
The Simulation of a Virtual TV Presentor

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Abstract

This paper presents the making of six short sequences of a virtual actor acting as a television presentor. In these sequences, a virtual Marilyn introduces the digital television technology. The audience sees Marilyn fully dressed, walking, talking, and moving with different body gestures. In this paper, we describe the making of these six sequences. Sequences are subdivided into steps based on the use of different modules of human animation such as body modeling, facial animation, body movements and deformations, cloth animation, etc. Finally, we describe the integration and the rendering.

Keywords: Modeling, Animation, Deformations, Virtual Presentor, Virtual Talk

1. Introduction

The digital virtual world of today's technology has given the opportunity to see a virtual actor announcing and moderating programs on television. This provides the possibility of virtual actors to interact with the real world. Computer graphics and animation has a tremendous role to play in making this plausible. This paper demonstrates how the know-how in these domains has been exploited to produce a virtual television presentor. The endeavor for this demonstration reveals in a smaller scale the complete flow of knowledge from a computer specialist who designs and develops modules, which are then used by directors and designerswho for performing the intended task given by the film producer.

For this project, we had to produce six sequences of 20 seconds each. An actress starts from a distance and walks. After a few steps walking, the actress stops and she is seen closely in the posture of an announcer. In the last sequence, the actress turns and walks away. For the sequences 3, 4, and 5 the actress is seen closely. These sequences will be broadcasted by several channels all over Europe to explain the role of digital TV technology. Both what is explained and who is telling it use the same technology and there is a unity in the presentation medium, which makes this project original for the present time.

These sequences have been produced using our human animation system, HUMANOID, which integrates all the components for modeling and animating a human. The originality of this system consists of dealing with all aspects of human animation.

This paper is organized as follows. First, we give in section 2 the overview of the tasks essential for this production along with the modules which have been used for the film. Section 3 presents issues of modeling the different parts of the body. The animation of different specific parts are presented in Section 4. Section 5 presents the rendering technique used for rendering the sequences. The pipe line for integration is shown in Section 6. Finally some concluding remarks are included.

2. Overview

The tasks involved for this production can be categorized as:

Story-board design : The outline of the story-board was provided by a text and a few sketches.

Subdivision of the story-board activities into the module tasks.

These tasks are :

* Body part modeling.

* Animation of the actress face for simulating speech and emotions.

* Body motion: walking and body gestures while speaking.

* Body deformations while moving.

* Hand deformations during movements.

* Cloth animation

* Rendering of the complete body with clothes

* Integration of the different modules in order to obtain body motion, face animation, and cloth animation.

For each of the above tasks, there is a specific module. Figure 1 shows the different modules and their links. For the rendering, the public domain ray-tracer "Rayshade" is used.

3. Modeling

Viewing and sculpting in real life have their equivalent in the virtual world. The user is able to turn around the object, make various modifications and improve little by little his/her modeling. In our case, objects to model are human body parts.

We used two different modeling tools in the production of our sequences. One is a surface-based sculpting program; with this program, the surface representing the model is deformed locally or globally to achieve the desired shape. The other tool we use is Bodybuilder dedicated for making bodies using metaballs. The two approaches employed are described in the following sections.

BB: Bodybuilder (Modeling and Deformation)

SM: Surface Manager (Surface Sculpting)

TRACK: Motion Generator and Controller

FACE: Facial Animation

HAND: Hand Deformation Controller

G2D: Garment 2D

G3D: Garment 3D

Figure 1. Tasks and their related modules.

3.1 Surface Sculpting

The Surface Manager (SM) is the underlying library for the interactive sculpting tool for creating, modifying an irregular triangular meshed surface [2]. The tool permits operations like adding, deleting, modifying, assembling, and splitting primitives of the surface. The methodology employed for interaction corresponds to the traditional sculpting with clay. Utilities for local and global deformations are provided in order to alter the shape attributes of the surface. This allows the creation of an object from scratch and also starting from a given object and transforming it into another one. This latter approach is often used as a designer normally likes to start with a simpler shape primitive (sphere, cylinder, etc.) and then obtains the final model through successive transformations.

In our film, this tool has been used primarily for transforming the already existing models of some body parts to the desired shapes. For example, the existing surface model of hands was refined to give a feminine look. Operations like assigning colors to the nails of the hands and stretching them have been also performed. Similarly, shoes were added to the feet. Although the head model was originally digitized, some modifications have been made to obtain a better neck appearance. Figure 2 shows the modeling of hands starting from an initial existing model.

