

IMPLEMENTATION OF WEB 3D TOOLS FOR CREATING INTERACTIVE WALKTHROUGH ENVIRONMENTS FROM BUILDING DOCUMENTATIONS

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ABSTRACT:

Web 3D tools provide software for building and viewing 3D world communities. Web content like text, images, movies and sound is integrated in those worlds as well as chat areas. Visitors can walk through the environment, talk and listen to others and are visible to others as avatars.

Since 1997 3D environments are published on the Web. Numerous software packages were released to the market. Lots of them escaped soon without reaching importance. Due to the proprietary formats and the limited bandwidth of the Internet connections most of them became failures.

VRML, virtual modelling language, was introduced to create and model virtual environments. This standard, defined by the Web 3D consortium, still plays a role. The future prospect as a subset of the upcoming X3D standard is the opportunity to discuss publishing of huge building models in walkthrough environments as VRML scene graphs.

1 WEB 3D TOOLS – STANDARDS AND PROPRIETARY FORMATS

Talking about open standards means applying interfaces like OpenGL, Direct 3D or Java 3D and using formats as XML, SVG, VRML, X3D or MPEG in applications accessed with standard software tools like viewers or browsers. Modelling in the above mentioned formats secures to a certain extend a future perspective. Companies try to promote their own proprietary formats by distributing software packages providing sophisticated modelling, faster access and advanced rendering.

The Web 3D consortium, <http://www.web3d.org>, defines the standards VRML and X3D. VRML didn't succeed as a wide spreading application. It filled a niche and is used usually for offline applications. VRML browser doesn't provide the high quality rendering like other real time 3D engines. But the power of VRML / X3D is higher than sometimes shown on the Web. Visiting ParallelGraphic's Web site documents the potential of VRML. With the Cortona browser and world building tools like Internet Space Builder the company provides application software that can be highly recommended for visualization of building recordings.

The future of VRML lies in X3D where it is implemented as a subset. The X3D Graphics Working Group is designing and implementing the next-generation extensible 3D (X3D) Graphics specification. The geometry and behaviour capabilities of VRML will be extended by using extensible mark-up language (XML). Unfortunately companies escaped from further development of their VRML browsers. Sony cancelled the Community Place development end of 2001. The status of the popular Blaxxun browser is unknown at the time of this writing.

Macromedia introduced Flash and started 2002 with Shockwave 3D. A sample can be viewed from the Internet at www.concordebusinesspark.at. It seems to be obvious that Flash and Shockwave and Apple's Quick Time VR be the most used software applications for 3D animations on the Web. The concept of the company RealViz and its image creation based software tools is based on Macromedia's technology; www.realviz.com presents a couple of applications. Another site highly recommended to visit is www.museumsinsel-berlin.de. This site demonstrates Web distribution of architectural objects in a professional manner.

Adobe unveiled Atmosphere in March 2001. The Atmosphere builder is still available as a free beta-version download. The final release of Atmosphere 1.0 will be announced soon. The community of Atmosphere enthusiasts is rapidly growing. Tools and third party modelling software (Caligary for Atmosphere and others) can be downloaded from the Web. Atmosphere takes extensive usage of the JavaScript API. Attached JavaScript files make objects move, add sound and fog and more.

All the above-mentioned software supports geometric modelling and import or conversion of third party file formats like DXF, or 3DS. Therefore this paper focuses not on geometric modelling, data import, integration and structuring of large data sets is the topic. Another important aspect for successful publishing is supporting the visitor's navigation. The viewers for navigating in virtual reality worlds allow different viewing modes. One can walk through a scene, fly over a scene or inspect the scene by rotation and zooming. If a visitor has lost his /hers orientation, he/she must be guided to well defined positions. Moving objects sometimes carry a camera. These bindings allow animations that are calculated on-line.

2 VRML – DATA STRUCTURE, SCENE GRAPH AND BROWSERS

The VRML format is based on SGI's OpenInventor format. It is a platform independent format, supported by most common 3D packages. It includes graphic, text, multimedia elements, network and scripting facilities.

A VRML file contains objects named nodes. A node exists of fields and parameters. The total 54 nodes can be grouped in geometric primitives, grouping nodes, light sources, appearance nodes, sound, definitions and prototypes, sensors and scripting nodes. The file is coded in UTF8.

VRML enables linking to other Web resources and contains facilities for interaction and animation. Scripting based on Java or JavaScript is possible. With the external authoring interface is a connection between VRML and the scripting language available. Like most of the data formats today, a VRML world is defined as a hierarchical scene graph. A scene consists of grouping nodes. Shapes are the components of groups. A shape consists of geometry (primitives, indexed face sets) and appearance (material, image texture).

