3D Attentional Maps - Aggregated Gaze Visualizations in Three-Dimensional Virtual Environments

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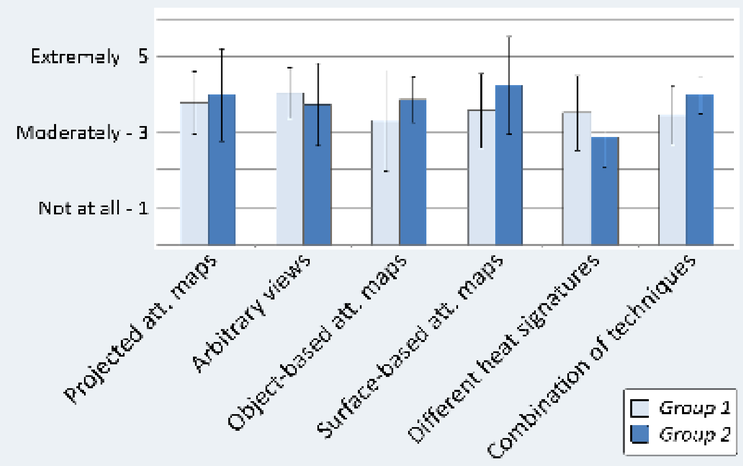
Motivation & Summary

Gaze visualizations hold the potential to facilitate usability studies of interactive systems. However, visual gaze analysis in three-dimensional virtual environments still lacks methods and techniques for aggregating attentional representations.

We propose three novel gaze visualizations for the application in such environments: **projected**, **object-based**, and **surface-based** attentional maps. These techniques provide an overview of how visual attention is distributed across a scene, among different models, and across a model's surface. Two user studies conducted among eye tracking and visualization experts approve the high value of these techniques for the fast evaluation of eye tracking studies in virtual environments.

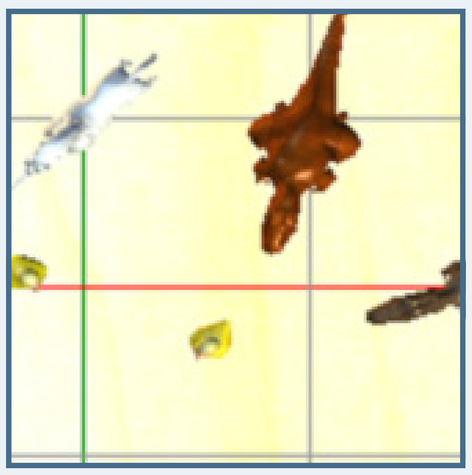
Formative Study

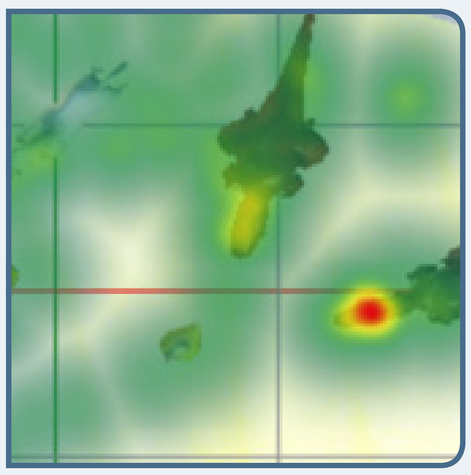


A formative user study with 20 eye tracking (group 1) and 8 visualization experts (group 2) has been conducted to assess the usefulness of the presented techniques (from 5 - extremely useful to 1 - not useful at all).

