Day 1:
Comparative Study of Retinal Vessel Segmentations

SIIT-Chiba project, October 15-22, 2015

Project Team in Retinal Group

- Project Advisor:
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- Project head:
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- Project members:
  1) Mr. Faisal Khan from SIIT
  2) Two Japanese students from Chiba University

Project Objective

- To study existing retinal vessel segmentation techniques
- To compare performance of those retinal vessel segmentations.

Project Plan

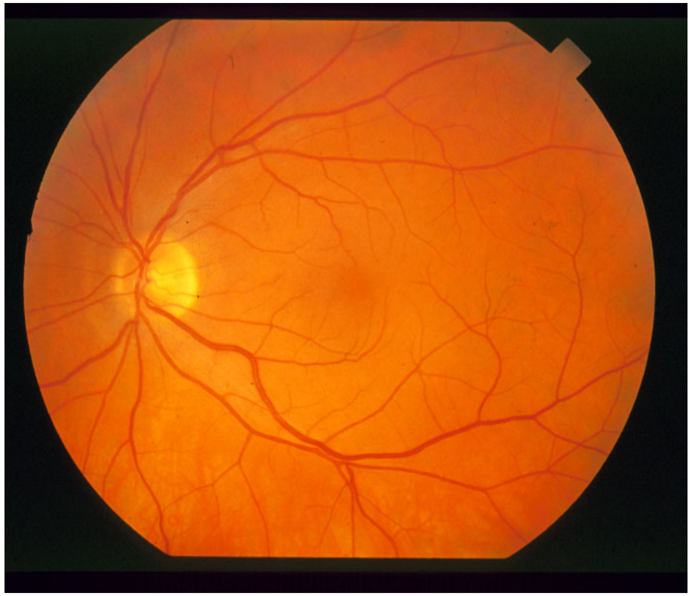
- **Day 1**: Introduction to the project
- **Day 2**: Review papers and some tutorials
- **Day 3-4**: Do experiments and evaluate the performances on selected approaches through demo applications
- **Day 5**: Discuss and present the results

Project Description

- To understand retinal vessel segmentations through following approaches:
  1) Local entropy thresholding
  2) Piecewise threshold probing
  3) Gradient orientation analysis
  4) Wavelets and edge location refinement

