Geodesic-based Time-Warped Reconstruction for Accelerated Particle-based Rendering

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ABSTRACT

Scattered, point-based primitives have become commonly used in various physical simulations and for the representation of high-precision 3D sensor data over the years. Physical simulation, in particular, requires a large amount of particles interacting with each other through various physical laws like gravity, atomic forces, electromagnetism, etc. To be accurate, a large number of particles must be used in order to approximate the real-world. Frequently the number of particles must increase as the simulation evolves in time and space [1, 2]. Visualizing large point-based data poses massive challenges in both computing scalability and rendering algorithms.

Recent advances in Graphic Processing Unit (GPU) technology provide an ever-increasing computing power to render and/or simulate point-based data. However, existing point-based rendering algorithms are not yet as efficient as regular gridded data in terms of computational scalability. This is due to the loss of topology resulting in a reduction of the effective memory throughput created by the movement of data between the CPU and the GPU. In the paper, we will present an efficient point-based rendering algorithm where careful attention to data-movement and implementation of a three-dimensional coherent cache technique is used to guaranty speed and efficient usage of the hardware. Using a new custom caching feature of the latest GPU hardware, we will demonstrate that large efficiency speed-ups are possible.

Even with a fast, scalable rendering implementation, the ability to effectively extract useful information from the point-based data is also a challenge. Recent point-based rendering algorithms using radial kernel to reconstruct an apparent surface have been developed with good computational efficiency. Unfortunately many of those algorithms are not very good at highlighting sharp features across multiple scales, or at smoothing noisy data in a dynamic and adjustable way. In this paper, we present a new geometrically-based time-warped reconstruction algorithm, allowing higher quality reconstruction with effective noise removal and multi-scale capability without loss of precision of large structures.

REFERENCES

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