Shuyi Liu, J Comput Sci Syst Biol 2015, 8:3
http://dx.doi.org/10.4172/0974-7230.S1.012

OMICS International
conferenceseries.com

International Conference on
Big Data Analysis and Data Mining

May 04-05, 2015 Kentucky, USA

Cuda-based parallel line integral convolution on gpu For high-performance visualization of large flow data

Shuyi Liu
Paul Laurence Dunbar High School, USA

Scientific visualization is an important application of computer graphics to scientific computing by providing deep insight into the complex pattern underlying big data, while *flow visualization* is crucial for visual data analysis in oceanographic-atmospheric modeling, computational fluid dynamics simulation, and electro-magnetic field study that involve in-depth exploration and interpretation of directional information. *Line Integral Convolution (LIC)* is a texture-based flow visualization technique for creating a realistic high-resolution representation of the global structure and local detail of the flow. One major issue with LIC is the high computational cost, which restricts its applicability to visualization of massive flow data. The coherence between the intrinsic parallelism of LIC (with image synthesis on a per-pixel basis) and the parallel computing capability of *CUDA (Compute-Unified Device Architecture)* for *GPU (Graphics Processing Unit)* allows for CUDA-based parallel generation of an LIC image on GPU, with all pixels synthesized simultaneously as opposed to the serial (one-by-one) mechanism on CPU.

This research addresses *CUDA-based parallel LIC on GPU for high-performance visualization of large flow data.* Built on a thorough investigation of the pipeline and implementation detail of CPU-based LIC, the innovative work consists in the design and implementation of a GPU-based LIC pipeline through CUDA. In addition, a Win32 program called *cudaLIC* has been developed and applied to the visualization of two large real flows (the Northeast Pacific ocean flow and Hurricane Isabel wind flow) for effective as well as efficient pattern analysis, with up to 30X speedup over CPU-based LIC yet with the same image quality.

Biography

Shuyi Liu is a junior at Paul Laurence Dunbar (PLD) High School, Lexington, KY. As a member of the prestigious MSTC (Math, Science, and Technology Center) program of PLD, he has accomplished a variety of AP classes such as “AP Computer Science AB” (including Java Programming), while he currently participates in the PLD Robotics club. With a strong passion for computer science, Mr. Liu is particularly interested in computer graphics, scientific visualization, image processing, parallel computing (through CUDA-based GPU programming), and GUI programming. Since the 2014 fall semester, he has been doing research on image processing under the supervision of Dr. Ruigang Yang (Professor of Computer Science at the University of Kentucky). Recently Mr. Liu won a second-place award at the Central Kentucky Regional Science and Engineering Fair (Feb 2015) under the “Computer Software” category and has been invited to attend the Kentucky State Science and Engineering Fair (March 2015).

zhanping.liu@kysu.edu

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