Volume Visual Attention Maps (VVAM) in Ray-Casting Rendering

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Introduction

Eye focus based interactive volume data visualization using ray-casting. Regions which are the user's focus of attention are highlighted and the rest is faded out using different techniques (opacity, color saturation, level of detail).

- **Def.**: VVAM : Visual attention maps for dense volume datasets, focused on ray-casting based rendering.

The problem

- Dense volume data visualization on conventional 2D monitors is complex due to the superposition of many data layers in the view plane.
  - Surface rendering methods only permit viewing a limited portion of the data.
  - Direct Volume Rendering (DVR), e.g. ray-casting, and related transfer functions permit viewing the whole dataset but are difficult to adjust in order to obtain the most convenient visualization.
- Medical professionals, e.g. radiologists, have an increasing patient number and less time for same tasks.
  - Higher efficiency is needed while maintaining a high effectiveness.

Evidence

- The user intentionally focuses his eyes on the regions he considers important.
  - Visual attention maps represent the person's focus of attention during certain time period [1].

Objectives

- Make the interactive volume data visualization process more intuitive and quicker, while keeping record of the regions reviewed by the user.
- Use eye gaze based UI to control ray-casting based visualization.
- Develop a ray-casting based interactive (GPU based) DVR algorithm which uses a VVAM to highlight the important data for the user while fading off the non-important.

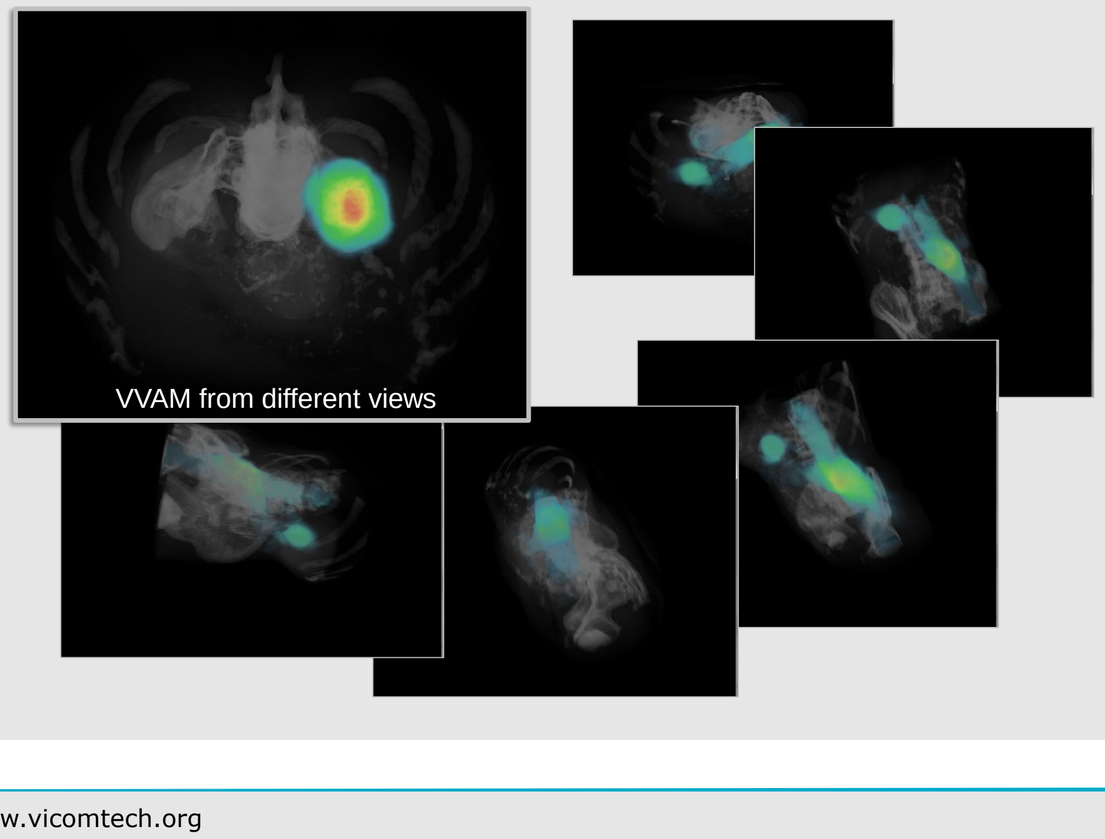
Materials

Prototype components

- Point-of-regard based, non-intrusive eye tracker.
- GPU (OpenGL + GLSL) based ray-casting DVR implementation presented in [2].
- VVAM module implementation in GPU, integrated into GPU ray-casting implementation.

Interaction

- Eye tracking is used to interact with the visualization in two different ways:
  1. To manipulate the virtual camera (zoom and rotation).
  2. Compute VVAM and use it to guide the rendering process.



