Evaluation of Artery Visualizations for Heart Disease Diagnosis

Pfister et al. 2011

Group 9 | DSE241 | 2018
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Motivation

- Low endothelial shear stress (ESS) has been associated with rapid progression of heart disease.
- ESS is calculated by blood flow simulations based on a patient's artery geometries.
- Effective visualizations of a patient's ESS data is vital for the quick and thorough non-invasive evaluation by a cardiologist
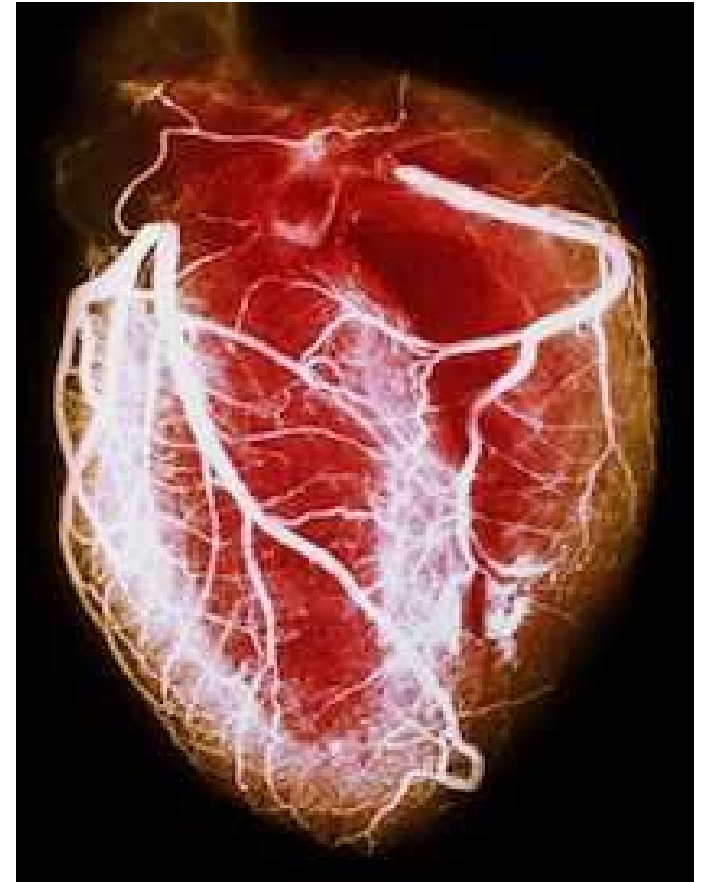
Problem Background

