VRML AS A TOOL FOR WEB-BASED, 3D, PHOTO-REALISTIC GIS

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ABSTRACT

As VRML (Virtual Reality Modeling Language) becomes more and more a common and accepted standard for visualizing vector graphics on the WWW (World Wide Web), the discussions on whether it has a realistic potential in utilizing geographical information are also often heard. There are serious efforts spent on developing the VRML to meet the specific needs of geographical information.

In this publication, an indoor 3D model is presented with the summary of the creation process and an analysis of VRML's potential as a tool for web-based, 3D, Photo-Realistic GIS is given based on the experiment and literature.

1 INTRODUCTION

1.1 The VRML

The VRML is an interpreted 3D modeling language introduced as a standard in 1993 and VRML97 a recognized standard (ISO/IEC14772) in 1997. The models created using this language require a VRML browser (such as; Cosmo Player, Corona, Live3D…) to be visualized. Most of the major CAD software include import/export functions from/to VRML file format (.wrl) for their 3D models in these days.

Although it has many performance limitations -mainly because it is an interpreted language- it has also many advantages: it is available nearly in all platforms, it has a wide audiance and it is cost-effective (Gahegan, 1999).

The GeoVRML Working Group under VRML Consortium is putting an effort to make the language more compatible for representing geo-referenced data.

1.2 Web-based GIS and Photogrammetry

There is a big demand for photo-realistic scene models so for the techniques relating to it from varying fields and it is no question everyone wants to have it available on a network. The on-line mapping and GIS (Geographical Information Systems) applications are now commonly available in varying qualities, mainly in 2D while photo-realism is more demanded in 3D applications, logically. Photogrammetric methods are used often for data collection for creating such 3D models, but equally needed when the phase for texture-mapping arrives.

In following chapters you will find a 3D model creation and it's conversion process to a VRML model.

2 REVERSE MODELING: THE 3D MODEL CREATION PHASE

First of all, the creation of a geometrically reliable 3-D model has its own aspects. In this study, close-range videogrammetry and "reverse modeling" (Haggrén et al., 1993-1996) techniques are used for modeling process. Then, the models are transferred to VRML models to increase the accessibility and publicity, which are important issues for a GIS.

Reverese Modeling. Instead of making the measurements and deal with the data afterwards- to make the model, one can make a visual-model (meaning no geometry considered) based on single video frames (no stereo images). Then make measurements on wireframe model as well as on the image, and "rectify" the model onto the image iteratively

from different viewpoints. This way, the correct geometry is determined and a more practical approach to make the 3-D models has been gained. The only data used is videography.

To supply coordinate reference, a common datum is determined, that its origin in this case is the corners of a room. All the objects in the room have their own coordinate system, relating the common datum. Only if a need occurs to relate this with a geographic coordinate system, then the geodetic control points become necessary.

Data and Implementation.

Data is collected using the Sony Camcorder TR-780-E Hi-8 CCD video camera, with autofocus and a fixed zoom in 5 second shots. Images are stored in 30-minute videotapes and grabbed by using IRSS (Interactive Resource Sharing System) which is an internal implementation of the institute.