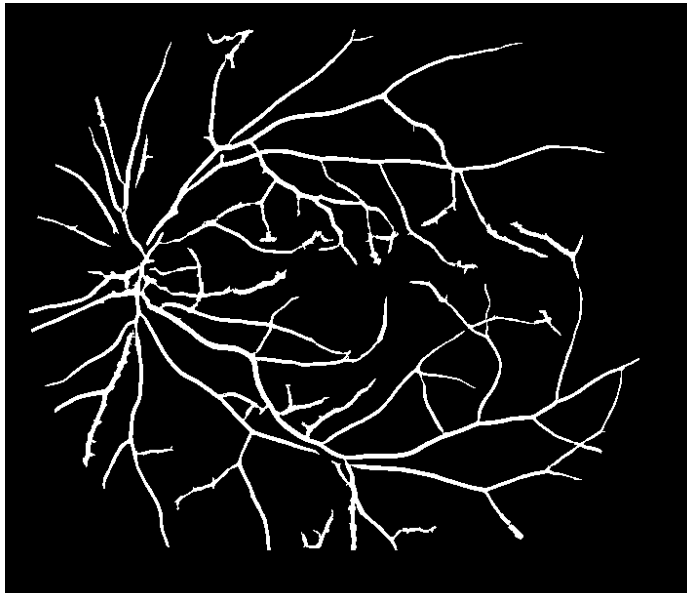
Plans

Input Image

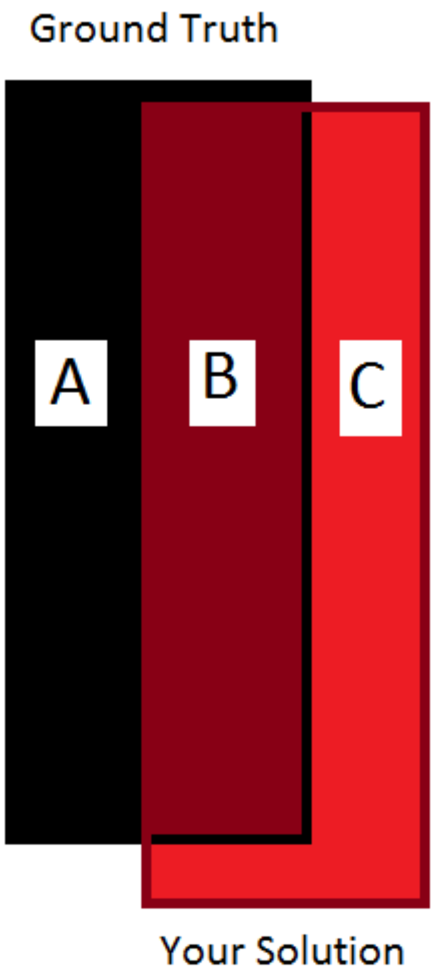


segmentation approaches

Output Image



Performance Measures



Measurements	Description
Recall (Sensitivity)	B/(A+B)
Precision (Positive Predictive Value)	B/(B+C)

