# Referee Report of Asen Atanasov's Thesis "Efficient and Expressive Microfacet Models"

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## New scientific results

In the submitted thesis, there are mainly two new scientific results. One is the analytic anisotropic model that is able to represent and edit (in the sense of linear transforms) anisotropic variations of a surface. The other is an efficient filtering method to render complex normal-mapped surfaces using an Inverse Bin Map (IBM).

## The importance of the scientific results for the area

To rendering and general computer graphics, the importance of the submitted thesis is clear. In practice, it enriches the types of appearance that computers are able to generate, making the rendered results potentially more realistic. In theory, this submitted thesis provides an extension to the microfacet theory, together with a thorough analysis on its linear transformation and aggregation. I believe these contributions are of great importance to the area.

## Possible applications to other (neighboring) areas

As identified earlier, the submitted thesis is able to improve the appearance of computer generated imagery (CGI). Therefore, as far as I can think of, any area that requires accurate visual clues to appearance can benefit from it, from the way we are entertained (e.g., movies and games), to the way we manufacture products (e.g., virtual prototyping), diagnose illnesses (e.g., interactive medical visualization), and train and educate our population (e.g., flight simulators, virtual reality instruction), and so on.

## Comments to the submitted thesis

The structure of the submitted thesis is good to me, and the conveyed ideas are clear. I think it's well written already. Therefore, I mainly focus on whether it reads smoothly. Specifically, I have the following suggestions (rather than requirements).

- Sec. 1.2: mention that these two phenomena are both related to the microfacet theory.
- Sec. 1.3: maybe echo the title that the proposed two models are efficient and expressive.

- Fig. 1.6: can come earlier into Sec. 1.2.2.
- Fig. 2.3: "broad" BRDF is a bit awkward to me – maybe "diffuse-like"?
- Sec. 2.2: to avoid ambiguity, I'd suggest using pure-specular for specular (delta) reflections, since some people use the word specular for glossy reflections
- Sec. 2.2.2: the Fresnel term may be introduced together with the concept of BRDFs, because the Fresnel term tells how much to reflect in total, while the BRDF describes how the reflected energy is distributed angularly. Then Sec. 2.2 can also be cleaner this way.
- Still Sec. 2.2: if diffuse reflection can be treated as less related to the proposed topics and Sec. 2.2.2 has been moved earlier, maybe Sec. 2.2.3 can go to Sec. 3, since it's well-suited to describe each microfacet's contribution.
- Sec. 3.1.1: if there's no constraint on the length of the main text, I think this is the perfect place to introduce Beckmann and GGX distributions. Consider taking them from the appendix to here. The GTR can still be in the appendix. I believe this will also make it easier to introduce the sub-class of distributions in Sec. 3.1.4.
- Sec. 3.1.3: cite GTR in the appendix.
- Sec. 3.2.2: could mention that 1) the normals are usually defined using textures which are images (and their pixels are named texels) and 2) the normals are interpreted differently using different interpolation methods. In this work, we assume that they are piecewise constant per texel.
- Sec. 4 and 5 are mostly OK since most of them are from research papers.
- Eqn. 5.2: it's been a while since the definition of C, should be good to recap it here.
- Fig. 5.7: it took me a while to understand that the curved flakes can take long to compute, so the rendering can still be incomplete for 1 minute. But it still looks weird to me. See if there's any way to complete it, so readers can focus on the noise level.
- Sec. 6.1: maybe mention the work "Mechanics-Aware Modeling of Cloth Appearance" by Montazeri et al.
- Still Sec. 6.1: consider thinking the future work in a bigger picture, especially along the proposed title, e.g., what else is missing that prevents efficient and expressive appearance models, and what else can be done in addition to the existing publications. Currently it's mostly focused on improving the two works on their own.

**Does this thesis prove the author's ability for creative scientific work?**

Yes. The proposed research directions are novel to me.

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