A good sample for explanation of a scene graph comes from the ISB manual. Imagine you are creating a Galaxy (scene) with the Sun (object) and the planets (sub-objects) around. Among the planets is the Earth with your house. Inside the house is a table. When you move the Sun to a different position, you expect moving all objects too. When you move the table in your house, nothing else should be changed.

A couple of browsers for interactive viewing and navigating through VRML worlds is available from the Intern Cosmo Player as a well known VRML browser is now owned by Nexternet, www.nexternet.org. The company published a new version under the brand Pivoron Player. Cortona VRML client from ParallelGraphics provides some extensions to the standard and a programming interface to access complex applications. Both browsers will support X3D in future.

If one likes to visit the old city of Xanthi, a sample for texture mapping and background modelling can be viewed under <http://www.67100.gr>. This scene takes extended use of texture mapping and displays an interesting solution for background and navigation support.

3 MODELLING A VRML SCENE

The process of modelling a VRML scene can be divided into four independent steps:

- Geometric modelling
- Rendering and animation
- Conversion
- VRML authoring

Due to the complexity of an architectural object it is recommended to use a high level CAD software like AutoCAD or other architectural software packages supplying solid modelling for geometric description. A NURBS-modeller as RHINO represents it extends the modelling facilities and enables precise description of curved surfaces and objects. Further processing of rendering and animation can be performed with plug-ins, AccuRender third party software from McNeel integrated into

AutoCAD, or stand-alone software like 3D Studio. All of the above mentioned software applications are equipped with interfaces for data interchange without any loss of information.

AccuRender, RHINO and 3D Studio provide conversion utilities to VRML. 3D Studio includes a bunch of VRML authoring functions. Despite this extension the AccuRender conversion function seems to be a practical solution. Another aspect is the transformation between the orientation of the co-ordinate system for construction and VRML viewing. Defining materials in AccuRender as solid colours shows a one by one result after conversion to the VRML format. Problems occurring by co-ordinate transformations due to model separations are unknown. Named AutoCAD views will be translated to viewpoint information to support navigation exploring the VRML file in a browser.

Figure 1 illustrates as an example the modelling of Church Alexander Newski in Vologda, Russia. The main geometry of the building is named as level of detail 0; other decorating elements are stored under level of detail 1. Finally windows, doors, the bells, railings, lanterns and other elements complete the model description to a high level of detail, resulting in a ten times higher file size as the low level of detail definition. Structuring a model in sub models like the example presented here, enables high performance rendering as well as using the complete data set or part of it for VRML files transferring to the Web.

Some VRML authoring like camera settings, light definitions, adding background or defining sensors and routing for interaction and animation is in most of the applications unavoidably. A short introduction into the authoring tools provided by ParallelGraphics follows in the next chapter.



Figure 1: Structured VRML model. Top left: LOD 0, top mid-right: supplement to LOD 1, down left: supplement to LOD 2, down right: complete model containing all three sub-structures.

The weight of the separate VRML-Files is shown in the following table. The file size in uncompressed and compressed mode, the number of faces and an estimated transfer time using a 56.6 Kbytes modem can be detected from the table.

For building presentations additional environment objects like sky, sun, ground planes people etc. should be applied carefully.

File name	File size compressed Mbytes	File size uncompressed Mbytes	Number of faces	Transfer time in seconds
LOD 0	0,1	0,5	17 996	14
LOD 1	0,3	1,9	60 324	37
LOD 2	1,0	3,9	186 536	120

Table 1: Comparing the file size of different levels of detail

4 VRML-AUTHORING – USING TOOLS FROM PARALLELGRAPHICS

4.1 ISB – Internet Space Builder

World builder tools are 3D authoring programs for creating complete 3D scenes. Internet Space Builder from ParallelGraphics includes powerful geometric modelling, texture mapping, camera settings and others under a comfortable user interface.

Creating and editing scenes and objects is supported by 3D Boolean operations over a broader range of 3D primitives such as spheres, pyramids, cones and cylinders. Capability of creating a shape using a smooth curve is given. Structuring the scene graph benefits from importing 3DS files (3D Studio) and DXF files (AutoCAD). In the context of ISB imported files can be objects or a complete scene. Objects can be collected in libraries or galleries for multiple use and easier editing.

Advanced interactive texture mapping and editing, setting material transparency and colour and the ability to draw directly on textures with immediate display of all changes in the 3D space features enable conveniently working. Editing operations are directly displayed in the perspective view window. Advanced setting of additional cameras enables easy navigation through the scene by selecting a camera from the viewpoint list in the browser. Output and input is VRML 2.0 compliance and possible in compressed (gzip) and non-compressed format.

