局部自适应的特征增强体绘制新方法

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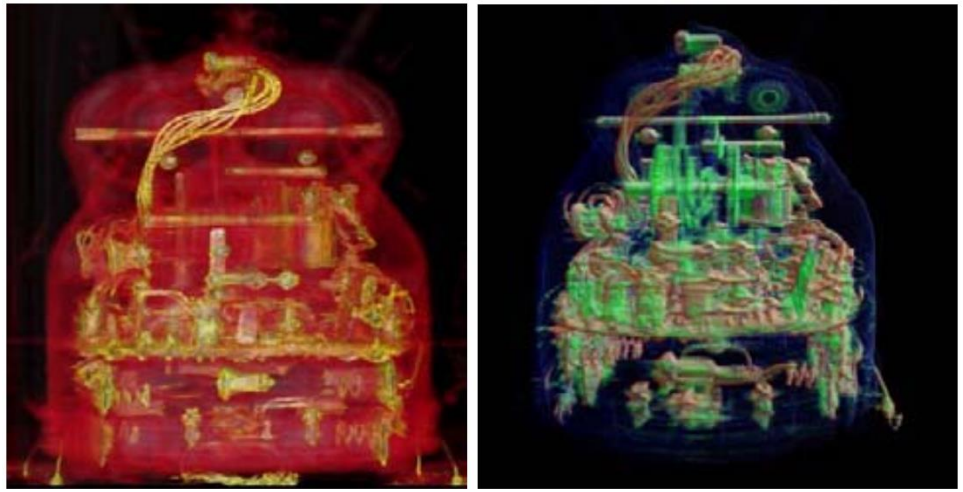
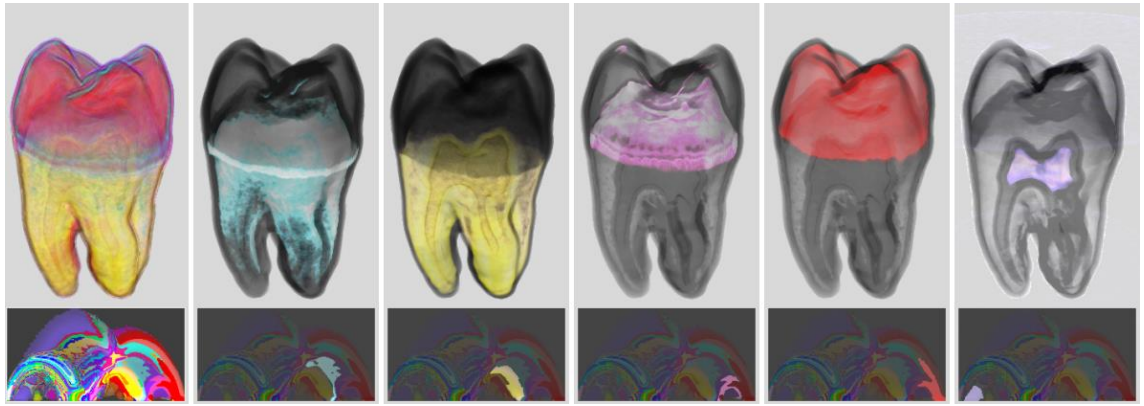
Outline

- **Research Background**
  - Volume Rendering Based on Transfer Function
  - Volume Rendering Based on NPR(Non Photorealistic Rendering)
- Problem Description
- Methodology
- Result
- Advantage and Limitation

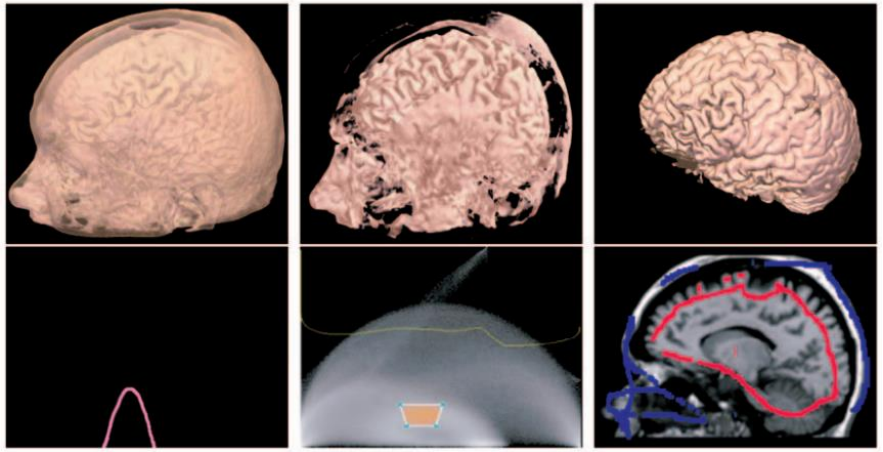
Volume Rendering Based on Transfer Function



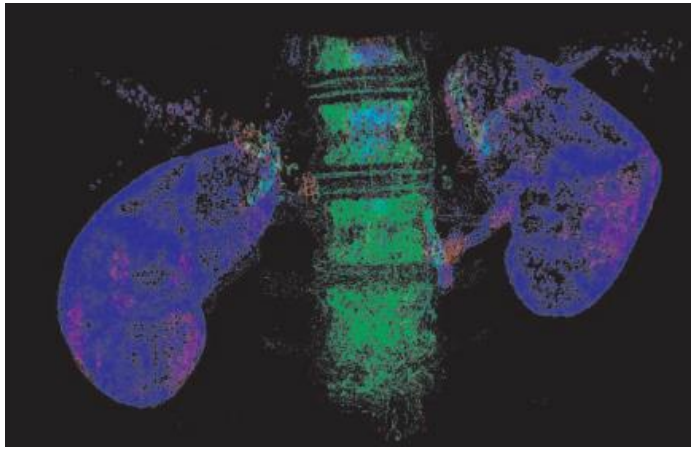
[Huang et al. 2003]



[Roettger G. 2005]

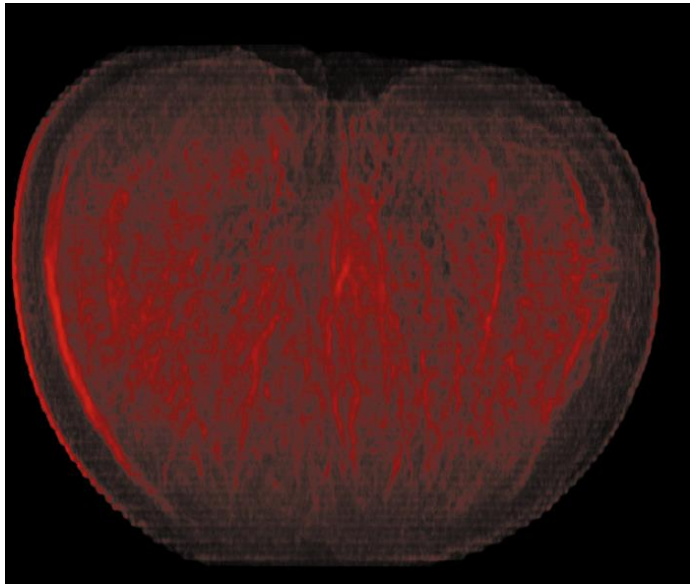


[Tzeng et al. 2005]