Some Tutorial to
Vessel Segmentation Project

Vessel Segmentation Functional Diagram

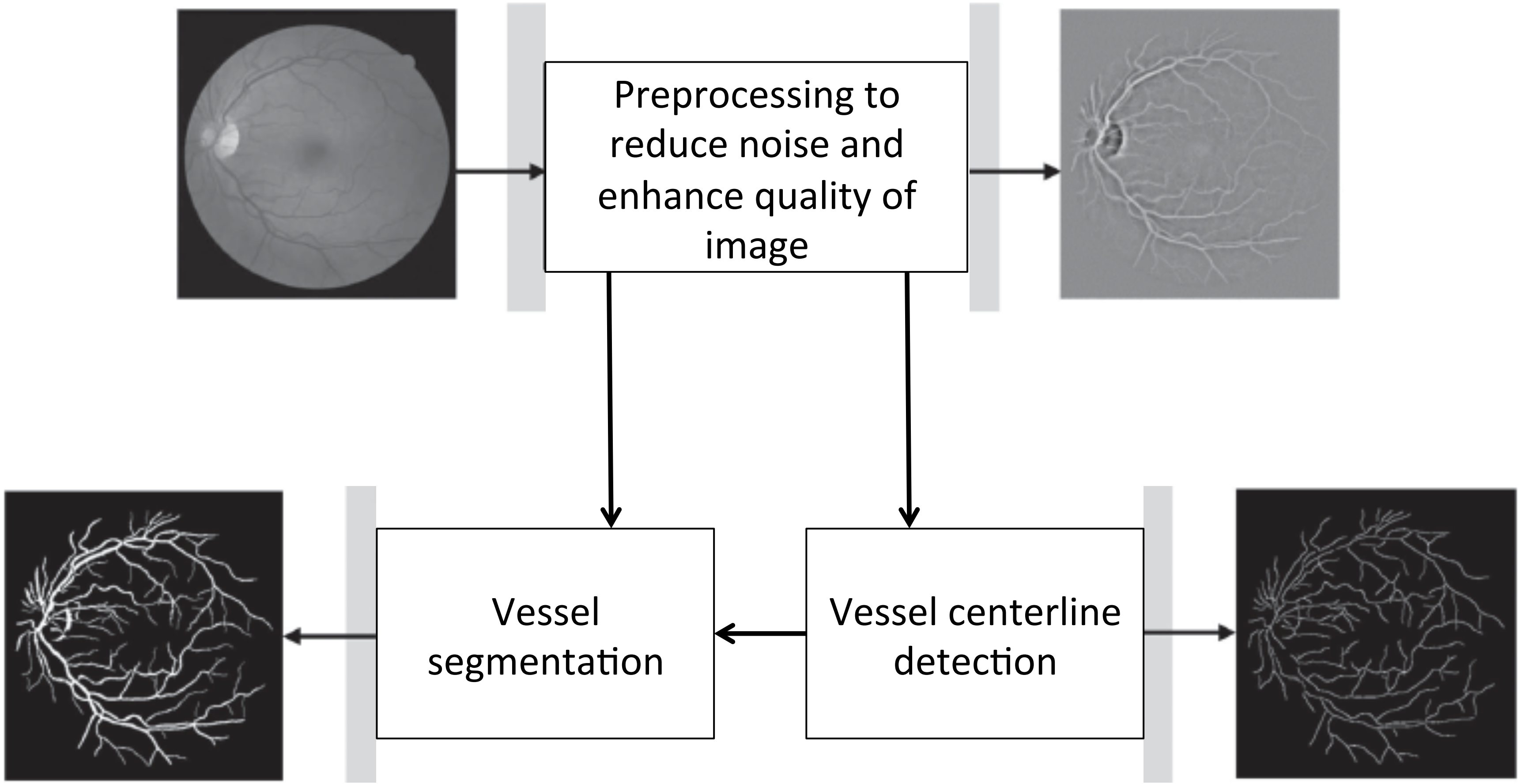


Image Preprocessing

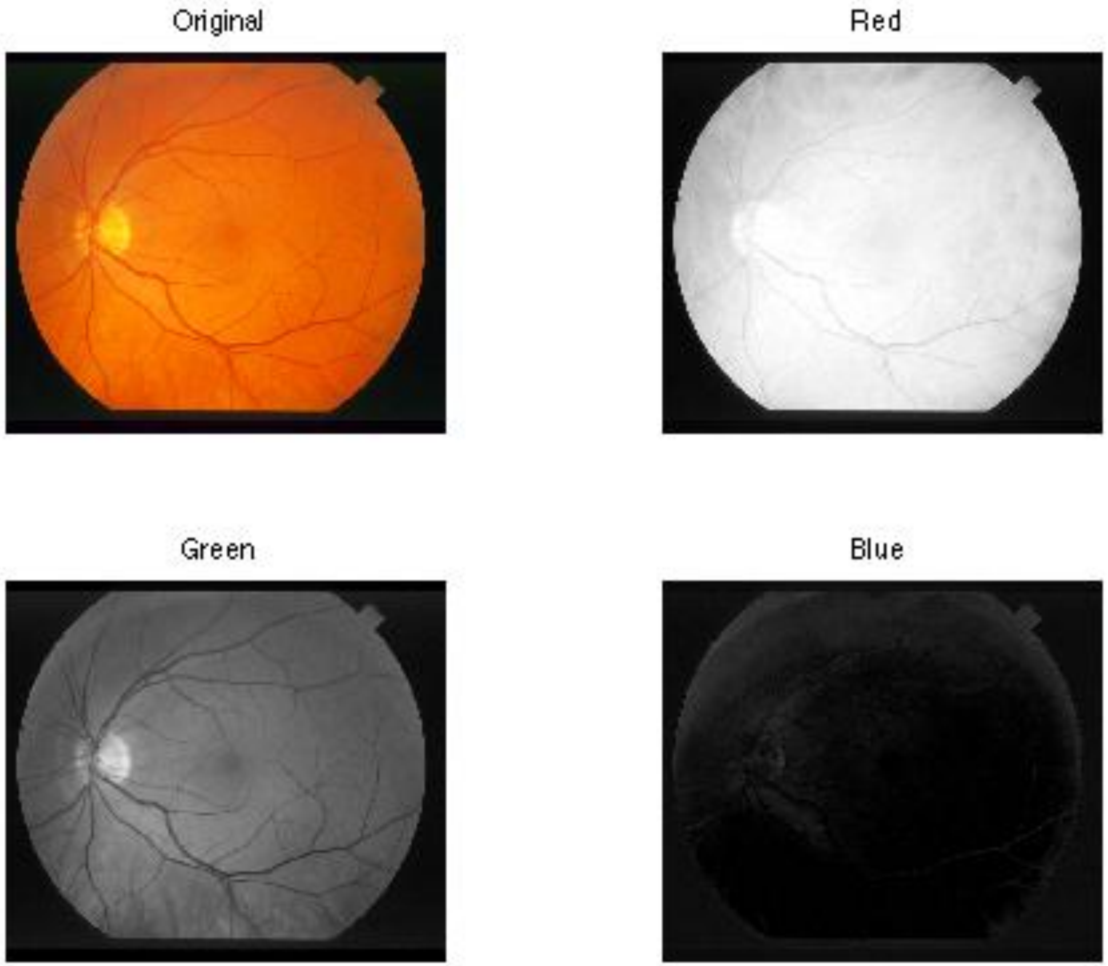
- Color spaces: RGB and HSI color spaces
  - In the RGB space, each color is expressed as a combination of its three primary colors: red (R), green (G), and blue (B).

