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11-13-2017

On Issues Related to Different Volume Rendering Methods and the "True Volume Rendering Integral"

→ **SURVEY:** Talk "Direct Volume Rendering" by D. Weiskopf, R. Machiraju & T. Möller
(http://vda.univie.ac.at/Teaching/Vis/14s/LectureNotes/11_direct-volume_rendering.pdf)

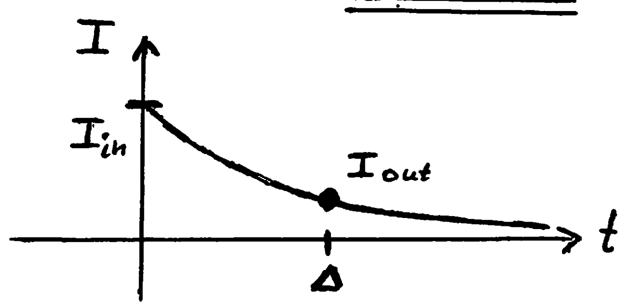
1) Basic ABSORPTION Model only:

constant/homogeneous absorption ⇒ coefficient α

$$\underline{I_{out}} = I_{in}\, e^{-\int_a^b \alpha(t)\, dt}$$

$$= \underline{I_{in}\, e^{-\alpha \Delta}},$$

where $\underline{\underline{0 \le \alpha \le \infty}}$!



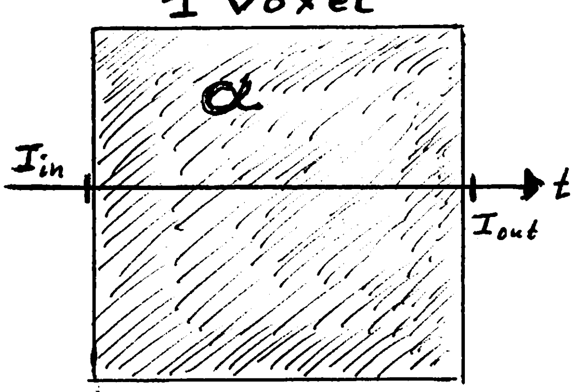
$\alpha = 0$ → complete transparency
$\alpha = \infty$ → complete opacity

! SABELLA's algorithm uses this model properly

!!! LEVOY ≠ BASIC ABSORPTION MODEL !!!

2) LEVOY's Algorithm:

1 voxel



- basic step ("compositing step") of LEVOY:

$$\underline{I_{out} = (1-\alpha)\, I_{in}},$$

where $\underline{\underline{0 \le \alpha \le 1}}$!

$\alpha = 0$ → complete transparency
$\alpha = 1$ → complete opacity

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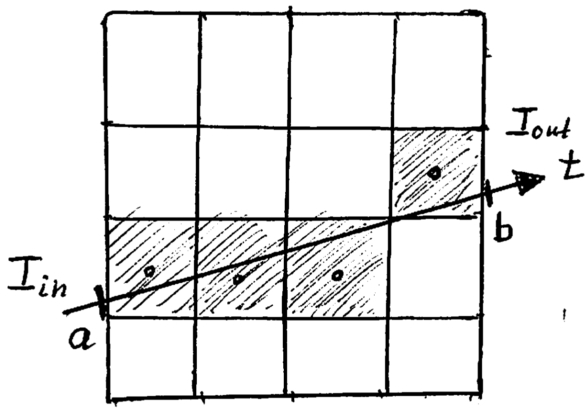
11-20-2017

Using Higher-order Approximations of the Volume Rendering Integral – For Better Reconstruction



Basic BRESENHAM Line approximation

- Simple absorption model:

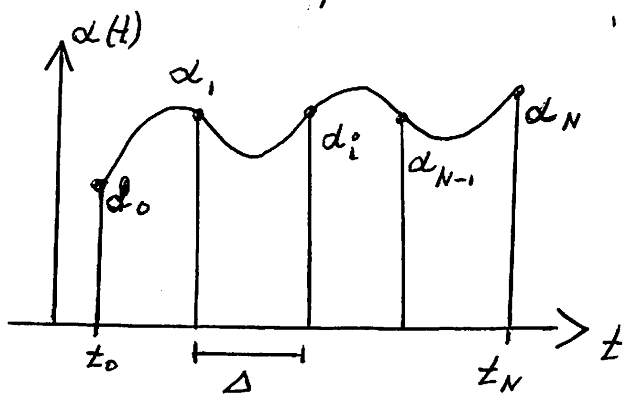
$$I_{out} = I_{in} \cdot e^{-\int_a^b (\alpha(t))\,dt}$$

- Need "good" approximations of

$$\boxed{\int_a^b \alpha(t)\,dt =: \underline{A}}$$

- Must use a BRESENHAM approach in combination with "good" approximation!

- Numerical approximation of integral value $\underline{A}$



→ Use also trapezoidal and Simpson's rules to estimate $\underline{A}$:

(1) Trapezoidal rule:

$$\boxed{A = \frac{\Delta}{2}\left(\alpha_0 + 2\alpha_1 + 2\alpha_2 + \ldots + 2\alpha_{N-1} + \alpha_N\right)}$$

(2) Simpson's rule:

$$\boxed{A = \frac{\Delta}{3}\left(\alpha_0 + 4\alpha_1 + 2\alpha_2 + 4\alpha_3 + \ldots + 4\alpha_{N-1} + \alpha_N\right)}$$

- **NOTE:** Bresenham does not lead to a uniform spacing Δ.
  ⇒ Proper adjustment needed.

- **NOTE:** Resulting Linear system for unknown α-values leads to a computationally more expensive method. BH