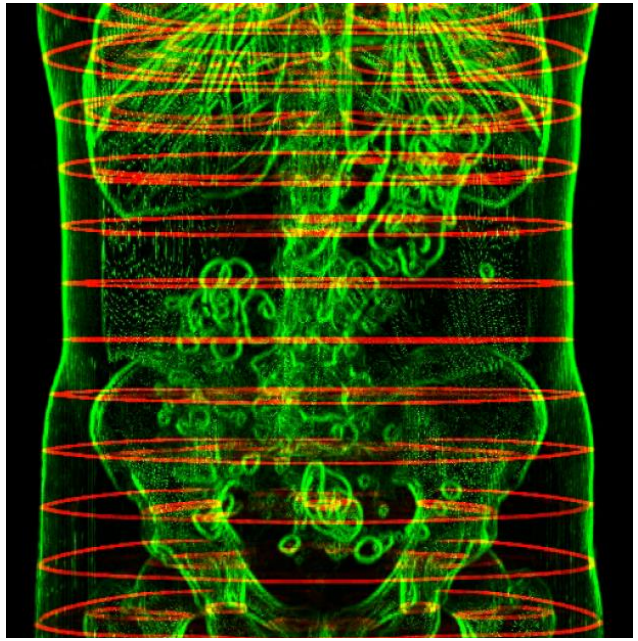


[Caban et al. 2008]

Volume Rendering Based on NPR



[David et al. 2000]



[Csébfalvi et al. 2001]

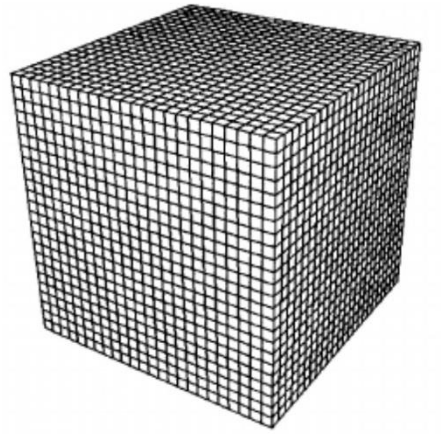
[Liang et al. 2012]

Outline

- Research Background
- **Problem Description**
- Methodology
- Result
- Advantage and Limitation

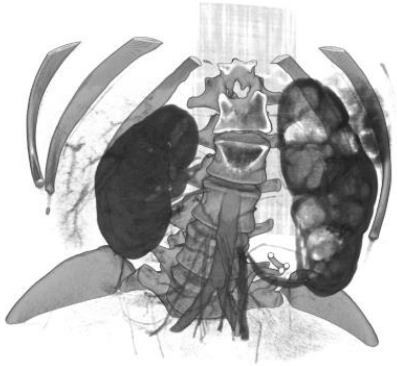
Problem Description

Improvement of Volume Illustration



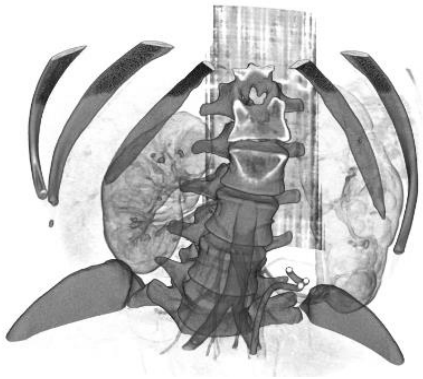
Grayscale
Raw Volume Data

Transfer



Opacity

Boundary Enhancement



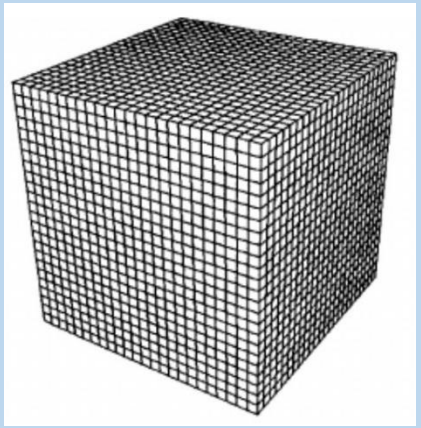
Result

Outline

- Research Background
- Problem Description
- **Methodology**
  - Simple Transfer Function
  - Volume Illustration
  - Adaptive Local Boundary Enhancement
- Result
- Advantage and Limitation

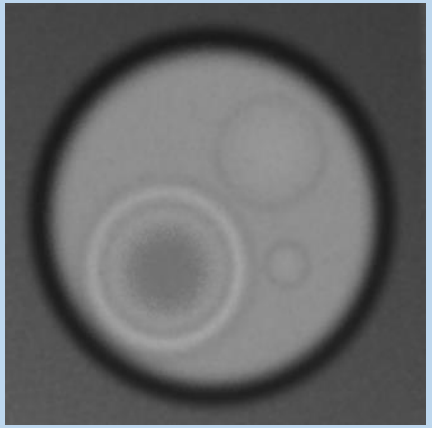
Simple Transfer Function

$$O_{p_i} = \begin{cases} 0 & I_{P_i} < I_{\min} \\ a \times (I_{P_i} - I_{\min})^b & I_{\min} \le I_{P_i} \le I_{\max} \\ a \times (I_{\max} - I_{\min})^b & I_{P_i} > I_{\max} \end{cases}$$



