A High Performance Route-Planning Technique for Dense Urban Simulations

John J. Tran and Robert F. Lucas
Information Sciences Institute, Univ of So. Calif.
Marina del Rey, California
{jtran, rflucas}@isi.edu

ABSTRACT

To exploit the explicit and implicit advantages of data parallelism and heavily threaded modern multi-core processors, specifically the NVIDIA family of general purpose graphic processing unit (GPGPU), research efforts such "Accelerating Line of Sight Computation Using GPUs" [Manocha 2005] and "Implementing a GPU-Enhanced Cluster for Large-Scale Simulations" [Lucas 2007] addressed the various problems found in military simulations,. Yet there remain many other practical uses for the GPU in these types of simulation applications. An example application that has immediate use for a fast and large-scale graph-based construct is a route-planning algorithm found in complex urban conflict simulation, *e.g.* the Joint Semi-Automated Forces (JSAF) simulation. JSAF currently employs a heuristic A* search algorithm to do route planning for its millions of entities -- the algorithm is sequential and thus very computationally expensive. Using the GPU, the JSAF simulation can off-load the route planning component to the GPU and remove one of its major bottlenecks.

The objective of this research effort is to build a framework that utilizes all the features and raw computational power of the GPU architecture to solve the above challenge. Our research effort addresses the many challenges of parallel programming on the GPU, *e.g.* data locality, massive thread counts, and race conditions, to name a few. Our project will greatly benefit the modeling and simulation community facing issues specific to route-planning and of particular interest are those simulations dealing with dense urban environments, homeland security, and mass casualty and disaster simulations. We achieve this goal by providing a practical and seemingly "endless" source of raw computing powers found in GPUs for massively large graph-based family of problems.

ABOUT THE AUTHORS

John J. Tran, a researcher at ISI/USC, is currently pursuing a doctorate in Computer Science from the Viterbi School of Engineering at the University of Southern California. He received both his BS and MS Degrees in Computer Science and Engineering from the University of Notre Dame, where he focused on Object-oriented software engineering, large-scale software system design and implementation, and high performance parallel and scientific computing. He has worked at the Stanford Linear Accelerator Center, Safetopia, and Intel. His current research centers on Linux cluster engineering, effective control of parallel programs, and communications fabrics for large-scale computation..

Robert F. Lucas is the Director of the Computational Sciences Division of the University of Southern California's Information Sciences Institute (ISI). There he manages research in computer architecture, VLSI, compilers and other software tools. He has been the principal investigator on the JESPP project since its inception in 2002. Prior to joining ISI, he was the Head of the High Performance Computing Research Department for the National Energy Research Scientific Computing Center (NERSC) at Lawrence Berkeley National Laboratory, the Deputy Director of DARPA's Information Technology Office, and a member of the research staff of the Institute for Defense Analysis's Center for Computing Sciences. From 1979 to 1984 he was a member of the Technical Staff of the Hughes Aircraft Company. Dr. Lucas received his BS, MS, and PhD degrees in Electrical Engineering from Stanford University in 1980, 1983, and 1988 respectively.