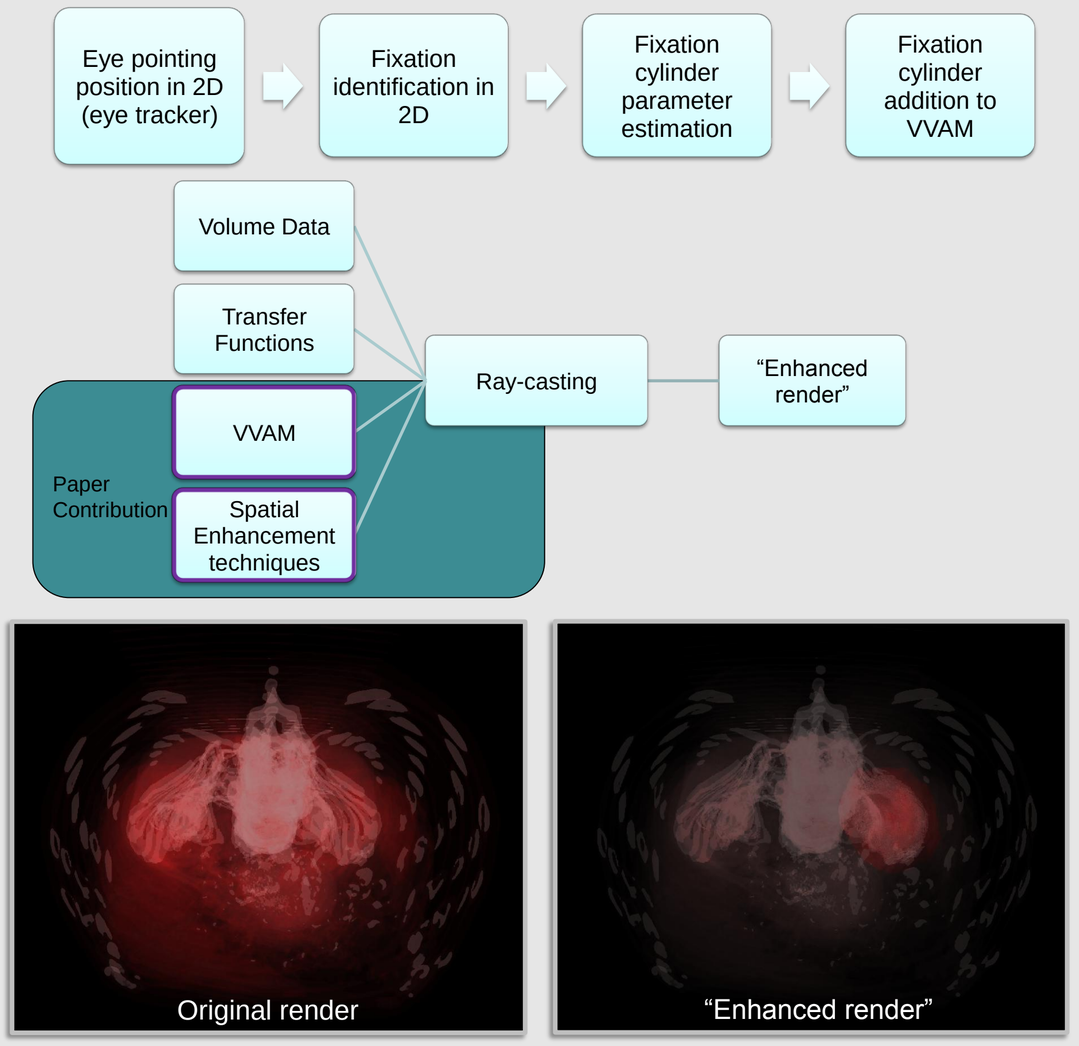
Methods

State of the art

- Offline attention map visualization in 3D using surface rendering [3].
- Offline DVR parameter tuning using 3D attention maps [4].

Contribution

- Definition of VVAM focused on ray-casting.
- Use of VVAM for interactive and online ray-casting based automatic region highlighting.



Discussion & Future work

- Validation is still needed to test if there is an increase in the effectiveness and efficiency of ray-casting based DVR visualization, specially in the medical field:
  - Effectiveness, because the VVAM shows which regions have been explored and which not, to avoid skipping regions and to teach best data reviewing practices.
  - Efficiency in terms of time required to review a volume dataset using eye based interaction.
- Future migration into a WebGL based implementation, following recent work [5].

References

[1] A. Bojko, "Informative or Misleading? Heatmaps Deconstructed," Human-Computer Interaction. New Trends, Berlin, Heidelberg: Springer Berlin Heidelberg, 2009, pp. 30-39.
[2] R. Marques, L.P. Santos, P. Leškovskv Y, and C. Paloc, "GPU Ray Casting," 17º Encontro Português de Computaçao Gráfica, A. Coelho, A.P. Cláudio, F. Silva, and A. Gomes, eds., En Anexo, 2009, pp. 83-91.
[3] S. Stellmach, L. Nacke, and R. Dachselt, "3D attentional maps," Proceedings of the International Conference on Advanced Visual Interfaces - AVI '10, New York, New York, USA: ACM Press, 2010, p. 345-348.
[4] A. Lu, R. Maciejewski, and D.S. Ebert, "Volume Composition Using Eye Tracking Data," ACM Transactions on Applied Perception, New York, NY, USA: ACM, 2010, pp. 1-20.
[5] J. Congote, L. Kabongo, Á. Segura, A. Moreno, J. Posada, and O. Ruiz, "Interactive visualization of volumetric data with WebGL in real-time," Web3D '11: Proceedings of the 16th International Conference on 3D Web Technology, Paris, France: 2011, pp. 137-146.