# Automatic Extraction of the Interest Organization from Full-color Continuous Images for a Biological Sample

## ー 生体フルカラー連続断面画像からの関心組織領域自動抽出法 ー

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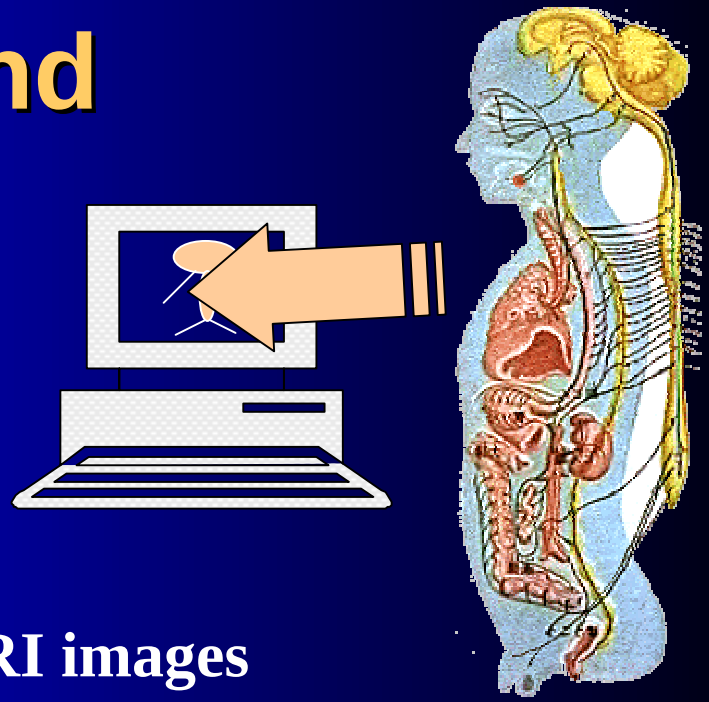
# Background

**Constructing 3-D model of biological tissue in PC**



**Conventional research**

**Gray-scale 3-D model by CT or MRI images**

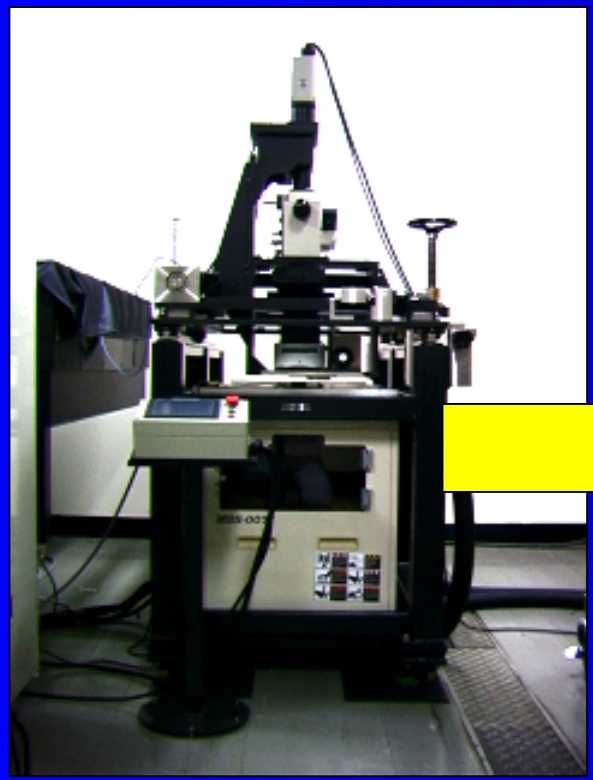
Desire for more detailed observation with color information