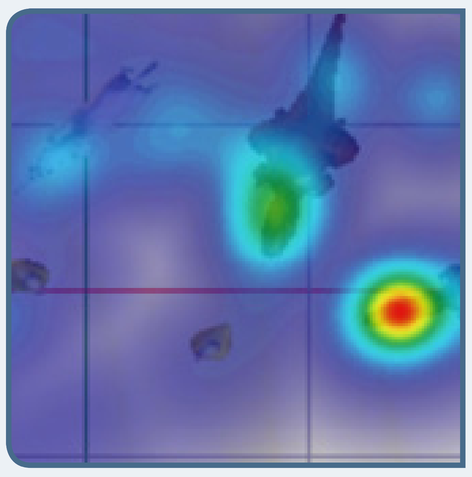
Projected Attentional Maps

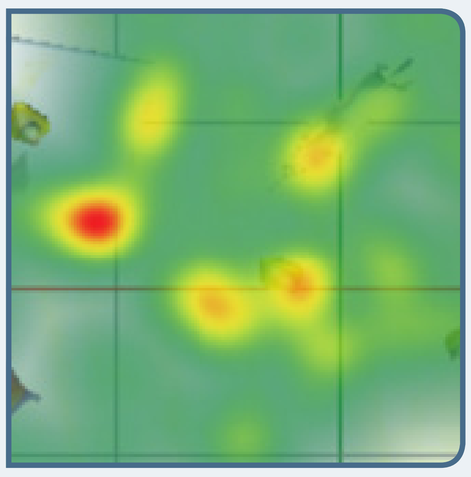
Projected heatmaps are two-dimensional planar representations of 3D gaze fixation data (similar to common overview maps). They allow for a quick overview of the gaze distribution across a scene.





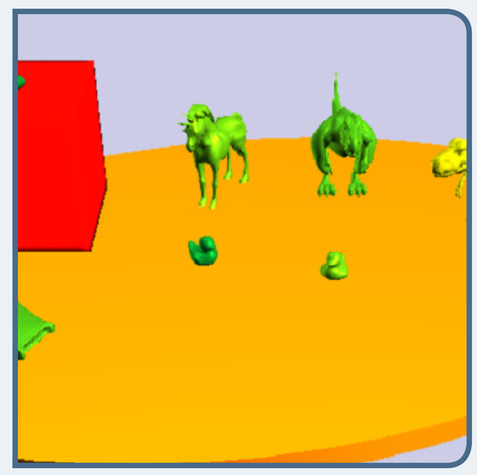
The visualizations can dynamically be adapted to different virtual environments, for example, by choosing from different color gradients or adjusting the variance of the distribution.



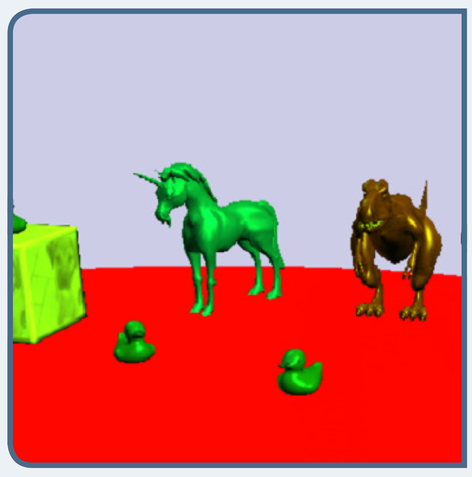


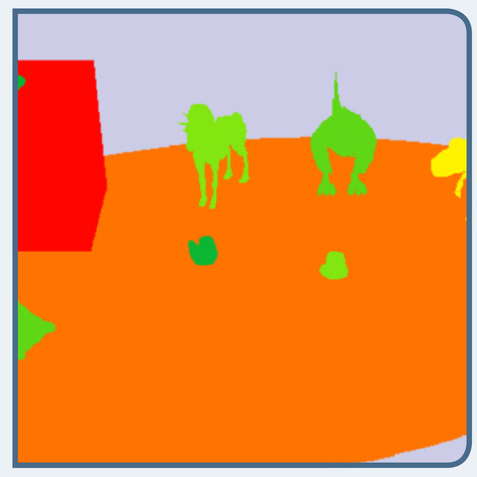
Object-based Attentional Maps

A certain color is assigned to each model's surface depending on the received visual attention. This supports rapid detection of viewed objects while providing feedback about how the models are situated towards each other.



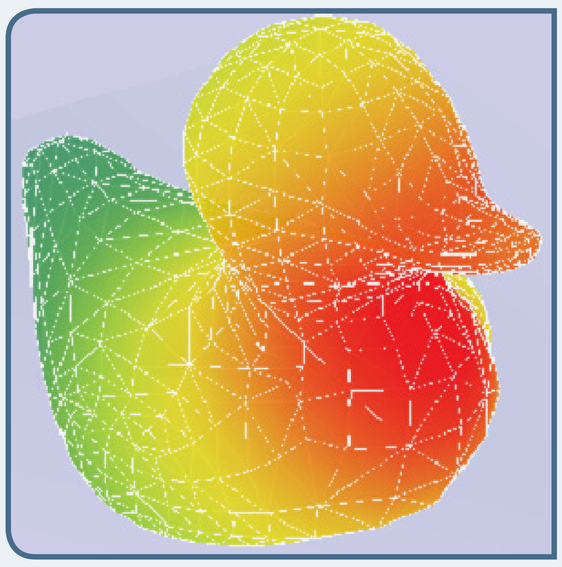
Different filtering options support a better discrimation of assigned colors (especially if they are similar). For instance, models' textures can be hidden and the default lighting / shading can be disabled.