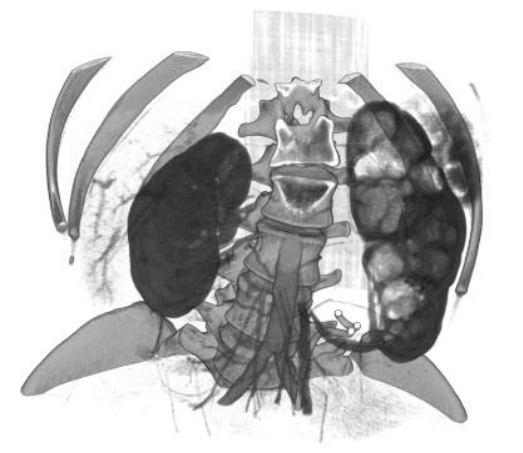
Grayscale
Raw Volume Data

Transfer Function



Opacity
Direct Volume Rendering

Volume Illustration



Same Tissue : Similar Grayscale

Different Tissue : Variant Grayscale

} **Boundary : Larger Gradient**

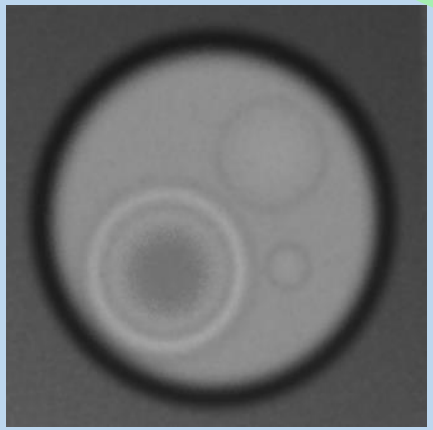
Central difference method

$$G(P_i) = \frac{1}{2}\begin{pmatrix} f(x_{i+1}, y_i, z_i) - f(x_{i-1}, y_i, z_i) \\ f(x_i, y_{i+1}, z_i) - f(x_i, y_{i-1}, z_i) \\ f(x_i, y_i, z_{i+1}) - f(x_i, y_i, z_{i-1}) \end{pmatrix}$$

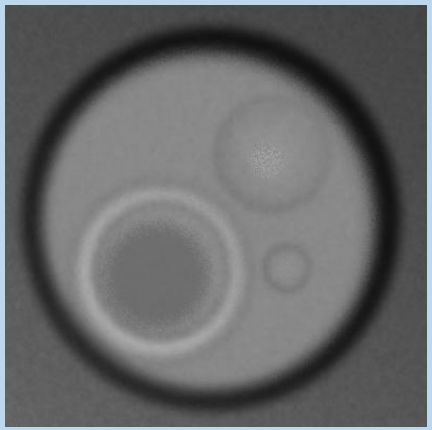
Volume Illustration

$$O_n = \alpha \times O_o + \beta \times O_o \times \|G\|^{\gamma}$$

Always Positive
Same β Everywhere



Boundary Enhancement



Direct Volume Rendering

Volume Illustration

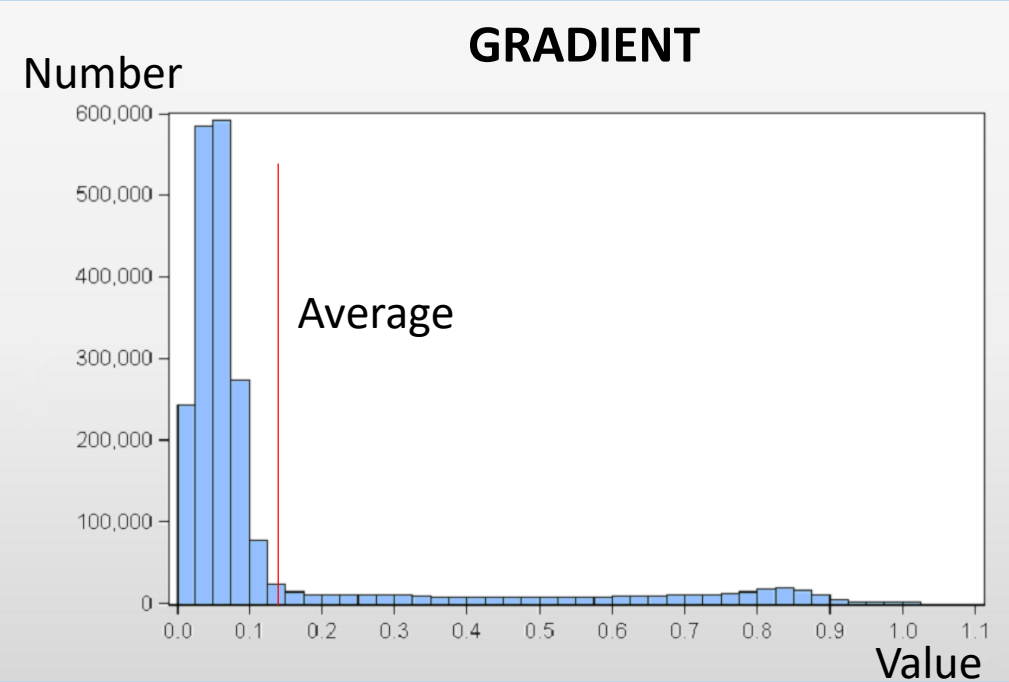
Adaptive Local Boundary Enhancement

$$O_n = \alpha \times O_o + \underline{\beta \times O_o \times \|G\|^{\gamma}}$$

Volume Illustration

- **Always Positive** → **Opacity ↑ Everywhere**
- **Same β Everywhere** → **Unbalanced Enhancement in Different Grayscale**

