DEVELOPMENT OF THE VIRTUAL ELA®-HOUSE

Milán Horváth[1], Csaba Dániel[2], Jacqueline Stark[3] and Cecília Sik Lanyi[4]
[1, 2, 4]*Department of Image Processing and Neurocomputing, University of Pannonia, Veszprém, Hungary*

[3] *Austrian Academy of Sciences, Department of Linguistics and Communication Research, Vienna, Austria*

Keywords: Virtual reality, aphasia, language therapy.

Abstract: In this paper, the rationale for the development and the process of creating the Virtual ELA® (Everyday Life Activities)-House are described. The Virtual ELA®-House is an innovative therapy program designed for use with clients with language and speech disorders and/or with other cognitive neuropsychological disorders, which result from brain damage, e.g. aphasia, apraxia of speech, neglect, etc. The Virtual Reality setting is chosen as a modern and relevant therapy setting which imitates real everyday life scenarios. Computer supported cognitive and language therapy allows for repetitive application in the clinical and home setting which is necessary for learning to take place. The advantages of employing a software program based on a Virtual Environment, in particular the Virtual ELA® -House, are discussed.

1 INTRODUCTION

Virtual Reality offers a wide range of applications in the field of cognitive neuropsychology, both in diagnosing cognitive deficits and in treating them. Virtual Reality is also a useful tool for skill-building and training by creating a virtual setting, which imitates the real environment including the attributes to be trained. The virtual world is a computer-based, simulated environment intended for its users to inhabit and interact via avatars. This habitation is usually represented in the form of two-or three-dimensional graphical representations of humanoids (or other graphical or text-based avatars) (Stark, 2005).

A Virtual ELA®-House was created to provide an alternative means of language and cognitive rehabilitation for use with clients suffering from various disorders of higher cortical functioning resulting from brain damage (The National Aphasia Association). The decision to create a Virtual ELA®-House was based on the impressive language therapy results from single case studies of aphasia based on the analogue version of the ELA- Photo Series (Stark, 1992-1998), (Stark, 2003).

One possible reason for the significant improvement in language skills following provision of ELA®-based therapy protocols is that the picture stimuli are realistic and relevant for everyday life. Thus, an important goal in this project was to attain a high degree of correspondence with the analogue ELA®-picture stimuli, which is also required for an authentic virtual world. In a virtual world the designer of a task attempts to capture all aspects which a particular task requires, but it is very crucial for it to be true to nature. If the virtual world established reaches this level, the user will feel that he/she is part of the Virtual Environment. The term Virtual Environment can refer to a room, a place, a house, etc.

During the design process of a Virtual World, the designer should be aware of the available possibilities. To design or model a virtual world, a personal computer is needed with 3D modeling software and a programming environment.

2 FIRST STEPS OF THE DEVELOPMENT – DESIGN, MODELING AND CONVERTING

2.1 Design and Modeling

Before modeling the Virtual World, the entire project must be designed. In our case the layout for the ELA®-Virtual House was designed by

Horváth M., Dániel C., Stark J. and Sik Lanyi C. (2008).
DEVELOPMENT OF THE VIRTUAL ELA® -HOUSE.
In *Proceedings of the Third International Conference on Computer Graphics Theory and Applications*, pages 519-523
DOI: 10.5220/0001099205190523

Jacqueline Stark. Figure 1 depicts the layout of the house, which consists of various rooms located on two floors and a basement:

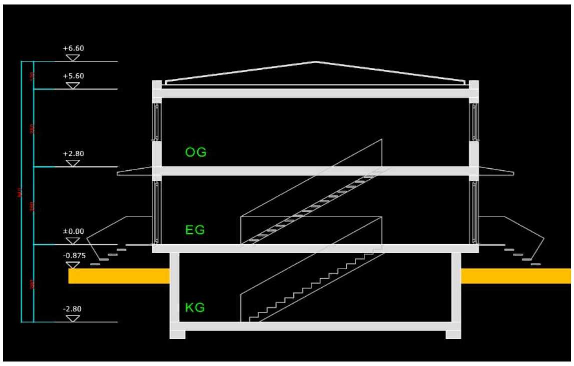

Figure 1: The floor layout for the ELA®-Virtual House.

After completion of the room layout for ELA®-Virtual House, modeling the components for the ELA®-Virtual House was initiated. For this operation, of the several available programs, we chose the Autodesk Maya(Autodesk Maya) program for the ELA®-Virtual House.

