Hybrid Medical Visualizations: Creation and Evaluation

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Outline

- Motivation and Related Work
- Combination of Several Rendering Methods
- Evaluation of the Produced Visualizations
- Conclusion & Future Work

Motivation and Related Work

• Surgery planning and education
  – Surgery planning, radiation treatment planning, tumor ablation planning
  – Computer support (usually) based on image analysis

• Segmentation information available

• Visualization in Intervention Planning Systems
  – More and more visualization options and parameters are available and useful in some cases (direct volume rendering, isosurfaces, colors, opacity maps, silhouettes, …)
Motivation and Related Work

Traditional illustrations:

- Expressive visualizations
- No interaction facilities

Motivation and Related Work

Traditional computer-supported medical visualizations:

- 3D-interaction is possible
- Context visualization hampers interpretation
  - Context structures cannot be discriminated or
  - Context is hiding the focus object
Motivation and Related Work

Computer generated line graphics with 3D-models

• Silhouettes, feature lines
  – Abstract visualization of the model
  – Support visual perception

• Hatching
  – Lighting information
  – Clarification of the objects shape
  – Surface structure of the object (like muscle fibres)

Isenberg et al. (2002) | Praun et al. (2001)
Combination of the Rendering Methods

- Conventional rendering (surface shading)
- Illustrative rendering (silhouettes and feature lines)
- Direct volume rendering (DVR)
Combination of the Rendering Methods

- Line extraction
- Depth data
- Visible lines
- 3D model
- Render shading
- Render lines
- Volume model
- Segmentation
- Mask volume
- Render volume

\[ \text{Combination of Rendering Methods} \]

\[ \text{3D model} \rightarrow \text{render shading} \rightarrow \text{mask volume} \rightarrow \text{render volume} \]

\[ \text{X} \rightarrow \text{result} \]
Combination of the Rendering Methods

- Improved context visualization
- More comprehensible renditions
- Classification in focus object, near focus object and context objects
Combination of the Rendering Methods

Visualization examples
Combination of the Rendering Methods

- Automatically adding depth cues to the lines
Combination of the Rendering Methods
Evaluation

Is the application of illustrative techniques suitable for medical visualization?

- Informal user study (8 surgeons, 12 lay people, 13 CG researchers)
- Context visualization
- Simplifying complex visualizations
- Analysis by decision tree
  - Reference image was compared with all other images
  - Number of votes was counted
### Evaluation

**Welches Bild gefällt Ihnen auf den ersten Blick besser?**

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**Auf dieser Seite geht es um die direkte Gegenüberstellung der beiden Visualisierungstechniken.**

- Wie gut ist die Leber von den umgebenden Strukturen zu unterscheiden?  
  *(gar nicht (--) bis sehr gut (++))*
- Können Sie die Lage der Leber zum Brustkorb einschätzen?  
  *(nein, überhaupt nicht (--) bis ja, sehr gut (++))*
- Wie gut sind die extrahepatischen Strukturen untereinander differenzierbar?  
  *(gar nicht (--) bis sehr gut (++))*
- Mit welchem Bild würden sie sich auf eine Tumorresektion vorbereiten wollen?  
  *□*
Evaluation: Compared Visualizations
Evaluation: Interpretation

- In general, less context information is preferred
- Basic information about all objects is necessary
- b/w-silhouettes are not sufficient for displaying context
- Emphasize affected vascular territories using silhouettes regarded as appropriate by six of eight surgeons
Conclusion

• Method to enhance visualizations by combining surface shading, silhouettes, and volume rendering
• Visualizations from actual data sets
• Automatic removal of self-occluding lines
• Interactive presentation possible
• Evaluation by surgeons and lay people
  – Application of illustrative techniques was assessed as helpful
  – Illustrative techniques cannot replace but enhance conventional rendering techniques
Future Work

• Improve technical quality of illustration techniques
• Integration of further illustration techniques
  – Hatching
  – Stippling
• Continue evaluation of computer-generated visualization techniques
• Derive requirements from illustrators/graphic designers for the tools we create
Thank you for your Attention!

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