Adaptive Local Boundary Enhancement

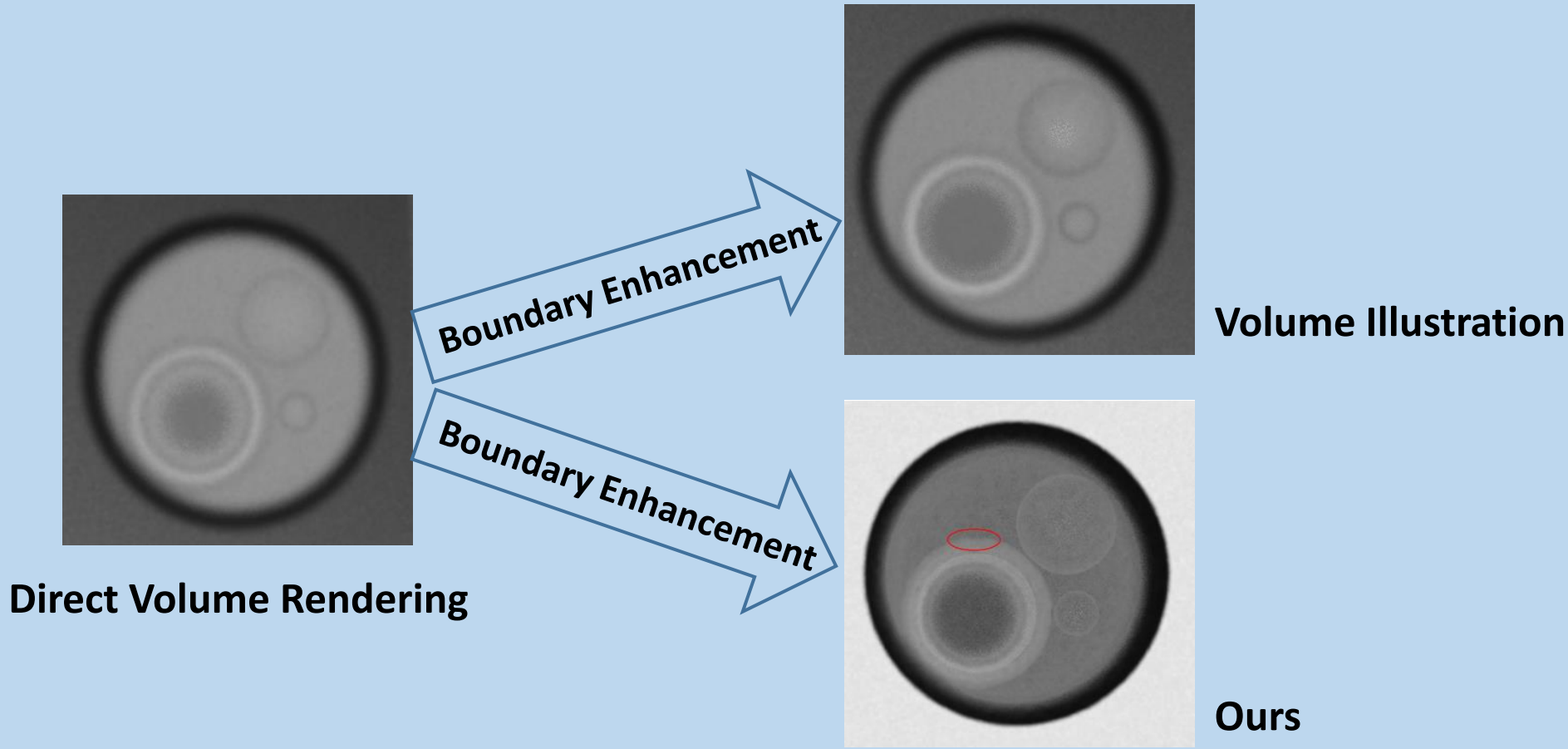


$$E = O_o \times \|G\|^\gamma \quad \text{Boundary} \quad : E > E_x$$
$$E_x = h \times \|\bar{G}\|^\gamma \quad \text{Non-boundary} : E < E_x$$

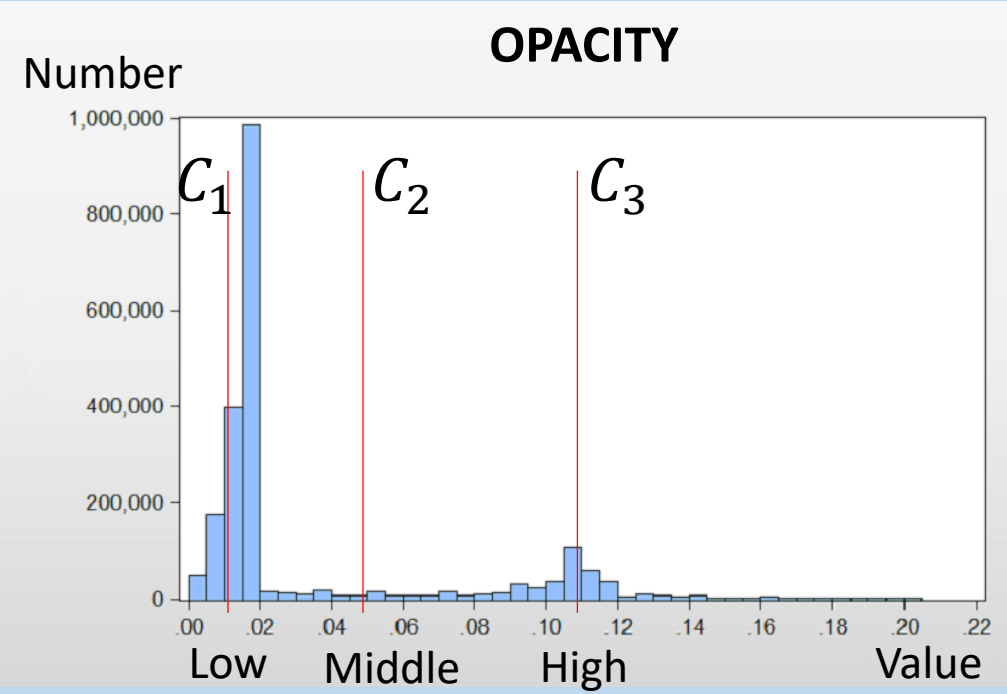
$$O_{new} = O_{old} + K \times (E - E_x)$$

