

doctoral thesis review

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High-Quality Shadow Rendering from Complex Light Sources

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In visual computing, there are still many open subproblems within the general one – how to optimize complex scenes rendering in real time. The author – under the supervision of Prof. Pavel Zemčík – focused on a High-Quality Shadow Rendering from Complex Light Sources. The goal of the dissertation is to improve the Shadow Mapping using Non-orthogonal Texture Warping of the shadow maps. **The subject of the thesis is relevant to current needs of the scientific community, which is indicated by multiple internationally recognized publications and, moreover, the doctoral thesis research is highly actual for practical use, as well.**

The English text of the submitted thesis consists of 3 introductory pages, 6 numbered chapters: 1 Introduction, 2 Global Illumination and Shadows, 3 Shadow Quality and Complex Light Sources, 4 Improved Texture Warping for Complex Light Sources, 5 Experimental Results and Discussion, 6 Conclusion. Bibliography (not given in Contents, pp. 74-77) refers to 41 items.

The methodology of this research project combines selected advantages of well-studied and understood methods, which are fully adequate and fit perfectly to the main stream research in the field (the methodology of mathematic modeling, computational geometry, computer graphics, applied and focused to special properties of the problem(s) to solve, e.g. the aliasing reduction, paraboloid mapping, observed complexity, quality metrics...). **The methods used in the thesis have been appropriate and led to a successful solution.**

The main contribution, page 73, is the „experimental evaluation of the hypothesis that parameterization of shadow map coordinates based on simple scene analysis can reduce aliasing error of the shadows cast by complex light sources“. The new method combines three ideas, Instant Radiosity, Imperfect Shadow Map and Dual-Paraboloid for omnidirectional light source. The experiments included quality and performance measurements. Additionally, there is another methodologic idea reported: to integrate Finite Element Methods for texture warping, which “did not perform successfully”, p. 70. The quality was achieved by better sampling of the scene and shadow map warping. The validation of the approach for real-time and complex light sources is supported enough by the extent of experiments conducted. **The dissertation fulfills the given goal(s) in full extent.**

The work is done and written in a professional quality. The thesis satisfies conditions of a creative scientific work and there is observable both deep erudition and rich experimental experience of the author. However, there are some questionable formulations or maybe mistakes.

Page 8: the symbol for normal vector is not unique and the „geometric relation between point and incident direction“ means the angle between two vectors. Page 11: The sentence $G(x, x')$ function of geometric relationship... has no verb. Page 14: What means „finite planes“? We work with finite planar subsets, always. Page 22: The formulation „if the Dual-Paraboloid is non-linear“ needs more explanation related to Fig. 2.18. Page 23: „projected to on one shadow map texel“. To or on? Page 29: „... it was shown...“ Does this mean, that Zhang et al. proved the optimality mathematically? Page 35: „direction of the paraboloid“ means probably the direction of the axis. Page 40: „number of rendered geometry“. Page 43: „hundreds per frame“. Page 44: „shahow“. Page 45: „parameterization of shadow map coordinates based on simple scene analysis can reduce aliasing error of the shadows cast by complex light sources“ is not a core, but the core idea, or hypothesis. Page 61: There are no red pixels in Fig. 5.2 (left), they are in the middle one. Page 62: What are the units for scene complexity? How is it defined here? Triangle count? Page 75: It would be desirable to unify the name of D. Brandon Lloyd in refs [19-22].

These remarks and a set of evident typo errors (marked in the printed copy) do not decrease the valuable contribution of the work. The written presentation could have been less noisy. There is missing the List of Symbols and List of Algorithms (there are five numbered algorithms).

The author co-authored 7 referred papers at international conferences [25-28], [30-31] and [37] (and software implementation, obviously), all of them related with the PhD topic. Publications of the author appeared in the years 2011-2015. Are there already some citations? The publications are comparable with PhD. projects known to me at multiple universities in Central Europe.

In the discussion, it would be desirable to discuss the following questions: 1. What was the main complication with the FEM experiment? 2. Is there, in the research community, a testing data set creation in progress? What are the properties of the easiest and the hardest instances?

Here are the required explicit judgements. 1. The thesis topic is very relevant in current state-of-the-art rendering research. 2. There are original contributions, as summarized above. 3. The main achievements were properly published at international level. 4. The author is a well informed scientific researcher.

Conclusion

The author of the doctoral thesis, Ing. Jan NAVRÁTIL, proved to have an ability to perform research and to achieve scientific results. I do recommend the thesis for presentation with the aim of receiving the Degree of Ph.D.

Bratislava, January 17, 2015