Interactive Visualizations

Standard axis-aligned slices

Rapid reconstruction affords quick injection of more involved visualizations/renderings:

- arbitrary slices (non-axis aligned slices) → 3D slicing
- 3D X-ray views from arbitrary view points
- full 3D volume renderings

All have been shown to run at 20-30 frames/s

- recall, GPUs are meant for graphics
- data is already in texture memory
- simply load another kernel into the shaders
- frames (projections) produced for visualization have similar costs than frames (projections) consumed for reconstruction

Streaming CT

Reconstruct (consume) incoming (produced) projections without buffering

- from 360 1024² projections to a 512³ volume at full floating point precision
- as shown, latest GPUs can achieve 30 projections/s reconstruction speed

Streaming CT With Direct Visualization

Watch the object evolve as it is acquired
CT Reconstruction Cockpit

Edit/tune on the fly:
- parameters
- projection sets
- algorithms

Couple with 2D/3D visualizations

Rapid and Extensible Software Development for Medical Imaging

eXtensible Imaging Platform:
- visual programming tool supporting interactive design of 2D/3D imaging pipelines and scene graphs
- open source environment with a host-plugin structure
- ITK/VTK/DICOM support

High-Performance Computing

Leverages the processing power of modern GPU graphics cards
- Fully programmable using the GLSL language
- Great flexibility for researchers to implement new image processing ideas

Showcase: programmable 3D volume rendering and MPR
- supports multiple volumes fused in the same scene
- synchronized 3D navigation of oblique MPR planes
CUDA Integration

Easy integration of existing CUDA kernel programs
Global memory management for both CUDA and mexture memory;
Provide CUDA-accelerated algorithms (distance transf., PDE solver, etc.)
Check MICCAI HPC workshop 2008 paper
"Scene graph-based construction of CUDA kernel pipelines for XIP"

Demonstrated Value of XIP Platform

Ongoing projects based on Open XIP – Government & Academia

- miRO Open Source imaging libraries and XIP Builder Tool
- miRO AVT Project (Algorithm Validation Toolkit)
- DoD TATRC/ACR's interoperability in Medical Imaging
- DARPA deep brain seizure mapping
- National Institutes of Health
- mHDI Optical Imaging for Drug Therapy Monitoring
- XIP’s collaboration with RTI on CBF imaging for XIP
- Northwestern University collaboration on multi-resolution histopathology

Check documents and downloads from:
https://collab01a.scr.siemens.com/xipwiki/index.php/Main_Page

Final Remarks

Have shown that:
• GPUs are an excellent and very flexible platform for CT reconstruction
• GPUs are bound to become even more attractive for this purpose
• additional advantages provided by excellent visualization capabilities
• CUDA and CTM provide a more intuitive programmer interface for MIC-GPU computing
  - thread management
  - memory management
  - access to more generalized computational resources
  - but without the extra benefit of super-fast interpolation, rasterization, texture interpolation, clipping, culling, etc

Final Remarks: Recap

Introduction
Graphics-style GPU programming with CG
GPGPU-style GPU programming with CUDA
GPGPU-style GPU programming with CUDA
CT reconstruction pipeline components
GPU-accelerated CT reconstruction
Extensions and final remarks
Further Information

Check at http://www.rapidCT.com for latest:

- tutorial updates
- fragment code samples
- executable applications of all routines (soon)
- applications
- publications
- contacts info
- community news and feedback

Any Questions?