- Rainbow is the standard color map used in the medical literature

- Rainbow color maps can be misleading since they are not perceptually ordered and isoluminant.
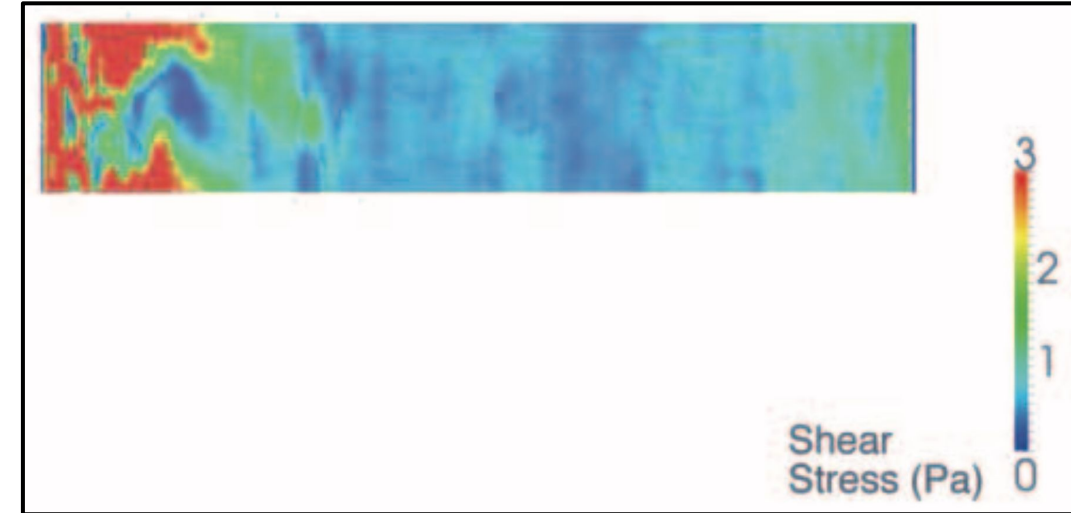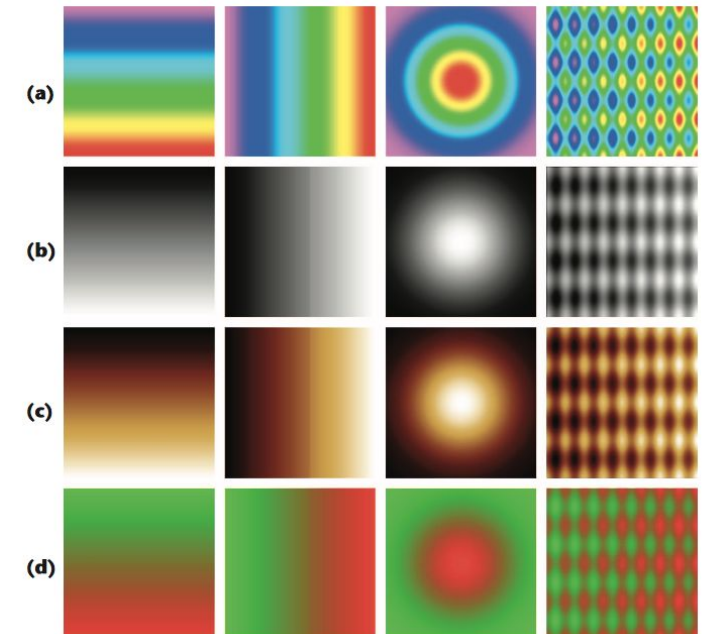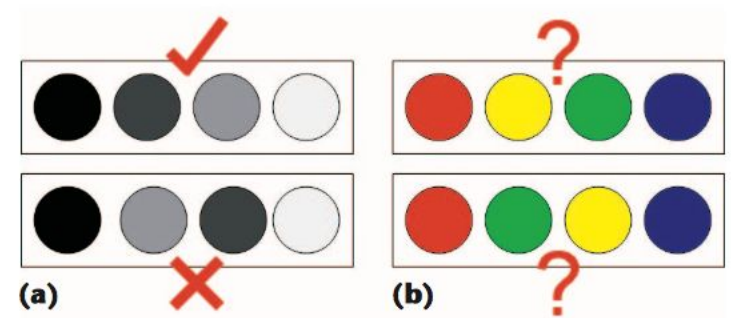

Fig. 1. Traditional 2D projection of a single artery

Related Work Overview

- The rainbow color map appears as if its separated into bands of almost constant hue, with sharp transitions between them.

- Viewers perceive sharp transitions as sharp transitions in data, even when this is not the case.

* D. Borland and R. T. II. Rainbow color map (still) considered harmful. IEEE Computer Graphics and Applications, pages 14–17, 2007.

Proposed Method/Solution

- See if there were quantitatively measurable performance effects based on the color scheme utilized, specifically the rainbow and the diverging color maps

- Test if a perceptually appropriate diverging color map leads to fewer diagnostic mistakes than a rainbow color map
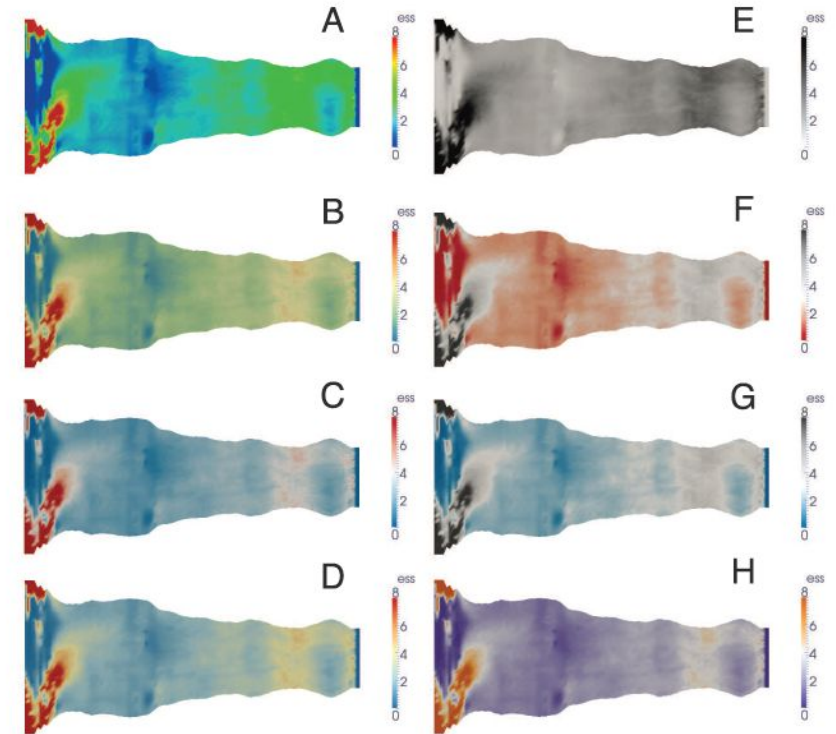

Fig. 4. Color schemes presented during the qualitative user study. The rainbow scheme (A) was preferred by most since it is what they are accustomed to viewing. The next most popular scheme was the red-black diverging scale (F). The grayscale image (E) was unanimously disliked since participants assume black-and-white images to be raw radiological data, while color indicates that the data has been processed or simulated.

Results

- Participants (medical professionals) found a significantly higher percentage of low ESS regions with a diverging red/black color map.

- Perceptually appropriate diverging color map leads to fewer diagnostic mistakes than a rainbow color map in both 2D and 3D
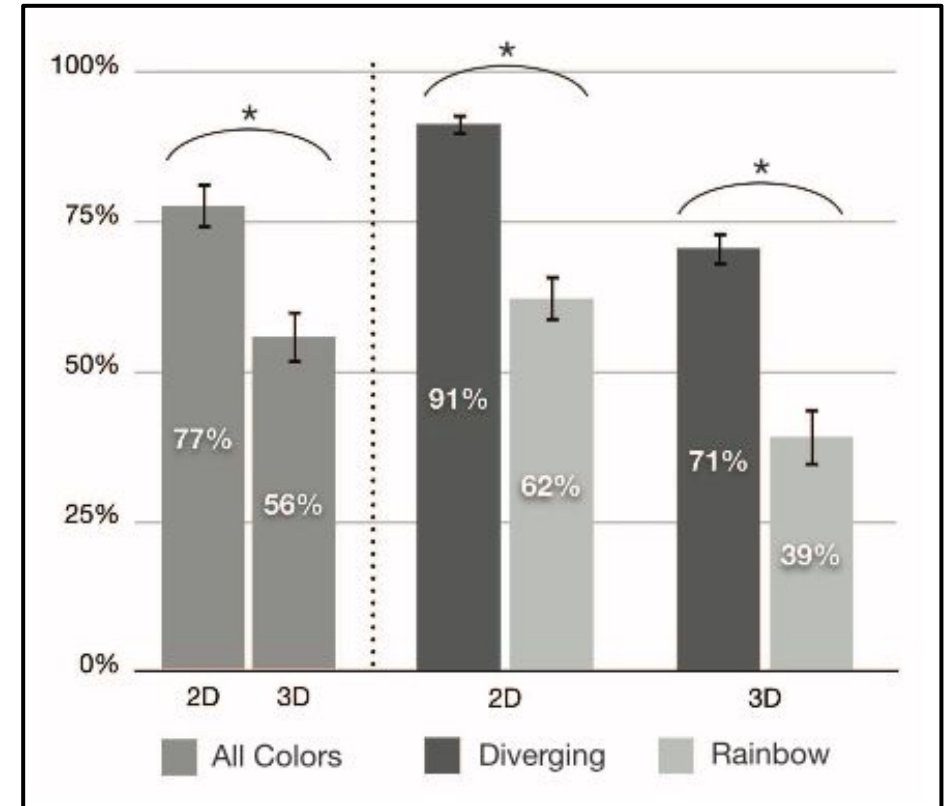