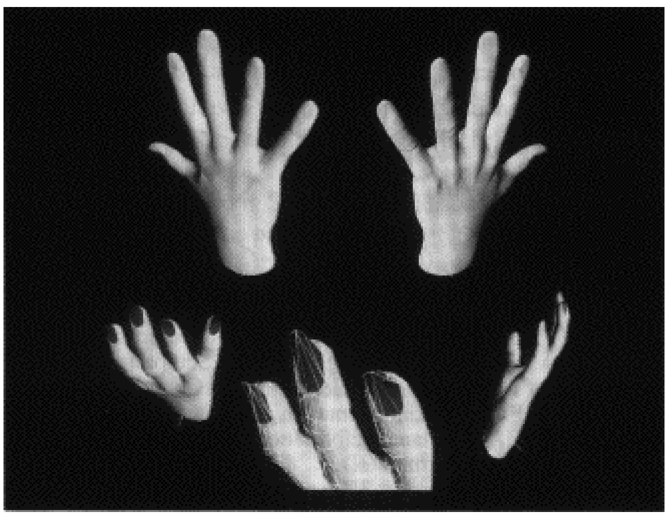

Figure 2. Modeling of hands

3.2 Body-Building

Bodybuilder (BB) is a software module which is designed to allow the user to perform simulation of the human body envelope [3]. This simulation is obtained through a hierarchy of metaballs which are attached or connected to joint articulations of a skeleton. The modeling of the body is obtained by deforming, translating and rotating the metaballs on X, Y, Z axis. As these manipulations of the metaballs influence the envelope of the 3D model, at this stage, the making is very similar to traditional sculpting. Each time the user modifies a metaball location or shape, the envelope gets stretched or deformed. Figure 3 shows an example of modeling a human body using metaballs.

Figure 3. Modeling human body using metaballs

Modeling a human body needs support of documents such as anatomy books which explain the basic concepts in human anatomy through drawing and pictures. These books also explain in general how to get started when wanting to draw or sculpt human figures. In the case of sculpting, the artist follows the approach by cutting squared volumes and blocking roughly proportions and landmarks of his/her clay figure; it is only when proportions and gestures are established that the artist starts to be creative visually. In Bodybuilder, one creates and adds metaballs one by one interactively, and first place them at specific landmarks such as the rib cage, torso, and hips. For Marilyn, we have used around one hundred metaballs which we first placed as mentioned above, step by step.

We first obtained a standard woman's model which we then carefully transformed to our needs to fit Marilyn's anatomy. With the use of Bodybuilder and working with the SpaceBall and stereo to see in 3D, it is definitely a great challenge to produce a nice and correct model; what appears to be correct on one side of the model may appear to be totally wrong when rotating the model around another axis. The user needs to pay attention to the front and profile viewing of his/her model, as well as the three quarter view which allows the user to compare the outline and maybe deform or move a metaball on one of the axis to reduce an eventual undesired bump effect.

In addition to providing the facilities of modeling bodies using metaballs, Bodybuilder offers possibility of joining other body parts (face and hands) which have been created by different modeling tool (SM).

4. Animation

4.1 Facial Animation

The module FACE [4] is used for animating the face. This allows the generation of different expressions and speech for the virtual actor. This software has a multilevel structure so that a user can manipulate and specify the animation at different levels. At the highest level, the user provides a script consisting of commands at a global task level, e.g., emotions, head movements and sentences or words. The script is parsed and decomposed into a series of performable actions which we call as Minimum Perceptible Actions (MPAs). The MPAs invoke the muscle actions which are simulated by Rational Free Form Deformations.

The user can interactively construct the expressions and phonemes of his/her choice. For facilitating manipulation for expression design, the actions are divided into four zones of a face, head, upper face (containing the part of eyes and above), middle face (portion below eyes and above mouth) and lower face (the portion below mouth). While constructing an expression, the user can manipulate the face by applying different actions. Figure 4 shows a working session with the FACE module.

Before starting to simulate the virtual presentor, a real person has been recorded on a videocassette. This helps the sampling of the voice into phonemes. In addition, it provides the precise information of the time of start of a word/sentence with duration. The temporal information recovered from the video cassette is used in the script of animation for specifying the start time and duration of different actions. The actions used in the script are: emotions, voice (words/sentences) and looking (head movements). There is a synchronization mechanism which allows simultaneous executions of multiple actions. For example, one can obtain emotion of happiness while the actor is speaking. The spatial intensity of each action can be modulated by changing the value of intensity for that action. The deformation rate is interactive-real-time (8 frames/sec). However, in order to verify the animation at the actual "real time" speed, a preview is used for the computed "rgb" frames.

