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## PhD Thesis Review

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Vědecké oddělení

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The dissertation thesis of Ing. Jozef Kobrtek presents several achievements in the field of shadow rendering, which he achieved within his doctoral studies. This review reacts on the resubmitted version of the thesis.

The thesis consists of 9 chapters. After the introductory chapter, the author presents the basic definitions related to the studied field and then, in Chapter 3, presents the overview and discusses the existing approaches to the generation of shadows, which are based on stencil shadow volumes, approaches using acceleration structures, and methods based on ray tracing. In these chapters, I really appreciate that the author paid specific attention to the explanation of the domain and the techniques that are commonly used. This part of the thesis is an exemplary case of presenting the background and related work. In my opinion, the issues with terminology, raised by the other reviewer, were properly addressed in the revised version.

Chapter 4 presents the first research contribution, which was published at the WSCG conference and in its journal in 2012 and the thesis author is the second author in this publication. It presents the comparison of the existing omni-directional techniques available for shadow mapping. The authors focused on comparing their performance, visual quality, and implementation easiness. The authors implemented two approaches, the first one based on cube mapping, and the second one on dual paraboloid. For each of them, they implemented several optimizations, based on frustum culling, and performed the comparison and final evaluation. Based on the feedback, this part was extended in the revised version by comparison with the shadow volumes, which contributed to the assessment of the visual quality.

Chapter 5 introduces an improved version of the silhouette extraction algorithm for shadow volumes. The motivation was that the available solutions were suffering from numerical instabilities that the authors were aiming to address. The results were published at the GraphiCon conference in 2013. The applicant was the fourth author of this paper. After discussing the limitations of shadow volumes with respect to their robustness towards non-manifold shadow casters, the author describes his CPU and GPU implementations that are then benchmarked and evaluated. The evaluation was again extended in the revised version, where the author discusses the elimination of artifacts.

Brno, 15/02/2022

Chapter 6 presents a shift of an algorithm for the shadow volume method to the tessellation shader. The corresponding publication was again presented at the WSCG conference in 2014, in the poster papers proceedings. The author details the design and implementation of the proposed approach, including the performance measurements to compare the original and new implementation. The revised version contains the updated measurements of the performance using more recent graphics cards.

Chapter 7 introduces a method that aims to improve the speed of silhouette extraction from shadow volumes. It utilizes an octree structure to precompute and store the potentially visible set of silhouette edges. The method was presented at the WSCG conference in 2019 and J. Kobrtek is the first author here. The method was further improved after the publication and the improvements are detailed in the thesis. This chapter also evidences improvements in comparison with the original version.

The last presented contribution, described in Chapter 8, presents a comparison of different omni-directional shadow methods. This chapter was significantly revised, as meanwhile, the publication dealing with this topic was accepted for publication and the chapter was adjusted accordingly.

Chapter 9 concludes the thesis and summarizes the achieved results.

The concerns of the other reviewer regarding the language issues were also addressed in the revision, however, I still found several errors, such as repetitions and typos.

For the defense, I have the following question:

*As you are the first author only in some of the presented publications, could you be more specific about your position in the papers? The responsibilities are discussed in the thesis, but I would appreciate the information about the driving force of the research direction in these publications.*

Brno, 15/02/2022

As also stated by the thesis author, this thesis does not introduce any breakthroughs in the field of shadow rendering, rather small improvements and optimizations that are aiming for better performance. The author paid specific attention and effort to thorough implementation of all selected algorithms and their evaluation. I highly appreciate the fact that all source codes are freely available, which contributes to the reproducibility and even more importantly, it makes the future comparisons with newly proposed algorithms way easier for their authors. Therefore, I appreciate the amount of work and contributions that the author gave to the computer graphics community.

In conclusion, I'm stating that the student successfully managed to reach the given goals of his PhD topic. The presented publications were mostly presented at reasonable venues, although only the last contribution, discussed in Chapter 8, was accepted to the impacted Computer Graphics Forum journal. Despite these limitations, I can conclude that Jozef Kobrtek managed to conduct a research work and reached outcomes that make him eligible to obtain the Ph.D. degree. Therefore, I **recommend** the thesis to be successfully defended.

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