CASE STUDY

High Performance Computing
2nd Generation Intel® Xeon Scalable Processors
Intel® Select Solutions for HPC
Intel® Omni-Path Architecture
Intel® oneAPI Rendering Toolkit

NIU and Atipa Technologies Tap Intel® Select Solutions for Innovative Approaches to Scientific Visualization

Northern Illinois University (NIU) team inspires next generation of visual scientists with large, interactive display for simulation and modeling

Solution Ingredients

- Atipa Polaris High Performance Computing and Visualization (HPCV) platform
- Intel® Select Solutions for Simulation & Visualization
- 2nd Generation Intel® Xeon® Scalable processors
- Intel® Omni-Path Architecture
- Intel® OSPRay and Intel® Embree, part of the Intel® oneAPI Rendering Toolkit

"Atipa and Intel's infrastructure makes it possible to train the next generation of visualization experts with advanced tools and software infrastructure they will encounter in most advanced industry settings."

– Michael E. Papka, NIU professor of computer science

Executive Summary

Researchers at Northern Illinois University (NIU) seek new ways to visualize complex data involved with astrophysics, bio-sciences, and much more. With support from Atipa Technologies and Intel® Select Solutions for Simulation & Visualization, the NIU team has the compute power needed to resolve large-scale simulations, including virtual reality (VR) and augmented reality (AR) scenarios. A central feature of NIU's visualization solution is a 16-foot by 8-foot display that allows scientists to see content at a level of detail not possible before. The unique display solution's user-tracking interface also lets scientists interact with it physically rather than using a keyboard or mouse. As a result, both scientists and non-scientists can tap the system's full potential.

Challenge

NIU is interested in the research and development of more effective ways to visualize and interact with complex data sets in three dimensions (3D) in order to derive new insights. Legacy approaches proved incapable of rendering the detail needed. The team sought to provide users new and intuitive ways to interact with their simulation data, in real time, without relying on a keyboard and mouse. The HPC system backing the visualization solution needed underlying infrastructure capable of supporting both the real-time and interaction requirements.

Solution

With the assistance of Atipa Technologies, NIU implemented Intel Select Solutions for Simulation & Visualization to power its unique simulation system. The NIU system, named Hopcroft, joins a lab comprised of Internet of Things (IoT) devices, tracking cameras, and a 16-foot by 8-foot tiled display wall. Hopcroft enhances the capabilities of the lab adding advanced computing capabilities for software, the Intel® oneAPI Rendering Framework and Intel® Omni-Path architecture. The resulting system offers researchers the ability to tackle challenging real-time data exploration in a more interactive and insightful way.

Results

NIU's Hopcroft visualization system will be used by students and researchers to explore complex concepts like human blood flow, brain structure, and exploding stars. Because Hopcroft is integrated into the lab, it has access to tracking cameras combined with commodity gaming input devices as an interface method, and offers new ways to interact with simulations involved in both science and visual arts workloads.

Figure 1: (top) Professors Michael E. Papka and Joseph Insley in front of NIU's ddiLab display wall. The image rendered on the wall is from a simulation of a massive blue star created by Insley using ParaView running on Hopcroft. Data courtesy of Lars Bildsten and Yan-Fei Jiang, University of California at Santa Barbara.

Figure 2: (bottom) Professor Papka working with an NIU undergraduate student on the tracking of 3D printed objects as tangible virtual display surfaces within an AR environment.

Modern visualization approaches require highly-performant HPC solutions

In the past, NIU's visualization techniques depended on desktop compute systems. However, the performance characteristics of those systems created bottlenecks. Desktop systems could not handle the computational scale and rendering capabilities needed for massive, data-centric projects at NIU.

Given Atipa's track record of success with HPC implementation, NIU brought in their experts to assist in procuring and deploying the needed HPC infrastructure, toolkits, and software. The open source ParaView application, used for analysis and visualization-based workloads, provides supplemental capability.

Solution Details

The combination of Atipa's Polaris Select HPCV platform and Intel Select Solutions offer NIU a more turnkey HPC system for rapid deployment. This, in combination with optimization through Intel® OSPRay and Intel® Embree libraries (part of the Intel oneAPI Rendering Toolkit), of the ray-tracing algorithms involved in Hopcroft's functionality, eliminate the need for supplemental graphics-accelerating processors.

Intel oneAPI Rendering Toolkit's Message Passing Interface (MPI) increases system scalability by combining HPC nodes to make the best use of the available memory pool. In doing so, NIU's system can accommodate data sets in the multi-terabyte range.

Intel® Select Solutions for HPC and AI

Intel® Select Solutions for High Performance Computing (HPC) offer easy and quick-to-deploy infrastructure that removes the complexity of advanced computing and helps accelerate the time to actionable insights for users in industry and science. Our portfolio includes workload-optimized configurations for Simulation & Modeling, Professional Visualization, Genomics Analytics and the newest HPC solution, HPC & AI Converged Clusters. Each of these solutions shares a common base architecture and complies with the Intel HPC Platform Specification. This offers each solution the advantage of validated compatibility with a wide range of HPC workloads, including those listed in the Intel HPC Application Catalog.