Boundary : Opacity ↑
Non-boundary : Opacity ↓

Adaptive Local Boundary Enhancement



Adaptive Local Boundary Enhancement

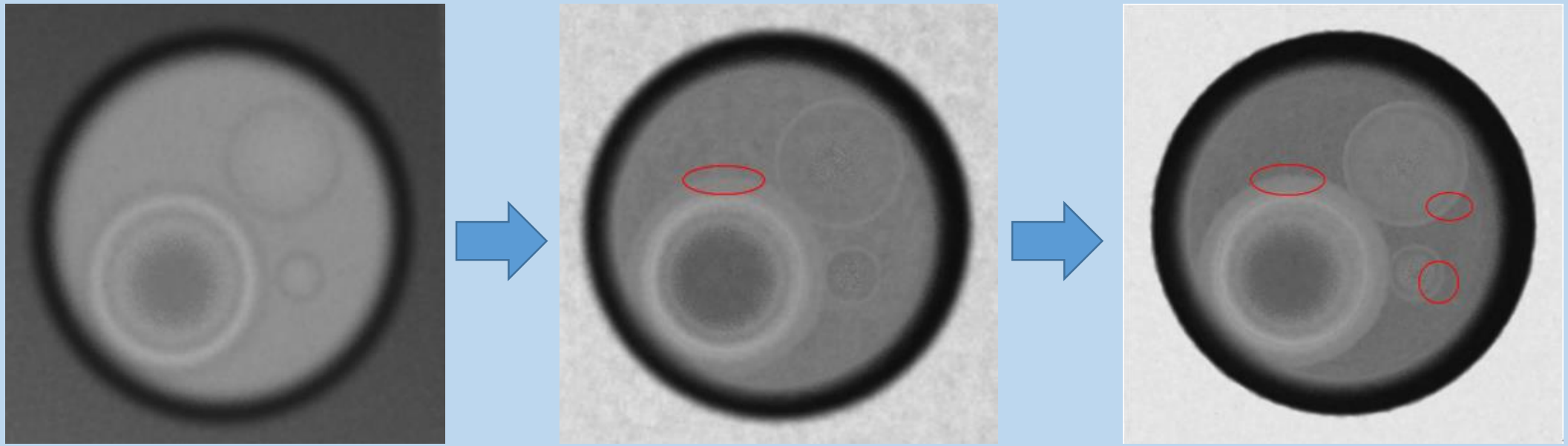


$$O_{new} = O_{old} + K \times (E - E_x)$$

$$K = \frac{1}{C_k + \sigma}$$

Global Balanced Enhancement

Adaptive Local Boundary Enhancement



Direct Volume Rendering

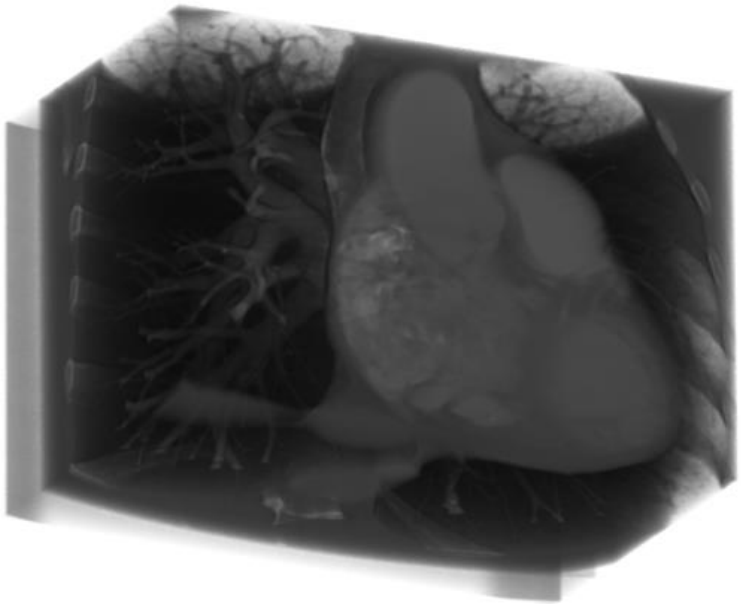
Gradient Enhancement
(Ours)

Clustering Enhancement
(Ours)

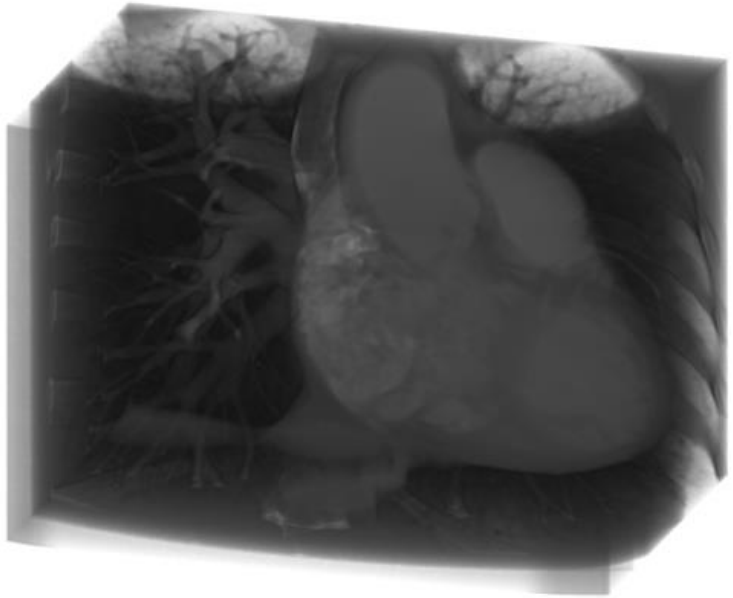
Outline

- Research Background
- Problem Description
- Methodology
- **Result**
  - Heart
  - Abdomen
  - Head
- Advantage and Limitation

