

3D Virtual Labs for Internet Application

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Abstract—This article covers a rather innovative and powerful technology that enables the creation of a 3D interactive laboratory for WEB applications based on open standard VRML format for 3D multimedia and the subsequent distribution of this virtual laboratory on the Internet. The project develops an environment, called "interactive technology of a 3D Internet Laboratory" to create various types of 3D laboratory experiments as well as their application via the Internet. The application produced is the creation of a 3D virtual laboratory for measurements and instrumentation. The description of the laboratory, fonts and data are also provided. The various steps for creating a 3D virtual laboratory are presented. Lastly, the application of the "interactive technology laboratory 3D" is displayed and can be considered as a step forward in the development of innovative technologies for distance learning.

Keywords—3D lab, internet; interactive application; new technology

I. INTRODUCTION

The visualization and manipulation of practical work in a laboratory allow students to obtain higher capacities to acquire additional skills. On the other hand, they can not only carry out practical experiments, but have the opportunity to manage, add, and extract information with some simplicity. Generally students have at their disposal laboratories that are limited to the analysis of processes, relationships, and behavior of real experiments. Recent hardware and software technologies, which showed encouraging results in relation to storage and maintenance of large amounts of data, motivated us to develop a virtual laboratory for measurements and instrumentation that can play a predominant role.

Today 3D environments are becoming increasingly sought by users of the most diverse fields of science, knowledge and communications. Moreover, the Internet application with interactive possibilities for user manipulation is created and all steps are proposed.

The created 3D maps for WEB application are based on VRML format – open standard for 3D multimedia and distribution of virtual world over the Internet. After the First International Conference on the WWW (World Wide Web) in Geneva 1994, Silicon Graphics Inc. developed a specification based on Open Inventor ASCII format. The VRML 1.0 was started in 1995 and a specific group proposed possibilities for animation, sound and greater interactivity. These applications were already included in VRML 2.0 in 1996. From this time

on, a formally constituted consortium has been responsible for the development of VRML, or the well known Web3D Consortium [1].

One way of using interactive 3D laboratory applications is achieved through the use of the Internet. For this purpose, images from several models of laboratory objects are constructed in the environment of 3Ds Max. 3Ds Max (formerly known as 3D Studio Max) is a 3D modeling program that enables rendering images and animations. The models of laboratory objects could be constructed in any other 3D authoring tool that can be exported to X3D or VRML as: Autodesk Maya, Blender, Cinema 4D, LightWave 3D, SketchUp and others.

With 3Ds Max, shapes with polygons or with parametric surfaces (NURBS surfaces, Patch ...) can be created. It is necessary to use parametric geometry to convert the templates into mesh before exporting, because most 3D Web solutions can only handle polygon surfaces.

Several parameters influence the 3D performances. In order to estimate the size of the polygon to the 3D scene, the main parameters are: the number of polygons, textures (resolution, Alpha) and the size of the presentation (width x height in pixels). A 3D scene with many objects will slow the frame rate (it is the measure of the frequency at which a device image processing consecutive images produces, designated by frames).

II. DIFFERENT KIND OF MODELS FOR A 3D VIRTUAL LAB

A. Object description

The term authoring systems is used to refer to a computer-based system that lets a generic group of non-programmers create (i.e. author) contents for intelligent tutoring systems. Although some intelligent tutoring systems have been created successfully, they are very expensive to build.

In the development of educational software, an authoring system is a program that allows a non-programmer to easily create software with some programming features. These programming features are constructed but hidden behind buttons and other tools, so, the author does not need to know how to program. Typically the authoring systems offer many graphics, interaction, and other tools needed for educational software.

With the visual interface it can be relatively easy to add all kinds of advanced functionality and interactivity to presentations, even without any prior programming skills or script.

B. 3D models

Nowadays, the majority of educational institutions try to create 3D models of laboratory environments. These 3D models give the possibility to students to understand and acquire knowledge of real-world experiences [2].

In this case of virtual lab, the aims are to build a 3D laboratory environment (measures and Instrumentation) in which the components can be viewed and manipulated. The aim is to build simple mounts/electrical schematics that later can be changed in their values, thus showing new results.

