1. Introduction

Most events and actions in the today world are typically dynamic. They evolve over time. Three-dimensional real-time computer animation is the most appropriate media to simulate these events and actions. It is the key media; but, accompanied by other media such as synthesized sound, speech and music, it will bring in the near future a new dimension to the multimedia. Moreover, interactive techniques are now essential to this multimedia approach. In particular, the advent of powerful 3D interactive devices brought a new approach to the virtual reality. The animator may now enter in the synthetic world that he/she has created, admire it, modify it and truly perceive it. Finally, computer-generated human beings should be present and active in the synthetic world. They should be the synthetic actors (Magnenat-Thalmann and Thalmann 1990) playing their unique role in the theater representing the scene to be simulated.

This paper presents the main techniques of Computer Animation and the impact of virtual reality on these techniques. In Section 2, we describe the main concepts of computer animation. Section 3 explains the problematics of human animation. Section 4 presents an overview of main 3D interactive devices for virtual reality. Then the last section presents four examples of using a virtual reality approach to problems of animation.

2. Concepts and Problems of Computer Animation

2.1 Introduction

Designing an animation sequence (Magnenat-Thalmann and Thalmann 1990b) consists of creating a scene, characterized by a description, called a script. Each scene contains static objects grouped into a decor and animated objects that change over time according to motion laws. Moreover, in a 3D space, scenes are viewed using virtual cameras and they may be lit by synthetic light sources. These cameras and lights may evolve over
time as though manipulated by cameramen. In order to create all the entities and motions, coordinate and synchronize them, known collectively as choreography, it is necessary to know the appearance of the scene at this time and then Computer Graphics techniques allow us to build and display the scene according to viewing and lighting parameters. The problems to solve are how to express time dependence in the scene, and how to make it evolve over time.

2.2 Motion control

A computer animated sequence is obtained by a series of images produced by the computer according to the animator’s directives. We may distinguish three general methodologies:

1. All frames are given to the computer by the animator. A typical example is the rotoscopy, consisting of recording the motion by a specific device for each frame and using this information to generate the image by computer.

2. The second and most used method is called keyframe animation. It consists mainly of giving to the computer a certain number of frames, called keyframes, and the computer derives the other frames using interpolation procedures like interpolating splines (Kochanek and Bartels 1984).

3. In the third approach, called procedural animation, motion is algorithmically described. With such an approach, any kind of law may be applied to the parameters. For example, the variation of a joint angle may be controlled by kinematic laws as well as dynamic laws.

2.3 Decors and actors

As in a theater, a decor is a collection of static objects. For example, a room may be a decor for a scene. Even in the absence of actors, an animated scene may be produced by moving a camera or changing a light parameter over time.

Actors are not necessarily human; a film may involve animals or any object which changes over time. For example, a clock is a non-human actor. Its animation consists of moving the clock pendulum using the corresponding physical law. More generally, we shall define an animated object that changes over time according to a list of transformations.

2.4 Camera animation

A scene is only meaningful when it is viewed. But there are many ways a scene may be viewed. It depends on the position of the viewer, where the view is directed, and the viewing angle. Such characteristics, and others, are generally grouped into an entity