CMPM 163 Notes

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Volumetric Effects and Models

- A **Model** is a representation, abstraction, or process of a given system that may or may not employ simplification, generalization, depending on the intended accuracy of the model.
- **Models** are useful because nature is mostly chaotic, and these constructs permit us to understand, find or create order, build a hierarchy of understanding, and eventually uncover a more universal pattern.
- **Volumetric Media** is a term that refers to physical volumes that have effects on transiting light.
- In ordinary life, the effects of **Volumetric Media** are not always apparent as many physical objects appear opaque or non-translucent.
- Density is typically the greatest effector when it comes to calculating volumetric effects.
- It is possible to distinguish between **Physically Correct** models and **Empirically Correct** models. The former is evaluated based on real principles, whereas the latter is merely intended to mimic the phenomena as they are observed.
- The amount of light passing through a fragment can be found by taking the integral of the product reflectance with the incoming light for all directions.
- The fundamental problem of light transport is that light transport has a fractal nature: light is reflected, refracted, and re-emitted by surfaces, so calculating the light hitting a surface from all direction also entails calculating previous iterations of the same equation.
- The concept of **Radiative Transfer** is an abstract model representing the aggregate transfer of light of the previous problem
- There are two principled methods of solving the **Radiative Transfer** problem: **Stochastic/Probabilistic** or **Deterministic**.

- Within the **Stochastic** method is the approach of **Photon Mapping** - individual "photon" interactions are modeled and stored as they occur, whereupon a raymarch is employed to determine which interactions would be visible to the viewer
- Within the **Deterministic** approach, volumes are broken into cells and the individual cells perform light interactions upon each other.
- **Light Scattering** is the gradual loss of illumination coherence throughout a substance

Methodology of Volumetric Effects Rendering

- A typical approach to soft volumetrics is to keep a 3D texture representing discretized densities of an object.
- Instead of solving the global transport problem, it is possible to employ **Principal Ordinate Propagation** – effectively, perform an iterated series of discretized ordinate solutions per light source, then sum the results.
- For a scene with many lights, they may be separated into **Distant Lights**, **Point Lights**, and **Virtual Point Lights**. Each will generate a light propagation lattice for the final calculation
- **Screen-Space Scattering** is an optimization that is applicable to sparse environments; it is an approximation that uses only the image-space depth to apply a volumetric media calculation to the entire screen space. Basically it assumes that there is a uniform volumetric media that encompasses the viewer and entire scene.
- Check out Inigo Quilez: `iquilezles.org`