RITK: The Range Imaging Toolkit

Sven Haase, Jakob Wasza, Sebastian Bauer
20.05.2013
Pattern Recognition Lab (CS 5)
Outline

- Motivation
- Fundamental Ideas
- Example Applications
- How To Install?
- Demo
Motivation

- Recent advances in range imaging (RI) induce the need of a framework dedicated to real-time processing RI streams
  - High Resolution (~300k Points) and real-time framerates (up to 90 Hz)
  - Low-cost Devices (~ $150)
  - Multitude of Applications (e.g. Augmented Reality, Medical Engineering)
Motivation

- **XGRT**
  - Open Source, rapid prototyping, pointclouds
  - Last update 02.2009

- **PCL**
  - Open Source, 2-D/3-D images, algorithms
  - Was only a library/collection without streaming

- **MITK**
  - Open Source, built upon vtk/itk
  - No real-time optimization
## Fundamental Ideas (Concepts)

<table>
<thead>
<tr>
<th>Object oriented, Cross-platform, C++</th>
<th>Dynamically loadable plugins/modules</th>
<th>Integration of special hardware</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Regular Library</td>
<td>• RI Sensors</td>
<td>• High Performance</td>
</tr>
<tr>
<td>• Application Framework</td>
<td>• Custom Filters</td>
<td>• Real-time Capability</td>
</tr>
<tr>
<td>• Rapid Development</td>
<td>• Sandbox Apps</td>
<td>• Heterogeneous Preprocessing</td>
</tr>
<tr>
<td>• State-of-the-art Programming</td>
<td>• RI Solutions</td>
<td>Pipeline</td>
</tr>
<tr>
<td>Paradigms</td>
<td>• Distribution of existing Modules</td>
<td>• Convenience Interface for</td>
</tr>
<tr>
<td>• MITK integration</td>
<td></td>
<td>GPGPU</td>
</tr>
</tbody>
</table>

Do not reinvent the wheel: build upon existing established libraries
Fundamental Ideas (Modules)

**ritkCommon**
- RI Data
- Pixel Container
- Pinhole Camera Projection

**ritkCore**
- Acquisition Pipeline
- Plugin Wrappers
- Main Application

**ritkCuda**
- GPGPU Interface
- Convenience Methods and Macros
- Raycaster

**ritkStatistics**
- Statistical Models
- Projective ICP
- PCA

**ritkVisualization**
- OpenGL Representations
- Control Units

**ritkVolumetric**
- Specific Raycasters
- Truncated Signed Distance Function

**ritkVTK**
- VTK Actor Pipeline
- Static VTK Visualization
Fundamental Ideas (Pipeline)

Assemble RI Solutions at Run-Time
Fundamental Ideas (GPU Pipeline)

**Figure:** Naive Approach of GPU Integration

**Figure:** Minimizing Copy Overhead
Fundamental Ideas (File Format)

- Compact RITK file format (header + payload) for:
  - static range images
  - range image streams

- Existing code to export:
  - vtk
  - ascii
  - mhd
  - png
  - …

Figure: Data format of a range image sequence
Fundamental Ideas (Multi Sensor)

- Stereo calibration for relative transformation
- Data fusion based on all data sources:
  - Conventional common visualization
    - Separated visualization
    - 3-D comparison for different sensors
    - Issues for overlapping regions
  - Volumetric fusion using a *Truncated Signed Distance Function*
    - Implicit smoothing
    - Generate RIs using a raycaster
Example Applications (Instrument Localization)
Example Applications (Patient Positioning)

CT/TOF data.

Left: correspondences. Right: initial registration.

Refinement.
Example Applications (Respiratory Motion)
How To Install?

- Download at http://www5.cs.fau.de/ritk
- Follow the instructions in the documentation
- Download additional files depending on your needs
  - CUDA Toolkit
  - QT
  - ITK
  - VTK
  - Libnoise
  - …
Demo
Thank you