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Supervisor's assessment of the thesis *„Appearance matching and fabrication using differentiable material models"*, submitted by Thomas Klaus Nindel at MFF UK

As submitted, the thesis has 77 pages, and is divided into three main sections plus some attachments. It is the result of a bit more than 4 years of Ph.D. studies, and contains two distinct contributions. These are tied together by the fact that they both deal with appearance modelling, and by the use of optimisation techniques to achieve results that would otherwise have been unobtainable. The first section of the thesis describes the topic domain, and fairly briefly but succinctly outlines the thematic foundation upon which the two contributions are built. This summary is well-written, and to the point: all the main technological underpinnings of the two contributions made by the candidate are discussed and presented in a clear fashion.

The second section presents an as of now still unpublished paper: the work was submitted to Eurographics 2023, but unfortunately rejected. The paper was apparently a borderline case: three out of five reviews were in favour of acceptance, and no deal-breaking deficiencies were found - but ultimately, there were apparently other papers that the IPC decided to prioritise. So in April, the paper will be resubmitted with improvements to EGSR 2023. The work the candidate performed for this section is a significant step towards enabling users to create high-quality solid wood material based on captures of real wood samples. Of course, just using a photograph of woodgrain as texture map is a technique that is almost as old as 3D graphics itself: but what the candidate makes possible with his approach is to automatically generate a plausible volumetric texture that matches the three-dimensional contents of a piece of wood to the structure seen on the top of a given board. The technique is efficient and robust, and an excellent example of how optimisation techniques can be used to extract relevant structure information from input images.

The third section presents the contribution of the candidate to the domain of full colour 3D printing: a 2021 SIGGRAPH paper that significantly pushed the envelope of what could be done with regard to contrast enhancement, and targeted fabrication of colour appearance in general. It cannot be overstated how significant an improvement this paper is: before, all such optimisation approaches were more or less ad hoc, while the paper the candidate first authored is the first truly principled approach that will allow to systematically enlarge the gamut of manufacturable appearance on full colour 3D polyjet machines.

Overall, the thesis presents two sound and significant contributions to the state of the art in graphics. Formally, the thesis only partially satisfies the conditions for a defensible Ph.D. thesis at MFF, insofar as the first contribution (appearance matching) has not been published at a peer-reviewed venue yet. However, the reviews of this paper at EG 2023 were overall positive with no significant defects being pointed out: due to this, we are confident the paper will, with minor improvements that do not concern the technique itself (but just its validation, which the reviewers focused on), see the light of day as a peer-reviewed publication very soon, hopefully at EGSR 2023. The second paper is a SIGGRAPH paper, and a truly significant result.

Due to this, I consider the scientific contribution of the author to be sufficient for defence of a PhD: him submitting the thesis before the appearance matching paper has fully made its way through the publication pipeline had valid personal reasons, and was not done lightly. He also has made significant contributions to two other papers, one of them at Eurographics, and one at SIGGRAPH Asia: so his track record is not limited to the two papers included in the thesis. Which is why I still recommend the entire thesis for acceptance, in spite of the formal issue.

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