Development of 3D Avatars for Professional Education

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Abstract. This article covers avatars as anthropomorphic tutors in learning processes within teaching and learning settings. Starting points and objectives are presented, as well as the requirements for the creation, the environment and the tools. The article focuses on the latter, the media-synergetic problems the different tools pose, and possible solutions to those problems.

1 Introduction: Avatars in Education

For the cognitive-emotional processing of information vital for learning, nonverbal impulses are of utmost importance. Such impulses are triggered by the form and modality of the communicating parties' gestural and mimic behavior. This is because nonverbal behavior has a greater impact on the regulation of relationships than verbal behavior. Thus some instructors are able to enhance the learning outcome by their demeanour alone. Others, while commanding the same expertise, achieve much lesser results - or even create counterproductive effects - just by the way they behave. In the design of human-machine-interaction this fact has played an important role from the beginning. Early on there have been attempts to design avatars capable of emulating the function of nonverbal behavior in the process of reception and storage of knowledge (MIT Media Lab, plus the universities Philadelphia, Northwestern and Stanford; in Germany the „Virtual Human Project").

However, multimedia specialists found in learning projects that the attempted implementations met with refusal by the users so that they did not meet expectations. The avatars used – e.g. the "assistants" used in commercial office systems – never rate better than "annoying gimmick".

Those hitherto disappointing results can be ascribed to the fact that the development work had almost exclusively been driven by engineers. Accordingly their focus was on the solution of (certainly non-trivial) technical problems like photorealistic renderings or optimizations of motion capture techniques. This led to the construction of avatars before it had been determined, which specific attributes of complex nonverbal behavior are responsible for cognitive and emotional reactions observed, which of those are supportive and which are disruptive factors for the learning process.

This approach had a particularly negative effect on the creation of the anthropomorphic avatars that are vital to learning processes. This is vividly demonstrated in the grave problem recently discussed under the label "Uncanny Valley".

If we are to successfully emulate the nonverbal behavioral patterns relevant to the information processing of the human brain, we must first develop profound knowledge of this centrally important component of communications behavior. In

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particular, we must learn which cognitive and emotional effects are triggered in the recipients by specific nonverbal behavioral patterns.

Only on the basis of this knowledge can we create avatars in Web 2.0 environments with two important properties: Firstly, to be able to keep a learner's attention and concentration on the learning matter, secondly, to kindle a learner's desire to learn, thus creating the precondition for their lasting and dedicated engagement with the learning matter.

2 Presentation of the Suitable Data Streams and Tools

2.1 Video

The sequences to be learned are recorded as a basis for the synthetic scenes that will be created. Naturally, the videos have to fulfil several requirements to serve appropriately. Primarily they have to show clearly and distinctly the motions of the nurse while executing certain operations. Close-ups of specific procedures performed on the patient are to be recorded in detail, using zooms and other video techniques. The video material serves both as general information and for the acquisition of 2D motion data of the nurse. That information is input in a special tool for rendering 3D motion data.

2.2 Tool to Generate 2D/3D Motion Data

The proprietary tool can show the videos in combination with a virtual stick-figure. Using that stick-figure, the operator can transfer the movement of the nurse seen on the video frame by frame to 3D space. To be as productive as possible the tool has to focus on the main task – the transformation of human motion from video sequences to three dimensional representations of the human skeleton. Thus a dataset of the 3D motion for use in a 3D animation system is created. The data has to be optimized and

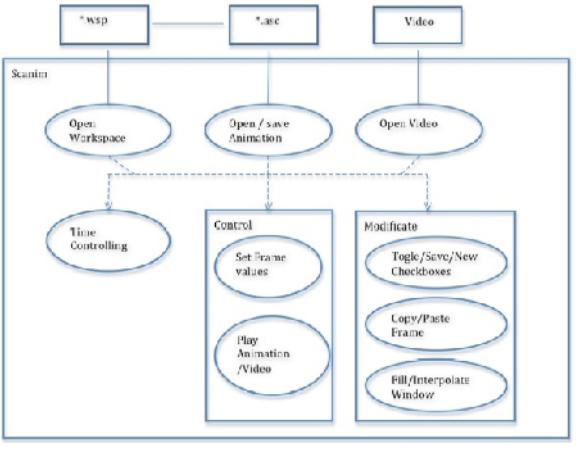

Fig. 1. Schematic view of the 2D/3D-transformation tool

structured to export it in a format that 3D applications can understand (see also point 2.3 and 3). In Figure 1 the combination of workspace data (*.wsp), rotational data of joints (*.asc) and the video-source is shown in a schematic view.