Figure 4. A working session with the FACE module

There are around 283 words in the speech for this film. In order to obtain precise mouth movements during sound emission, some phonemes are re-designed and created. This is done using the list of phonetic transcription codes from the dictionary. For fast delivery of words, some of the phonemes are de-emphasized or eliminated, currently the decomposition of word to phoneme is not a function of speed of delivery.

The head model of each frame is attached to the rest of the body at the neck in the Bodybuilder module.

There is no temporal integration of facial animation with the rest of the body. However, we can define a global time clock (in TRACK see section 4.2) and in this time frame, we can insert the facial animation wherever we want. This allows us to synchronize the facial expressions with body gestures of the rest of the body. For example the rolling of head may invoke movement of shoulders in a certain direction.

4.2 Body Motion

The motion of the body is generated and edited in the module TRACK [5]. It has different types of motion generator such as walking, grasping, inverse kinematics, dynamics and key framing. The sequence of motion is associated with an articulated figure.

The user can specify the motion using different types of motion generator and can preview it in real time. Motions can be previewed with the wireframe skeleton, the solid skeleton and also with the complete deformable body. However, this latter is not very fast because of rendering. Figure 5 shows the motion created for an articulated human figure.

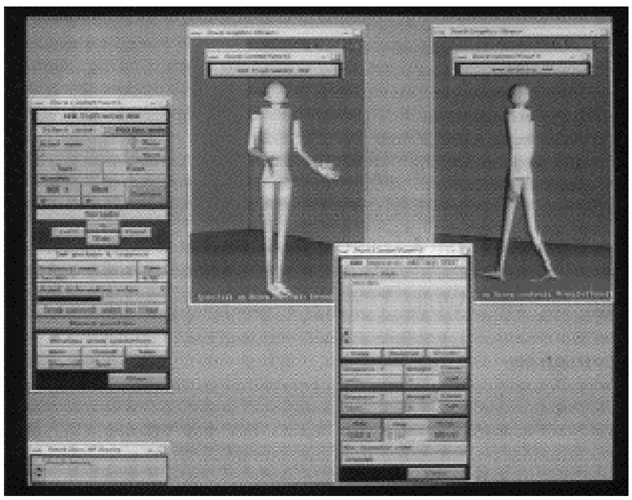

Figure 5. Motion created for an articulated human figure

The types of motions created by different generators can be blended. For the film, primarily two types of motion generators have been used: key framing and walking.

4.3 Body Deformations

The module Bodybuilder performs the deformations of the body when the actor is in motion. There is an association of the metaballs with the articulation of the skeleton. The movement of the body, which depends on the joint values influences the shape and size of the attached metaballs. This in turn changes the surface envelope of the skin. The skin of the body is defined as a B-spline patch.

Bodybuilder can also load a motion sequence of TRACK and run it for previewing the deformations while the body is in motion. Figure 6 shows the different layers of display in Bodybuilder while the actor is in motion.

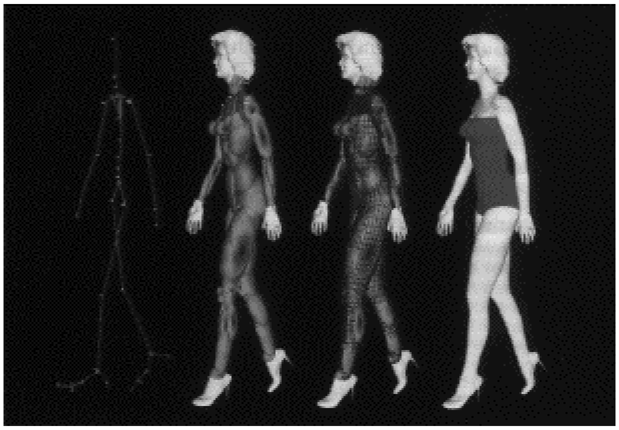

Figure 6. The different layers of display in Bodybuilder

4.4 Hand Deformation

Like the head, hands are also considered apart for the animation. In fact, the underlying problem for hand animation is different because of the topology of the palms which motivates the use of an approach different from metaballs. It uses enhanced FFDs with Dirichlet's surfaces [6].

Deformations are calculated automatically using specific control points and depending on the joint angle changes for the joints in the fingers, palm and wrist. There are different types of control points defined to give the different effects e.g., normal, constraint, and inflating.

The movements of the hands are generated in the TRACK module. For the film, the movements of hands are quite important as they show the natural gestures of a TV presentor.