Fig. 7. **Average percent of low ESS regions identified** broken down by 2D and 3D representation, and color. Error bars correspond to the standard error and the asterisks indicate results of statistical significance.

Results

- Even though participants were far more likely to identify ESS regions using diverging (red/black) color maps, it took a lot longer per image.

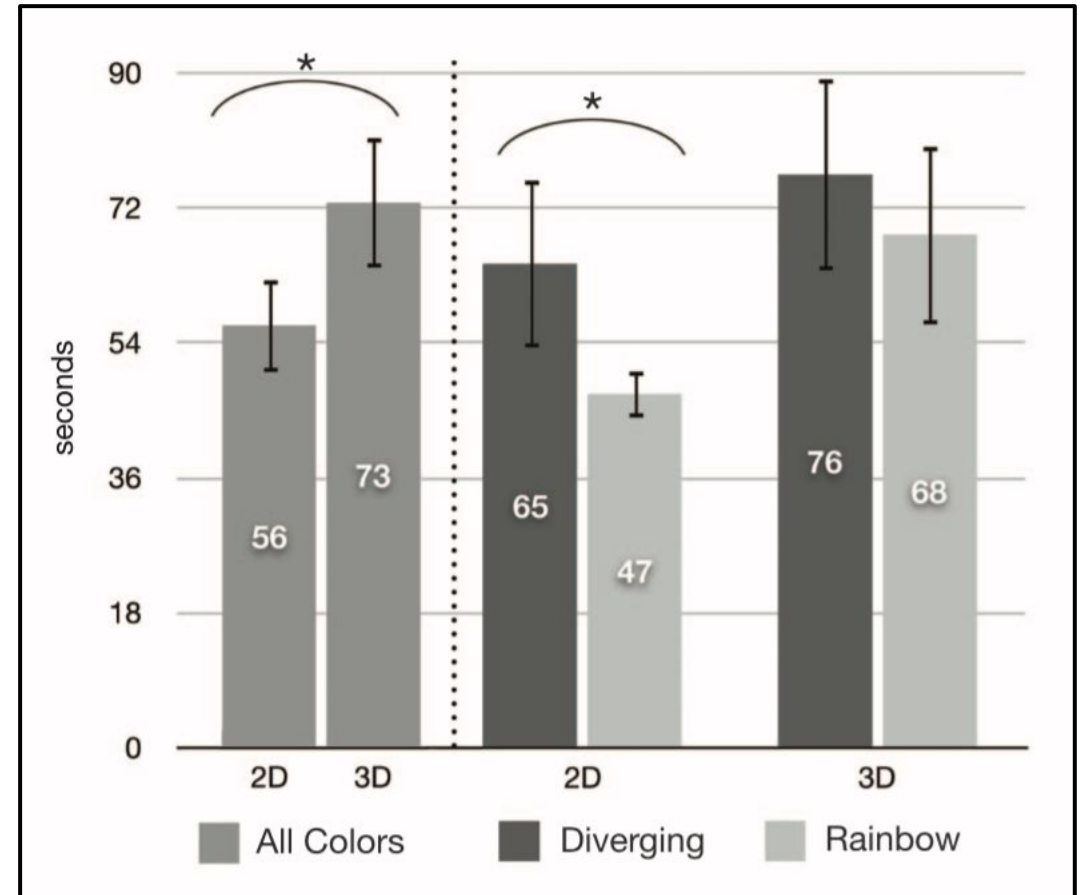- This can partially be explained by subjects being more used to rainbow color map.

