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RESEARCH ARTICLE

Real-time generation of smoothed-particle hydrodynamics-based special effects in character animation

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ABSTRACT

In the previous works, the real-time fluid-character animation could hardly be achieved because of the intensive processing demand on the character's movement and fluid simulation. This paper presents an effective approach to the real-time generation of the fluid flow driven by the motion of a character in full 3D space, based on smoothed-particle hydrodynamics method. The novel method of conducting and constraining the fluid particles by the geometric properties of the character motion trajectory is introduced. Furthermore, the optimized algorithms of particle searching and rendering are proposed, by taking advantage of the graphics processing unit parallelization. Consequently, both simulation and rendering of the 3D liquid effects with realistic character interactions can be implemented by our framework and performed in real-time on a conventional PC. Copyright © 2013 John Wiley & Sons, Ltd.

KEYWORDS

real-time visual effects; smoothed-particle hydrodynamics; character animation

Supporting information may be found in the online version of this article.

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1. INTRODUCTION

Special animation effects have been widely used in video games and virtual reality (VR) systems to enhance the realism of the virtual character's behaviors. Moreover, they play an indispensable role to create astonishing visual effects and artistic perceptions, such as the water splash, the flame, and smoke emitted from weapons. As shown in Figure 1(a), for instance, the water splashing effect improves the dynamics of the character with much more fantasy. However, most of them are added manually by artists in the postprocessing stage, which can be adopted in the business of advertisements, films, and other offline rendering systems. In real-time applications, when the character motion is complex, the special effects are usually either independent from the character motions or adjusted for each character by animators. The former choice could hardly convey the details coupled with the character's motions, while the latter increases the burden of the artist work. The techniques, which can automatically generate 3D special animation effects to enhance the artistic quality and realistic details, therefore become increasingly demanding.

Fluid is a typical effect that is commonly used. Many representative characters in computer games were initially designed with fluid properties, such as sprites, monsters with special characteristics, and slimes as shown in Figure 1(b). Fluid oozing from the skins of this kind of characters is helpful to convey the features of their appearances. However, in retrospect to the past video games and other VR systems, most of the fluid effects were implemented by traditional particle systems. Thus, only the approximate and independent particle motion was considered. Because no interaction among particles was taken into consideration, the realistic details were difficult to be generated. For the sake of reality, various physically based simulation techniques have been introduced at the cost of more intensive computation in the simulation and rendering. In particular to the effects related to the fluid simulation, they can improve the immersion. However, when compared to other physically based phenomena such as rigid body simulation, the complexity is much higher because of the high dynamics of the fluid.

In this paper, we intend to simulate liquid coupled with the motion of character, hence to achieve further advanced motion effects with realistic fluid dynamics. As commonly