The base software was Sense8's WorlToolkit and the C code developed on their libraries (Mattila, 1997). Images are transferred into .tga format to be able to process by World-Toolkit.
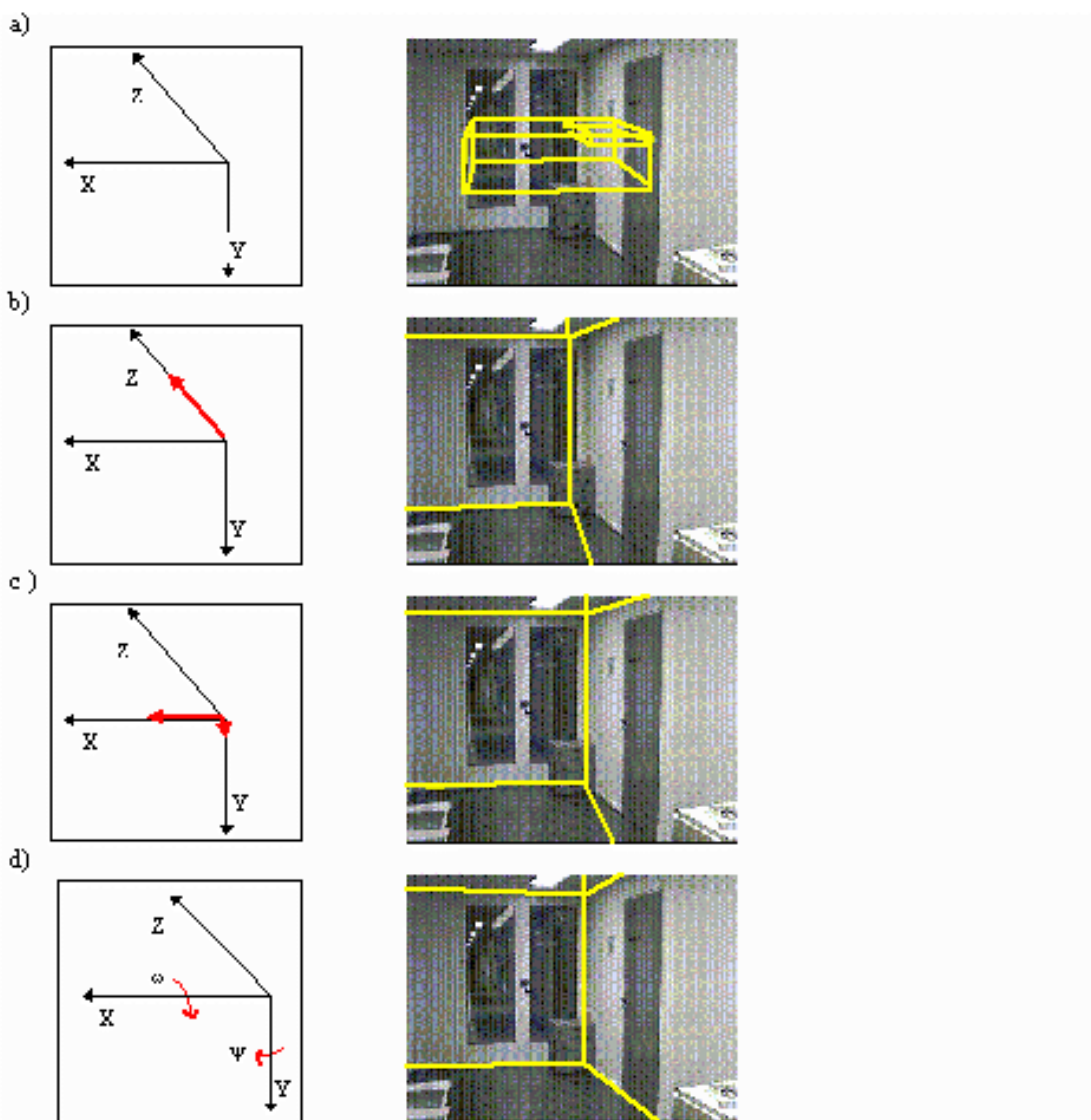

Figure 1. The graphical relative orientation of an image and the room model. The change of viewpoint is shown on the left and the results on the right: a) a video image presented as a background and the movable room model on it; b) the viewpoint of the model changed so that the scale corresponds the one of the image; c) the viewpoint of the model changed until the location in X and Z is the right one; d) the orientation specified by the ω- and ψ-rotations.

The image above is taken from Haggrén.

To continue the process the images are read from files into WorldToolkit, then a simple box is created; the size is visually adjusted to start with. Navigation of the wire frame model on 2 dimensional background to supply the visual matching is the main process to create the visual model. Then every object is symbolized with box-shaped wire frames. Most of the cases one object would have more than one box to be completed.