Intel Select Solutions for Simulation & Visualization builds on the Simulation & Modeling solution and allows users to process massive data sets concurrent with simulation runs through in-memory computing and open source libraries that are optimized on Intel® Xeon® Processors. As a result, users are able to create photorealistic and interactive visualizations to more quickly gain insights and more effectively communicate new product designs and research breakthroughs.

Explore the Intel Select Solutions for HPC capabilities and performance optimized configurations at **www.intel.com/selectsolutions**.

NIU Inspires Next-Generation Artists, Too

While Hopcroft most often powers scientific workloads, Associate Research Professor Joseph Insley from the Northern Illinois University School of Art and Design is engaging visual artists at NIU to tap its potential. The advent of computer-generated imagery (CGI) presents opportunities for increasingly-realistic films and 3D art. The combination of VR, AR, and the lab's massive screen size offers designers new tools to create immersive experiences not possible with conventional desktop systems.

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Lessons Learned

Implementing the large visualization solution at NIU revealed unique considerations:

High definition imaging involves enormous screens for accurate visual detail. NIU found that a combination of sixteen screens, working in tandem, provided ideal capability for creating massive simulations capable of resolution down to the single pixel level.

Spotlight on Atipa Technologies

Headquartered in Lawrence, Kansas, Atipa Technologies is a leading provider of cost-effective high-performance computing and storage solutions to government, academic, and private institutions in the United States. Atipa's solutions supported more than 60 systems noted on Top500.org's lists of the fastest supercomputers in the world.

For more information, visit:
www.atipa.com

Hopcroft's real-time compute capabilities along with the Data, Devices, and Interaction Laboratory's (ddiLab) massive monitor enable a more human in the loop experience for simulation scientists.

While today's HPC system offer ample performance, the NIU team found that obtaining good data, curating it, and comparing it in preparation for Hopcroft proved an important element for success.

Learn More

https://www.atipa.com/hpc-visualization

https://www.intel.com/content/www/us/en/products/solutions/select-solutions/hpc/professional-visualization.html

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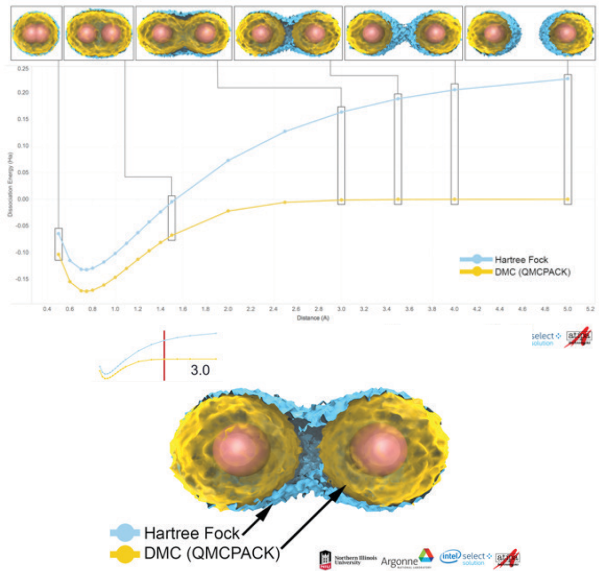

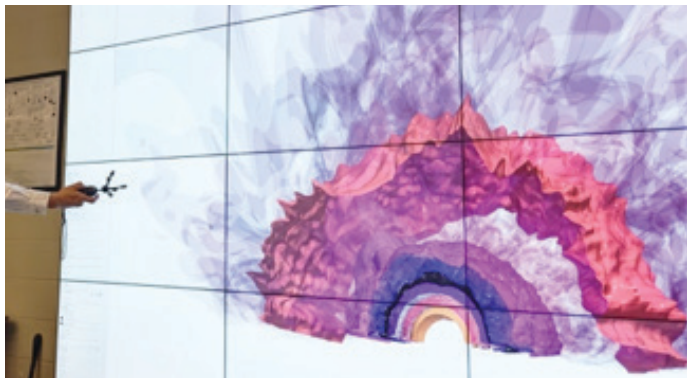

Figure 3: (top) Visualization of comparison of electron density approximation methods, rendered on Hopcroft using the molecular visualization program visual molecular dynamics (VMD). Simulations were run on Hopcroft by researchers Dr. Anouar Benali from Argonne National Laboratory Division of Computational Science and Professor Ralph Wheeler from the Northern Illinois University Department of Chemistry and Biochemistry.

Figure 4: (bottom) Using tracking cameras and reflective markers coupled with a game controller, students can utilize natural methods for interacting with data visualizations on the display wall.

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