An RGB Image with MATLAB

```
>> img1=imread('im0162.jpg');        %Image loading
>> img2=rgb2gray(img1);              %RGB to gray scale
>> whos

Name      Size          Bytes       Class

  img1    605x700x3     1270500     uint8
  img2    605x700       423500      uint8

>> subplot(2,2,1), imshow(img1)          %Original
>> subplot(2,2,2), imshow(img1(:,:,1))   %R plane
>> subplot(2,2,3), imshow(img1(:,:,2))   %G plane
>> subplot(2,2,4), imshow(img1(:,:,3))   %B plane
```

ref. Dr.Kondo's handout

An RGB Color Image



HIS Color Spaces

- The HSI (or HSV, IHS) color space represents a color in terms of *hue* (H), *saturation* (S), and *intensity* (I) (or *value* (V)).

- **Hue** represents a dominant wavelength of a color that is the true color attribute.

- **Saturation** refers to the purity of a color. For example, a deep red has high saturation while a light red has low saturation.

- **Intensity** represents the brightness of a color

ref. Dr.Kondo's handout

Features of the HSI Color Space

- The HSI color space decouples the intensity component from the color-carrying information (*hue* and *saturation*) in a color image.

- As a result, the HSI model is an ideal tool for developing image processing algorithms based on color descriptions.

- Gray-level algorithms can be performed on the *I* component, whereas segmentation can be performed on the *H* component.