Fig. 9. **Average total time spent on each image**

Results

- When accounting for the number of regions identified, 2D images with diverging and rainbow colormaps were equally time efficient.

- A 3D experiment showed that diverging color maps make it far easier to identify low ESS regions.
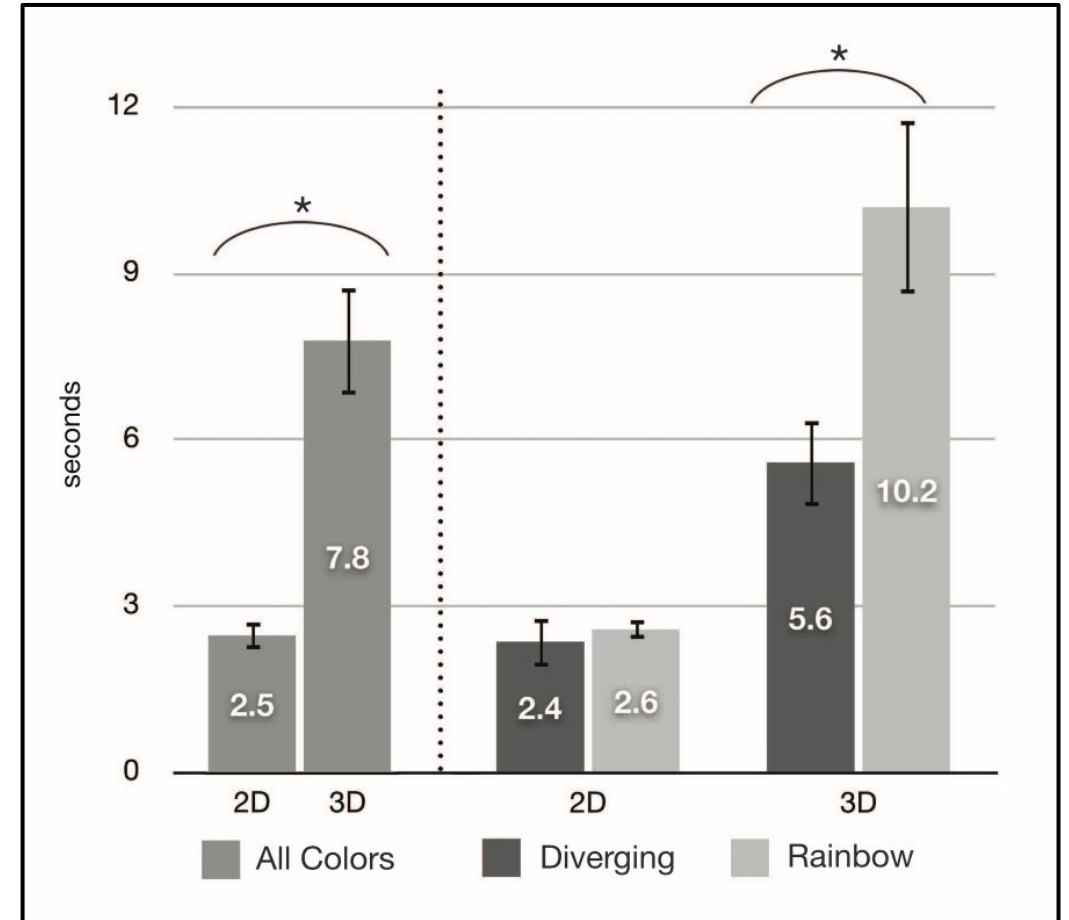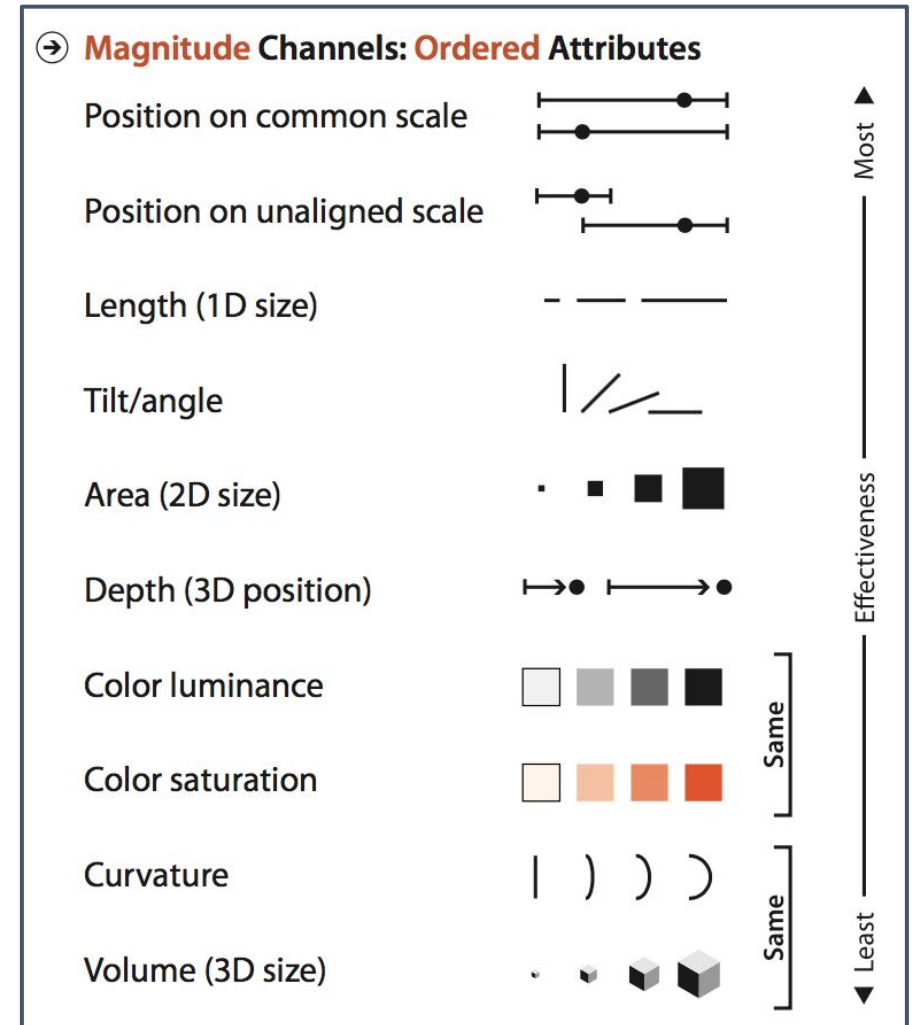

Fig. 10. **Average rates of seconds per region to identify**

Results

- The low ESS Regions that were not identified by participants were generally the smallest in area of all the regions in a given dataset
- These regions were also very close to the diverging point in the colormap bordering between "low ESS" and normal
- The order of expressiveness was essential for classification.

Magnitude **Channels: Ordered** Attributes

- Position on common scale
- Position on unaligned scale
- Length (1D size)
- Tilt/angle
- Area (2D size)
- Depth (3D position)
- Color luminance
- Color saturation
- Curvature
- Volume (3D size)

Most — Effectiveness — Least

Same

Same

Conclusion

- Color maps impact task performance
- The best color choice is a diverging color scheme utilizing red highlight the regions of greatest interest
- All participants preferred the rainbow color scheme when in reality they did not perform as well as the participants who used the diverging color map.

Any Questions?