Ray Tracing for Light and Radio Wave Simulations

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Abstract

In this thesis we present methods to simulate the propagation of light and radio waves using ray-tracing techniques. Both visible light and high frequency radio waves can be modeled by using geometrical optics. Rays are traced from the radiation sources and interact with objects. Our goal is to provide efficient and accurate solutions. We achieve this by using ideas from computer graphics, applying them in the field of radio wave propagation, and also transferring results back to computer graphics.

In the first part of this thesis we introduce the general concepts of optics that are needed for the later chapters. Next we explain propagation models in general and ray tracing in particular. We introduce our novel algorithm, the Photon Path Map, as well as a 2D beam tracing method. We continue with a visible light propagation algorithm for real-time visualizations. Furthermore we show how to model antennas with arbitrary radiation patterns and line out how this could also be applied to visible light sources. After shortly explaining how to incorporate polarization effects into our ray tracing system, we turn to interactive visualizations of our wave propagation simulations. In the last chapter we then show how to incorporate the ray tracing based propagation model into a network simulator, for greater accuracy of mobile network simulations.

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