MIC-GPU: High-Performance Computing for Medical Imaging on Programmable Graphics Hardware (GPUs)

Extensions and Final Remarks

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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

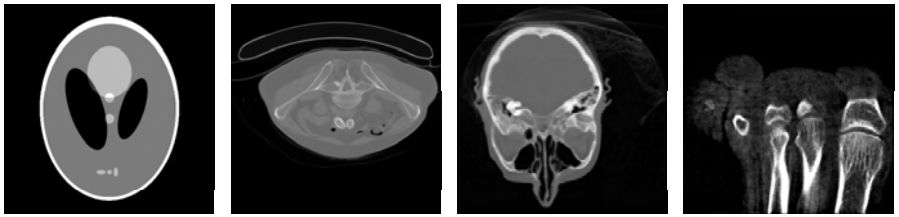
All have been shown to run at 20-30 frames/s

- 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

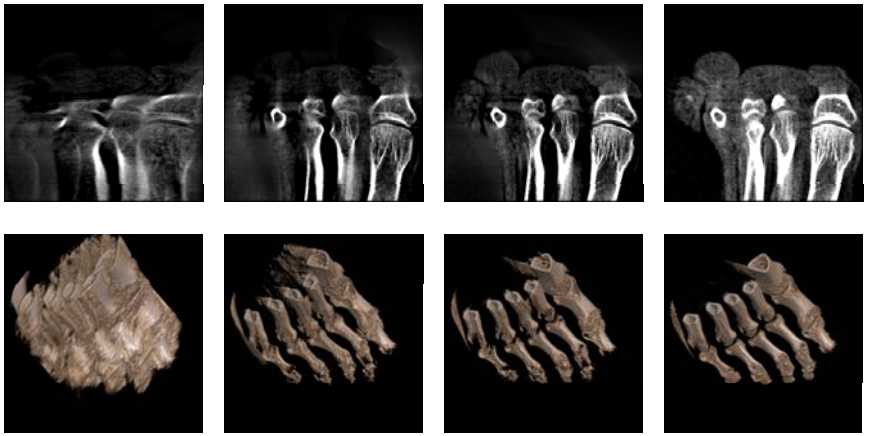
Reconstruct (consume) incoming (produced) projections without buffering

- from 360 1024^2 projections to a 512^3 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

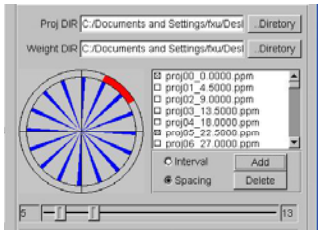


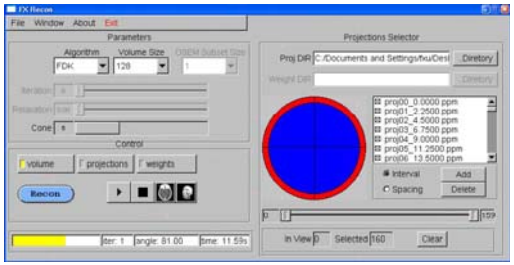
CT Reconstruction Cockpit

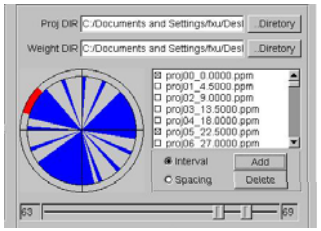
Edit/tune on the fly:

