THE USE OF THE VIRTUAL REALITY MODELLING LANGUAGE FOR VISUALIZATION OF 3-D ELECTROMAGNETIC FIELD COMPUTATION RESULTS

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Abstract

Research groups working in the domain of electromagnetic field computation are mainly not working on the algorithms for the visualisation of complex geometries in 3D. However, it is necessary to have a graphical representation of computational results. Among the general needs are the visualisation of solid models, meshes and field values. In this paper, a platform independent visualisation tool is introduced which is suitable for studying 3D finite element models.

INTRODUCTION

The Virtual Reality Modelling Language (VRML) is a general 3D visualisation language which was originally meant for interactive simulation applications on the Internet [1]. It allows the creation of 3D static worlds with hyperlinks to and from other pages. The language has been selected for 3D visualisation on the Internet from a large group of candidate languages. It is based on the Open Inventor File Format from Silicon Graphics Inc.

VRML is widespread used and becomes more and more a standard language within the World Wide Web. Pro/ENGINEER, a leading CAD program, already includes a VRML exporting possibility for their models. Recent upgrades of the language include interactivity and definition of predefined behaviours [2].

Because of its platform-independence and its ASCII-format, the language is interesting for the visualisation of scientific results. Fig. 1 shows a multicolour example of the magnetic field distribution in a saturated iron core. VRML-models can be incorporated in WWW-pages, sent by e-mail or edited by hand.

THE VRML LANGUAGE

Stated generally, VRML defines a set of objects useful for the construction of 3D graphics. These objects include geometric primitives like tubes and spheres but also transformations, light sources, colour and reflection properties.

The language can be used to view both finite element models, meshes and computed results. To view models, some elementary rendering techniques are included which allow a more realistic appearance of the model. Different light sources (directional light, spot light) exist. In some VRML viewers, the ambient light can be modified during viewing. The colour of the objects can be specified with values...
VRML-viewers are available as stand alone programs e.g. on HP workstations or as an internet-browser plugin (Cosmo Player is very popular). Since most operating systems allow multi-tasking, the combined use of the field computation software with the VRML-viewer is possible.

Since the VRML file format is very compact, it takes very little computational effort to create a VRML-file even for complex models. The ASCII file format enables to program interfacing routines by using standard programming languages. Once the file has been loaded into the viewer, the graphic can be rotated, translated and zoomed in and out by means of simple mouse clicks. No user command line input is necessary.

**DISCUSSION**

A general discussion of advantages and shortcomings of using VRML in a field computation software environment is given in the following section.

The language specification and the viewers are cost-free. Both can be downloaded from the Internet. Since the language is intended for use within an Internet browser, it is inherently platform independent. It can be used on both powerful workstations and standard PC’s. Positioning of the model and changing the viewpoint happens by means of mouse clicks. These actions are performed in real-time at high frame refresh rates. One of the reasons for this is that advanced rendering techniques have been omitted in order to be able to using the tool on regular PC’s. No user commands have to be typed in Fig. 2 shows an example of a simple inductor model with a two-layer winding. The model for the iron core is generated by means of an extrusion based mesh generator. This feature is illustrated by the visualisation of the planes necessary for the extrusion process.

**RATION IN A FIELD COMPUTATION PROGRAM**

View a model, a mesh or a colour shaded plot of computed field values, a VRML-file (.wrl) has to be created. To view the results, the file has to be loaded into the VRML-viewer.
becoming a world wide standard for viewing 3D objects, it can be used for the exchange of
results between co-operating research groups. VRML models can easily be read in a WWW-page. Because the file is in ASCII-format, it is possible to convert the files
different platforms. Because the language is general, the user/programmer is free to include
t axes, select which parts of the model are to be viewed and which not.

file is in ASCII-format, different parts of 3D images can be joined by means of a simple
Paste operation on two text files. In Fig. 3 the example shows an image which was
joining a high-voltage tower model with a slice of the electric field distribution at the
vel. The tower model was obtained from the mesh generation while the electric field
represents the field solution of the 3D finite element model.

Fig. 3: View of the electric field distribution at ground level below a 150 kV high-voltage line.

Obvious shortcoming is the fact that for every 3D image, a new file has to be created. If
properties have to be added or changed in the graphic (e.g. changing the background colour),
it is to be edited manually. The previous discussion can now be summarized by listing the
advantages and disadvantages of the proposed 3D-viewer for FEM applications:

\[ \text{Advantages:} \]
- Independent
- Standard language
- ASCII file format
- Decentralization and transformation of the model

\[ \text{Disadvantages:} \]
- For each graphic is necessary.

Though VRML is widely accepted as the standard for visualising 3D environments, competition is
coming from Java3D. Java3D has a lot of advantages in common with VRML: cost-free, platform
independent, etc. Java3D will include VRML file loaders, but 3D objects created by a Java applet are
not necessarily stored in a file. However, VRML is certainly easier to learn. Java3D is an API which
means that it can be part of a complete application package in Java. Java3D is therefore more
powerful but it requires better programming skills than VRML interfacing. However, Java3D cannot
be easily incorporated into existing source code. The standard for Java3D has been set by SUN
Microsystems.

CONCLUSION

In this paper, the Virtual Reality Modelling Language (VRML) is introduced. This is a visualisation
language originally meant for viewing 3D models on the Internet. Here, several aspects of using this
language within a field computation software package independent of the Internet are discussed. The
language together with an appropriate viewer can be used as a 3D postprocessor tool for Finite Element
models. Writing interfaces for VRML only requires basic programming skills.

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