**Need for color images of internal tissue picturized in detail**

# Getting Color Volume Data

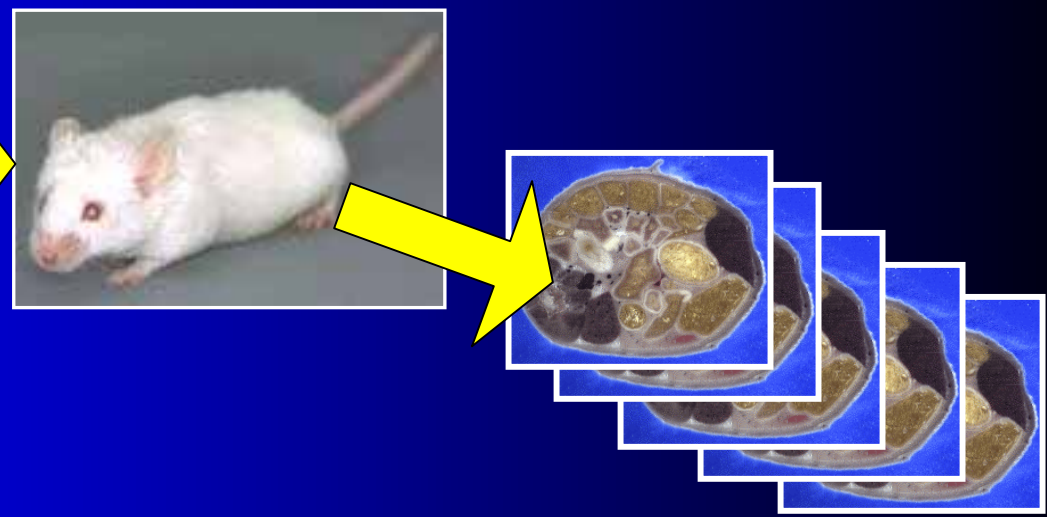
**Color image of biological internal tissue**

- **Visible Human Project by U.S. National Library of Medicine**
- **Development of New Observation System : 3D-ISM**



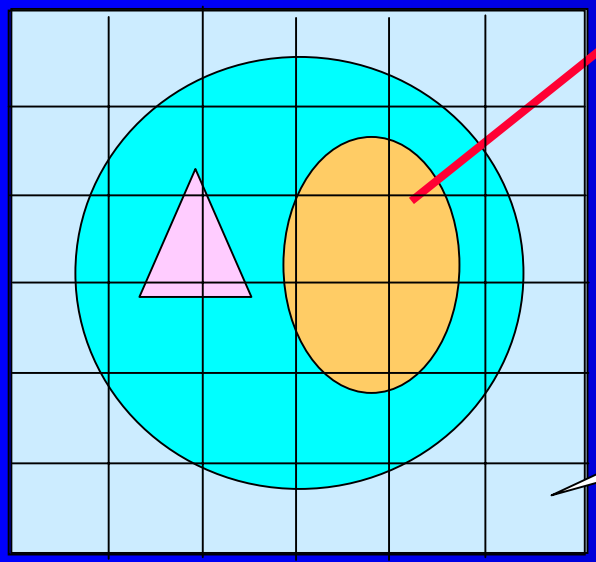
**Outlook of 3D-ISM**

**High resolution and full-color**
**continuous sectional images**



# Essential Factor for Constructing 3-D Model

Extracting each tissue from all continuous images



**ROI** (Region of Interest)

How to extract ?

- Manual extraction (by anatomical knowledge)
- Applying threshold to pixel value

P*x* = (**R**, **G**, **B**)

Biological color image by 3D-ISM

*But!!*

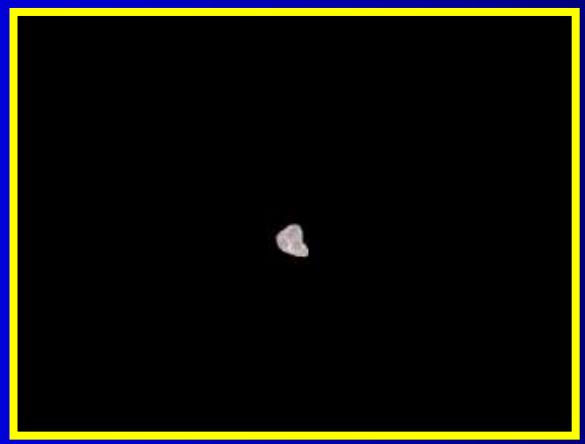
- Huge numbers of images
- No definite difference between tissues

