Visualisation using Knowledge Assisted Sparse Interaction

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Overview of Presentation

- Knowledge-Assisted Visualization
  - LiveSync: Knowledge-Based Navigation
  - Contextual Picking
  - Knowledge-Assisted Sparse Interaction
  - Semantics Driven Illustrative Rendering

- Smart Super Views

LiveSync: Knowledge-Based Navigation

- Interaction with 2D slices
- Automatic generation of expressive 3D views

Contextual Picking - Overview

- Knowledge Base
- Contextual Profiles
- Initialization
- Loading Data Set
- Contextual Profile Selection

Contextual Picking - Results

KASI Project

- Knowledge Assisted Sparse Interaction for Peripheral CT Angiography

The KASI Framework (software)
- Interaction level
- Algorithm level

User interaction
- Application design mode (designer)
- Specification of controls and details
- Diagnostic evaluation mode (radiologist)
Overview of Presentation

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- Smart Super Views

Smart Super Views - Motivation (1)

- A Knowledge-Assisted Interface for Medical Visualization
  - PACS workstation

Smart Super Views - Motivation (2)

- Slice Views
- Curved Planar Reformation Views

Smart Super Views - Motivation (3)

- Currently
  - a lot of views
  - always shown, even if not applicable

- Goals
  - only relevant views
  - shown if suitable

Outline (1)
Outline (2)

- Views depend
  - on user interaction
  - on the region under the cursor
- Views interactively provided
- Selection of a view for detailed inspection

Image becomes the user interface
Rule Specification (1)
- Relations between input and output
- User-defined rules
- If-then clauses

Input Layers:
- Vessel
- Bone
- VesselTree
- Slice

Output Views:
- Vessel (CPR)
- Bone (DVR)
- Tissue (DVR)
- Slices (sagittal, coronal, axial, oblique)

If vessel is low and bone is high then view is... 
If vessel is high and bone is high then view is tissue...

Rule Specification (2)
- Rules stored in an external file
- Adapted to specific demands of users
- Defined by domain experts
- Flexible extension by adding new rules
- Human readable form

User Interaction
- User defines a ROI by moving the mouse
- Compute input values for all variables
- Layers are used inside the ROI

One value for every input variable
- Sum over all pixels inside the ROI
- Pixels weighted with distance to center
- Specific layers for input variables

View Ranking
- Fuzzy logic for the inference system
- Fuzzy Inference System
- Fuzzy rules specified by domain experts

Fuzzification Implication Evaluation Aggregation Defuzzification
Smart Super Views

Visual Mapping (1)

- Super ellipse
  - \( n = 0.5 \)
  - \( n = 2 \)
  - \( n = 4 \)

- Various shapes with one parameter
- View relevance mapped to the exponent
- Highly relevant views are
  - bigger
  - rectangular

Visual Mapping (2)

Shape mapping function
- Avoid very thin star shapes
- Cover most dominant shapes (rectangles, circles, stars)

\[ \frac{x - x_{\text{pos}}}{\text{size}} + \frac{y - y_{\text{pos}}}{\text{size}} \leq 1 \]

Size of view in pixels
- Increased if view selected

Results

Results (1)

Results (2)
Smart Super Views - Conclusion

- Provide intelligent views
- Image becomes the user interface
- Deployable as an addition to the PACS workstation
- Applicable to other scenarios
  - Geo maps
  - CAD programs

Feedback

- Smart Super Views provide
  - only relevant views
  - more interaction than static images (seen as fairly easy)
  - intuitive discrimination of views (with basic knowledge of underlying algorithms)
- Interaction: zooming, rotating, panning, windowing function, transfer function
- Additional view in a radiologists workflow

Scenarios (1)

- MIP or CPR solely not sufficiently accurate
- Some pathologies might remain unrevealed
- Most accurate is MIP + axial slices
- Provided by defining proper rules
- Axial slice image always highly relevant when using MIP or CPR

Thank You! - Questions?

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Feedback
**Scenarios (2)**

- Interdisciplinary medical discussion rounds
  - Radiologist
  - Clinician
  - Surgeon
- Different requirements and perspectives
- Encoded within specific rules

**Conclusion**

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  - Geo maps
  - CAD programs

**Motivation (1)**

Office – Ribbon
Photoshop – Main Menu
Popup Menus
Control Panels

**Results (2)**

Geo maps
CAD programs