

FINAL PROJECT OF DIGITAL IMAGE PROCESSING

Getting started with Enhancement Image Techniques

Group 3. PIXEL:

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Outline

- Introduction
- Contents
 - Mechanisms
 - Review of some popular techniques
 - Some advanced techniques
- References

Introduction

➤ Enhancement Image is very useful:

- In real life: Photoshop...
- In feature extraction
- As pre-processing steps of recognition tasks (OCR, object recognitions...)

➤ What is enhancement image?

- Emphasize image features which obtains visually more pleasant or detailed
- Less noisy output image

Introduction

➤ Approaches: Color-based and Edge-Based

- Plenty of studies were based on color or edge for a long time
- Similar to human eye

➤ Help to:

- Solve practical problems
- Open up certain picture for investigation, conclusion or further use.

Contents

Watch [clip](#)

- Basics of Image Enhancement Techniques
- Review of Image Enhancement Techniques
- Summary

Some popular techniques

➤ Spatial Domain

- Point Operations: Applying Threshold, Contrast Stretching, Basic Gray Level Transformations, ...
- Histogram Equalization
- Operator Filters: Average, Median, Gauss...

➤ Frequency Domain

- Find Fourier Transform Function $F(u, v)$
- Find Filter Function $H(u, v)$
- Enhanced Image $G(u, v) = H(u, v)F(u, v)$

Some popular techniques

➤ Built-in in OpenCV and many image processing libraries

- Basic Gray Level Transformations: Image negative, log transform, linear transform.
- Histogram Equalization
- Operator Filters: Average, Median, Gauss...
- Frequency Domain Techniques: Low pass filter, High pass filter

➤ Some advance techniques

- Point Operations: Otsu's Threshold, Contrast Stretching, Gray Level Slicing
- Image Average
- Contrast Limit Adaptive Histogram Equalization.

Global Threshold – Otsu's Method

1. Threshold:

$$\begin{cases} f(x, y) \geq T: \textit{object} \\ f(x, y) < T: \textit{background} \end{cases}$$

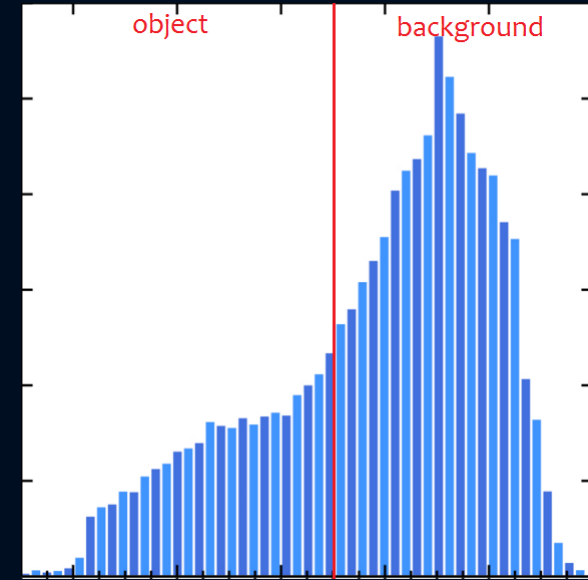
2. Adaptive Threshold – Otsu's Method

- Step 1: Compute the normalize histogram P of input image L gray levels.
- Step 2: Suppose that threshold selected is $T = k$.

Let C_1, C_2 is set of pixels with gray level $< T$, gray level $\geq T$.

Let $\Pi_1(k), \Pi_2(k)$ is probability of occurring C_1, C_2 .

$$\Pi_1(k) = \sum_{i=0}^k p(i), \Pi_2(k) = 1 - \Pi_1(k)$$



Global Threshold – Otsu's Method

Let $m_1(k)$, $m_2(k)$ is mean intensity of C_1 , C_2 :

$$m_1(k) = \frac{\sum_{i=0}^k i * p(i)}{\Pi_1(k)}, m_2(k) = \frac{\sum_{i=k+1}^{L-1} i * p(i)}{\Pi_2(k)}$$

Let $m(k)$ is mean intensity up to level k :

