



Chapter XI

Using Animation to Enhance 3D User Interfaces for Multimedia

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Cartoon animation techniques have previously been used to enhance the illusion of direct manipulation in 2D graphical user interfaces. In particular, animation may be used to convey a feeling of substance to the objects being manipulated by the user. To lay a solid framework for this work, an extensive review of current applications of animation to user interfaces is presented. This chapter goes on to present an expansion of the 2D animation concepts to the domain of 3D interfaces for multimedia and virtual reality.

This chapter focuses on the improvement of the legibility of users' actions in 3D multimedia and virtual reality applications, and details animation effects to support this legibility. In particular, I present animation effects for 3D graphical object manipulation. These effects include a standard set of 3D direct manipulation operations which have been extended to include animated visual feedback to add substance, operation cues for the user and constraint visualisation. The visual feedback effects using 3D warping can substitute for haptic feedback, as in the case of the squashing of an object when pressed against a wall, or the stretching of an object to show frictional forces. Finally, a pinning effect is explored for multiple users' manipulating a common object in a collaborative environment.

INTRODUCTION

This chapter presents research in the area of animating direct manipulation 3D interfaces for multimedia and Virtual Reality (VR) applications. In common with recent work (Chang and Ungar, 1993; Hudson. and Stasko, 1993), I have set out to explore how techniques borrowed from cartoons and computer animation can enhance the experience of interacting with a computer. However, I am not concerned here with portraying animated data, as would be the case when operating animation editing tools, such as an algorithm animation editor (Stasko, 1990a) or when using animation to supplement the presentation of otherwise static information, such as an animated help system (Sukaviriya and Foley,

1990; Thies, 1993). Rather, I wish to apply animation to the interface itself—to enhance or augment the effectiveness of human interaction with applications that present a graphical interface.

In 1993, I started to investigate animation effects for visual feedback with 2D user interfaces (Thomas and Calder, 1995b; 1995c). I then progressed to applying these animation effects to 3D interfaces (Thomas, 1998a; 1998b). It is proposed that the distortion of 3D graphical objects presented in this chapter enhances a user's impression of substance when interacting with objects in a multimedia or VR application. In addition, it is proposed that the animation effects can add additional visual feedback as to the type of operation being applied to an object and may augment visual cues for constraints. For immersive VR applications, the animation effects may be applied as a useful substitute for haptic feedback and provide additional visual cues for collaborative operations.

My work is based on fundamental animation techniques, and these animation techniques have been exploited to enhance window-based user interfaces. The chapter starts with a detailed description of the animation process; this is followed by how animation has been applied to current user interface technology. The issues, controversies and problems I am investigating are presented as a means of providing a framework for my new techniques. This is followed by a set of solutions and recommendations for the previously presented issues, controversies and problems. The core technique to my solutions and recommendations is the distortion of graphical objects through warping to produce the desired animation effects. The chapter presents the warping effects for the above distortion of graphical objects in context of 3D user interfaces. The implementation issues of warping in the 3D domain are then discussed. I present a set of future directions for the use of animation to improve 3D user interfaces. Finally, some concluding remarks are presented.

ANIMATION TECHNIQUES AND PRINCIPLES

Animation is achieved by presenting images at a rate fast enough to give the illusion of motion. These images are referred to as frames in an animation or movie. They can be taken from photographed objects, drawn by hand or rendered by a computer. However the images are created, they are ordered and shown at an appropriate rate to produce an animation. This section provides a basic understanding of how animations are generally created.

The Mechanics of Animation

A description of the important skills and techniques animators use in their art is first required to understand the animation process. Defining the appropriate amount of change in an object's position between each frame of an animation is the core objective in creating a convincing illusion of movement. The basic natural laws of motion also must be considered in order to determine the amount of change between frames.

A common first exercise for animators is to investigate the rate of change of a single object, and this object many times is a bouncing ball. Figure 1 demonstrates a very simple animation of a bouncing ball. Static images cannot fully convey the dynamic nature of an animation, but several successive frames from the bouncing ball animation are superimposed in the figure to suggest the overall animation. This short animation can be repeated as many times as desired, to give the illusion of a ball bouncing along a hard surface. Note how the ball loses speed on the way up the path and gains speed on the way down, how the

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