2.1.1 Criteria for Selecting the Autodesk Maya

3D modeling is the process of creating three-dimensional surfaces using a computer for the purpose of rendering them into a picture or a sequence of pictures (Harovas et. al, 2000). Maya is a manifold 3D modeling program, which encompasses textures, thus allowing for animating software. This program is very versatile due to its wide range of applications. The Maya project has a scene where the house is modeled and built by means of a wide range of tools. To model a building - such as the ELA®-Virtual House – the first step was to create a polygon cube. This cube can be transformed, rotated or scaled to achieve the desired position and size. The cube must then be divided for the next modeling steps. Every polygon object has faces, vertices and edges. In the case of a cube there are 8 vertices, 6 faces and 12 edges. It is possible to transform, rotate or scale these vertices, faces and edges. The subdividing process generates more vertices, faces and edges, which allows the building of more exact and realistic objects.
Figure 2 shows the basic form of the cube after its creation. In Figure 3 the result of the subdividing process is shown, namely, that there are more vertices, faces and edges which are necessary to model the task.

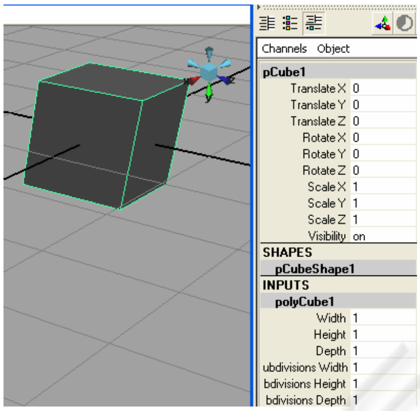

Figure 2: A simple cube.

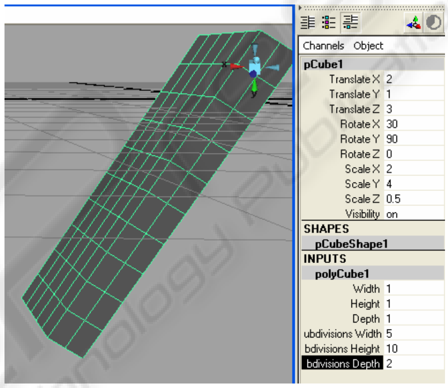

Figure 3: A cube with rotation, translation and scale.

In Maya there are eight fundamental polygon objects: sphere, cube, cylinder, cone, plane, torus, pyramid and pipe. With Maya it is possible to build any objects from these polygons with the aforementioned transformations, rotation and scales.

An object can consist of one polygon object, or several polygon objects. In the second case, objects which belong together can be combined by using the Combine polygons tool.

2.2 Providing Realistic Textures and Materials

In the modeling process, after the object has been completed, the next step is to give it texture. For this operation texture mapping was used. Texture mapping is a method for adding detail, surface texture, or color to a computer-generated graphic or 3D model (Texture mapping). A virtual house has many textures, mostly in JPEG format. Maya can work easily with this format as well as with almost all of the other picture formats. The ELA®-project requires the use of precise and realistic images, therefore the analogue photos from the original

ELA®-Photo Series were scanned and additional digital photos were made of components of the real rooms. These images provide the basis for the modeling of the entire house and the individual rooms. The important parts of the pictures were copied and used to texture the objects in Maya. There are several methods for texturing an object, but the simplest way is to assign a material to an object. First of all, the type of material is chosen. In this project, lambert material was used for the wall material. This is a material (shader) that represents lusterless or dull, mat surfaces (such as chalk, sheenless paint, unpolished surfaces) without mirroring qualities. For metal-like materials, blinn material is used. It is a material (shader), that is particularly effective at simulating metallic surfaces (for example, brass or aluminum), which typically give soft specular, i.e., mirroring , highlighting. It must be stressed that Maya supports many types of materials. With Maya it is even possible to design one's own material by adding special colors, transparency, ambient color or incandescence. Maya saves the configurations and these can be used for other models.

In the process of modeling and texturing, numerous objects were created, including walls, windows, floors, doors, etc. It is very useful to use layers in Maya, especially if the project consists of many individual objects. The project is more comprehensible, if the individual parts are categorized. Working with layers makes it easier to maintain an overview of the whole project. The procedure is simply to add a new layer to the project, and select the objects which belong to the same category, and then add selected objects to the layer. First, the layer must be named. When the modeling and texturing part of the layer's objects has been completed, it can simply be hidden, if necessary.

Proper layers represent categories. In each category there are objects which have their own texture map or color, and which belong together. The result of modeling and texturing is shown in Figure 4, where the layers present the individual parts of the house, such as the roof, the inside walls, the furniture, etc.