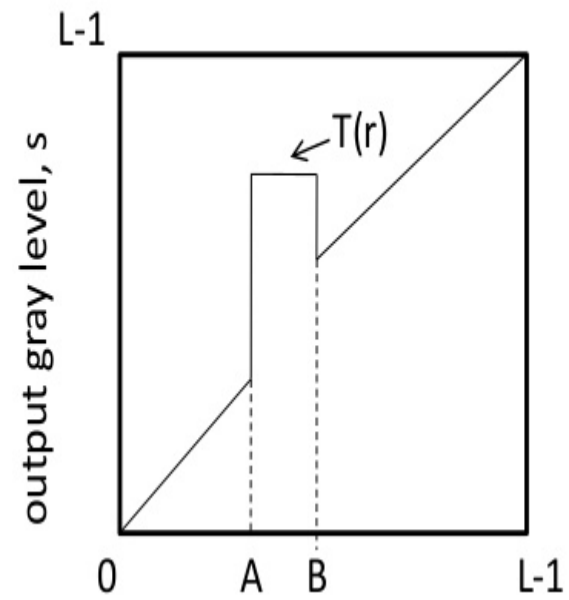
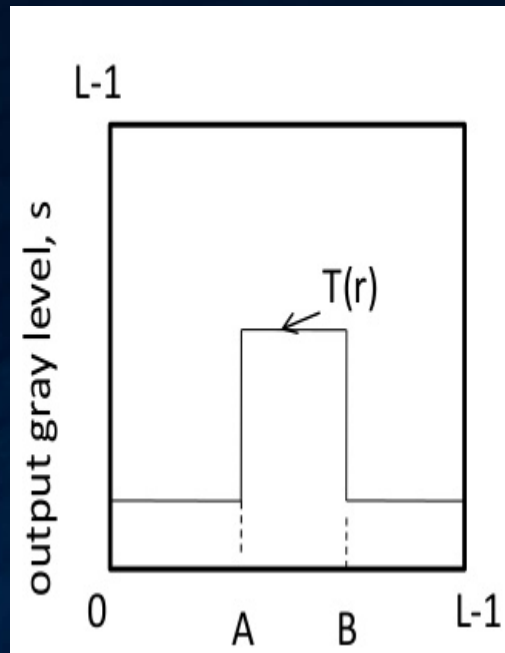
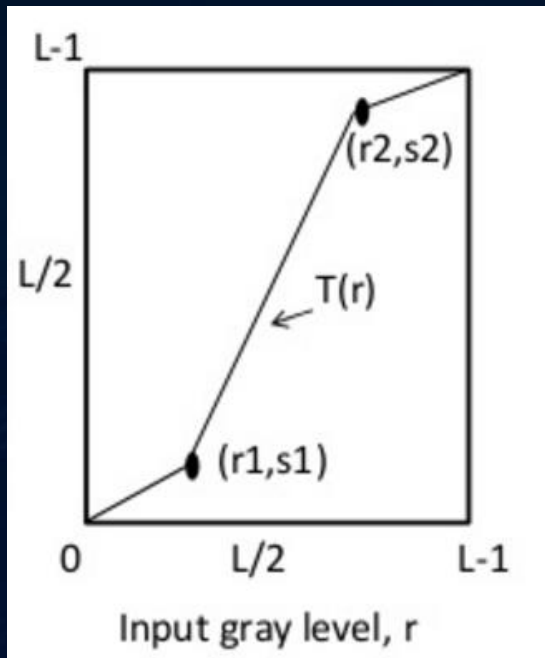
$$m(k) = \sum_i^k i * p(i)$$

Let m_G is global mean intensity:

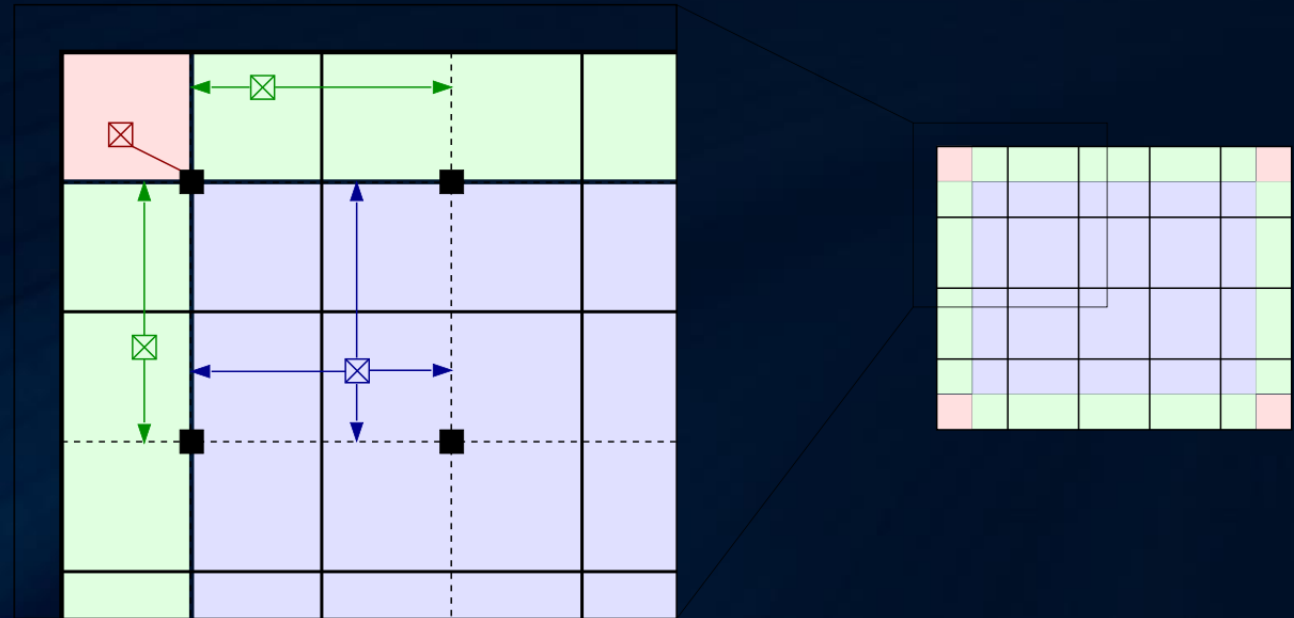
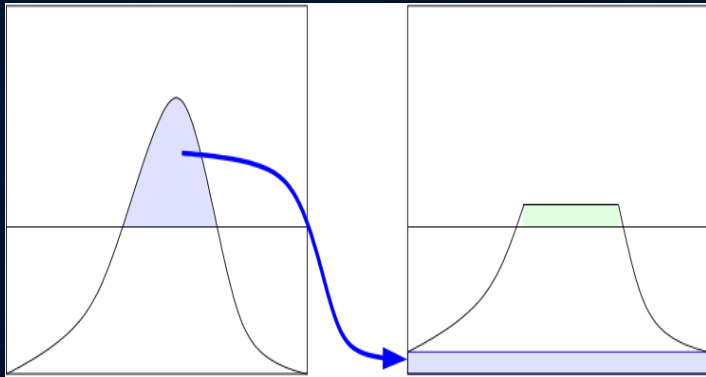
$$m_G = \sum_{i=0}^{L-1} i * p(i)$$

Step 3: Find k that $\sigma_B(k) = \Pi_1(k) * (1 - \Pi_1(k)) * (m_1(k) - m_2(k))^2$ is max.

Contrast Stretching and Gray level Slicing



Contrast Limit Adaptive Histogram Equalization



Summary

- What is the advantage/disadvantage of each technique?
- The effect of each technique in practical purpose: sharpening, blur reduction, removing noise, ...?

TABLE I. CONTRAST ENHANCEMENT		
Comparison of different contrast enhancement techniques		
	<i>Advantage</i>	<i>Disadvantage</i>
Linear Contrast Stretching	Can only be used for linear stretching.	Can't produce much attractive results in many cases.
Histogram Equalization	This technique is best for visual perception especially when image have close contrast data. The application of this technique produces best results for radiographic and thermal images.	The main disadvantage of the techniques is noise amplification when the image has major low intensity area.
Adaptive Histogram Equalization	This is the best technique to be applied when global histogram equalization can't produce good results.	The problem with this technique is its limited contrast enhancement due to local contrast enhancement.

References

[1] Rafael C. Gonzalez Richard E. Woods - Digital Image Processing - Pearson (2007)

[2] Slide "Image Filtering: Noise Removal, Sharpening, Deblurring", EE314: Multimedia Communication System - 1, Polytechnic University Brooklyn.

[3] Webdoc "Image Thresholding", University of Alberta

[4] Washington courses' materials: "Chapter 5: Filtering and Enhancing Images".

Link

[2] http://eeweb.poly.edu/~yao/EE3414/image_filtering.pdf

[3] <https://webdocs.cs.ualberta.ca/~nray1/MyWebsite/ImageThresholding.htm>

[4] <https://courses.cs.washington.edu/courses/cse576/book/ch5.pdf>