2.3 3D Computer Animation System

The project uses the well-known animation system Autodesk Maya to visualize the avatars. Maya works with *.ma files that contain all necessary information for the creation of a 3D computer animation. It is also possible to work with *.anim files, that predominantly contain the motion data of joints. It is necessary to develop adequate conversion tools and interfaces as a part of the discussed project. Their task is the transfer of the 3D motion data generated from the real life videos to the Maya system for creation of the desired learning sequences in Maya.

Computer animations are created by first modelling the characters and objects for the learning sequences as three dimensional geometric shapes, and then rigging and preparing them for animation.

Rigging is the construction of a skeleton with bones and joints and setting it up for animation. The properties of the rig define how the elements of a mesh (a polygon lattice) can be moved. Quite often the construction is oriented along the properties of a real skeleton, e.g. emulating a real thighbone or a real knee joint.

After the creation of the skeleton, the polygon mesh can be linked to it (skin binding). Often a further work step – called skinning – is required, eliminating the imperfections which can occur while linking mesh and bones.

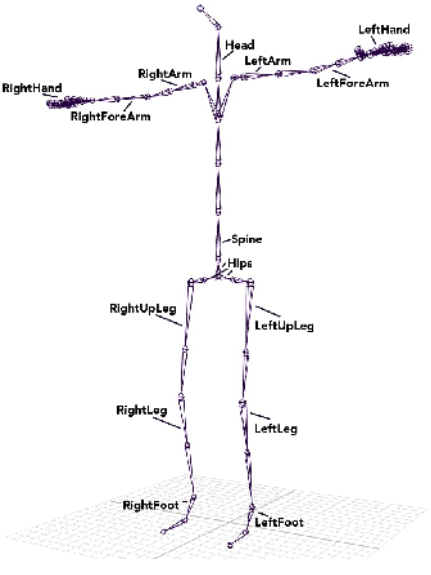

Fig. 2. Creation of the skeleton with correct naming

With the optimized motion data (see point 2.2) the motion of the characters can be controlled in detail. Additional visualization effects (e.g. illumination, camera moves) are added in the 3D computer animation system. In addition to Autodesk Maya the software Motion Builder will be used here. The character has to look in the direction of the positive z-axis and be in the T-stance: the avatar stretches its arms in a straight angle of 90°. Legs are close together (Figure 2). The FBX-plugin from Autodesk is used to interchange the data between Maya and Motion Builder.

3 Software Technologies

The following technologies are utilized:

- Programming language: C++
- Graphic user interface: QT V4.3.3
- 3D graphics engine: OpenGL
- Framework: Eclipse

The tool for generating 2D/3D motion data generates the data for the skeleton from a video sequence. The motions in the video are transferred to the avatar. Variations of these motions can be created within the tool.

The motion data must be importable to commercial animation software programs to visualise, shade and render the avatars appropriately. The imported data is applied to a skeleton. At this point the 3D-modeled surrounding can be added and the motion edited using commercial software. The tool for generating 2D/3D motion data is supposed to show the following features:

- Platform independence
- Efficiency
- Extensibility
- Maintainability
- User friendliness

Platform independence: Platform independence is exceptionally important, because there are plans to provide the software as a download on the internet so that several people around the world can transform the 2D video data to 3D rotational data. Therefore it is absolutely necessary to make the software available for users of all systems. The platform independence was achieved by the use of the GUI-library QT.

QT is a C++-library for platform independent programming of graphic user interfaces. There are interfaces to various programming languages.

Efficiency, Extensibility, Maintainability: The use of an object oriented programming language largely ensures efficiency, extensibility and maintainability of the software.

Two technologies were under consideration as the object oriented programming language: Java and C++.

Research showed that C++ is the best choice for the project because the use of OpenGL is not common in java programming and requires the special Java library JOGL. This turned out to be a particular disadvantage.

4 Objectives

The project includes and optimizes the following, among others:

- The collection and analysis of tools and appliances available for creating and appropriately animating 3D objects for use in teaching and learning scenarios in the area of nursery education.
- Development of a tool or a procedure for determining empirically which nonverbal interaction patterns help to foster an enduring interest in the use of web based teaching/learning scenarios.
- Use of the findings generated with the above mentioned tool for developing an avatar with a nonverbal behavior that is adjusted to the reception processes of users in a way that activates learning processes and supports them.

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