4.5 Cloth Animation

Clothes [7] for the animated body are created in two different steps:

Designing cloth panels, using a 2D editor.

Seaming the panels together and calculating the animation, using a 3D simulation program.

4.5.1 Cloth structure

A garment is basically a single surface discretized into triangles. The surface may have whatever needed topology, as there is no constraints on the triangle shape (the discretization may be irregular). Mechanical calculation is performed onto this surface, using predefined mechanical parameters. Collision detection is performed with the underlying body (or any other object of the scene), as well as self-collision detection.

The discretization rate is very important for choosing the right compromise between animation quality and computation speed. We have defined a 3000 polygon cloth for getting less than one minute calculation per frame, still having acceptable deformations and wrapping around the body.

4.5.2 Cloth design

Defining a complicated shape such as a cloth is done by assembling several flat polygons - panels - together, like what is done for assembling real garments.

The main design tool is an evolved polygon editor. It allows us to define geometrically the panels by drawing polygons on a grid. The grid is used to maintain dimensional consistency among the panels, as well as giving a starting point for building triangles that will compose the cloth surface.

Seaming lines are then defined on the polygon borders. They are defining how the panels will be seamed together for composing the cloth. All the information is stored in a single file, which is used by the simulation program. Figure 7 shows the 2D panels designed for Marilyn's dress.

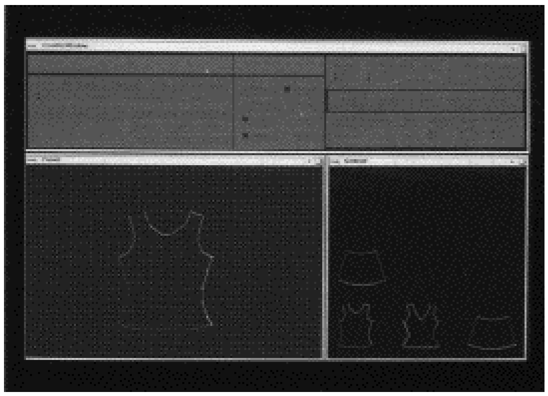

Figure 7. 2D panels designed for Marilyn's dress

4.5.3 Cloth assembly

Next, we build the 3D cloth around the body using a mechanical simulation program.

We use a standard position for the body that facilitates the clothing process without interference of the garment with different parts of the body (arms, legs, etc.).

The program lets the user interactively position the cloth panels around the body. This positioning has to be very accurate, as it will contribute to the equilibrium position of the cloth on the body.

Once this placement is made, forces are defined along the seaming lines so that to pull these lines together. We are using a special kind of adaptive "elastics", that will create forces for a quick movement, constrained by the maximum allowable deformation of the cloth. Mechanical simulation is performed using suited mechanical parameters for improving the calculation time. The panels get wrapped on the body through collision detection and response on it.

Once the seaming lines are close enough, the data structures of the panels are topologically merged together to create a single surface.

The whole seaming process takes on average 10 min. on an Indigo Silicon Graphics. Then, the body is slowly moved to the start position so that the cloth gets a suited initial position.

4.5.4 Cloth animation

We are using the same simulation program for computing the animation. The cloth is animated using mechanical computation as the body is moving. Collision detection and response is performing the interactions between the body and the cloth. An animation sequence of 600 frames is computed in less than 10 hours on Indigo Silicon Graphics (R4000).

The main difficulty of this whole work is the definition of the cloth in order to get the final position around the body nice and realistic. Any unsuited shape will bring undesired wrinkles that will appear, especially when the cloth is tight around the body. Friction has to be adapted in order to allow the cloth to slide to its equilibrium position, but damping the movements enough to remove cloth vibrations and unsteadiness. All these adjustments have required several test simulations for getting correct results for tight garments.

Figure 8 shows the steps from putting the garment on the body to the animation with body movements.

5. Rendering

For rendering, we used the public domain ray-tracing software "Rayshade." This program has been modified to allow parallel execution on IBM SP2 and CRAY T3D machines. This gives fast rendering which is useful for film production. The setting of materials, light and camera are done through files. A material preview (Material Manager) is used for fast previewing of the rendering parameters. It is often observed that the rendering parameters used for rendering in a conventional mode (using graphical library) and in the Rayshade don't give the same result. The material preview helps deciding the parameters for "Rayshade." For the dress, texture and bump mappings are used for more realistic rendering.