In this environment, rather hard to navigate, but concerning the time usage and complexity still more reasonable then measuring all the details, the images are processed to get the functional model. Note that the viewpoint of the model is moved, not the model itself. The idea in simplest words was to find the same viewpoint as the camera was standing. The complete model can be seen below:
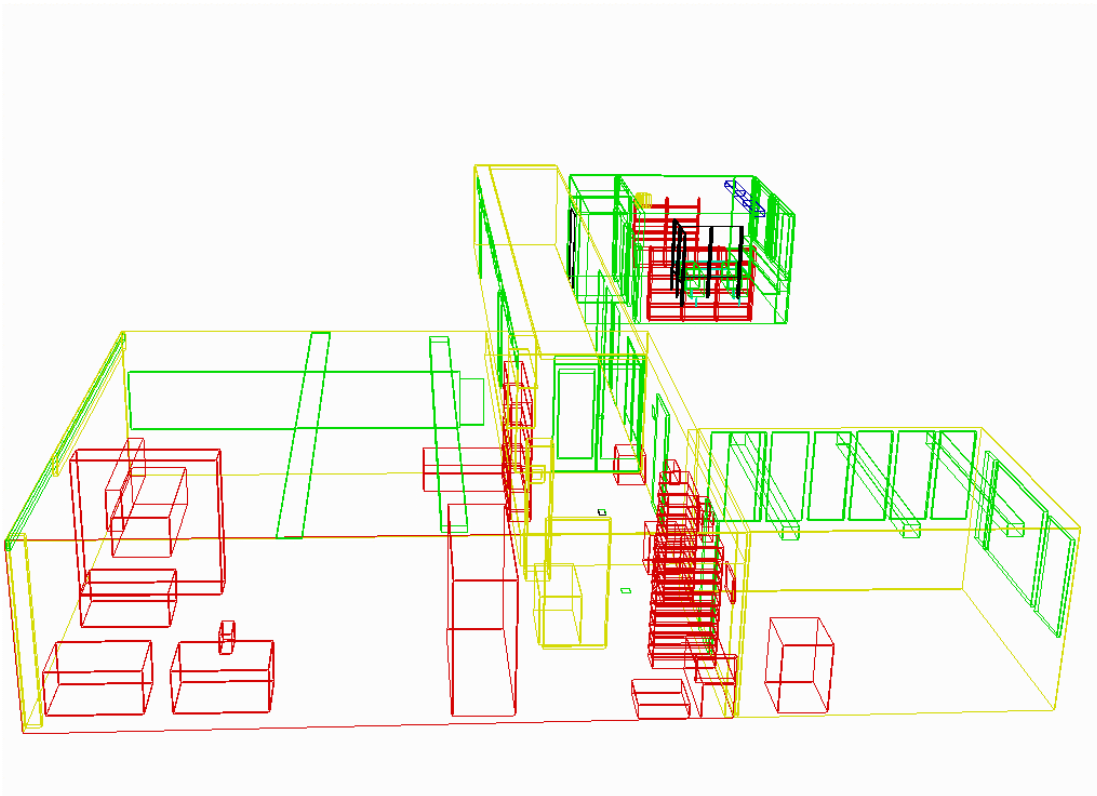
Figure 2. The completed model: 3rd Floor of the institute, notice the level of detail.

After completing the functionally correct model, control points on the image and corresponding points on the model are measured. These control points are used to "rectify" the model onto the image (photogrammetric bundle block adjustment). The process is repeated several times from several different viewpoints iteratively to get the best possible correction. This is needed because of using single images. Accuracy values f6r X,Y,Z coordinates ranged a maximum of s_z =0.62 cm and a minimum of s_y = 0.25 cm, please note the proportional accuracies.[Haggrén, Mattila]:

POINT	X	Y	Z	s_x	s_y	s_z
1	63.142	-1.402	-356.909	0.272305	0.272366	0.560964
2	48.588	49.585	-380.862	0.277134	0.257210	0.577030
3	8.123	2.494	-321.470	0.312742	0.280385	0.559316
4	-5.372	54.031	-345.401	0.319738	0.265001	0.572219
7	-22.543	-26.322	-351.431	0.341388	0.296909	0.612104
8	-34.312	22.658	-373.072	0.348206	0.273469	0.623333
21	38.595	-65.091	-369.311	0.288465	0.310697	0.600461
31	12.245	-54.912	-358.055	0.309054	0.309336	0.603973
35	-60.187	-51.852	-306.018	0.395445	0.325832	0.603796

Table 1. Model coordinates (X, Y, Z) and their accuracies (s_x, s_y, s_z) in centimeters.

3. CONVERTING AND EDITING THE VRML MODEL

This model is converted to a VRML model by using an automatic converter called CrossRoads. (This software is a freeware that can be found in WWW.) But the automatic converter changed the original coordinates using a self-defined origin, and this was not wanted. So all the coordinates are edited as point clouds as they were in nff files and only the headings are kept from the automatic conversion results.

