Volume rendering in the web browser

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Introduction

Keywords

- Isotropic Uniform from all directions
- Plenoptic Vector field applied to light (intensity, emission, radience

Methods

Applications

Conclusions

Introduction

This report explores some of the techniques which can be used to render a 3d-volume in a web browser using the extremely popular Javascript library THREE.js. There are quite a few techniques available for rendering. The report briefly presents a few of the techniques and then explains in more detail, the technique of Direct Volume Rendering using Raycasting.

By limiting oneself to using the browser as a rendering medium, the number of devices being able to run and display the result is enormous.

The rendering equation

The initial problem we are trying to solve is how light scatters in a 3d-space and then how to project it down to a discrete 2d-plane. This procedure is called rendering. A very well known and used approximation of the light scattering is called the rendering integral. Some of the earliest papers on the subjects by Kajiya[**?**] and Immel[**?**] as a generalization of various other methods.

$$I(x', x) = \int_a^b f(x)\,\mathrm{d}x \tag{1}$$

The rendering integral describes the light intensity of a point in space. For

Certain phenomena cannot be expressed with this lighting model. Specifically caustic effects such as reflection and refraction are not being taken into account with this type of integral.

Volume rendering methods

Slicing

One approach is slicing

CT-scans, MRI-cams

Analogous to the way the data is produced

Mobile devices

Artifacts

Direct Volume rendering with Raycasting (simplified)

Entities used in the method:

- Two-dimensional plane representing the image to be rendered. Discretized into pixels.
- Three-dimensional vector/scalar field of the volume to visualize. Probably best described as a function of a position in the volume returning the density/other data which somehow affects the pixel color.
- Eye/camera (position and direction).

The goal of the method is to render a volume data set to a two-dimensional plane.

Raycasting

We imagine an eye or a camera looking at the volume, from which we shoot rays through every pixel in the plane. We sample the volume vector field along the ray for density.

Calculation of intensity for light rays

Improvements and additions

Transfer function

$$D(x) : \mathbb{R}^3 \to \mathbb{R}^3 \tag{2}$$

Transfer function describing what

$$t : \mathbb{P} \to \mathbb{R}^3 \tag{3}$$

Early ray termination

Grouping of similar regions to reduce sampling

Implementations

Tools/libraries

A great help when writing code for 3d-graphics in the browser is the Three.js [1] javascript library. The framework reduces the amount of code needed to produce WebGL code.

[1] `http://threejs.org`