Need for a new extraction method suited to biological color image

# Purpose of this Research

- **Extracting ROI from all continuous images**

Original image

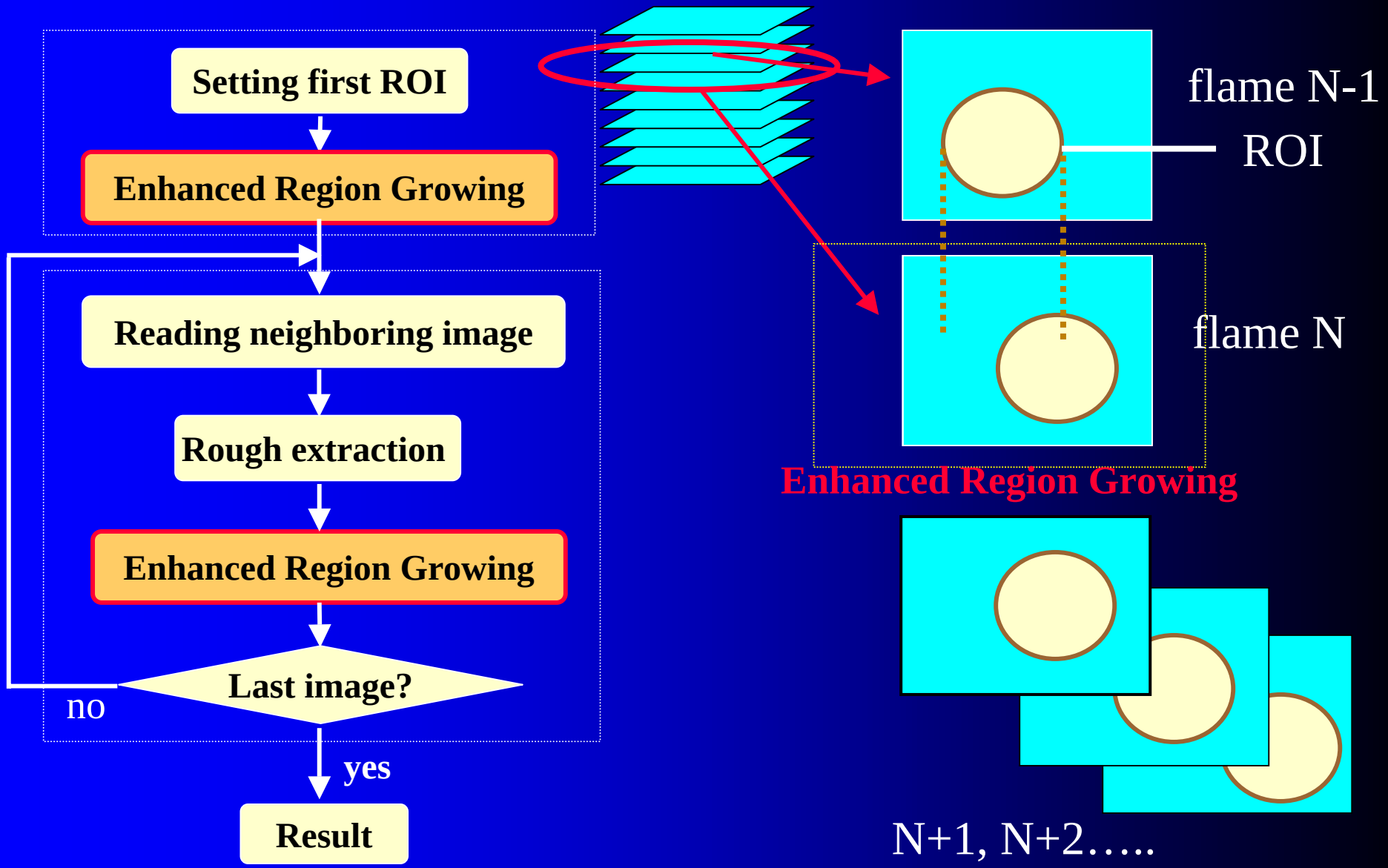


Sample of extraction

Sample of 3-D model

Development of new segmentation technique suited for biological color continuous images

