GPU Computing at UMD

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http://gvil.umiacs.umd.edu
**Chimera: UMD GPU-CPU Cluster**

**The Team:**

Amitabh Varshney (PI)
Rama Chellappa (Co-PI)
Ramani Duraiswami (Co-PI)
Joseph JaJa (Co-PI)
Dianne O’Leary (Co-PI)
Shuvra Bhattacharyya
Michael Cummings
Larry Davis
Leila DeFloriani
Howard Elman
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David Jacobs
Fritz McCall
David Mount
Hanan Samet
Alan Sussman

**Summary:**
Build upon the synergies in coupling GPUs (Graphics Processing Units), CPUs, displays, and storage to address a variety of computational and scientific problems
Research Applications

Interleaved Computation and Visualization

- **High-performance Computing**
  - Querying and Visualization of Large Scientific Datasets

- **Scientific Computing**
  - Linear Algebra, PDEs, Linear Programming

- **Scientific Visualization**
  - Visualization-assisted Computational Steering for Protein Studies

- **Virtual 3D Audio**
  - Real-time Soundscape Rendering

- **Computer Vision**
  - Modeling and Visualization of Humans and their Activities

Data Streaming Applications
Additional New Research Areas

- Computational Genomics
- Computational Astrophysics
- Numerical Relativity
- High-energy Plasma Physics
- Automated Nano-assembly
- Climate Modeling
- Web Archives
- Computer-Aided Manufacturing
CS Advances on GPUs at UMD

- *Parallel Algorithms – Prefix Sum, List Ranking*
- *Searching and Sorting on GPUs*
- *Matrix Factorization and Linear Programming*
- *Fast Multipole Methods*
- *Neural Networks*
- *Image and Video Processing*
- *Mesh and Tetrahedral Processing*
- *High-Performance Visualization*
Sponsored GPU Research at UMD

- Geometric Computing for Macromolecules – NSF
- Hardware-accelerated Data Visualization – ARL
- Cultural Visualization Engine – DOD Navy
- FlexiView – DARPA
- Automated Nanoscale Assembly – NSF
- GPU Computing for Tree of Life – NSF
- Auditory Virtual Environments – DARPA
- Chesapeake Bay Forecasting – NOAA
Participants

• **Over 20 faculty spread across:**
  – College of Computer, Mathematical and Physical Sciences
  – A. James Clark School of Engineering
  – College of Chemical and Life Sciences

• **Over 60 graduate students have directly participated in programming and research on GPUs**

• **Graduate courses on Scientific Computing, Spatial Data Structures, and Graphics** – roughly 40 students each year

• **Undergraduate Lab equipped with GPUs**
GPU Projects at UMD

FlexiView (Vision + Graphics)

Amitabh Varshney, Rama Chellappa, Larry Davis, Art Pope, Yanlin Guo
Rob Patro, Aswin Sankaranarayanan, Roman Stanchak, Kaushik Mitra, Anirudh Kembhavi
Isosurfaces and Volume Rendering

Jusub Kim, Qin Wang, Sujal Bista, Cheuk Ip, Derek Juba, Rob Patro
Joseph JaJa, Amitabh Varshney

GPU Projects at UMD

- Medical Image Registration
  Omkar Dandekar, Raj Shekhar

Rigid Registration

Elastic Registration
Multiview Markerless Motion Capture

Rama Chellappa (Computer Vision)

- Voxelize and use Laplacian Eigenspaces for segmentation
- Skeletonize and probabilistically register to Human body

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Summary

• Relevance for a surprisingly large number of applications in science, engineering, and medicine

• Commodity Supercomputing

• Effective and fun platform for parallel programming and parallel algorithms