02941 Physically Based Rendering DTU Compute

Worksheet 8

Given optical properties as input, you should be able to render a homogeneous participating medium or a translucent material in realistic surroundings. The next step is to acquire optical properties that accurately capture the appearance of real-world materials. The assignment in this area will be open-ended. Creativity is encouraged.

Learning Objectives

- Combine shading and tracing techniques with theory for light-material interaction.
- Analyse real-world light-material interaction and propose ways of simulating it.

Appearance Modelling

During the course, we have identified the key optical properties needed for physically based modelling of different types of materials and visible phenomena. The following is a short summary.

- The complex index of refraction ($n = n' + i\,n''$) is an important optical property for all materials. It describes surface scattering and absorption and is thus in combination with microgeoemtry omnipresent in material appearance modelling.
- The BSDF (f_s) is useful for describing light scattering by surfaces. Rough surfaces can be obtained from a description of the surface microstructure. This description could be a microfacet normal distribution and an assumption of V-groove microfacets.
- Scattering properties (σ_s, p) are useful for rendering volumes and translucent materials and capture the subsurface scattering of light by particles. Scattering properties can be obtained from a description of the composition of particles and their microgeometry. This description could be a particle size distribution and an assumption of spherical particles.

The assignment is now as follows.

- Find a material or visible phenomenon that you would like to model. Take (or find) a photograph of whatever you choose.
- Write down what type of rendering method and optical properties you would need to render the appearance of the chosen material or phenomenon.
- Search the literature to see if the needed optical properties are available, and to see if a rendering method already exists. Write down references and a short description of the literature you found.
- Describe how you would do the rendering using the methods covered in this course. Include in the description any difficulties and extensions of the framework that might be necessary. Although it is not required, feel free to do experimental renderings of the material or phenomenon that you have chosen.

Worksheet 8 Deliverables

A description of how you would render the appearance of a material or a visible phenomenon that exists in the real world. Please include a photograph of the chosen material or phenomenon as well as any optical properties that you might have found in the literature, and give references.

Reading Material

The curriculum for Worksheet 8 is

- Dal Corso, A., Frisvad, J. R., Kjeldsen, T. K., and Bærentzen, J. A. Interactive appearance prediction for cloudy beverages. In *Workshop on Material Appearance Modeling (MAM 2016)*, pp. 1–4, The Eurographics Association, June 2016. https://doi.org/10.2312/mam.20161247
- Frisvad, J. R., Christensen, N. J., and Jensen, H. W. Computing the scattering properties of participating media using Lorenz-Mie theory. *ACM Transactions on Graphics (SIGGRAPH 2007) 26*(3), pp. 60:1-60:10, 2007. https://doi.org/10.1145/1275808.1276452

Additional resources:

- Hannemose, M., Doest, M. E. B., Luongo, A., Gregersen, S. K. S., Wilm, J., and Frisvad, J. R.. Alignment of rendered images with photographs for testing appearance models. *Applied Optics 59*(31):9786–9798. November 2020.
  https://eco3d.compute.dtu.dk/pages/appearance#ao2020
- Frisvad, J. R., Jensen, S. A., Madsen, J. S., Correia, A., Yang, L., Gregersen, S. K. S., Meuret, Y., and Hansen, P.-E. Survey of models for acquiring the optical properties of translucent materials. *Computer Graphics Forum (EG 2020) 39*(2):729–755. 2020.
  https://people.compute.dtu.dk/jerf/cg-opt-props.html
- Stets, J. D., Dal Corso, A., Nielsen, J. B., Lyngby, R. A., Jensen, S. H. N., Wilm, J., Doest, M. B., Gundlach, C., Eiriksson, E. R., Conradsen, K., Dahl, A. B., Bærentzen, J. A., Frisvad, J. R., and Aanæs, H. Scene reassembly after multimodal digitization and pipeline evaluation using photorealistic rendering. *Applied Optics 56*(27):7679–7690, September 2017.
  https://people.compute.dtu.dk/jerf/papers/abstracts/reassembly.html
- Refractive Index Database: https://refractiveindex.info/
- McGuire Computer Graphics Archive (Meshes): https://casual-effects.com/data/