



In Prague, 6. 1. 2019

Supervisor's Ph.D. thesis assessment

Ph.D. candidate: RNDr. Martin Šik

Ph.D. thesis title: Global exploration in Markov chain Monte Carlo methods for light transport simulation

Supervisor / author of review: doc. Ing. Jaroslav Křivánek, Ph.D.

I will start my assessment by stating that I consider the candidate, Mr. Martin Šik, an independent, creative researcher fully capable of devising and executing novel research ideas in the field of Computer Graphics. I recommend his Ph.D. dissertation thesis entitled "Global exploration in Markov chain Monte Carlo methods for light transport" for defense.

My collaboration with the candidate started in 2010 when I supervised a team software project, where he was a team member. The candidate stood out as one of the most brilliant team members, a skillful programmer and a fast thinker. Later, he extended the work on the team project into his Master's thesis, the results of which were published at the Pacific Graphics conference.¹ Starting from October 2012, he joined the Ph.D. program in my group at Charles University, Prague. Since the very beginning, the candidate excelled at the speed with which he was able to absorb new ideas and turn them into actual software implementations. While his dissertation thesis is based on his work on Markov chain Monte Carlo light transport, he has additionally made some fundamental research and implementation contributions to two papers published at ACM SIGGRAPH 2014. In the first one², he carried out extensive research and testing of various spherical distributions and developed methods for their estimation using the EM algorithm. In the latter one³, he was instrumental in delivering a working implementation of the developed algorithm. During his internship to PIXAR Animation Studios, he successfully transferred the technology from the latter paper into PIXAR's award-winning physically-based renderer Photorealistic RenderMan.

¹ M. Šik and J. Křivánek, Fast Random Sampling of Triangular Meshes, Pacific Graphics, Short Papers 2013.

² J. Vorba, O. Karlík, M. Šik, T. Ritschel, and J. Křivánek. On-line Learning of Parametric Mixture Models for Light Transport Simulation, ACM Trans. Graph., SIGGRAPH 2014.

³ J. Křivánek, I. Georgiev, T. Hachisuka, P. Vévoda, M. Šik, D. Nowrouzezahrai, and W. Jarosz, Unifying Points, Beams, and Paths in Volumetric Light Transport Simulation, ACM Trans. Graph., SIGGRAPH 2014.



Since early 2016, the candidate has been one of the pillars of the research and development team behind the commercially successful Corona Renderer. This involvement illustrates the ability of the candidate to carry our research work not only in the academia, but also of practical industry relevance.

His Ph.D. thesis is concerned with the use of Markov chain Monte Carlo (MCMC) methods in light transport simulation for realistic image rendering. The thesis content relies on three main contributions, two of which have been published in major journals and the last one appeared as a poster, but will be submitted for journal publication shortly.

His first contribution⁴ is an extensive and detailed survey of Markov chain Monte Carlo methods in light transport. While the survey does not bring any new algorithmic contributions per se, it provides numerous useful insights on the existing MCMC methods presented in a coherent manner. The algorithms are dissected into individual building blocks, which allows identifying new unexplored directions that could bring further benefits.

The next contribution⁵ relies on a paper presented at ACM SIGGRAPH Asia 2016, in which the candidate develops a robust rendering algorithm based on the synthesis of the most successful ideas from Monte Carlo light transport, such as path reuse, image-plane stratification, and path space exploration through MCMC methods.

Finally, the last contribution⁶ clearly identifies the insufficient global exploration as the main culprit behind the suboptimal performance of current MCMC light transport simulation methods. Based on this observation, the candidate thoroughly investigates various existing, and proposes new algorithms aiming at improving global exploration. I believe that the impact of this work reaches beyond the boundary of computer graphics, as global exploration is an important concept in all the application areas of MCMC methods, such as Machine learning, finance, etc.

In conclusion, I strongly believe that Mr. Martin Šik's research work will have a lasting impact in both academia and industry. I am convinced that his work provides plentiful evidence of his maturity as an independent and creative researcher.

Kind Regards,



Jaroslav Křivánek

⁴ M. Šik and J. Křivánek, Survey of Markov Chain Monte Carlo Methods in Light Transport Simulation, IEEE Transactions on Visualization and Computer Graphics, 2019.

⁵ M. Šik, H. Otsu, T. Hachisuka, and J. Křivánek, Robust Light Transport Simulation via Metropolised Bidirectional Estimators, ACM Trans. Graph., SIGGRAPH Asia 2016.

⁶ M. Šik and J. Křivánek, Improving Global Exploration of MCMC Light Transport Simulation, ACM SIGGRAPH 2016 Posters