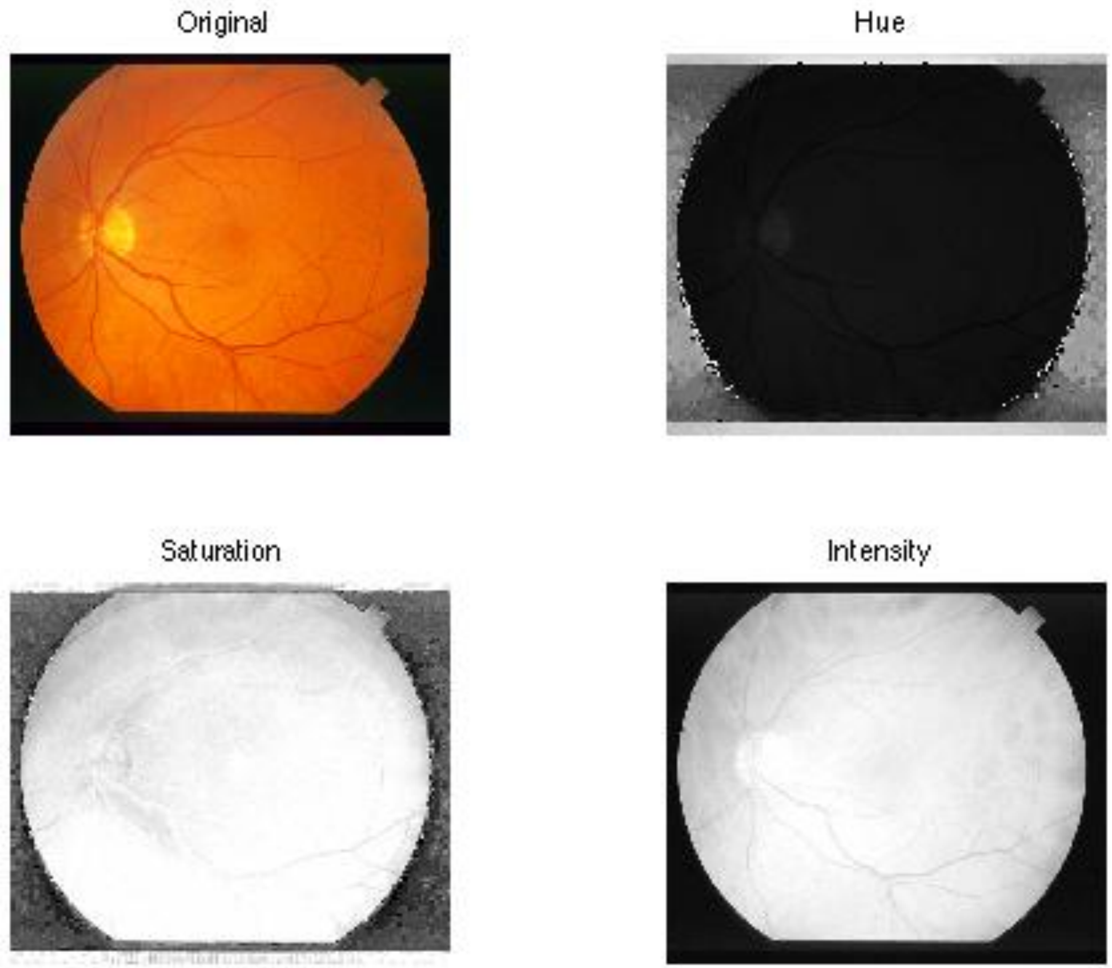
ref. Dr.Kondo's handout

HSI Color Space with MATLAB

```
>> img=imread('im0162.jpg');
>> hsv=rgb2hsv(img);            %RGB to HSV
>>
>> subplot(2,2,1), imshow(img)         %Original
>> subplot(2,2,2), imshow(hsv(:,:,1))  %Hue
>> subplot(2,2,3), imshow(hsv(:,:,2))  %Saturation
>> subplot(2,2,4), imshow(hsv(:,:,3))  %Intensity
>>
>> img4=hsv2rgb(hsv);                  %HSV to RGB
>>
```