- parameters
- projection sets
- algorithms

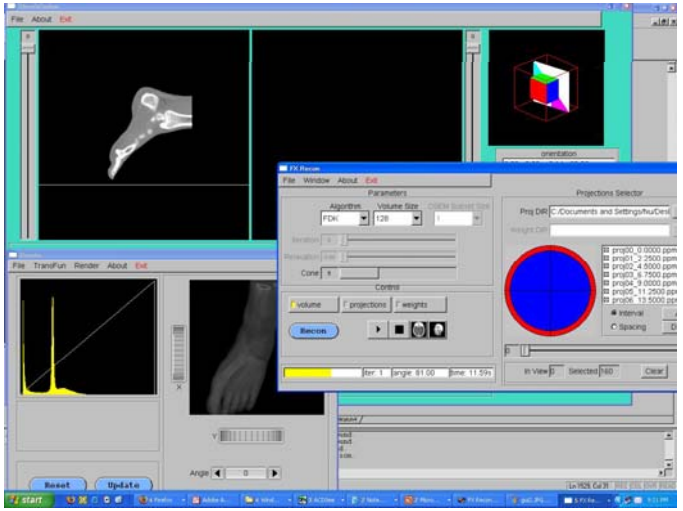
Couple with 2D/3D visualizations







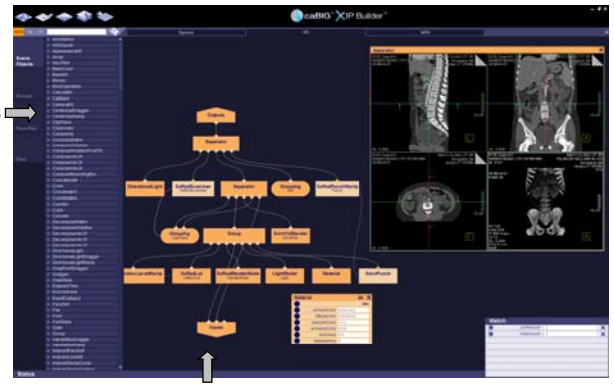
CT Reconstruction Cockpit



Rapid and Extensible Software Development for Medical Imaging

e**X**tensible **I**maging **P**latform:

- 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

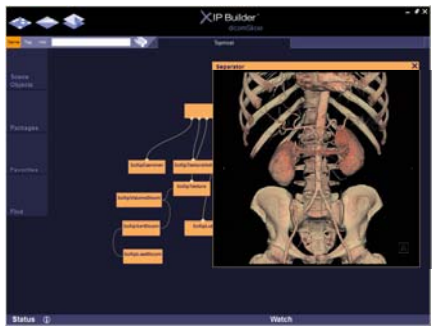
Leverages the processing power of modern GPU graphics cards

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

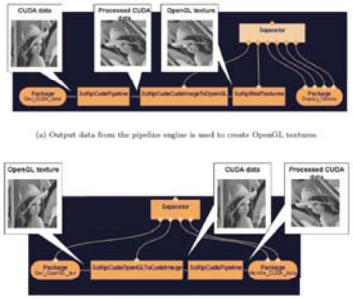
Easy integration of existing CUDA kernel programs

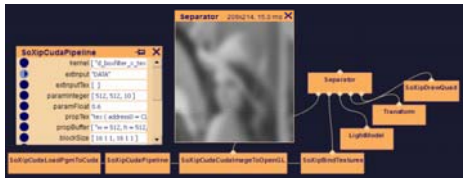
Global memory management for both CUDA and mexture memory;

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"





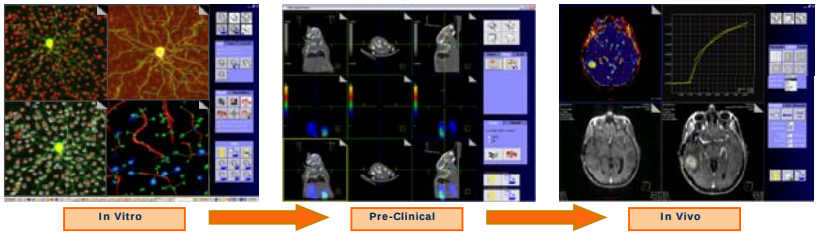
Demonstrated Value of XIP Platform

Ongoing projects based on Open XIP – Government & Academia

- caBIG Open Source imaging libraries and XIP Builder Tool
- caBIG AVT Project (Algorithm Validation Toolkit)
- DoD TATRC/ACR's Interoperability in Medical Imaging
- DARPA deep-bleeder acoustic coagulation
- Beth Israel Intraoperative Fluorescent Imaging
- NTROI Optical Imaging for Drug Therapy Monitoring
- caBIG AIM Project (Annotation Imaging Markup based on XIP) - Northwestern Univ.
- CenSSIS collaboration with RPI on Cellular Imaging for XIP
- UPENN collaboration on multi-resolution histopathology

Check documents and download 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?