Posudek diplomové práce

Matematicko-fyzikální fakulta Univerzity Karlovy

Autor práce	Bc. Jaroslav Nejedlý
Název práce	Reprezentační neuronové sítě pro diferencovatelné renderování objemu
Rok odevzdání	2024
Studijní program	Informatika **Studijní obor** Počítačová grafika a vývoj počítačových her

Autor posudku	Tobias Rittig, Ph.D. **Role** Vedoucí
Pracoviště	KSVI, Additive Appearance s.r.o.

Text posudku:

Topic Summary
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The thesis investigates the possibility to use NeRF-style neural networks as a differentiable 3D scene representation in the context of color 3D printing. In detail, the goal is to replace a hand-crafted 3D data structure that is capable of integral queries (summed area table) with a simple network in order to allow differentiability.
The student investigates the underlying technologies (NeRF and Mip-NeRF in combination with RPNNs) and gradually builds an understanding of the capabilities and limitations of each. Through a detailed evaluation, the reader is shown each step of a highly-experimental research process involving the combination of multiple cutting-edge technologies.

The results indicate that this research direction requires further investigation and that the combination of the high-frequency 3D printing data, the representation network and the prediction network is not as straight forward as anticipated.

Formal presentation
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The overall structure of the thesis is following an academic standard and the chapters build upon each other without much repetition. The English level overall is good.
The writing could be more structured and formalized as it reads a bit colloquial and scattered at times. Especially the results section is difficult to read, as figures are often further aways from their text sections.
The background section could be improved with more references to relevant textbooks and other sources. Otherwise it covers the variety of topics in the detail level required to understand the thesis.

Methodology
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The experiments shown in the thesis consistently build upon each other and gradually introduce the reader into more advanced concepts. Starting from 2D imagery, the Mip-Nerf technology is explored before widening the scope to 3D. The isolation of parameters and investigation of their effects allow for a detailed insight into the topic even for less advanced readers.

Implementation
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The implementation has certainly not been easy as a great variety of technologies (TensorFlow 1+2, OpenVDB, existing research-grade code) were required to build the experimental framework for this thesis.
The attachments include that framework and notebooks that should be able to reproduce the experiments of the thesis. Although not personally tested, the supplied descriptions should allow for easy replication.

Speaking as a supervisor, the student demonstrated an independent and scientific workflow. Regular meetings kept the project progress on track despite several major technical difficulties.
Finally, the student gained notable expert knowledge in the field which he has demonstrated with this thesis. The mixed nature of the results are of technical nature and cannot be negatively attributed to the student for a lack of effort. Thus I recommend it for defense.

Questions
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- The FLIP metric 2D images all have quite similar patterns (thus frequency content), meaning the error only differs in magnitude. Can you comment if an addition to the positional encoding which would correspond to the frequency band(s) in the error images would improve the results?

Práci doporučuji k obhajobě.

Práci nenavrhuji na zvláštní ocenění.

Pokud práci navrhujete na zvláštní ocenění (cena děkana apod.), prosím uveďte zde stručné zdůvodnění (vzniklé publikace, významnost tématu, inovativnost práce apod.).

Datum 5. February 2024 **Podpis**