposes than visualisation. Time has come to try to change this trend and to convince the municipalities that interoperability and semantics are important issues for the future. It is important for them to see that 3D modelling, mapping and geographic information are subjects on the same agenda towards an integrated solution for an object-oriented mapping of multidimensional geographic objects in the urban environment. Many relevant subjects could be discussed regarding these matters, but in this paper we will narrow the discussion down to the ideas behind a development of a system called GRIFINOR, that can handle multidimensional geographic objects as Java-objects. GRIFINOR is a new platform for 3D geovisualization. The purpose of the GRIFINOR platform is to provide researchers and developers with an open source platform, a counterpart to proprietary developments in Geographical Exploration Systems. Centralized and proprietary Geographical Exploration Systems only give us their own perspective on the world. On the contrary, GRIFINOR is decentralized and available for everyone to use, empowering people to promote their own world vision.

3D CITY MODELS

Catching and registration

Today most of the geographic information that public administration and planning are based on, are registered as 2D plus z (height information as attribute value). This datamodel fits very well to the world of GIS and the standards of traditionally projected cartography. Although it is very common to measure spatial physical objects, such as fences, borders, buildings, roads etc. using new surveying technology, the mapping of these objects in a spatial database are still based on data models for simple features. Whether the coordinates are caught using GPS, laser-scanning or photogrammetry, it is normal procedure to strip the z coordinate because of the difficulties this will give in relation to the data-model of a standard GIS application. Normally the z will be saved as an attribute to the database. For interoperability purposes the best thing to do in relation to catching and registration would be to keep all three coordinates (x, y and z) in a neutral geocentric coordinate system and work with this data representation internally in the spatial data infrastructure (*Kolar, 2004*).

3D reconstruction

If a 3D city model were to be required on a local initiative, the normal procedure would be to take contact to companies that specialise in 3D reconstruction and city modelling. But because it is a very complex task to understand and communicate a 3D city model, it also very quickly becomes a complex task for the local administrators to define the demands for such a model, and in stead of thinking in terms of context and interoperability, they often become fascinated by the fact that the companies are able to present a very visually convincing solution to them. The issues that are discussed are typically linked to the traditional understanding of a mapping situation, where issues such as absolute geometric accuracy and completeness of the model would be important. But in a 3D reconstruction of a city model, the interesting discussions are not how close to reality you can get or the fidelity of the details in the model. The interesting subjects are topology, relative accuracy and interoperability of the model in relation to other information systems.

Most of the content in a 3D city model has to be reconstructed from various sources and by using various methods of 3D reconstruction. There are numerous ways to reconstruct a building, and the different combinations of these methods gives various and very different results in both a geometrically understanding and in data quality. One of the widely used methods for acquiring 3D geometrical context today is by using airborne laser scanners. The output from the scanning must be processed, ideally to reduce information to the lowest possible level of entropy. This process introduces removal of noise, intelligently adding missing information, and removing the huge amount of redundant information present in the surface scan. Still the only information that is available after this is a surface model that afterwards is tessellated in a useful resolution. After covering the facades with textures, it really is possible to create something that visually resembles the reality. But contextually and semantically this kind of city model do not satisfy the need for interoperability.

Verisimilarity

We introduce a new term that can express the degree of similarity that the 3D city model have to reality. The reason for this is the obvious hunt for photorealism that many developers of 3D city models have engaged in. We define verisimilarity as the ordinal quality of a visual representation appearing to be very similar to the truth or the reality. The term derives from the adjective verisimilar, and is also found in literature studies in the form of the noun verisimilitude. In literature, the term denotes the extent to which the characters and actions in a work of fiction exhibit realism or authenticity, or otherwise conform to our sense of reality. A work with a high degree of verisimilitude means that the work is very realistic and believable, that it is "true to life". In fact it has become a literary technique or plot device to assist a writer in presenting a work as actually true, which was important in times when it was taught that reading fiction was sinful (*Wikipedia, 2006*). The word verisimilarity comes from latin in the form of verisimilis, which is a combination of veri (genitive of verum) meaning truth and similis meaning similar or alike.

As suggested earlier in the paper, the use of a 3D city model is very context-dependent, which means that in some cases it will make perfect sense to give priority to verisimilarity over interoperability. These situations would happen if the 3D city model were to be used for simulation purposes and for pure visualisation purposes (*Bodum, 2005*). To illustrate this situation, a specific case will be introduced here. The municipality of Aalborg have been renovating the pavement and the design of the main traffic corridors within the centre of the city. To support the planning and renovation process and for visualisation purposes, the 3D city model of Aalborg were used as settings for a simulation of a future scene (see figure 1), where street interior, pavement, signals, cars, people were modelled with a high degree of verisimilarity. The simulation was produced as an off-line animation, where directional sounds etc. were put into the setup. This made it possible for the administration and the planners to show the direct consequences of a specific change in material of pavement or to evaluate the spatial situation when standing in the street. But the rendering of the scene was only made a single time, after which it was impossible to change much more than the position on the timeline of the produced video. In other words, the flexibility of the 3D city model disappears if verisimilarity is a goal in itself.

Interoperability

The future of 3D city models depends on the ability to adjust the data models behind them to a higher degree of interoperability. The term interoperability is used when someone wants to explain the ability of systems, units, or forces to provide services to and accept services from other systems, units or forces and to use the services so exchanged to enable them to operate effectively together. The degree of interoperability should be defined when referring to specific cases just as it was the case with verisimilarity. The first hurdle to pass when reaching for a higher degree of interoperability is to go from a traditional non-geographic CAD database, to a database that supports geospatial objects.

Figure 1: This picture is taken from the animation of a 3D city model of Aalborg where a high degree of verisimilarity was reached.

Spatial databases for 3D city models

The main part of the 3D city models of today is stored in either relational or object-relational DBMS'. This is due to the fact that these data models have proven very reliable in both conceptual and commercial solutions. New research has shown a great potential for a completely different strategy within the 3D city modelling. This strategy involves the use of object oriented DBMS, which can store both geometry and attributes in the same structure (*Stoter and Zlatanova, 2003*). By constructing and storing the objects in an object-oriented database, it gives new possibilities for visualisation of the information within the geographic objects. (*Bodum, Kjems et al., 2005*). But one thing is the storing of objects. Two other very important subjects for the 3D city models are the indexing and the different levels of detail that are necessary to work with for the objects. These mechanisms are the main attractions in the new system that is introduced in the last part of this paper.

GRIFINOR

The Centre for 3D GeoInformation at Aalborg University has launched a project called GRIFINOR to research the aspects in order to develop a system that implements the fundamental concepts of management and visual interface for the model-map. Grifin stands for Geographic Reference Interface for Internet Network. GRIFINOR is a platform technology including a navigator based and the name is derived from the Grifin acronym. The original intension was to gain ability to visualize geographic data, mainly cadastral and topographic data, which would be combined from different resources but its generally applicable potential for communication of information has been recognized soon after the project started in 2002.

The World Wide Web and GRIFINOR

GRIFINOR, like the World Wide Web (WWW), is a system with client-server architecture. The client's role is to provide users with a viewer and navigational capabilities. Servers provide storage and data management technology for the model-map. GRIFINOR can be presented as an analogy to a database driven web site running a content management system (CMS). CMS serves as a good example because it offers similar operational behaviour to GRIFINOR. CMS usually manage the content decomposed into atomic elements in a database. From these elements any web page provided by the system can be generated. The content elements can be edited (to a certain extent) independently from the rest of the data in the database. Edits can be performed literally at any time, also when the site is available online. Any change is instantly available on the network to web browser clients, meaning that the result of the service is distributable. All these features have analogies in the GRIFINOR system, even though the nature of the content is very different.

The content

The content of a website consists of documents, which are basically a collage of text and multimedia and reside in a hyperlinked graph space provided by WWW technology. While the graph space has no geometry associated with it GRIFINOR is tightly coupled with the three-dimensional space. GRIFINOR's content is data representing geometry (shape) and visual appearance (colour, gloss, texture and translucency) in the 3D space with Cartesian coordinate system corresponding to the system of coordinates used by GPS. Another distinct feature of GRIFINOR over the WWW is the existence of the "default content". Its definition refers to the real world in terms of geometry. Namely, the default content represents the geometry of static (Static here means invariable in geometry and position with respect to time, where tolerance to "the invariability" and limits to the "time" are left on consensus) tangible geographic features. Such features can be for example houses, street lamps, highways, bridges or individual trees. However cars, ships, people, animals, atmospheric features, borders, iso-lines or labels are considered as subjects to an application specific content. It should be stressed that the categorization of the features is also application specific, such as the information that a given geometrical figure is "a house", "a train station", has "an address" or what is "the number of people living in the house". The same accounts to a specification of relations within such ontological classification.

Object oriented design

In order to ease the development of applications design, the GRIFINOR system is fully object oriented. Therefore the GRIFINOR system should be seen as an extensible collection of individual units, rather then as a monolithic list of instructions to the computer. Each unit, or object, is capable of receiving messages, processing data, and sending messages to other objects. The same holds for the content itself, which are objects as well. Generally speaking the content consists of objects, which usually remain persisted in the database of objects on the server and when requested by the client they are sent over to be processed by other objects typically for sake of visualizing their content as geometry on a display.

An open source solution

Another purpose of the GRIFINOR project is to provide researchers and developers with an open source platform, a counterpart to proprietary developments in Geographical Exploration Systems. Centralized and proprietary Geographical Exploration Systems only give us their own perspective on the world. On the contrary, GRIFINOR is decentralized and available for everyone to use, empowering people to promote their own world vision.

