Posudek diplomové práce

Matematicko-fyzikální fakulta Univerzity Karlovy

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Název práce	A methodical approach to the evaluation of light transport computations
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Studijní program	Informatika **Studijní obor** Počítačová grafika a vývoj počítačových her

Autor posudku	Ivo Kondapaneni **Role** oponent
Pracoviště	Katedra softwaru a výuky informatiky

Text posudku:

Content of the work. The goal of the thesis is to provide an evaluation framework of light-transport algorithms implemented in different frameworks and on different platforms. In the introduction the author describes the overall idea, and explains what kind of issues one has to consider when implementing such an evaluation framework. In the next two chapters some basic concepts of radiometry, color perception as well as basics of light transport simulation are explained in order to give a reader a necessary context. In the third chapter the author tries to determine the major properties and design decisions underpinning the framework. The last two chapters cover the implementation details, usage, file organization, and document the curated set of scenes used in the framework.

Contribution, pros and cons of the proposed solution. As an active researcher in the field of light transport, I can directly see the potential value of this thesis. The whole field would benefit from having a clearly defined benchmark consisting of a set of canonical scenes and scripts facilitating comparisons of all researched algorithms in an easy way with a minimum effort.

The most difficult part is in my opinion curation of the common set of scenes and its import into various frameworks. The author suggests some principled categories of how to organize scenes depending on the type of light transport specific to them. For that he uses notation used in the literature and, roughly speaking, he categorizes the set of scenes into simple, more complex, and super complex light transport cases. The only thing I was missing here is light transport in large scenes and complex geometry – I generally agree, that scenes need not to be always complex as suggested by author, but one algorithm can behave nicely in a small and simple scene (even with complex light transport effects) and totally fail in the complex/large geometry scene with simple light transport. And vice versa. Despite this I consider the exposition of the process of scene curation, and the quality of implementation as very good.

But I have also some criticism for the overall functionality of the framework: I do not believe that evaluation of correctness alone is that much useful. In my opinion the efficiency evaluation should have been included and discussed in the text as well, and some functionality supporting such evaluation should have been implemented in the framework. Moreover, even the already discussed correctness evaluation is problematic: when all algorithms are more-less equivalent, which one should act as a reference? Maybe including some mode, where a user manually picks which rendering algorithm should act as a reference could be useful here. Also some overview web page, where we could see statistics about all algorithms in all scenes should be part of this solution. Last point I was missing is some detailed analysis of the more advanced light transport algorithms (BDPT, VCM, PPM, guiding methods) by means of the framework.

Nevertheless, despite all my criticism above, I believe this work is a nice step towards having a useful benchmark for evaluation of light transport algorithms, and I hope we will see some continuation of this work in the future.

Detailed suggestions:

- sekce 1.2
  - Maybe add more details about colors and why different mixtures produce different sensations? Also what is RGB here, should be introduced at least informally. Also a bit more detailed explanation of what we lose when we switch to RGB rendering and why it is even possible that it gives tangible results.
- sekce 2
  - Number equations !!!!
  - Explain some radiometry first and then introduce LTE.
  - In LTE description, more mathematically sound description of S2: space of directions.
  - First introduce the primary estimator, then the secondary. Also define random variable X properly: define what is the integration domain (you need it for f(x) and the integral as well), then define X as a random variable with values in that domain and having a certain distribution described by a pdf p(x). Of course we could make it even more formal, but then the text would not be concise.
  - Equal-star : no need to use such a symbol.
  - Variance, formal definition would not hurt.
  - Importance sampling and zero variance - Better explanation for motivation. Zero variance is not a motivation for importance sampling, it is just the best case, which is not achievable in practice.

- sekce 2.3.1
  - Path-tracing algorithm: we should not stop at that moment as light itself can also reflect (unless it is a black-body object). That error is also in Fig. 2.8, 5).
  - I am missing a better description of MIS in Next-event estimation. What is a point of having included description of MIS while not explaining its usage here?
- sekce 3.1.1
  - Efficiency is a technical term defined as an inverse of Variance per unit cost. Should be introduced and explained.
  - Rendering speed is also tied to efficiency, if we measure cost as time taken by the rendering. In the end, same time (which is time based efficiency) and same sample count (which is sample based efficiency) comparisons are used in the literature, and I would expect these terms covered here.
  - Maybe discussion why it does/doesn't make sense to do efficiency evaluation and discussion of possible measures for doing so could be added:
    * Equal time is directly usable when it is measured on the same hardware, and this is the measure where a high quality implementation pays off.
    * Equal sample count efficiency is more theoretical performance gauge and thus there can be quite some discrepancy between Equal time and Equal sample. In general, researchers report both.
- sekce 3.2
  - Why are the evaluation results just difference images? In 3.1.1 it was said that efficiency would be evaluated as well. Also, it might be easier for a user to see some numerical evaluation of correctness, was any suitable measure for such purpose considered?
- sekce 3.4
  - Why not use mitsuba 0.6 then? Due to license limitations?
- sekce 5.2.1
  - Normals and their interpolation, is it the same in PBRT vs. Mitsuba?
  - Simple models: I would say that scene complexity might easily render some algorithms as unusable. That and the relative scale of the scene vs. what portion of the scene is actually viewed (teapot in a stadium effect). Therefore, I slightly disagree here.
- sekce 6

– Author writes there is one correct solution, but which one? We actually do not have it, we have a set of renderers which produce some results. What is correctness then when we do not have the ultimate reference to any of the scene?

Práci doporučuji k obhajobě.

Práci nenavrhuji na zvláštní ocenění.

V Praze dne 02. 09. 2020

Podpis: