Directable Trailing Effect

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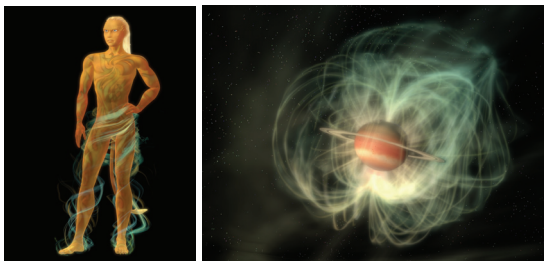

Figure 1. The trailing effect for Dave and Magnetosphere

1. Introduction

One of the most common effects in the animated feature film Quantum Quest are the trails that fall behind and twisted around all photon characters, including the hero character Dave (Figure 1). The quantity of shots that required this effect warranted the development of a trailing system. In photography, when an image is taken with moving light sources and a slow shutter speed (long exposure time), light trails occur. Several computer graphics techniques such as 3D motion blur or 2D image filters can be used to produce this effect. However in a stereoscopic feature film like this, traditional 2D image filters may break the illusion of depth. 3D motion blur can yield favorable results, but is limited in its ability to incorporate stylization and other surrealism animation effects. The trailing effect can also be produced by particle systems in commercial animation software but the design process is tedious and time-consuming.

Most of the previous work on directable special effects focused on fluid splash instead of trails [Thronton 2006][Cegielski 2006]. In this work, we propose an implemented system based on particle dynamics with the aims of easy posing and simulation of trails in 3D space. Example key effect shots for photon characters as well as Magnetosphere are shown in Figure 1. This system contains an integrated tool for generating trail emissions, controlling the particle dynamics, and generating surfaces from the resulting particles for rendering. Animators are allowed to interactively set up, alter, and preview the desired trails with a good variety of shapes and motion types.

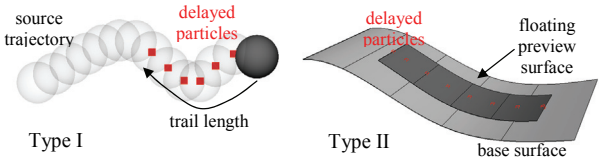

Figure 2. How two types of trails are generated

2. Forming a Trail

The basic idea behind trails is to generate delayed particles connected over time according to their temporal relationships to form trail surfaces. We have designed the following two types of control mechanisms for the prodcution of trailing effects with different motion characteristics for various application scenarios:

2.1 Type I: Fast moving objects with fall-behind trails

Like standard light trails in photography, the moving objects serve as emitters with trajectories and volume references for the generation of particles. For this type of trails, the length of a trail, which is usually the most significant artistic characteristic, is determined by the velocity of the moving object. Therefore, we have designed a length control mechanism for both animation preview and particle simulation. For the animation preview, the system calculates the emitter's motion and generate the preview trail surface in 3D space. The length of the preview trail surface is proportional to the number of frames that the trail should fall behind the moving emitter as shown in Figure 2. Later the length is transferred to the particle simulation as lifespan of the delayed particles. Force fields could also be applied on these delayed particles to achieve various artistic looks.

2.2 Type II: Trails generated along animated paths

In Quantum Quest, the characters of Photon species have many twisted light trails around them (see Figure 1). If the type I control is used, many trail sources will need to be set up to achieve this effect. Therefore, we have designed an extremely light, modular trail rig to enable these twisted trails to be posed and animated in 3D space as shown in Figure 2. The rig is composed of a base NURBS surface with a floating sub-surface on it and several control nodes around the character's limbs and body. Each node is animate-able and controls the CVs of the base NURBS surface for path reference. The velocity reference is obtained from traveling speed of the floating sub-surface related to the base surface's UV space that could be controlled by animators as well. By adjusting the trajectory, this control mechanism could yield smoother collision avoidance than particle dynamics. Since the path does not need to follow any physical rules, desirable artistic results could be created. Particle dynamics can then utilize these two reference parameters to generate delayed particles under proper conversion (surface to trail path, UV speed to particle velocity and lifespan). We also use fractal displacement on the base surface to create layered surfaces for fake volume reference.

3. Generating the Trail Surface

During the generation of these delayed particles, each particle maintains its own timestamp and emitter id. We utilize these two attributes to associate the delayed particles with multiple curves. Then we can duplicate the curves with various positional and rotational offsets and loft them together to form the trail surfaces. By attaching an appropriate surface shader, the approach of using trail surface could achieve almost the same result as the pure particle solution but requires only 5% or less of the particles. Thus, in our system, not only the trailing effect is directable, the efficiency of particle simulation and rendering is also greatly improved.

References

THORNTON J. D. 2006. Directable simulation of stylized water splash effects in 3d space. In *Proc. of SIGGRAPH '06* (*sketch*), 94.

CEGIELSKI, S. 2006. Character splash system. In *Proc. of SIGGRAPH '06* (*sketch*), 19.