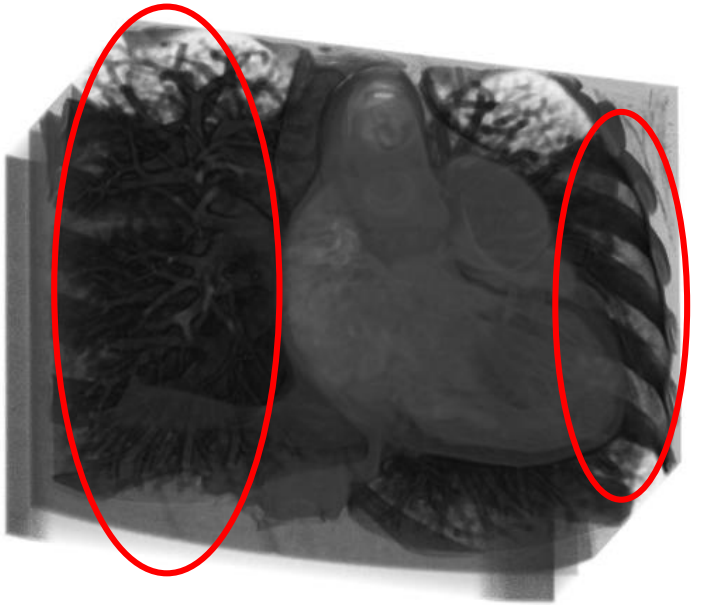
Result-Heart



Direct Volume Rendering



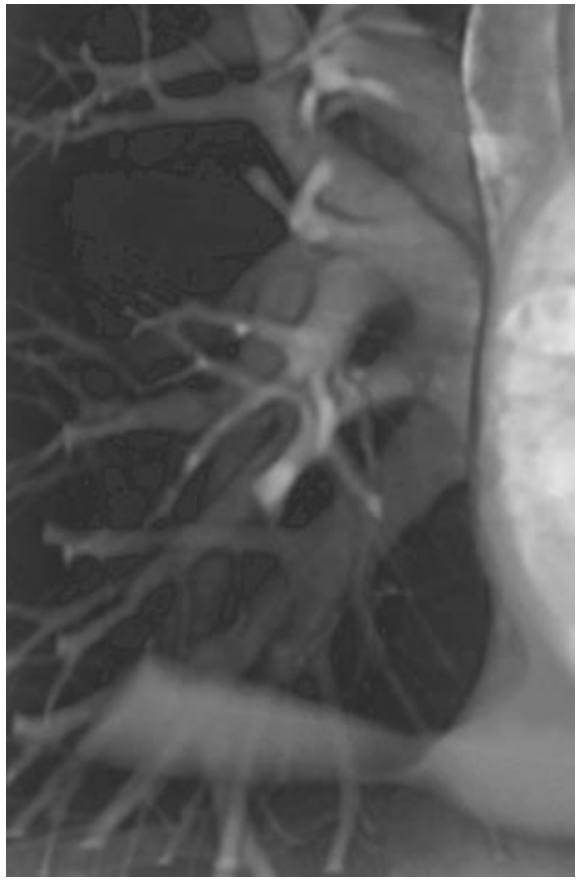
Volume Illustration



K_1=0.58, K_2 =0.8, K_3 =0.48, h=1

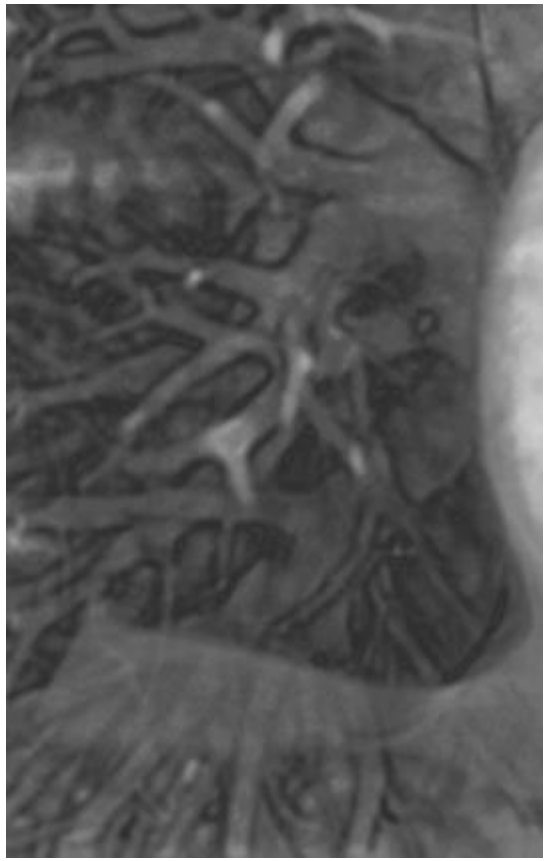
Ours

Result-Heart



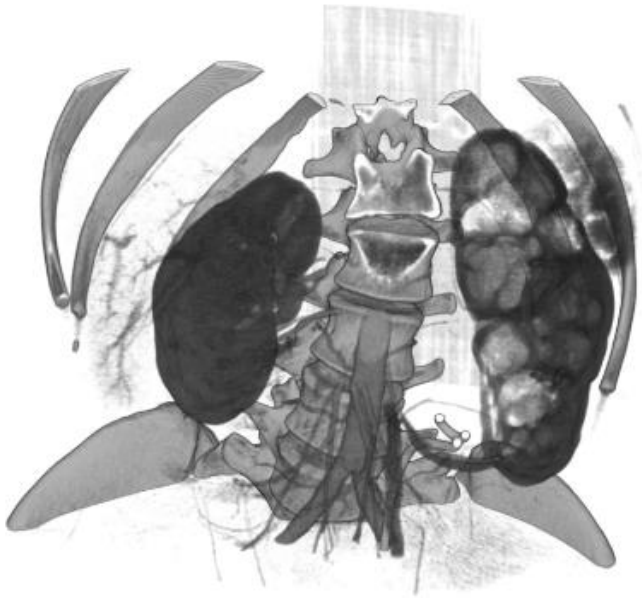
Direct Volume Rendering

Volume Illustration

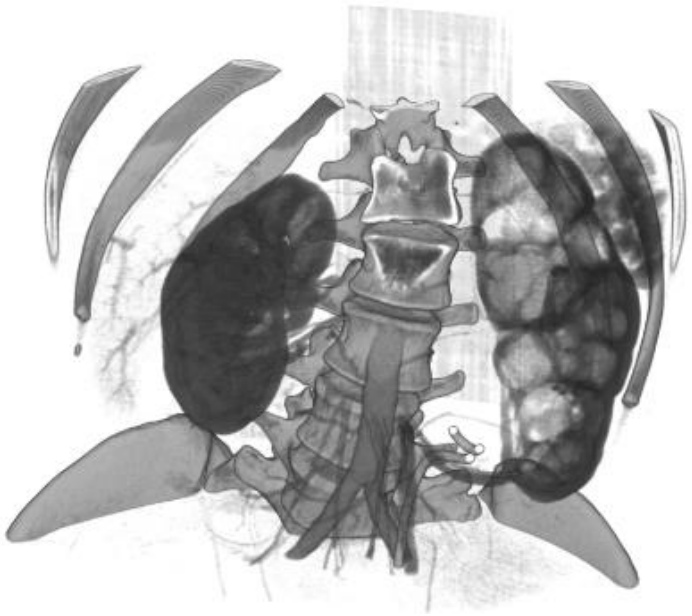


Ours

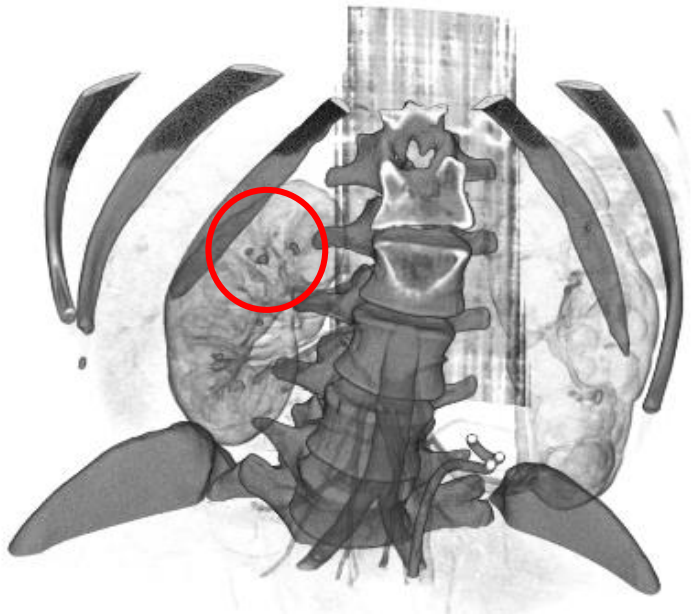
Result-Abdomen



Direct Volume Rendering



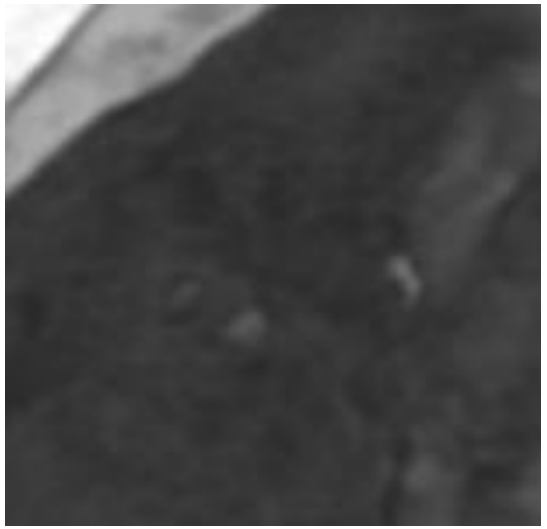
Volume Illustration



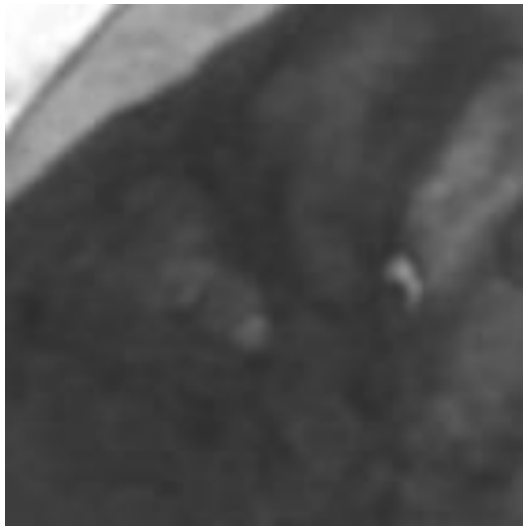