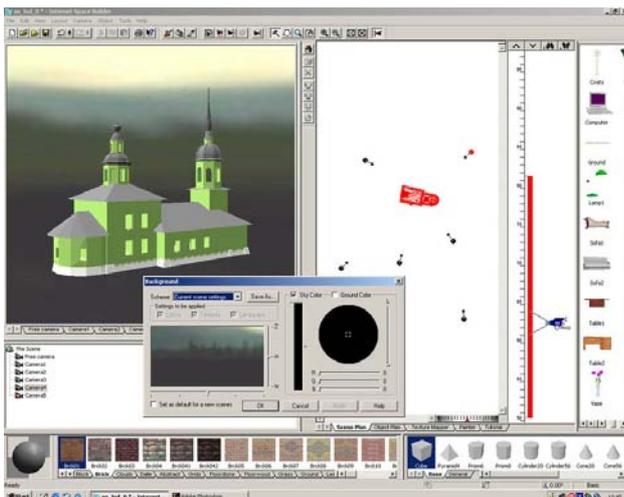


Figure 2: Screenshot from ISB. Showing the perspective view, a plan view of the scene, vertical camera setting support, access to objects, scene structure, texture maps and the shape window.

The top window, s. figure 2, displays a tool for background settings. Defining the attributes of a background-node is supported by a colour picker or selecting a background image from a list of predefined landscapes.

Texture mapping and editing is very comfortable. With drag and drop from the galleries textures are attached to surfaces in the perspective view. The texture mapper provides editing functions for size and orientation.

4.1 VRML-Pad

VrmlPad is another powerful and flexible authoring tool from ParallelGraphics that allows text editing of VRML files.

Construction of advanced 3D worlds requires scripting and interfacing of user external applications. The advanced user has to code the VRML content using a text-editor. VRML-Pad provides dynamic error detecting, view and enumerate syntax and wide range of semantic errors and warnings: undefined identifiers, non-matched fields, duplicated node definitions and more.

With the document Tabs switching between multiple opened documents is easy. The scene tree allows editing and navigation through the hierarchical scene structure. Operations like: delete, comment and rename nodes, PROTOs and field declarations, view and edit scene routes. Synchronize selection in both directions. Delete, comment and add new routes using Start Route and Add Route commands are supported. Finally the VRML script debugger locates bugs in your VRML code.

For more sophisticated applications, ParallelGraphics delivers a software developer kit. Further information about the tools mentioned here and Web applications can be found on the Web site www.parallelgraphics.com.

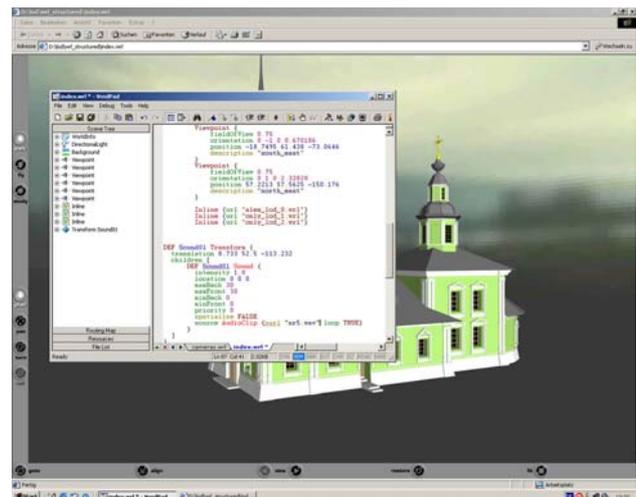


Figure 3: VRML-Pad displaying content of the file index.wrl, the initial call for displaying the database. Containing viewpoints, background, sound-node and the inline-nodes with the geometric description of the 3D objects.

This file contains within the inline node the references to the geometry. Further statements define camera settings, navigation information and environment. A sound node plays some music if the visitor moves inside the Church.

5 ACCESSING A VRML DATABASE FROM THE WEB

There are several possibilities to optimise a VRML database for Web publishing. As announced in the previous chapter, structuring a 3D World in separate scene graphs and applying different levels of detail is a condition. For optimising data transfer and navigation, a scene graph should be well structured. Elements repeated in the scene should be defined once and referenced multiple times. Texture mapping should be applied carefully. The geometry in the following example, s. figure 4, consist of 83 750 faces. The model is simply converted accepting the loss of structure in this case it is an example that has to be improved.