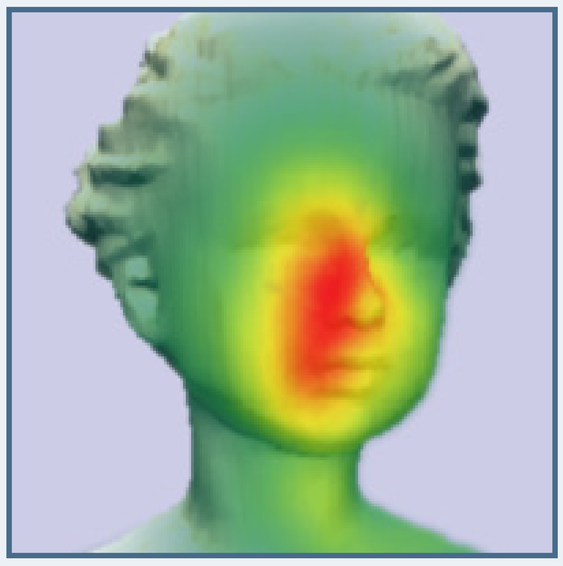


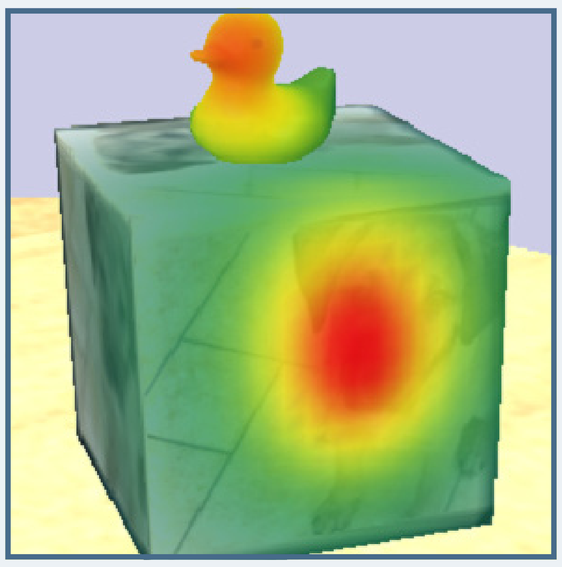


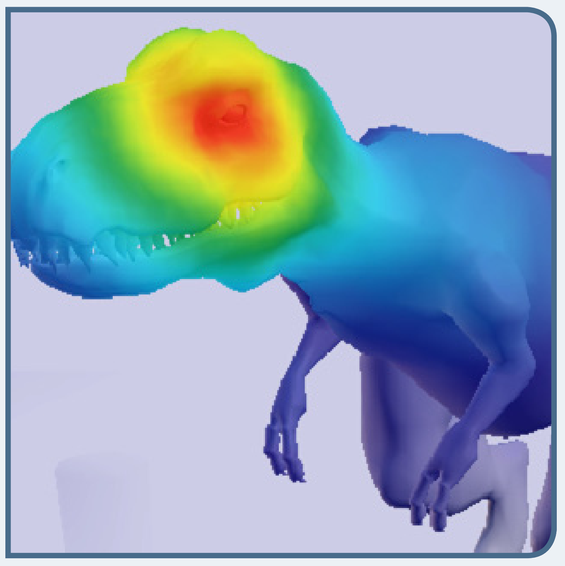
Surface-based Attentional Maps

Surface-based attentional maps represent aggregated fixation data directly on a model's textural surface. That allows for drawing conclusions about which regions of a model attract high visual attention. Thus, this technique facilitates detailed inspections of visual attention across 3D surfaces. As for projected and object-based heatmaps, it is possible to adjust various filtering options (e.g., disabling textures and showing wireframe models), distribution variables (e.g., the variance of the distribution) and color gradients.









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