# Outline of Extraction



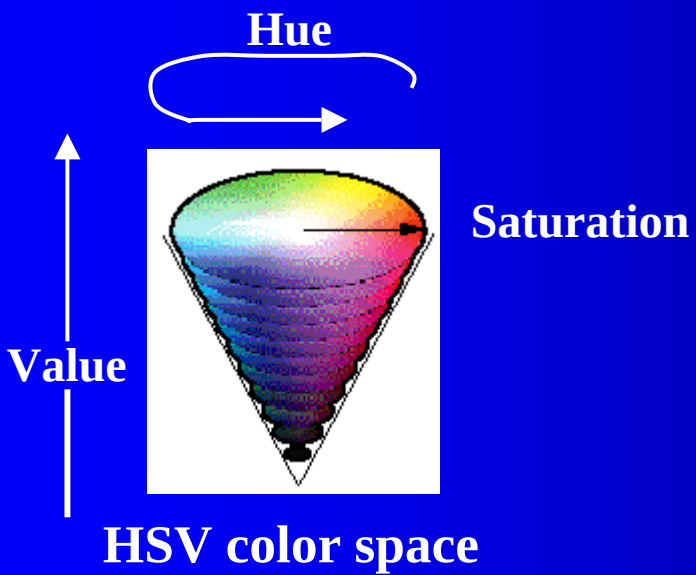
# Defining Region by Pixel Color Information

**Need for detecting slight change of pixel color value**

- **Color change in the vicinity of boundary**
- **Color similarity in the same tissue**

