Software tools for on demand slice reconstruction

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It is infeasible to reconstruct entire 3D volume in real-time
Possible to reconstruct individual slices
Show these slices in context
  ▶ 2D slices together in 3D space
  ▶ Low resolution 3D preview
In a setup with many degrees of freedom, context is especially important. Show projections and acquisition geometry together with reconstruction
Rich feedback gives intuition even if the user is unfamiliar with the application
On demand reconstruction

Idea:

- Show slices of which the orientation can be changed
- While changing the orientation of a slice, a low-resolution preview from a 3D reconstruction is shown
- When a new orientation is chosen, the new slice is reconstructed on-the-fly

To realize this, we need to revisit the way we implement the tomography pipeline.
Simple pipeline

Acquisition

Scanner → Cluster

Reconstruction

Workstation

Visualization
Show the acquisition geometry together with the reconstruction
Show the projection images relative to the reconstruction
Any other (diagnostic) information for the acquisition that is relevant to the reconstruction
Reconstruct *on demand*

The building block for realizing the real-time slicer idea
(Outlook)

- Measure *on demand*, control experiment
- Visualizer and control software in one package
Cluster → Scanner

![Diagram showing the relationship between Cluster, Scanner, Acquisition, Reconstruction, Workstation, and Visualization]

(Outlook)
- Algorithm controlled dynamic measurements
Outline

1 Motivation

2 Technology and Software

3 Demo
Extending the pipeline

- We want all of the components to be able to interact in real-time
- Communication is done using packets, that manage the scene, and represent changes, updates, ...
- Important requirement: framework should support all pipeline topologies, arbitrary (physical) locations of components
Slicing tool

Current situation:

Acquisition

Simulation

Cluster

Workstation

Reconstruction

Visualization
Slicing tool

- Implementation of the extended pipeline in a software package
- Proof-of-concept; control center for a distributed reconstruction pipeline
- Extensible software. Independent modules:
  - Scene management
  - Reconstruction
  - Geometry
  - Easy to add more modules, e.g. *Partitioning*
  - ...
Slicing tool
Technology

- Written in C++, with Python bindings available
- Current implementation based on:
  - ZeroMQ for communication
  - OpenGL for visualization
- Standardized description of acquisition geometries and data
- Communication protocol based on message passing
- Visualization server as the control center

All these components are independent, and will all be available as open source software.
import tomop

def callback(orientation):
    return slice_data(orientation)

server = tomop.server("Shepp–Logan")

server.set_callback(callback)

server.serve()
Outline

1. Motivation
2. Technology and Software
3. Demo
In a real-time setting, we can show and reconstruct (ortho)slices instead of 3D volumes. By showing these in context, we try to regain some of the intuition we get from a full reconstruction. We are experimenting with ways to realize a simple real-time pipeline.