The idea is to create a three-dimensional model (3Ds Max, Maya, Cinema 4 D, LightWave, SketchUp, Blender or any other 3D tool) and then export to WireFusion®, a program used to create interactive presentations targeted to the Web, using those 3D models [3]. In this program there is the possibility to add some interactivity and/or animations. However, all animations must be constructed beforehand in the source of the 3D model [4]. The Project for the creation of a 3D lab is presented here. To achieve this objective models constructed in 3Ds Max were used. They have enough high resolution and accuracy for practical needs. In the proposed project the processing of the images, before being transformed into 3D modeling, is done in 3Ds Max.

The different types of objects are separated in different layers, and thus they can easily be imported later in the 3D modeling program and can be easily manipulated.

III. STEPS IN THE MODELLING OF A 3D VIRTUAL LAB UNITS

A. A 3D virtual lab

In general it was felt that, the development cycle of presentations can be carried out in three phases:

- The first phase is to create all the resources that will be needed: 3D models, images, movies, sound, etc., that can be created in other programs, such as Autodesk® 3dsMax®, Adobe Photoshop, CINEMA 4 d® R11 .5, or similar.
- The second phase is to import these capabilities to a program used to create interactive presentations targeted to the Web and, through visual means, develop presentations. In our case we used the Wirefusion®. WireFusion® is a powerful technology that allows the quick creation of interactive 3D presentations for the internet. WireFusion is typically used by designers, programmers, architects, creating 3D configurations, visualizing product design and architectural design. WireFusion presentations are also used for e-learning or computer based training (CBT), training sales forces, support teams and for customer support.

- The third and final phase is to introduce the presentations on the Web or as offline presentations.

WireFusion is a visual programming tool "drag-and-drop" developed to create advanced interactive 3D visualizations for the Web or as stand-alone presentations offline, even without any prior programming or scripting skills. It has a visual interface that can easily add advanced functionality and interactivity to presentations under development [5].

A 3D virtual lab could be characterized as a highly realistic three dimensional computer virtual representation of the laboratory. The represented objects and phenomena are classified, designed and visualized according to the specific purpose. The concrete contents of the 3D lab are designed after the definition of objects and phenomena that will be included.

B. 3D Virtual Lab for interactive Internet application

Creating a 3D Virtual laboratory for Wirefusion involves the use of VRML files, files that require 3D model rendered in 3DS Max.



Figure 1. Construction of the digital model of the multimeter

C. Modeling of different objects for the 3D virtual lab

More detailed objects contain more points and polylines or more graphic information, which the VRML file is going to transfer to the software for the conception of an interactive Internet application. A high detail level may mean that the initial file will have higher memory and its manipulation and uploading to the WEB will consume a lot of time and take large hardware resources.

The choice of all the textures, animations and lights needed must be produced while working in 3DS Max. That information is recorded in the VRML file and is transferred to the WireFusion program. An object without a texture or an animation in 3DS Max cannot be textured or animated in WireFusion. If the object is textured and uses some kind of animation before exporting, it will be easier to change or manipulate later on. After finishing the work on the model in 3DS Max, the scene is exported in VRL (VRML) file format.

IV. WORK WITH WIREFUSION

The Demicon WireFusion software for importing, processing and visualization of 3D models on the Web was used. The WireFusion is the software that allows the creation of interactive 3D Web presentations. It starts by loading a 3D model, configuring/optimizing it and adding widgets (component of a graphical user interface (GUI), which includes Windows, buttons, menus, icons, scroll bars, etc.) and logic for the presentation. The 3D model is created in a 3D modeling software such as 3DS Max, Maya or any other software that can export to X3D or VRML 3D modeling.

The results are presentations that can run in browsers supporting Java 1.1+ [4].

The work of the 3D scene requires adjustments on how to move and react to user commands. Each object can be edited and inserted separately. Each object can be turned on or off or be characterized as "Touchsensor" (Figure 2).