## Ingenious point 1

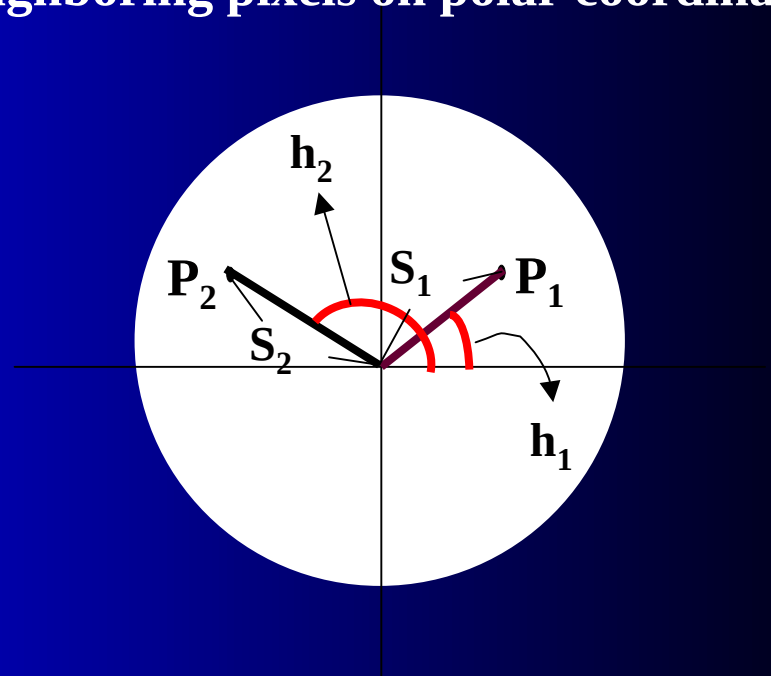
**Convert pixel value from RGB to HSV**




**HSV color space**

## Ingenious point 2

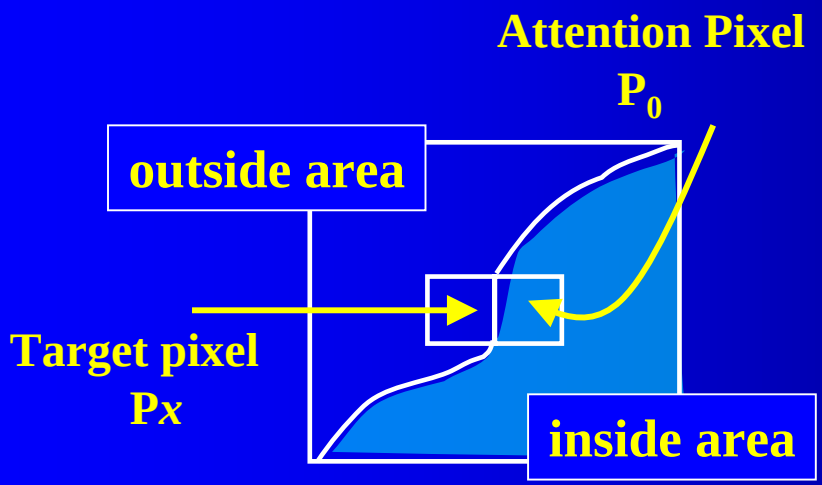
**Computing difference value between neighboring pixels on polar coordinate**



# Conventional Method
## (Region Growing)

(1) Defining rough area by arbitrary threshold

(2) Detecting true boundary by another arbitrary threshold




$$Px = \begin{cases} inside & if \quad |f_x - f_0| < \delta \\ outside & otherwise \end{cases}$$

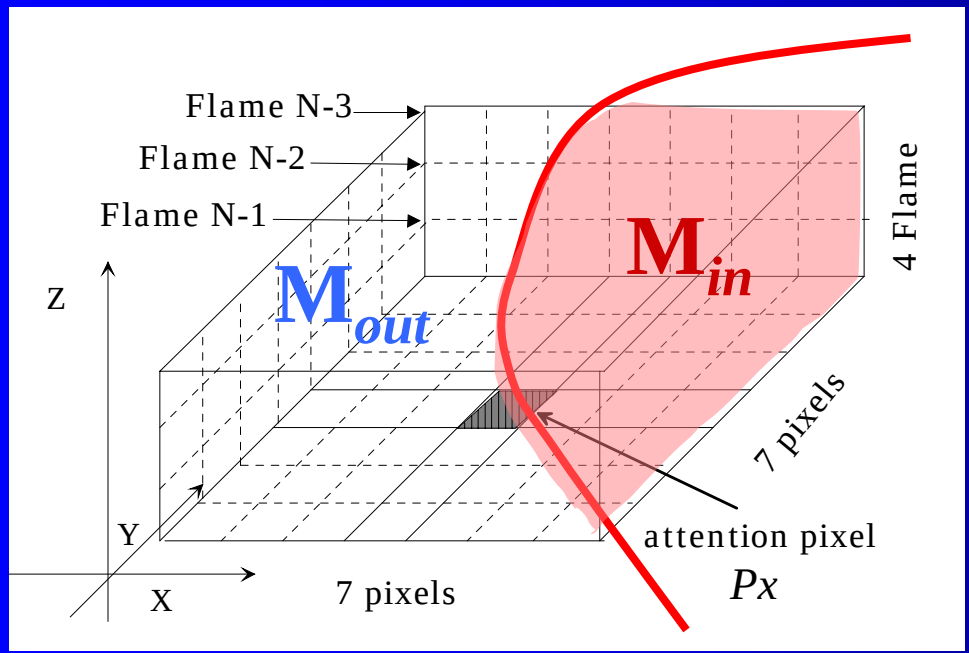
***Fatal Problem !!***

**Biological internal color image → Complex in color distribution**

**→ Difficult to extract ROI by arbitrary threshold**

# Proposed Method
## (Enhanced Region Growing)

1. Evaluation of region : 2-D → 3-D
2. ~~Threshold~~ → median value of an each local area




**median value of**

**outside local area : $M_{out}$**

**median value of**

**inside local area : $M_{in}$**

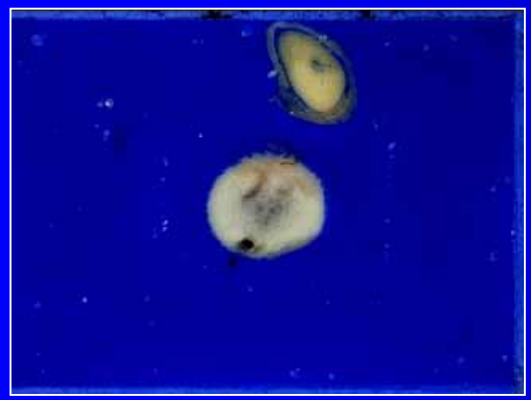
The pixel value of P*x* is compared with the similarity of $M_{out}$ and $M_{in}$.