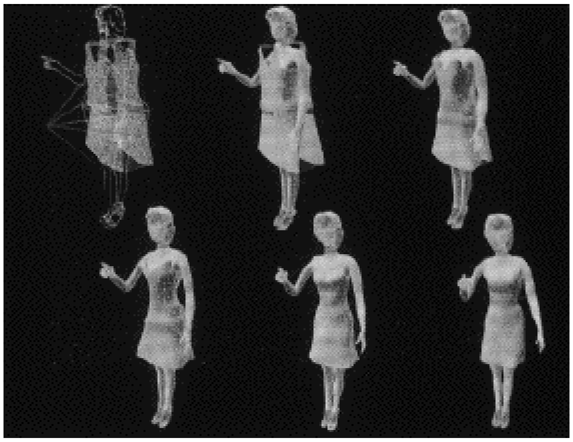

Figure 8. Steps from putting the garment on the body to the animation with body movements

6. Integration

The integration of the modules is performed by file transfer. Bodybuilder performs the integration of the different body parts (head, hands, feet and the rest of the body). As an output, it produces a data file in SM format. The sequence generated by TRACK can be loaded and for each frame a data file of the body in SM format is produced. For clothes a different format of the file "dsr" is used which is created by the module of cloth animation. Materials, camera and light are specified in different files. These are then used by the converter program to Rayshade. Figure

9 and 10 show the result sequences for two sequences.

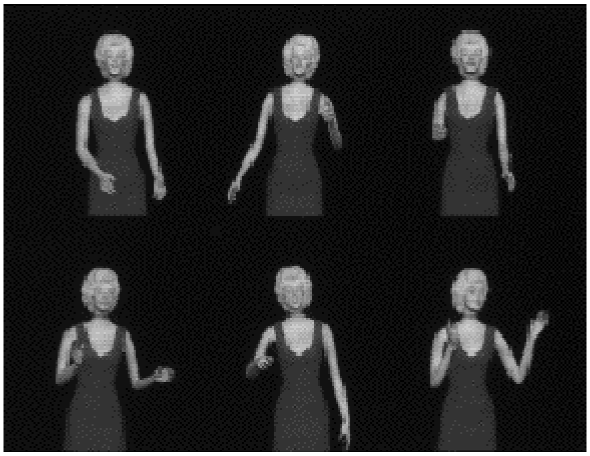

Figure 9. Final results

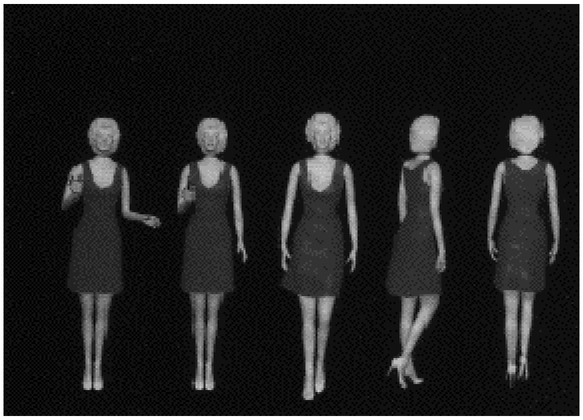

Figure 10. Final results

The output image format is "yuv" which is obtained by first converting the "rle" images of Rayshade to "rgb" files and then to "yuv". For the video, we have used the ACCOM device for storing the images from the Silicon Graphics workstations. The images are later recorded in D5 format. The calculation of the images was done in 16/9 format.

7. Conclusion

We have presented a case study of making a virtual actress "Marilyn" as a television presentor. This demonstrates how different modules of our human animation system HUMANOID have been used for making such a production. These modules include: modeling, facial animation, body motion, body and hand deformations, cloth animation and rendering.

The making of Marilyn as a virtual presentor has given some insight for future research.

Among these are:

The grid in 2D panel design for clothes is too constraining and does not allow fine geometrical adjustments. More freedom should be given to geometrical positioning as well as more tools for maintaining panel size consistencies.

Texture design of cloths should be included into the 2D panel design software.

A comprehensive interface for manipulation of cloth animation parameters should be added

Automation for generating phonemes from the voice should be developed.

Employing skin textures and hair rendering for realistic visual results.

Acknowledgments

The authors would like to thank George Brugger, Mehdy Davary, Sylvie Holowaty, Jean Claude Moussaly, and Pascal Volino for their help in the production of this paper. This research was sponsored by the Swiss National Research Foundation, the Office Federal for Education and Science, the Humanoid ESPRIT project and ZDF television. The virtual presentor Marilyn was produced for the German ZDF television channel. We would like to thank Mrs. Hildegard Werth from ZDF for her support and collaboration.

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