Also some lightning effects, transparency, colors, anchor, camera positions, texture, links from the model (anchor points) and some other details are coded in VRML file manually.
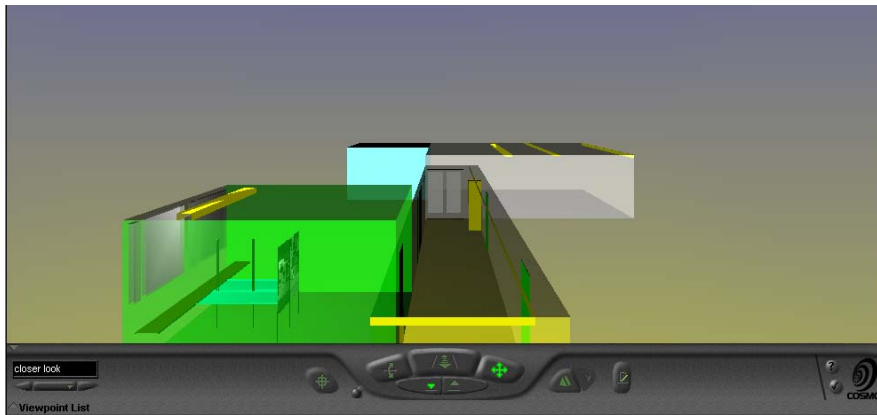

Figure 3. This camera position shows a little bit of bird's view. Attention to the lightening effect in lower left corner on one of the windows in the green room. As you can realize there is much less detail transferred into wrl format. The nff wireframe had more detail.
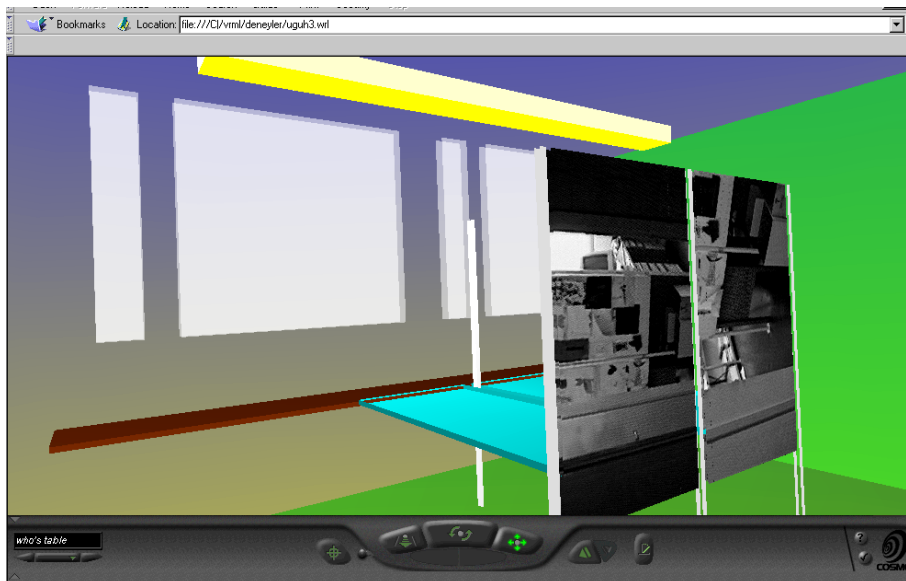

Figure 4. Photo-Realism: Sample textures are added on some objects on the model.

Texture mapping using real images in this context has yet many problems regarding view of angle, lights etc. although one can orient the images relative to the geometrically correct model (Çöltekin et al, 1999). The bandwith would also create problems in a heavily photo-realistic model using real photographs (Çöltekin et al 1997) although there are developments for handling this problems (e.g. using sensors to control the level of detail).

Linking Graphic Data to the Non-Graphic. There are several ways to make the model more accessible such as using objects with defined behaviour, or hot objects, or determining the levels of detail. In this case we have used the basic anchor point link from some of the objects. The links in our model carried the objects to the relevant non-graphic information and vica versa. The most primitive GIS function of querying graphic and non-graphic information from one another is provided already with this method

3   CONCLUSIONS

Although yet to be developed to meet the criteria in the field, VRML has something to offer for platform-independent, 3D and photo-realistic GIS implementations.

