SYNOPSYS®

DATASHEET

Accelerating Biomedical Optics Design with Light Scattering Analysis

Features at a Glance

- LightTools software can help accelerate development of biomedical optics with its analysis and visualization capabilities.
- LightTools can be used in conjunction with Simpleware software to provide simulation data to develop a new generation of light-based technologies, including advanced biomedical diagnostics and treatments.
- Synopsys' expert illumination and optical engineers can help you with your product design needs. Contact us at optics@synopsys.com for more information.

Introduction

When you are designing illumination optics for medical devices—particularly when modeling scattering properties of biological tissues—it's important to use specialized light propagation analysis to verify design performance.

Synopsys' LightTools software can help accelerate development of biomedical optics with its analysis and visualization capabilities. LightTools accurately simulates light propagation through biological tissue using optical properties of the media such as absorption and scattering. In addition, LightTools can be used in conjunction with Synopsys Simpleware software to run detailed optical scenarios in 3D anatomical models.

Henyey-Greenstein Volume Scattering in LightTools

LightTools supports the Henyey-Greenstein model to define volume scattering properties of a material by providing data for the scatter distance (in terms of mean free path, scattering coefficient, or reduced scattering coefficient), transmissivity, and anisotropy factor (i.e., angular scattering distribution). This volume scattering type, which is useful particularly in the biomedical field for modeling tissue, has the advantage of using only one variable to describe the angular scattering distribution. This single variable, a parameter of the Henyey-Greenstein phase function, is based on the average direction that rays will scatter. This variable can be obtained from medical literature to model specific types of tissues.

LightTools Co-Simulation with Simpleware Software

LightTools can be used with Synopsys Simpleware software to provide simulation data to develop a new generation of light-based technologies, including advanced biomedical diagnostics and treatments.

Simpleware software provides a solution for the conversion of 3D image data (MRI, CT) into models for visualization, design, analysis, and simulation via exports to CAD, CAE, and 3D printing. Together, Simpleware software and LightTools can enable real-world optical scenarios to be accurately reproduced in simulation by using detailed models of human anatomy. R&D simulations for medical devices, as well as for consumer products and electronics which optically irradiate the human body, can be achieved through this software partnership. Bespoke anatomical models can also be developed for unique applications and LightTools simulation requirements.

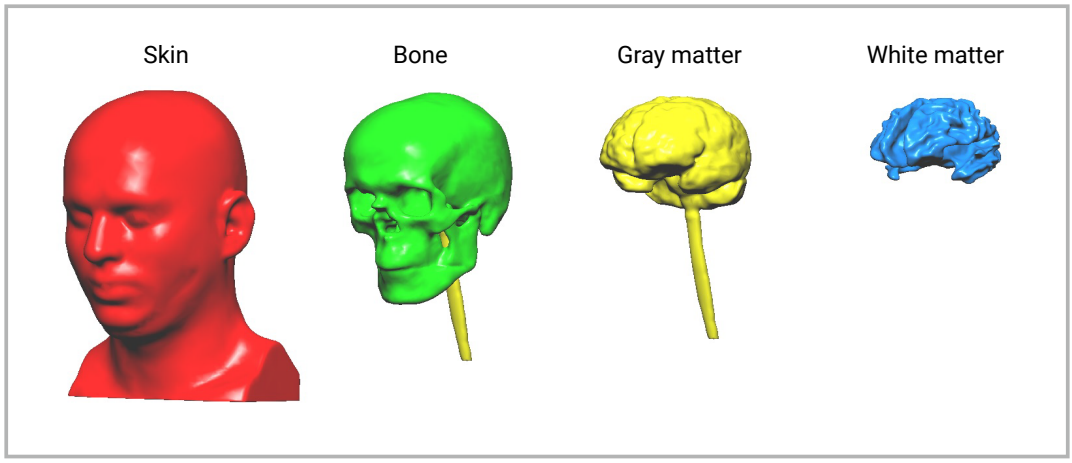

Figure 1: Head models created from image data using Synopsys Simpleware software. Simpleware and LightTools can be used in conjunction to run detailed optical scenarios in 3D anatomical models for biomedical applications.

Case Study: Biological Tissues Simulation

Figure 1 shows an example human head model created in Simpleware software and imported into LightTools for volume scattering analysis of biological tissues. The model consists of four layers: skin, bone, gray matter and white matter.

The optical parameters used for all layers of the model are available in industry literature. Example values are shown in the following table.

	Tissue layer	Refractive index	μa Absorption coefficient	μs Scattering coefficient	Transm. per mm	Mean free path MFP
750mm	Skin	1.41	0.09	2.75	0.9139	0.3636
	Bone	1.54	0.028	1.89	0.9724	0.5291
	Gray matter	1.36	0.05	8.7	0.9512	0.1149
	White matter	1.38	0.105	32.3	0.9003	0.0310

To model the media between layers (extracellular fluid), the entire model is immersed in the media with a refractive index of 1.51.