# Experiments

1. Extraction of human eyeball
2. Extraction of stomach region from mouse
3. Extraction of lens from human eyeball

# Experimental Result 1

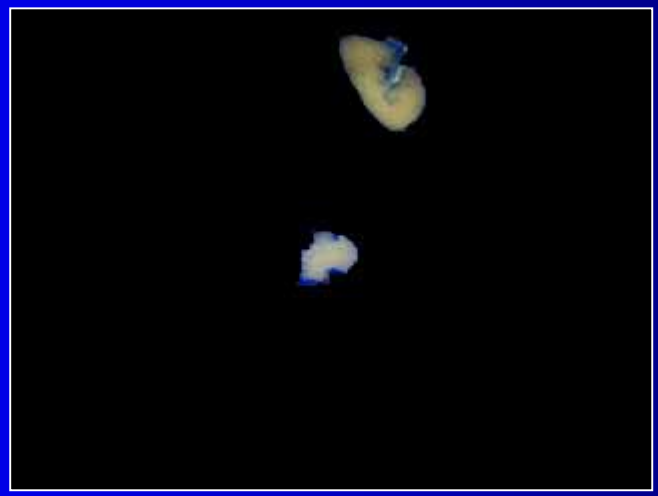
- **ROI : whole eyeball**



**Original image**

**Original image :**
**human eyeball**
**320✕240 (pixel / slice)**
**840 slices (212μm / pix)**
**Z-axis resolution : 10μm**

3-D model



**Extraction result from continuous 840 images**

# Experimental Result 2

- **ROI : stomach**

Original image : mouse
320✕240 (pixel / slice)
150 slices (212μm / pix)
Z-axis resolution : 30μm

Original image and extraction result from continuous 150 images

# Correct Answer Rate
## (Experiment 2)

| *Flame* | *inside area* | | | *outside area* | | |
|---|---|---|---|---|---|---|
| *N.o.* | *Result/Ans.* | *E* | *Rate %* | *Result/Ans.* | *E* | *Rate %* |
| *1st* | 1451/1493 | 42 | 97.19 | 75263/75307 | 44 | 99.94 |
| *5th* | 1606/1672 | 66 | 96.05 | 75101/75128 | 27 | 99.96 |
| *10th* | 1663/1726 | 63 | 96.35 | 75015/75074 | 52 | 99.92 |
| *30th* | 1975/2093 | 118 | 94.36 | 74628/74707 | 79 | 99.89 |
| *50th* | 2254/2329 | 75 | 96.78 | 74372/74471 | 99 | 99.87 |
| *100th* | 3397/3586 | 189 | 94.73 | 73029/73214 | 185 | 99.75 |
| *130th* | 3871/4083 | 212 | 94.81 | 72289/72717 | 428 | 99.41 |
| *140th* | 3561/3789 | 228 | 93.98 | 71942/73011 | 1069 | 98.54 |
| *150th* | 3372/4347 | 975 | 77.57 | 71828/72453 | 625 | 99.14 |

# Experimental Result 3

- **ROI : lens of human eyeball**

**Original image**

**Original image :**
**human eyeball**
**320×240 (pixel / slice)**
**120 slices (212μm / pix)**
**Z-axis resolution : 10μm**

3-D model

**Extraction result from continuous 120 images**

# Conclusion

- We proposed the extraction technique of interest region from biological full-color continuous images.

(1) We converted the pixel color value from RGB to HSV color space.

(2) We detected the difference between the tissues by a slight color change of hue and saturation value of an each pixel.

(3) We enhanced the conventional Region Growing method so as to apply to biological color images.

We succeeded in proposing the new extraction method,
which does not need arbitrary threshold or anatomical knowledge.

# Future Work

- Complete 3-D extraction
- Establishment of evaluation method