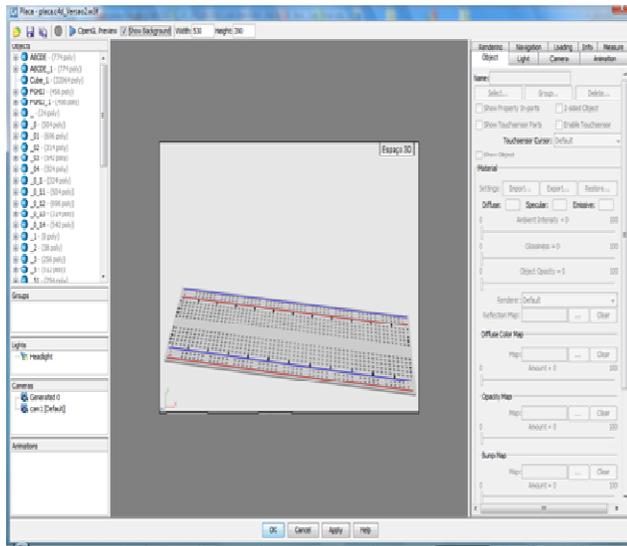


Figure 2. 3D model of a 3D scene in WireFusion

The compression level of the object will determine how the display of their representation should be detailed. If it has a high value definition, all details of the objects will be visible, but this will increase the file memory required. If it has a low value, the objects are shown widespread. The minor polygons involved in its construction do not appear. The object may lose some graphic information, but the advantage is that the file size is extremely low.

After completing the 3D scene a number of components and controllers can be added, so that the user can do all actions and movements that he/she wants. Objects such as buttons, media, functions and commands can also be added to the scene to establish connections and links between the different components.

A. Creating logical links between the different components

WireFusion works with functions and pre-programmed operations [4]. This set is designated as WireFusion objects or just objects. The use and re-use already made and tested will be

able to ensure presentations and small and fairly robust operations. The idea of programming in WireFusion is very similar to more conventional programming techniques. The data or information such as strings, numbers, colors, images, etc., is passed from one function to another. However, the difference in relation to the so-called conventional techniques is that WireFusion accomplishes it by joining objects purely by visual means. When new objects become available, they can be easily installed and used in the WireFusion project [6]. Each object has "out-ports" and "in-ports" and that way it is possible to perform the assigned logical actions. The advantage is that here the user does not need to write any code. The user can create only visually algorithms. Creating connections is an important part of the process of producing presentations to behave as desired (Figure 3) [7].

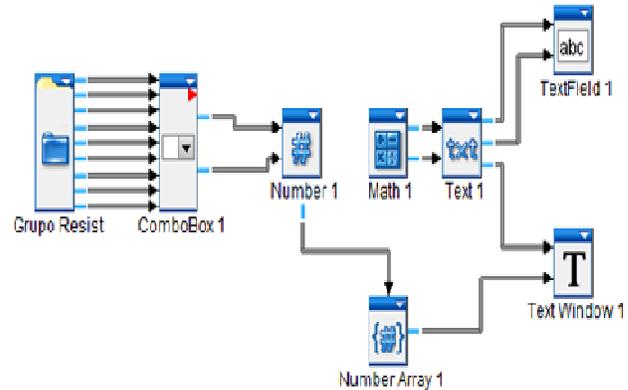


Figure 3. Logical links between the different components

Since each object has a specific task or function associated with it, it is necessary to divide the project into small pieces that can be resolved by using only a few objects. If there isn't anything specific, it can create the function that is needed by connecting several objects. Therefore, it is very important to know and be aware of what the various objects can perform within the library of Wirefusion.

More experienced users can create their own functions, writing and compiling Java source code in the Java object.

In the case of Java applet, the software exports *.HTML file together with adjacent folders, that are required for web publishing of the presentation. With Java application, a *.jar file is exported for independent visualization of the presentation (see Figure 4). The *.HTML file is edited by adding an HTML code for the complete design of the WEB-page. The whole project is uploaded to a site, offering a free server or domain.

B. Using a 3D reducer and optimizer

There are some programs of 3D reducer like the VIZup 3D Reducer, which supports Wavefront .OBJ, VRML 2.0/97 and StereoLitho (STL) file formats [8]. Another is the Simplygon, a complete pipeline toolkit for automatically optimizing 3D contents for different platforms, generating LOD (level of detail) models and creating game-ready contents from source assets [9]. These models are constructed with the help of the

3D modeling tools, as well as models converted from CAD software which can be extremely complex. These models may consist of many hundreds of thousands of polygons and it is practically impossible to process in real-time visualization.

These programs can generate a polygon reduction system that enables the reduction of the number of polygons in a complex 3D model while retaining the quality and appearance of the original. For the use in virtual reality and real-time visualization systems it is fundamental that the end result of the reduction is a 3D model with a well-balanced level of details and size.

Decreasing the size of 3D models stored on the Web makes the download of those models considerably faster for users and customers. The process of polygon reduction is quite simple and does not require any advanced knowledge of CAD or CAE. It is able to pick the best compression parameters for a particular model and perform the reduction automatically. These programs automatically pick all necessary parameters without any manual interference.

The programs of the process of polygon reduction have the unique ability to maintain the visual fidelity of the model even at high compression ratios. In compressing a model, those programs delete some vertices, but the coordinates of the remaining vertices do not change. That way, there are minimal distortions during texture mapping, as the texture coordinates of the vertices remains the same. If the resulting model doesn't look well, it is always possible to refine it by using an optimization algorithm. This will make the model look very smooth.

With this kind of software, it is possible to reduce polygons and optimize 3D models, and presentations before publishing them on the Web. Also, it simplifies generating LODs to games and it is the best thing to virtual reality. Accounting for level of detail involves decreasing the complexity of a 3D object representation. Another advantage with this kind of software is that the routine operation is time-consuming. The product allows the quick optimization of the 3D models and effectively reduces the level of compression needed for many models. The effect of any level of compression can be seen immediately. They suppress some vertices, but the coordinates of the vertices other don't change. Thanks to this, there are some distortions during texture but the texture coordinates of vertices remain the same.

V. CONCLUSIONS AND POTENTIAL WORKS

The 3D Virtual Lab provides an environment very suitable for laboratory practice, and for the representation of objects and phenomena (Figure 4). A variety of input data can be used for materials and experiments required by those laboratories.

The Internet and VRML offer great potential. The interactivity and dynamics help to minimize the difficulties of the users. Through interactive presentations users can get all kinds of information through texts, media, graphics, realistic

images that are available when they are needed. The models presented are visual and realistic and different objects can be manipulated individually. Technology provides the distribution of interactive presentations via the Internet, which is one of the biggest advantages.

The rapid development of technologies offers the possibility of developing interactive 3D Labs – the models are quite detailed and represent further information and links to other sources. Thus, these models can become a part of a large laboratory and a step towards building virtual worlds.

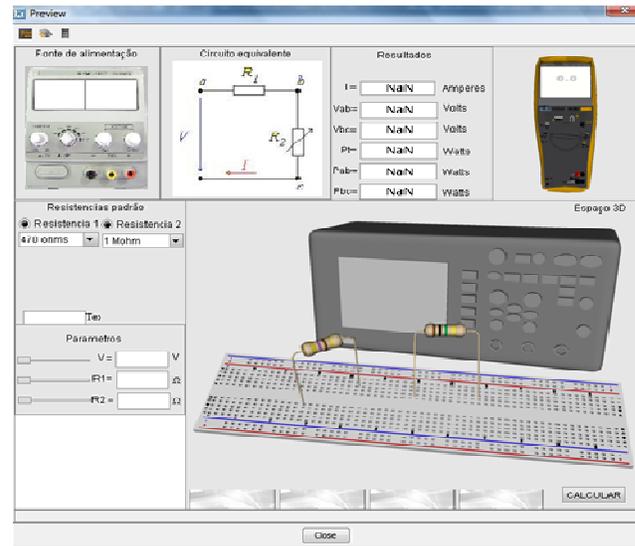


Figure 4. 3D virtual lab for interactive Internet application

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