Opponent's review of the habilitation thesis

doc. Alexander Wilkie, Dr. MFF UK, Praha:
Predictive Rendering

On the formal side, the presented habilitation thesis "Predictive Rendering" is a collection of five reviewed articles already published in renowned journals (2x ACM Transactions on Graphics, 3x Computer Graphics Forum) reprinted in chapters 2-6 and extended by the first chapter Introduction.

References
The thesis referees 153 publications published in top international conferences organized by ACM and IEEE and renowned journals listed in Current Contents. Author has the up to date knowledge about topics related to predictive rendering particularly spectral rendering, 3D printing, and data appearance acquisition.

Novelty:
Doc. Wilkie is the pioneering author who participated in the novel field of predictive rendering since its beginning in 2001. Several of his works has moved the research field to an industry standard in VFX and production industry often due to provided open source code by the author.

Compared to the author thesis (2007), a significant extension of the definition of Predictive Rendering can be seen, where he introduced the capture stage which stand at the beginning of pipeline, and the final production step. Since 2007, author focused his research to predictively store, manipulate and display all aspects of object appearance with further extension to manufacturing of 3D object.

Originality
Doc. Wilkie published his personal novel research results he obtained with his co-authors. He clearly states his contribution in the mathematical theory, methodology and practical coding often for the industry partners (Weta Digital). Thesis is the extension of his previous thesis submitted to TU Vienna in 2007. The thesis content is quite different from previous version because it consists of his recent work reviewed by international experts. The Turnitin system show the similarity 15% in common thesis parts, like name, references, and with the research papers where he was a co-author and listed them in the Chapters 2-6. The original contribution of the author is listed in the chapter review part.

Text:
Thesis text has 78 pages of double column dense text. Introduction chapter outlines the research context, defines the problem of predictive rendering, and give an overview of the selected papers and author contributions. An example of how predictive rendering is already an industry standard is introduction of extended CAD models of products which include accurate appearance descriptions. Doc. Wilkie contributed to industry areas such

as VFX industry (Weta Digital), in the car industry by predictive simulation of object appearance and authoritative control over the appearance of manufactured objects.

Chapter 2: Realistic Sky Dome Models presents an analytic model that is based on the widely used Preetham model which may be considered as a part of capturing step in the proposed PR pipeline. To avoid capturing the large amounts of natural data authors implemented a brute force, first-principles model of atmospheric light transport. Based on synthetic data authors devised an extended skylight model and fitted the parameters of the formulas to reference renderings. Later the results were extended by IEEE CGA journal paper and the SCCG ’13 conference paper. The model was crafted to be as useful for the spectral rendering community and eventually became widespread used.

Chapter 3: Hero Wavelength Sampling is considered is a part of rendering step in the proposed PR pipeline. Using one wavelength per sampled path introduces a lot of colour noise and in most cases, it is quite wasteful computation. The proposed idea is to randomly sample the hero wavelength for each path, and all directional sampling is solely based on it. The additional wavelengths are placed at equal distances from the hero wavelength, so that path wavelengths evenly cover the visible range. Recently, HWS has become the common choice for inclusion of spectral rendering in path tracers.

Chapter 4: Contrast Enhancement for 3D Print Textures is a part of production step in the proposed PR pipeline. To obtain the impression of a crisp albedo texture on top of the 3D print authors propose the optimization for a fully volumetric material distribution that preserves the target appearance. Author did the measurement of 3D print material parameters these were used to accurately determine the index of refraction of the involved materials, which was an essential ingredient in setting up a predictive simulation. Later the results were extended by ACM TG 2019 journal paper.

Chapter 5: Practical Fluorescence Path Tracing is a part of rendering step in the proposed PR pipeline. This work is a mathematical formalism, and provided the foundation for including fluorescence, both on surfaces and in volumes, in a modern renderer. And finally, authors also managed to get Hero wavelength spectral sampling to work with wavelength-shifting media, which again significantly increases convergence speed.

Chapter 6: Fluorescence-enabled Spectral Uplifting is an undergoing research again a part of rendering step in the proposed PR pipeline. Spectral uplifting for gamut limited RGB tristimulus values solved by authors provides smooth reflectance spectrum plus a fluorescent part.

In conclusion there is no doubt that the thesis presents the author original and novel results in compact way. The author undoubtedly proved capability of independent creative and adventurous conduct at the methodological and practical level. The applicant for the title of associate professor has achieved wide word recognition in the field. Habilitation thesis of **doc. Alexander Wilkie, Dr.** is written thoughtfully, factually correct, mathematically correct, with a nice graphic-formal design, clear and at the same time concise.

Based on the above facts I recommend the Science Council of Charles University in Prague to appoint **doc. Alexander Wilkie, Dr.** for Associate Professor in Informatics and Software Systems.

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