A source creates a parallel monochromatic beam with wavelength 750 nm. Figure 2 shows nine receivers included in the LightTools model to register the light irradiance.

Figure 3 shows the LightTools visualization of volumetric scattering layers after running the illumination simulation.

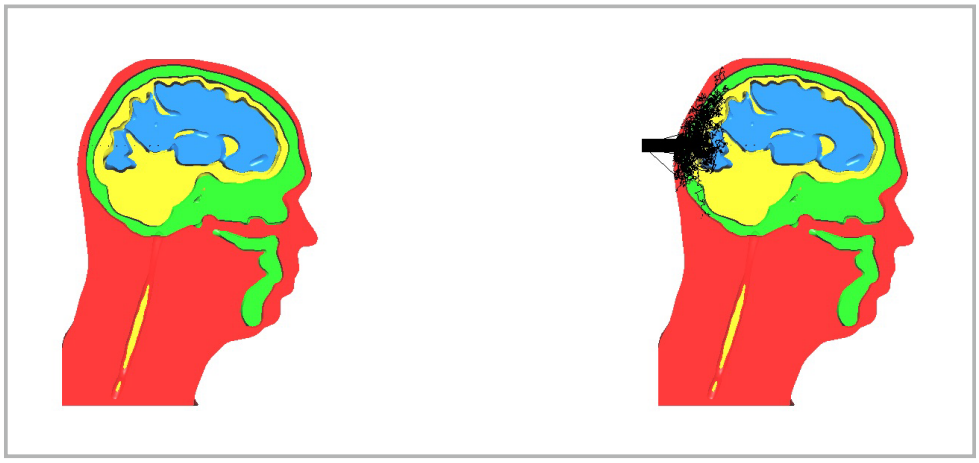

Figure 2: Receiver locations in LightTools model

Figure 3: Illumination visualization results

Figure 4 shows the registered irradiance on the nine receivers.

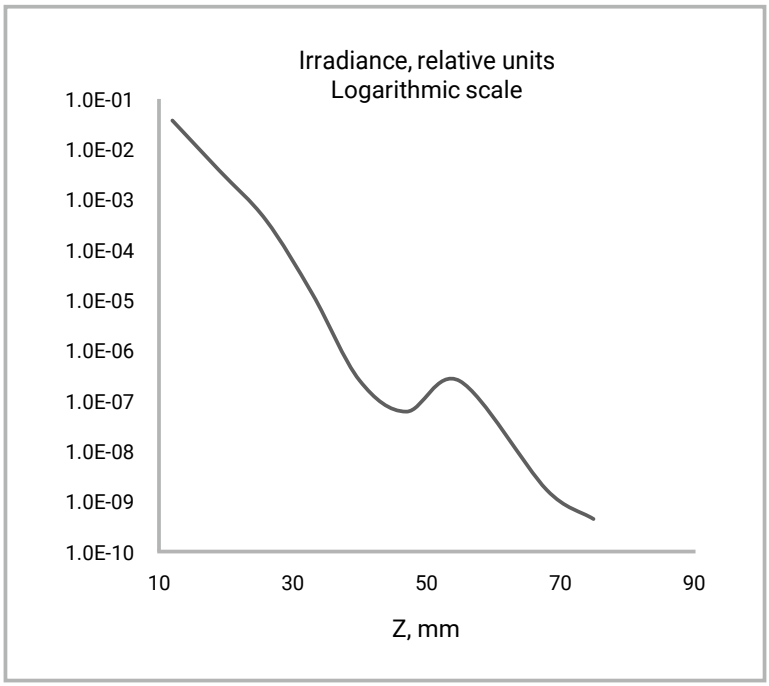

Figure 4: Irradiance distribution within the head model

Conclusion

We have shown that light propagation through various layers of the human head can be achieved using Simpleware CAD data and LightTools biological tissue modeling capabilities. The emerging area of using light for biological and medical monitoring, therapy, and research, as well as wearable biosensor technology product development, can benefit from these design capabilities.

Designing Illumination Systems for Medical Devices? Our Expert Engineers Can Help.

If your team is strapped for time, Synopsys' experienced staff of illumination and optical engineers can help you meet your product design needs effectively. Contact us at optics@synopsys.com to get started.

For More Information

Visit synopsys.com/optical-solutions to learn more about LightTools for illumination design and Synopsys' optical engineering consulting services.

Visit synopsys.com/simpleware to learn more about Simpleware software for 3D image data visualization, analysis, and model generation. Contact us at optics@synopsys.com to get started.

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