ref. Dr.Kondo's handout

HSI Components of an RGB Image

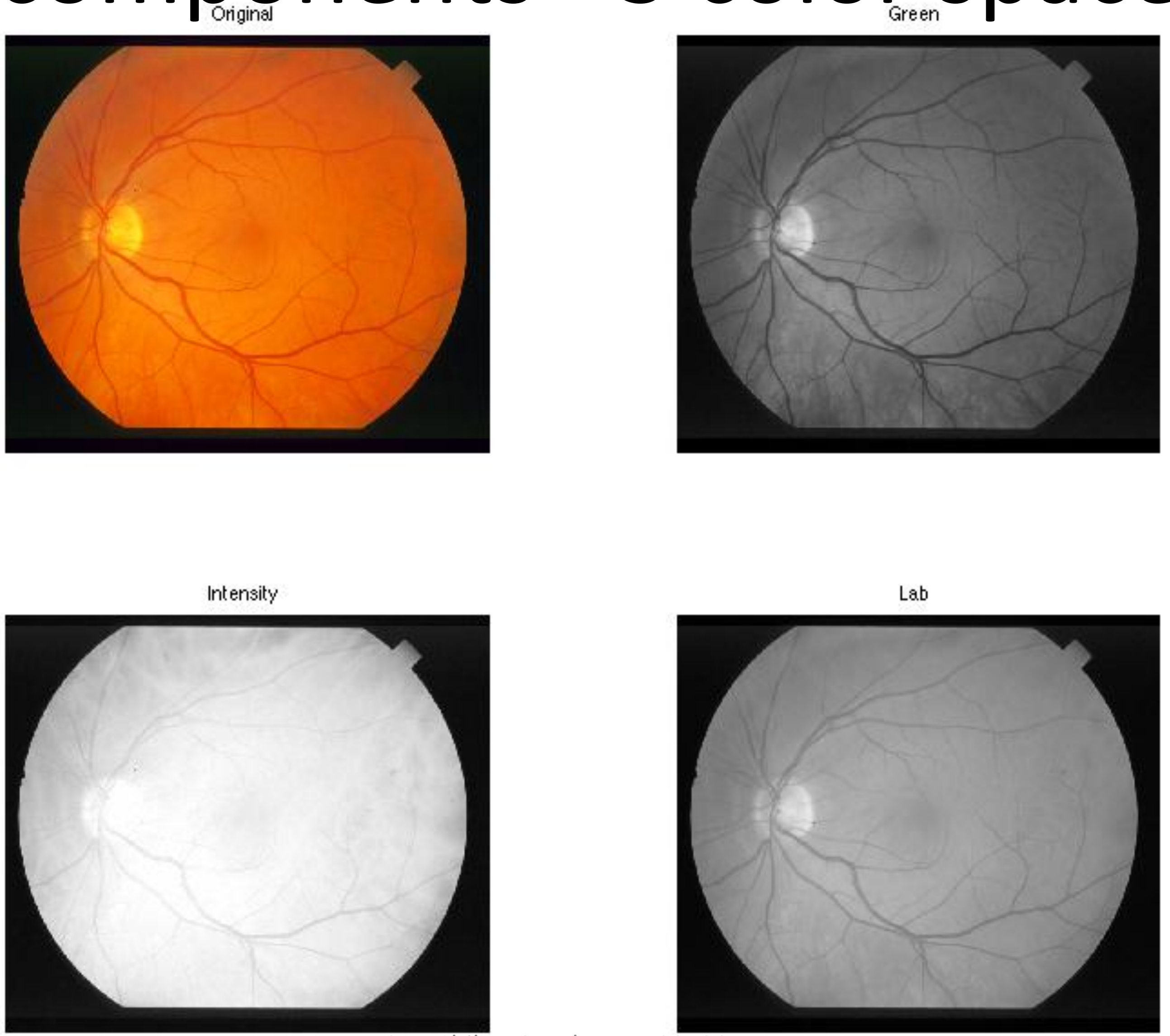


Lab color space

- Lab color space allows to get the most homogeneous region and preserves optic disk edge better
- Matlab command:

```
rgb = imread('im0162.jpg');
C = makecform('srgb2lab');
lab = applycform(rgb,C);
labExt = lab(:, :, 1);
```

3 components - 3 color spaces



Noise Reduction:
Nonlinear Smoothing Filters (Median Filters)

- The Median filter replaces the value of a pixel by the median of the gray levels in its neighborhood (=within the Median filter).

$$g(x,y) = \underset{(s,t \in S_{xy})}{\text{Median}} \{ f(s,t) \}$$

123	125	126	130	140
122	124	126	127	135
118	120	150	125	134
119	115	119	123	133
111	116	110	120	130

Neighbourhood values:

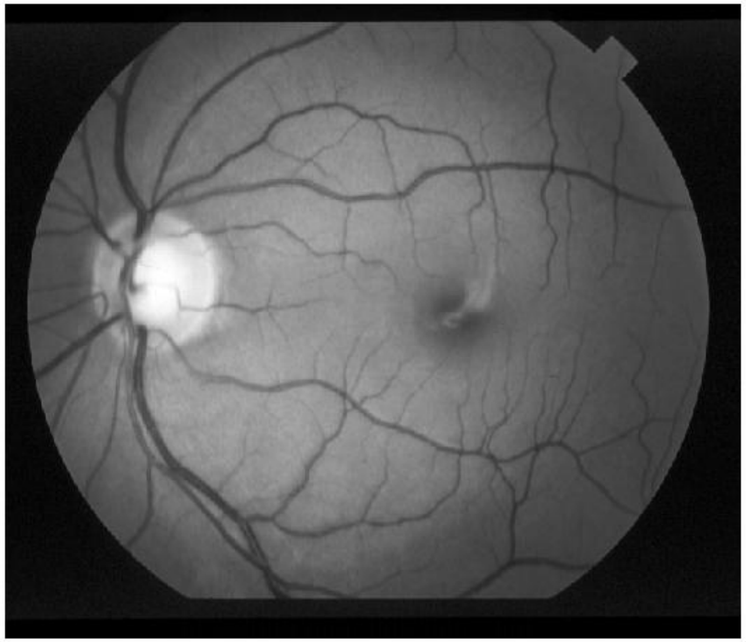
115, 119, 120, 123, 124,
125, 126, 127, 150

