Light Ray Tracing

BACKGROUND

At the interface between two different types of media, light rays are both refracted and reflected. The proportion of rays which are reflected is given by a quantity called the reflection coefficient which is dependent on the incident angle of the rays relative to the slope of the interface.
Generally, the path light rays travel through a material is dictated by a series of refractions and reflections as a result of the various interfaces between different media. A simplistic example would be that of light rays passing through a defined volume of crushed glass. The rays would be refracted and reflected in various directions due to the numerous interfaces between glass particles and air.

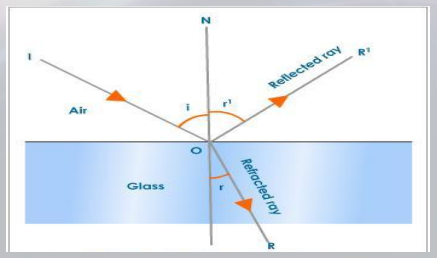


Figure 1: Refraction and reflection at the interface between glass and air.
NB: In the model all refractions and reflections are done in three dimensions.

OBJECTIVES

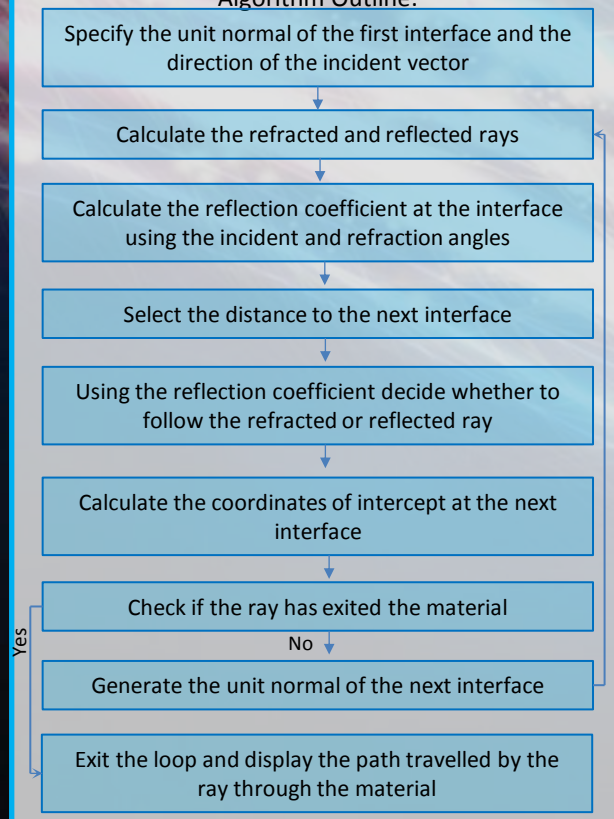
- Develop a computer algorithm using MATLAB which simulates a light ray travelling through a material comprised of a two different media e.g. glass and air.
- Use the algorithm to reconstruct the path travelled by a single light ray within the material and determine when the ray exits the material.

MODELLING

To model the scenario in which a light ray passes through a material composed of two different media two key assumptions were made:

- The orientation of each interface was random over 180 degrees about the incident ray
- The probability distribution of distances between successive interfaces followed a decaying exponential.

Algorithm Outline:



OUTCOMES

- The computer algorithm was able to simulate a light ray passing through a material containing a series of interfaces between two media
- The algorithm was able to reconstruct the path travelled by the ray within the material
- A comparison programme written to validate the model produced results with minor differences suggesting the algorithm is producing useful output.

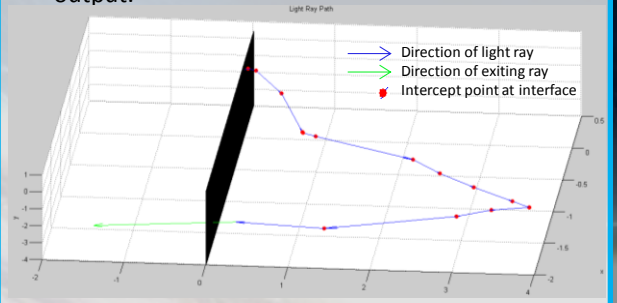


Figure 2: Sample light ray path

FUTURE WORK

- The model should be run numerous times in order to generate statistical data on the spread of where rays leave the material and on average how long they spend in the material.
- The model could be trialled with various combinations of materials and particle sizes which can be controlled via specific parameters within the algorithm.
- In order to improve the model and make it more realistic the amount of energy rays lose at each interface could be tracked.
- In order to validate the overall output of the model experimental data is required for comparison.

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