5.1 Implementing of Anchors

VRML-files are usually accessed from Web sites embedded in HTML pages. The HTML page shown in figure 4 displays some text about “Simeonsplatz” and provides the user with a guide how to navigate through the model. A low detailed model of the area can be easily explored. In this particular case, for a quick impression what kinds of objects are presented, texture mapping can be an alternative instead of colour presentation. Geometric description is limited to a few faces, textures are very small, and texture mapping does not require too much computing power. According to a Web site that starts with index.html the main VRML file is named index. wrl and takes use of the inline-node. The inline-node is a grouping node that reads its children data from a location referenced in the url-field. The information targeted to, is embedded in an anchor node, marked here with bold characters:

```
#VRML V2.0 utf8
WorldInfo {
  info [ "Example for embedding shapes and ge
    geometry into an Anchor"
  ]
}
Group {
  children[
    Anchor {
      url " defension
        skaserne/defensionskaserne.wrl"
      parameter ["target=-new"]
      description "... your way to
        Defensionkaserne"
      children [ # description of shapes
        Shape {
          appearance Appearance {
          }
          geometry IndexedFaceSet {
          }
        } # end Shape
      ] # end children geometry
    } # end Anchor
  ] # end Group children
} # end Group
```

An anchor defines the embedded shapes as a link to the object with a higher level of detail supplying the appropriate parameters. If the pointing device touches the geometry in the browser window, the message “... your way to Defensionskaserne” is display. A click loads the referenced file into a window targeted as -new.

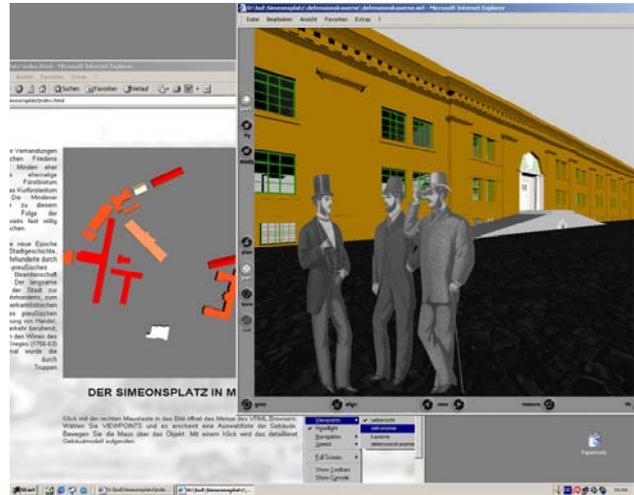


Figure 4: User interface for Web access to the VRML database of an urban area. A low level detailed structure is embedded in anchors. Navigation through this model enables linking of detailed models in new browser windows or frames.

The detailed model contains the low level structure as well. Walkthrough and linking from object to object can easily performed.

5.2 LOD – Level of Detail

From the viewpoint of a reduced rendering time, it is important to cull out objects that are far enough away from the navigator. It is unnecessary to render those objects in detail. The LOD node specifies various levels of detail or complexity for an object and provides hints for browsers to choose the appropriate version of the object automatically based on the distance from the visitor.

In the following code example are three versions of the object referenced. Dependent from the spatial distance of the navigator, a different model is displayed. The distances are noted in the field range. The level field contains a list of inline nods or empty WorldInfo information from the lowest to the highest level. The nearest position contains a low level model because a navigation inside should be enabled in this case. It is often useful to add an empty WorldInfo as the first or last level. Nothing is displayed if the user is very far or near to that object. A code sample looks as followed:

```

LOD {
  range [10, 75.0, 100.0, 125.0, 200.0]
  level [
    Transform { translation 0 0 0 children
      Inline {url "alex_lod_0.wrl"}
    }
    Transform { translation 0 0 0 children
      Inline {url "alex_lod_2.wrl"}
    }
    Transform {translation 0 0 0 children
      Inline {url "alex_lod_1.wrl"}
    }
    Transform { translation 0 0 0 children
      Inline {url "alex_lod_0.wrl"}
    }
    WorldInfo{} # empty
  ]
}

```

6 Conclusion

Designing walkthrough environments with VRML is despite the limitations of the rendering quality of existing browsers an opportunity due to the open standard.

The object has to be modelled for multipurpose use from Web access with limited bandwidth to real time VR in immersive environments. Not only the graphical presentation is important for a high quality presentation. Additional content for object description and further information has to be added by linking to different sources.

There are a lot of alternatives for accessing the database existing. Level of detail LOD, referencing external files with the inline node, defining anchors, using hot spots in image maps and the panorama technology are some of them.

A not unimportant aspect for quality is the ease of navigation and the environment for presentation. Modelling of buildings, urban areas and landscape covers very large areas. Displaying them with a few pixels on a small screen is not sufficient.

Linking multiple graphic frames together and extending the display size using data projectors results much more in a realistic impression as the try to reach photo-realism.

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