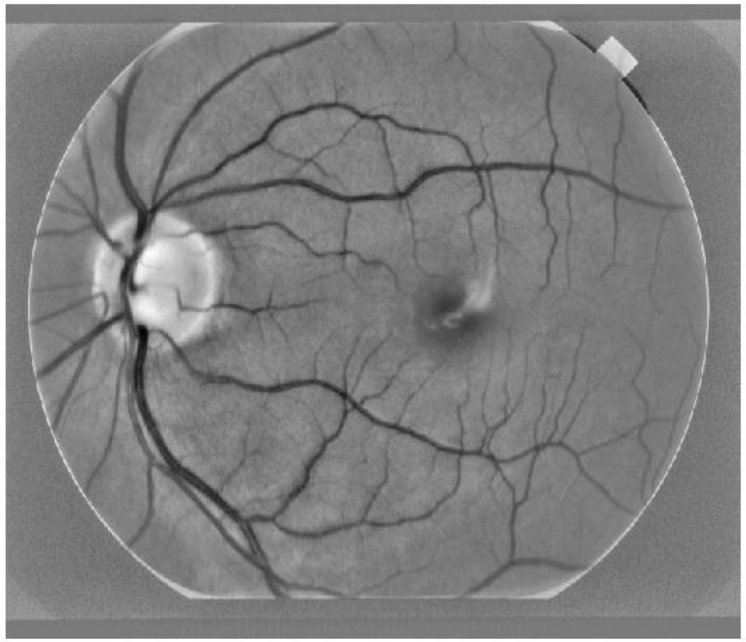
Median value: 124

ref. Dr.Kondo's handout

Median Filter

- The left image has a shading problem. Devise a method for shading correction using the Median filter in order to obtain an output image as the right image.





ref. Dr.Kondo's handout

Matlab command for median filter

- medfilter = medfilt2(img, [ws, ws]);

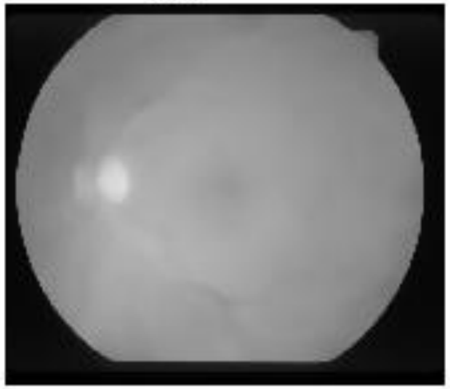
Gaussian smoothing filter

- To suppress high response signal
- Matlab command:

```
h = fspecial('gaussian', hsize, sigma);
filterIM = imfilter(img, h, options);
```

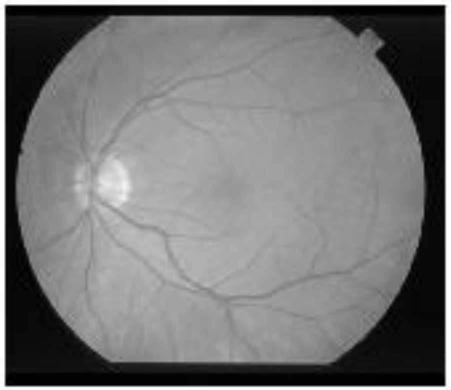
Basic Edge Detection

After apply median filter



After enhancing blood vessel

Preprocessed image



After apply edge detection

Problem#1

- Referring to the previous pages, color spaces, noise reduction, and smoothing filter, produce a retinal image with four components of color spaces: grayscale, green (RGB), intensity (HIS), and Lab spaces.
- Preprocess four inputs by reducing noise and suppressing high response signal
- Apply a conventional edge detection method.
- Discuss about four outputs.

Problem#1: Matlab command

```
>>    oimg = imread(filePath);
>>    cimg = % provide image from 3 components: Green (RGB), Intensity (HSI), and Lab space
>>    % reduce noise by using median filtering
>>    mf = medfilt2(cimg, [30, 30]);
>>    subplot(2,2,1), imshow(mf), title('After apply median filter');
>>    shCr =  cimg+ (cimg- mf) * 0.5;   % Shading correction
>>    subplot(2,2,2), imshow(shCr), title('After enhancing blood vessel');

>>    % Gaussian smooting filter to suppress high response signal
>>    mask = fspecial('gaussian', [3 3], 3);
>>    filterIM = imfilter(shCr, mask, 'replicate');
>>    subplot(2,2,3), imshow(filterIM), title('Preprocessed image');

>>    eIM = edge(filterIM);          % edge detection
>>    subplot(2,2,4), imshow(imcomplement(imclearborder(eIM))),
>>    title('After apply edge detection');
```

Conclusion

- Most of vessel segmentation application works on green component which retinal structure can be distinguished apparently.

Thank you