Potential applications

GRIFINOR offers great potential to develop applications in many different domains, such as location based service portals, defence, intelligence, disaster management, real estate, media, gaming, environmental impact assessment etc (*Stoter, Sørensen et al., 2004*). For example, a real estate agency can show highly detailed models of houses and apartments, with price and loan possibilities. Clients can take a virtual tour of the neighbourhood. But the possibilities do not stop here: they could also use an application calculating and displaying the distance between the house and schools, movie theatres, shopping places, as well as the cost of driving from this house the client's workplace. The client could then look at urban planning projects in the area and make sure that no parking lot is planned to replace this beautiful park behind the house.

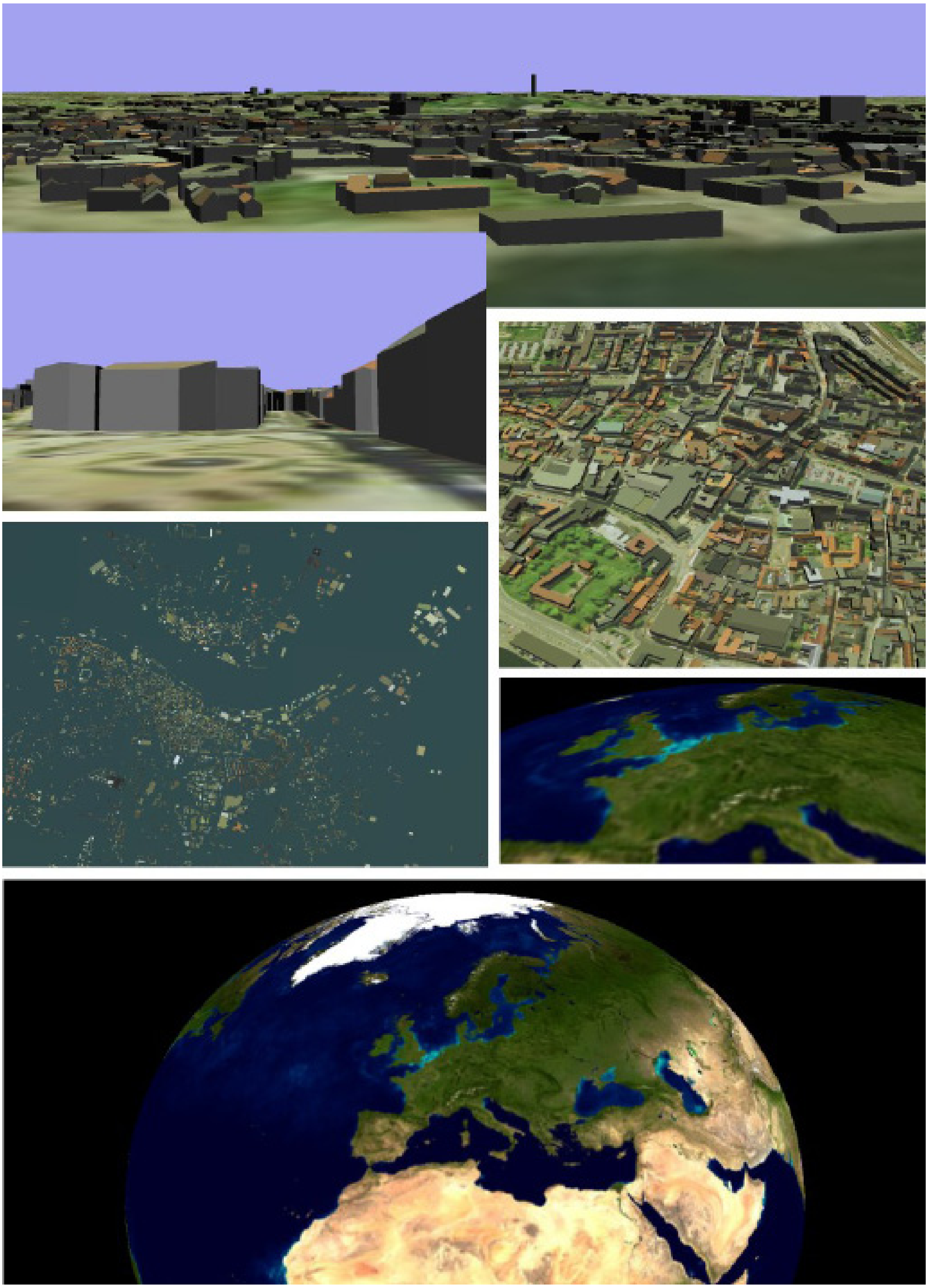

Figure 2: A mosaic of images from GRIFINOR platform.

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