2.3 Converting: An Advantage of Software Independence

This project was developed in the programming environment Eclipse (Eclipse), where the programming language is C++. Use of the engine Irrlicht (Irrlicht Engine) enables the user to walk around in the Virtual House, click on several objects

Figure 4: The ELA®-House in Maya.

around in the Virtual House, click on several objects and respond interactively. Irrlicht is a free open source 3D engine. However, one problem involved in using Irrlicht is that it does not support the Maya binary files. It was a challenge to find a way to export the model to a file type supported by Irrlicht. Maya can export its models to object format, but this format contains only geometry, and textures cannot be saved in this format. The solution to this problem was the program Right Hemisphere's Deep Exploration (Deep Exploration).

2.3.1 The Advantages of using Deep Exploration

Deep Exploration supports almost all 3D or 2D file types, including Maya's scenes. When the program runs, a scene, a file browser, and a little viewer appears. It is possible to open a saved Maya file in the scene field of Deep Exploration. Deep Exploration is not merely a file converter. When the file is loaded, the user is able to turn or fly around the object, zoom in or zoom out, but it is not possible to modify the object. Deep Exploration can assign textures or colors to the objects, but this operation and the possibilities are very far from those which one is able to accomplish with Maya.

Once the scene is loaded, the software is ready to export the result to all file types that Deep Exploration supports. A very popular format is the DirectX file format. The DirectX file format is an architecture- and context-free file format. It is template-driven and is free of any user-knowledge or experience. The file format may be used by any client application and currently is used by Direct3D Retained Mode to describe geometry data, frame hierarchies, and animations (DirectX). If the exporting process is done correctly, the resulting file is an .x file consisting of the whole geometry and inside the file the paths of the texture files are also included. As of this point the resulting **.x** file is ready to be imported into the Irrlicht.

3 THE SECOND STEP OF THE DEVELOPMENT: MAKING THE MODEL INTERACTIVE BY USING IRRLICHT

The Irrlicht Engine is an open source**,** high performance**,** real time 3D engine written and usable in C++ and also available for .NET languages. It is completely cross-platform, using D3D, OpenGL and its own software renderer, and it integrates all the state-of-the-art features for visual representation such as dynamic shadows, particle systems, character animation, indoor and outdoor technology, and collision detection, which can be found in commercial 3D engines. It is a powerful**,** high level API for creating complete 3D and 2D applications required in games or scientific visualizations. It comes with an excellent documentation, which is very useful in the development of software.

This engine is being used in many projects. There are enhancements for Irrlicht all over the web, including alternative terrain renderers, portal renderers, exporters, world layers, tutorials, editors, language bindings for java, perl, ruby, basic, python, lua, and so on.

Irrlicht has its own graphical file manager, named irrEdit (Ambierra: irrEdit), to load, rebuild and test our C++ project every time. In irrEdit it is possible to load many .x files, position, rotate or scale the object, but it cannot be modified. After the house model was loaded, some furniture models were added, so it became possible to furnish the whole house according to the layout. The irrEdit loader can save the objects, transformations, rotations and scales in its own file format, which at the moment is best for Irrlicht. These saved scenes, which can be modified for the specific exercises, are loaded into the program.

4 THE MAIN FEATURES OF THE SOFTWARE

The Virtual ELA®-House program can be executed on Windows following installation. The project supports two languages for the clients: German and English. Before beginning the program, the user can choose between a male and a female voice. After that the user selects an exercise from the various types of exercises. The picture stimuli used for all of the language therapy tasks are taken from the ELA®-Photo Series. A constant blue-red figure shows the user where he/she is looking at the moment, when he/she is walking in the house.

4.1 Types of Exercises for the Virtual House

4.1.1 Discovery Task

In this task, the avatar wanders through the house on his/her own to learn the vocabulary of the objects and activities in each room of the house. Two different symbols are used for showing the active object. A blue cube is for an object, as shown in Figure 5 and a yellow sphere is for an activity. When the client clicks on an object by means of the right mouse button, a window appears. In the window an image of an object or an activity and four buttons are shown. With three of these buttons the user can read or hear separately, or see and hear the description of the image simultaneously. With the fourth button he/she can close the window, and continue discovering the components of the house.