K_1=0.66， K_2=1， K_3=0.72， h=3.24

Ours

Result-Abdomen



Direct Volume Rendering

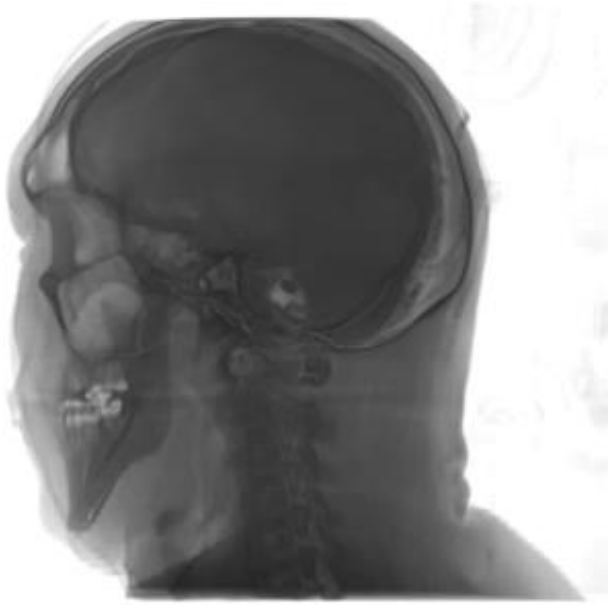


Volume Illustration

Ours

Result-Head

Direct Volume Rendering



Volume Illustration

K_1=0.66， K_2=0.67， K_3=0.34， h=1.12

Ours

Result-Head

Direct Volume Rendering

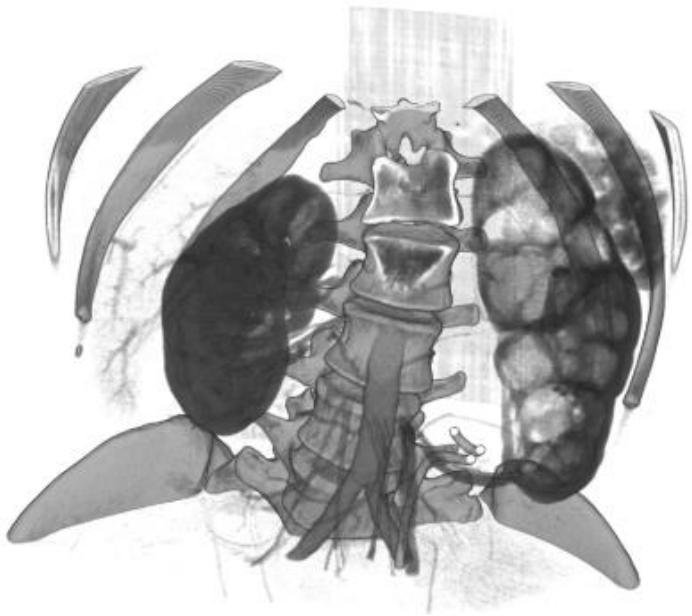
Volume Illustration

Ours

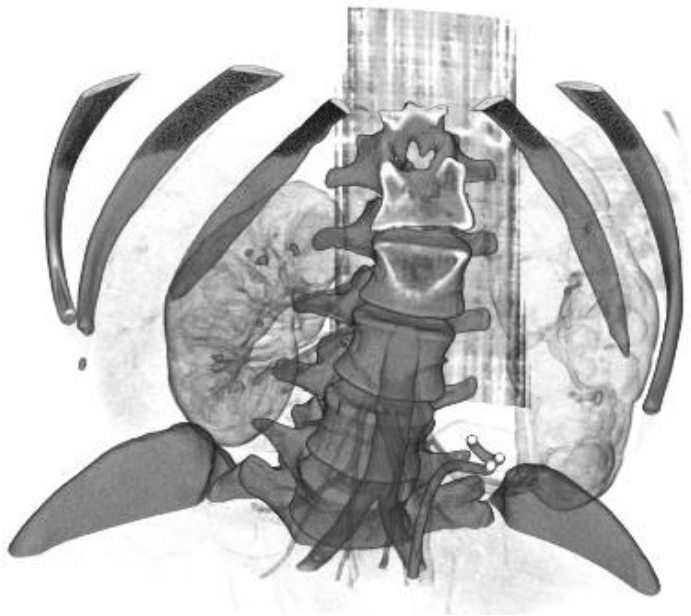
Outline

- Research Background
- Problem Description
- Methodology
- Result
- **Advantage and Limitation**
  - Advantage
  - Limitation

