EVALUATION OF ARTERY VISUALIZATIONS FOR HEART DISEASE DIAGNOSIS

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NON-INVASIVE DIAGNOSIS

Obtain patient CT data
Segment arteries
Generate patient geometries
Clinical decision
Visualize and analyze data

DATA

plaque
low ESS
very low ESS

This can rupture and give you a heart attack!

Data: initial disease

Initial disease

Low ESS = BAD
cannot directly measure ESS in living patients!

DATA

• ESS Vessel Visualization

• 2D vs. 3D Evaluation
  [e.g., Cockburn & McKenzie (2002), Laidlaw, et al. (2005), Troy, et al. (2007), Forsberg et al. (2009)]

• Semi-structured interviews
  • 10 medical doctors and researchers
  • Brigham & Women's Hospital (Boston, MA)

FORMATIVE QUALITATIVE STUDY

Visualize and analyze data
Clinical decision

3D vs. 2D rainbow vs. diverging
QUANTITATIVE STUDY: GOALS

• 21 Harvard Medical students (12 women and 9 men)
  • Mixed within-subject and between-subject design:
    - within = dimensionality of representation (2D or 3D)
    - between = color mapping (rainbow or diverging)

• Dependent measures:
  - fraction of low ESS regions identified
  - number of false positives (i.e., non-low ESS regions identified as low ESS)
  - time to complete a diagnosis

QUANTITATIVE STUDY

COLOR

Preferred (standard)
Non-rainbow favorite!
Too "radiological"

COLOR

3D
LAYOUT AND PROJECTIONS

COLOR

QUANTITATIVE STUDY

3D vs. 2D
rainbow vs. diverging

e.g., Participant A
e.g., Participant B
QUANTITATIVE STUDY

RESULTS

Strong effect of dimensionality on accuracy
39% How many low ESS regions found?
62%

ACCURACY

39% How many low ESS regions found!
91%

How many low ESS regions found?

Participants more efficient in 2D.

EFFICIENCY

Rainbow color map has greater effect on efficiency in 3D.

EFFICIENCY

2.6 sec/region 10.2 sec/region

SUBJECTIVE RESPONSES

I found it easy to identify low ESS regions.
I was able to perform the task efficiently.
I am confident I found all the low ESS regions.
I am confident all the places I marked are really low ESS.

CONCLUDING REMARKS

• 3D representation is still essential for surgical planning
• 2D tree diagram applicable to other applications
• Quantitative study convinced our users of good visualization practices

FINDINGS SUMMARY

• Domain experts important for design and evaluation
• Even for 3D spatial data, a 2D representation is more accurate for spatial tasks
• more efficient for spatial tasks
• Rainbow color map is not accurate and not efficient has adverse effects even greater in 3D

COMPLEXITY

Accuracy decreases with increased data complexity in 3D

COMPLEXITY

Accuracy decreases with increased data complexity in 3D (not true in 2D!)

Participants more efficient in 2D.

2D 3D

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SUMMARY

Domain experts important for design and evaluation
Even for 3D spatial data, a 2D representation is more accurate for spatial tasks
more efficient for spatial tasks
Rainbow color map is not accurate and not efficient has adverse effects even greater in 3D

3D representation is still essential for surgical planning
2D tree diagram applicable to other applications
Quantitative study convinced our users of good visualization practices