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Report on PhD thesis: Marek Wernikowski

The PhD thesis of Mr Wernikowski covers the topic of effectively generating stereoscopic images by exploiting knowledge of the human visual system. In particular, the thesis sets out to make the following major contributions to the field:

1) Reduce the complexity of the computation traditionally required
2) Maintain the same level of quality
3) Improve rendering quality or increase performance without the human being able to perceive the difference

A key focus of the thesis is to benefit from knowledge of the acuity of human vision, which is only at its highest in a small circular area around the gaze point.

The thesis consists of 6 chapters. It starts with a short (unnumbered chapter) which briefly states the problem definition, proposed solution, the key goals of the thesis, what type of methodology was used and a description of what to expect in the rest of the thesis. This chapter provides a very helpful overview of the thesis. Personally, I think this should have been labelled as "Chapter 1: Introduction".

Chapter 1 provides the background to the research by providing details of how human vision works and introduces the concept of foveal rendering. The chapter start with a slightly redundant description of how each of the different parts of human vision that are described, relate to different sections in the thesis. The descriptions are quite succinct but do provide enough detail to lay the foundation for the rest of the thesis. One part of the human vision system that I was surprised is not discussed is "visual attention". This plays a key part of where the eye attends to in a scene and thus what is actually being looked at. This can typically compliment any gaze measurements, for example:

- S. Hillaire,G. Breton,N. Ouarti,R. Cozot,A. Lécuyer "Using a Visual Attention Model to Improve Gaze Tracking Systems in Interactive 3D Applications", Computer Graphics Forum, September 2010.

Perception-driven rendering is detailed in **Chapter 2**. The focus in this chapter is how a computer graphics rendering pipeline can be modified to exploit certain feature of human vision to reduce overall computational effort or improve overall quality of the resultant image. The chapter provides significant mathematical detail which describe the various phenomena that are being considered. Of special importance to this thesis are the descriptions in Sections 2.2.4 and 2.3.5 on "Experimental evaluation". The chapter concludes with a chapter summary and a very helpful description as to what the author's contribution has been.

Chapter 3 investigates how metamers may be created and evaluated using machine learning with the goal of understanding how the value of structural distortions. The importance of high

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frequency is correctly identified. This chapter provides a lot of detail on the approach taken. A new method of including perception criteria directly in the GAN's discriminator is presented. This approach is then shown clearly with objective and subjective results to provide higher perceptual quality images than previous approaches. A limitation though is identified as the large structure present in artificial bodies. The chapter concludes with a short summary, and again the helpful details of the author's contribution to this body of work.

Chapter 4 undertakes the improvement of multi-focal rendering. This is achieved with a novel hybrid approach of Linear Blending (LB) and Light Field Synthesis (LFS). The chapter starts with a background section, which perhaps should have been included in Chapter 1. A number of experiments were conducted to investigate the perceptual quality of the results. The hybrid method is able to produce better quality compared with each of the individual approaches while also decreasing the computational cost. A number of limitations of the new method are listed, including the size of the display. It also does not take into account factors such as head movement, sensitivity or accommodation. A helpful summary and description of contribution is again provided at the end of the chapter.

Chapter 5 should be entitled Conclusions rather than Summary and then the Section entitled "Conclusions" is really just a summary of the conclusions. An interesting result that is highlighted is that the experimental results shows that participants preferred a simplified adaption model compared to a more realistic one. Another valuable result was to identify the value of creating metamers rather than exact copies. Furthermore, the ability to achieve perceived high-quality images with the new hybrid method with a three times lower rendering cost is a also a significant achievement. The summary of conclusions is very helpful and clearly lays out the significant contribution of the thesis to the field. Finally, the Future work section specifies some interesting aspects that need to be explored further.

Limitations

There are a few minor limitations in the thesis that the candidate should think about:

1. The images used for the evaluations are all quite static and rather "artificial". The human eye is never stationary and continually focusses on different aspects of the scene. How would your approach deal with movement in the scene?
2. Related to this is the question of saliency. The human eye will foveate on objects that are salient in a scene, especially moving ones. How could saliency be incorporated into your system?

Stengths

The thesis is well written and very well structured. I particularly liked the "Summary" and "Author's contributions" sections. The candidate's contributions are clearly explained and evaluated in detail. Five papers, including papers in top journals is an impressive number to come out of this research.

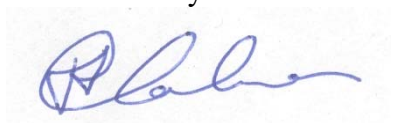
Summary

In summary, this thesis is a significant body of work. The candidate has clearly shown a very good knowledge of the field. The dissertation is classified by the Reviewer in excess meeting the requirements

- I vote for distinction of the dissertation.

Taking into account the presented achievements of the PhD student, and in particular his original contribution to knowledge, I believe that the reviewed work meets with a clear excess the requirements for doctoral dissertations specified in the law on academic degrees and academic title. Therefore, I request that its Author be admitted to public defence.

Yours sincerely



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