Future research still lies ahead for texture mapping and more interactivity to represent and be able to manipulate 3D data remotely.
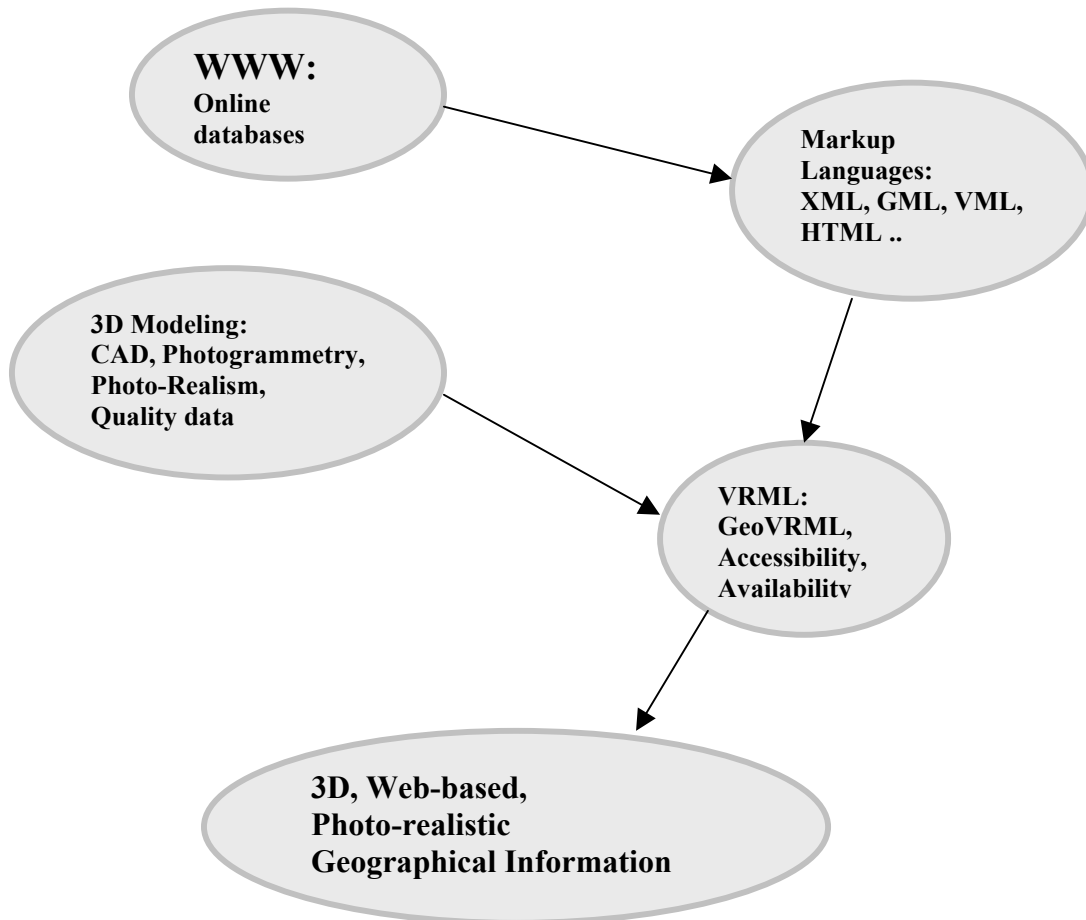
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RESOURCES

www.geovrml..org

http://www.vrml.org/

http://www.w3.org/

http://www.cosmosoftware.com/

http://www.austin.ibm.com/vrml/

http://www.meshmart.org/vrmlup.htm

http://kia.etel.ru/books/hic/ch52.htm

http://www.ummu.umich.edu/eng477/projectsf97/

http://www.planet9.com/indexnetscape.htm

http://www-vrl.engin.umich.edu/index.html

http://vrml.miningco.com/library/weekly/mpreviss.htm

http://home.hiwaay.net/~crispen/vrmlworks/process.html

http://www.ee.surrey.ac.uk/Personal/ee41rs/vrmlguide/index.html

http://www.ee.surrey.ac.uk/Personal/ee41rs/vrmltut/

http://vs.spiw.com/vs/downld1.html#CPC

http://www.dsl.whoi.edu/DSL/sayers/VRMLplot/

http://www.meshmart.org/vrmltool.htm#CONVERTERS