PhD thesis review

# Title: Affordable optical measurement methods for predictive rendering

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This PhD thesis describes a method to measure the optical properties of translucent materials made of light-absorbing and light-scattering participating media. The optical parameters include scattering and absorption coefficients as well as the phase function. While there has been multiple efforts for *computationally* measurement of optical properties, the current methods suffer from accuracy issues. The most related work, by Oscar Elek et al. in 2017, uses a dictionary-based model where a few captured samples are matched to an extensive library of physically rendered images where the rendering and the capture setup are matched.

The trouble with this related work, which is practically using an inverse rendering approach, is that there are unresolved similarities partly due to the use of RGB measurements. This thesis tackles the same problem (and more by including the phase function anisotropy) using a novel approach. Mainly, the thesis proposes the concept of appearance maps that characterize the relationship between the unknow optical properties and the appearance of the samples. The concept is implemented using a low-cost optical measurement setup using only a few measurements per sample. The approach is evaluated both in simulation, and with physical prototypes created using 3D additive printing.

The main application focus is the full-color 3D printing where the optical properties of the base inks of these printers are measured.

There is an extension of the thesis to a new domain where the fluorescence properties of fluorescent materials, in form of the Donaldson Matrix is found using an affordable measurement setup.

The thesis touches on an important area, i.e., computation-based systems identification with the goal of characterizing the properties of physical systems from low cost capturing devices. The thesis is well presented with high quality writing and high-quality results and a number of fabricated samples using a multi-material inkjet 3D printer. A key contribution is the introduction and formulation of appearance maps. This thesis is the first study to offer a measurement setup for key optical properties of translucent materials which is both accurate and affordable.  As a result, it has the potential to spur follow-on work. Regarding applications, multi-material 3D printers remain the workhorse for appearance fabrication which is a thriving sector.

Overall, this is a solid work that moves the field forward and the thesis is ready to be presented and defended in front of the committee.

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