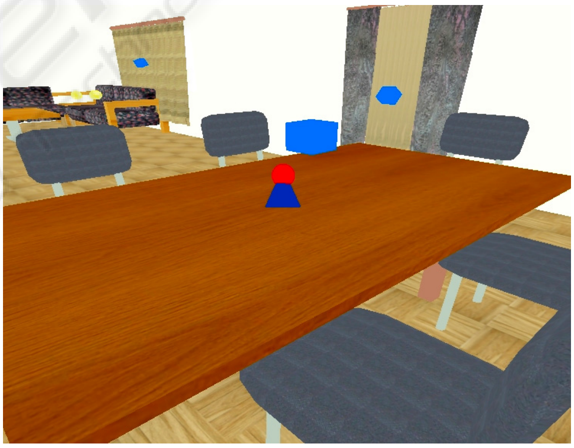

Figure 5: A virtual table with chairs.

4.1.2 Structured Discovery Task

A variation of the first task is that the avatar is standing outside the house**.** The avatar receives either an auditory command or one in written language to which it must respond. The following questions are included in this task:

- 'Where does activity 'x' usually take place?' or, 'Where is activity 'x' usually performed in the house?' A sentence is heard or is written on the screen requesting the avatar to move to that location in the house, where he/she thinks the activity could be performed. For one level of difficulty, when he/she clicks on the correct room, a certain symbol blinks. At a more difficult level, the avatar has to be more specific and click on the exact location, where the activity takes place. For example, if it is a picture of a boy brushing his teeth, for the first level the avatar would move into the bathroom, To be more specific, the avatar must click on or near the sink in the bathroom. If the avatar makes a mistake in the selection of the room, some response is heard or seen, signaling to him/her to continue the search. If the avatar is in the right room and makes a mistake pertaining to the exact position, then he/she also hears/sees a response: ‘You are getting closer, keep trying/looking’.

- ‘Where does ‘x’ object belong in the house?’ The avatar clicks on an icon on the screen and an object appears. He/She should then look for the location where that object should be placed in the house. The same types of responses are used as in the previous exercise.

4.1.3 Memory Task

Several items (i.e. objects) are shown on the screen and the program then puts these pictures in different places in the house**,** one at a time**.** (Range of difficulty: the number can be set to include 3 to 5 objects). The avatar’s task is to find the hidden items in the house in the same order as they were shown. The items can be hidden in different places.

These are a few of the exercises included in the present version of the Virtual ELA®-House.

5 CONCLUSIONS

The software development and the designing and modeling of a Virtual ELA®-House is a very complex task. The project has two significant parts, which can be completely separated from each other. The first part is the software development, and the second is the modeling and texturing. During the modeling, the most difficult task was to produce a house which gives the users a feeling that the house exists, and that they are actually walking in the house. For this task digital photographs were used from a real house. Difficulties arose during the texturing part of the project. New images were created based on the actual photos, with different resolutions and compilation. In this project, the programming task was completed after being tested only once in a simple building. This was necessary because the software development and the modeling tasks were performed at the same time. After the second task was completed, the two tasks were integrated into the software environment, where the finished project was built and tested.

In the future, other exercise types will be added to the program which will be based on feedback from the clients and an analysis of the data collected while clients are using the ELA®-virtual house program. An author system will also be developed for the therapists working with individual clients to adapt the program according to the individual needs of each client.

ACKNOWLEDGEMENTS

The authors would like thank the Austrian Science and Research Liaison Office (project number: 2007.ASO-N/4/5) for their support in the development of the ELA®-Virtual House.

REFERENCES

Stark, J. A., Analysing the language therapy process: The implicit role of learning and memory. *Aphasiology, 19, 10/11* (2005), 1074-1089.

The National Aphasia Association, which is available at: http://www.aphasia.org/

Stark, J. A., Everyday Life Activities Photo Series, Manuals to Set 1 to Set 3. Bösmüller/ Jentzsch, Vienna (1992-1998)

Stark, J. A., Everyday Life Activities Object Photo Series Set 1, Jentzsch, Vienna, (2003)

Autodesk Maya, available at: http://usa.autodesk.com/adsk/servlet/index?siteID=123112&id=7635018#

Perry Harovas, John Kundert-Gibbs and Peter Lee, Mastering MAYA Complete 2, ISBN: 0-7821-2521-2, 2000 SYBEX, Inc.

Texture mapping, which is available at: http://en.wikipedia.org/wiki/Texture_%28computer_graphics%29

Eclipse – an open development platform, which is available at: http://www.eclipse.org

Irrlicht Engine, Available at: http://irrlicht.sourceforge.net/

Deep Exploration, which is available at: http://www.righthemisphere.com/products/dexp/

DirectX file format, which is available at: http://local.wasp.uwa.edu.au/~pbourke/dataformats/directx/

Ambierra: irrEdit, which is available at: http://www.ambiera.com/irredit/