Advantage



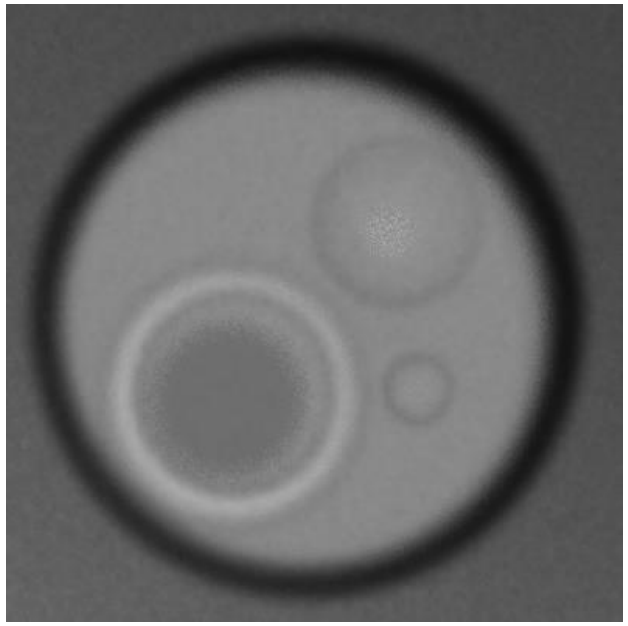
Volume Illustration



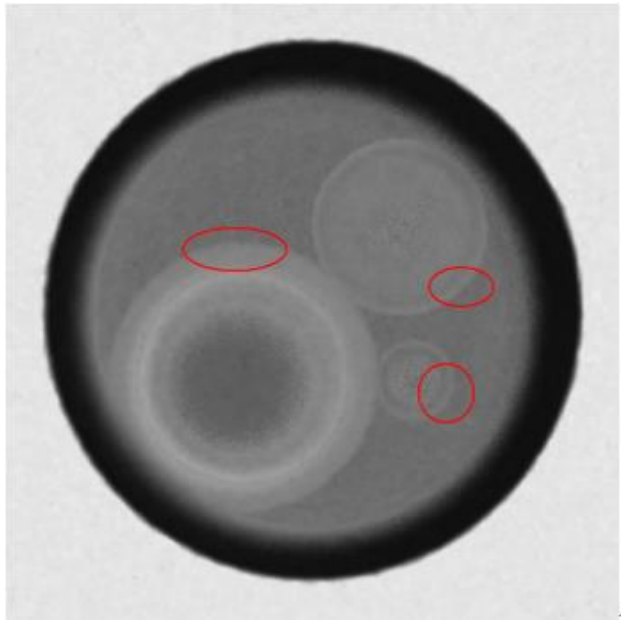
Ours

Clearer Boundary

Advantage



Volume Illustration



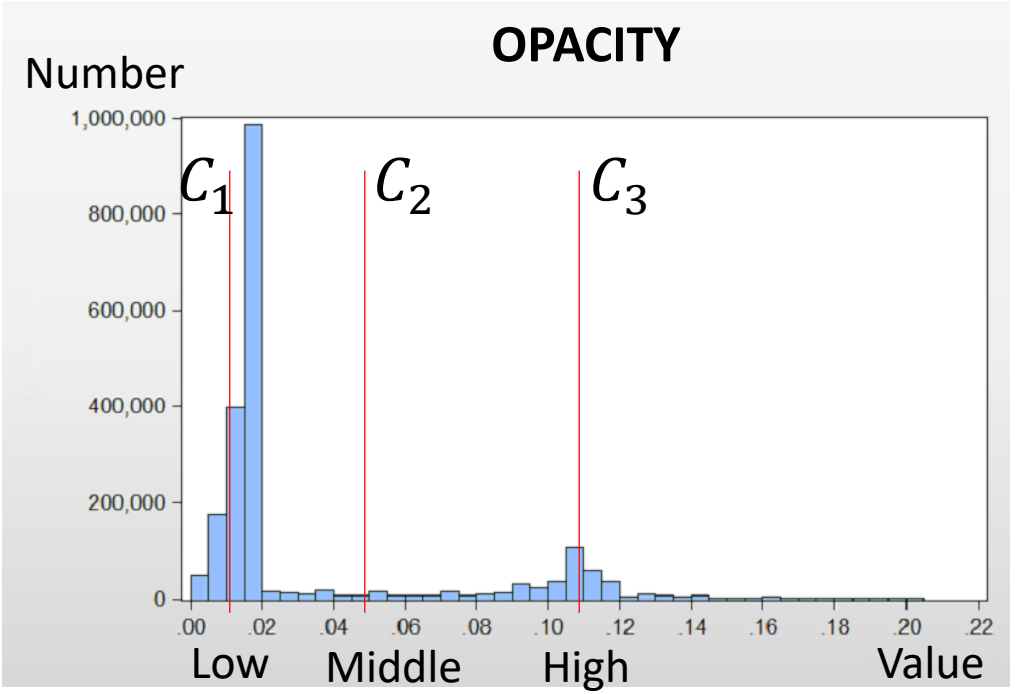
Ours

Global Balanced Enhancement

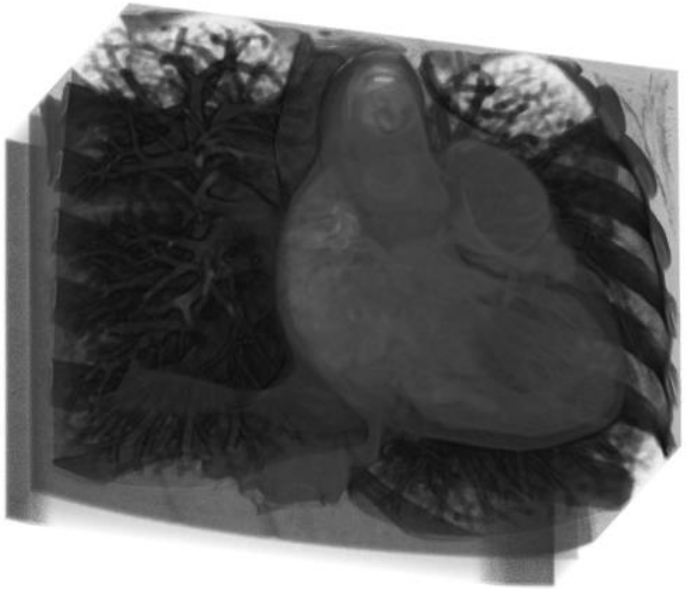
Limitation

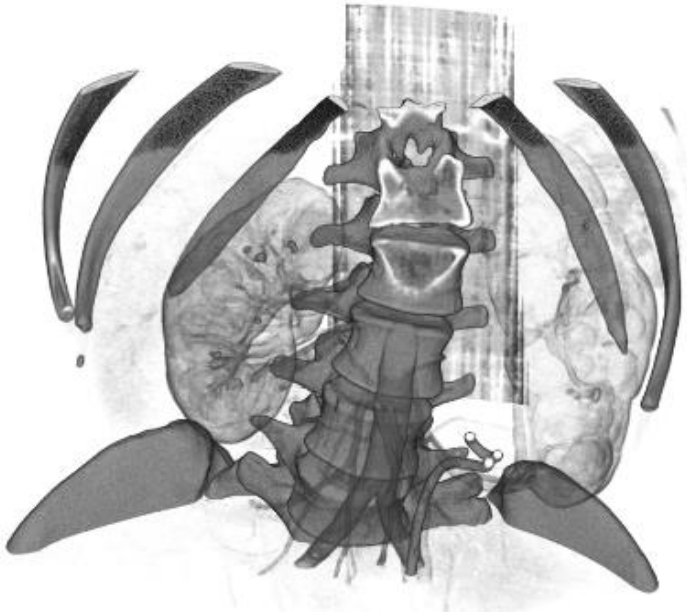
$$K = \frac{1}{C_k + \sigma}$$

How many Clustering center?



Limitation





No Color Information

Thank you