Measured and predicted visual fixations in a Monte Carlo rendering noise detection task

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Introduction

Producing a very high-quality computer-generated image (CGI), termed photorealistic, involves lighting simulations that require significant computing power. The CGI algorithms induce some visual noise, which varies inversely with the number of iterations. A major issue is to automatically decide when to stop the image computation without a detectable loss of visual quality to optimize computing time.

Method - N = 11

We used 4 scenes at various stages of computation (i.e. various noise levels). In a trial, a random part of the image was replaced by the corresponding portion taken from the highest quality image.
Task 1 : Estimation of perceptual threshold in a 2-Alternative forced choice (2AFC) task by asking observers whether they detect some visual noise.
Task 2 : Eye movements recording while observers performed the same 2AFC task with stimuli at 50% threshold.

Stimuli

Funding

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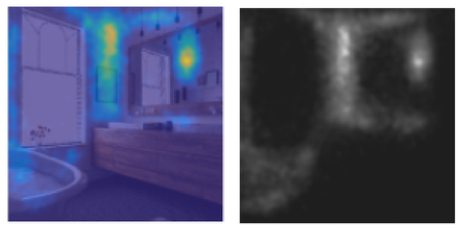
Maps

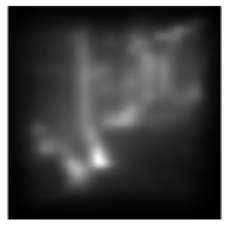
For each image we produced :

1. Fixation map & Fixation map on gray scale [2]

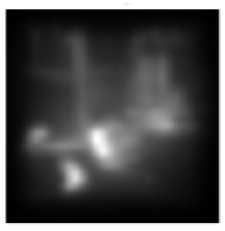


2. Noise saliency map (NSM) : the deviation between the first and the last image generated during the rendering process.

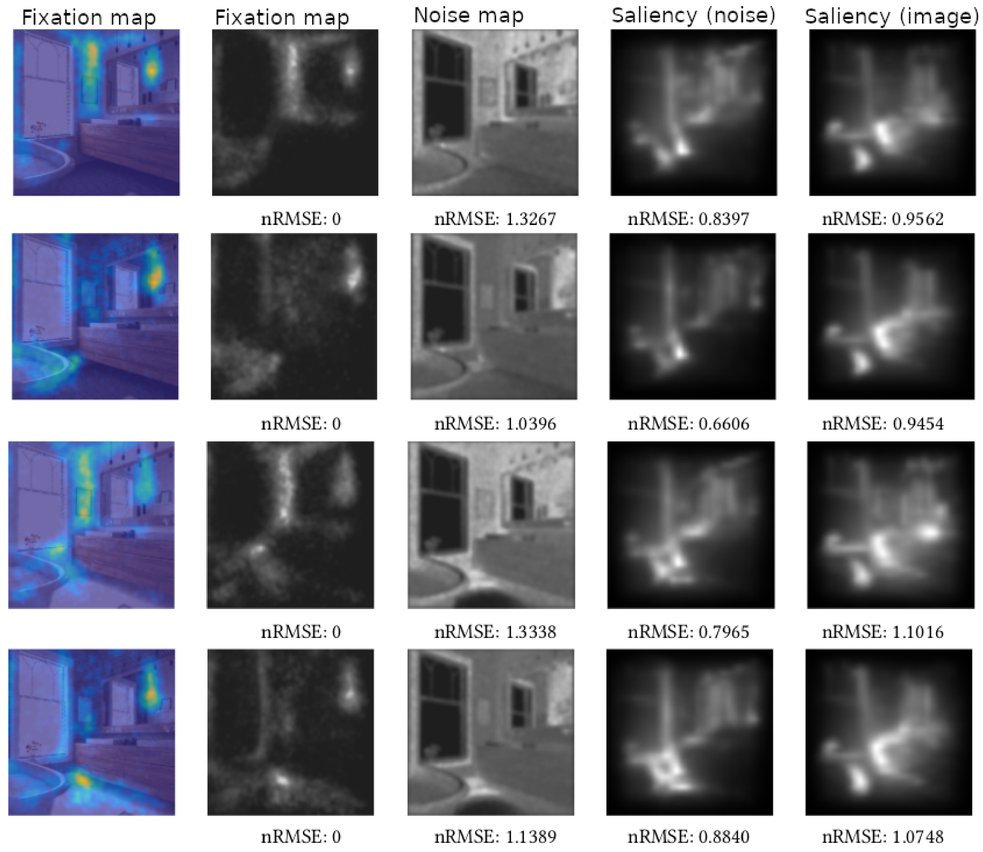
3. Graph-based visual saliency (GBVS) saliency maps of the noise map [1]



4. GBVS saliency maps computed over the first image of the dataset



Results



Discussion

Applying the GBVS saliency map model on the Monte Carlo noise estimated by the difference between two images (first and last image of the dataset) allows to better estimate the fixation maps obtained from human observers. We propose to implement an automatic stopping criterion adapted to human vision using these saliency models.The proposed architecture rely on the comparison of the last two NSM, obtained from the last two computed difference images. A nRMSE score specifies how close the current NSM is to the previous one (obtained n samples earlier). To validate the proposed rendering pipeline we would be to produce images with several defined nRMSE thresholds which may then be presented to human observers.

References

[1] J. Harel, C. Koch, and P. Perona. Graph-based visual saliency. In *Advances in Neural Information Processing Systems*, 2007.

[2] J. Lao, S. Miellet, C. Pernet, N. Sokhn, and R. Caldara. iMap4: An open source toolbox for the statistical fixation mapping of eye movement data with linear mixed modeling. *Behavior Research Methods*, 49(2):559–575, 4 2017.