

# Posudek diplomové práce

Matematicko-fyzikální fakulta Univerzity Karlovy

**Autor práce** Bc. Brečka Bohuš  
**Název práce** Efficient light transport simulation of participating media in color 3D printing.  
**Rok odevzdání** 2021  
**Studijní program** Informatika    **Studijní obor** Počítačová grafika  
**Autor posudku** Dipl.-Ing. Thomas Nindel    **Role** oponent  
**Pracoviště** KSVI

## Text posudku:

Overall, the presented work is of good quality, both scientifically and from a formal standpoint. The authors' goal is finding and implementing means for lowering the computational cost, and memory requirement of the prediction step of a 3D-printing optimization algorithm. To achieve his goal, he analyzes different algorithmic and code-level improvements of the general path-tracing used therein. The analyses are based on measurements of computation time and image variance for a few reference objects. As a result, a significant performance improvement, compared to the reference implementation, is achieved.

The author identifies applicable ways for potential improvements and describes them well. Literature work is adequate and refers relevant, recent publications. The analysis is sometimes lacking in execution, however (see details below), and some passages seem to have been written in a hurry. The author seems proficient in the technical aspects of the implementation. Readability is very good, I quite like the author's writing style. Orthography is good.

My biggest criticism is about the implementation of memory-saving techniques. This is motivated by the intuition that reducing overall memory-usage would result in better performance due to lower memory-bandwidth requirements and better cache efficiency. As the experiments with homogeneous media in Section 3.4 demonstrate, the maximum achievable improvement is in the order of 10 percent. It is curious why the author still continues implementing the memory-optimization (OpenVDB, lookup-tables for media properties, homogeneous core) even after showing that little is to be gained by that.

Some details:

- The Author describes the promising approach of Zero-Variance Volumetric Path Tracing, but then omits half of it. Why?
- Section 3.1, some statements about the Monte Carlo estimators imprecise

- Using control-flow to map materials to physical properties instead of a lookup-table is likely suboptimal
- Homogeneous core experiments only consider a certain extrusion depth. However in the 3D print optimization algorithm, heterogeneity is progressive with iterations, this effect should be considered in the analysis
- Assumption of increased performance through lowered memory usage does not hold as seen from Tables 3.5, 3.7, 3.9, 3.10 even after significant optimization
- Analysis of Russian Roulette parameters is excellent, 3.6.2. :)
- Using white-only models for most of the experiments 3.6.6. is not meaningful for the context, author should use textured objects
- 3.7.1: author relies on highly subjective visual inspection, I recommend measuring measured variance

Overall, the author has shown his proficiency in the general approach of problem solving, due to him considering alternative algorithms, algorithm level optimization and code level optimization. I recommend the work for defense.

**Práci doporučuji k obhajobě.**

**Práci nenavrhuji na zvláštní ocenění.**

V Praze dne 18. 6. 2021

Podpis: