FINAL PROJECT OF DIGITAL IMAGE PROCESSING

Enhancement Image Techniques

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Outline

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  - Basics of Image Enhancement Techniques
  - Review of Image Enhancement Techniques
  - Survey on Image Enhancement Techniques
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Introduction

- Enhancement Image is very useful:
  - In real life
  - In feature extraction
  - In object recognition
- What is enhancement image?
  - Emphasize image features which obtains visually more pleasant or detailed
  - Less noisy output image

Introduction

- Abstract:
  - Review and Survey of Enhancement Image Techniques
- Approaches: Color base and Edge Base
  - 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
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- Summary

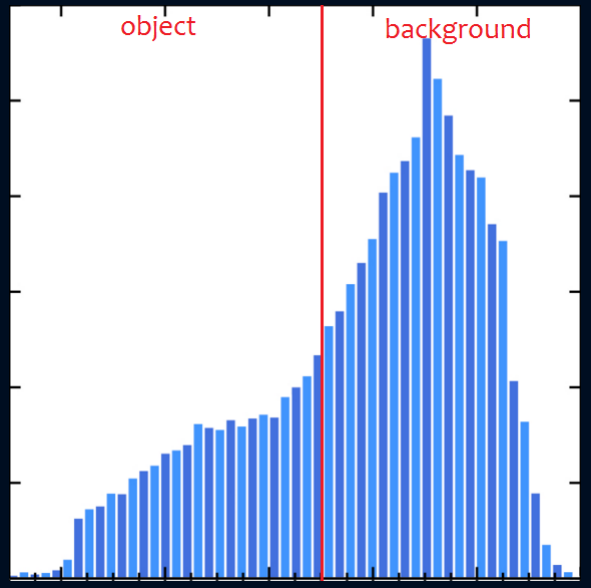
Basics of Image Enhancement

- 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 $G(u, v) = H(u, v)F(u, v)$

Review of Image Enhancement

- Old Techniques
  - 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
- New Techniques
  - Point Operations: Applying Threshold, Contrast Stretching, Gray Lever Slicing
  - Image Average
  - Contrast Limit Adaptive Histogram Equalization.

Global Threshold – Otsu's Method



1. Threshold:

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

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.

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

Global Threshold – Otsu's Method

Let $m_1(k)$, $\mathrm{m}_2(k)$ 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:

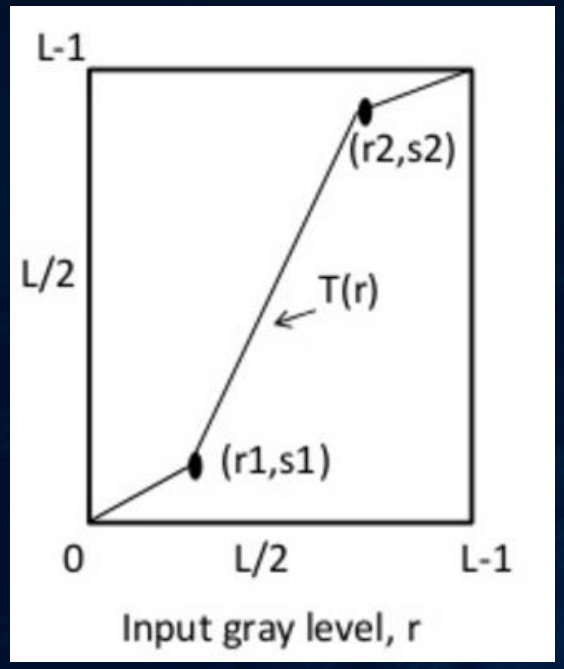
$$m(k) = \sum_{i}^{k} i * p(i)$$

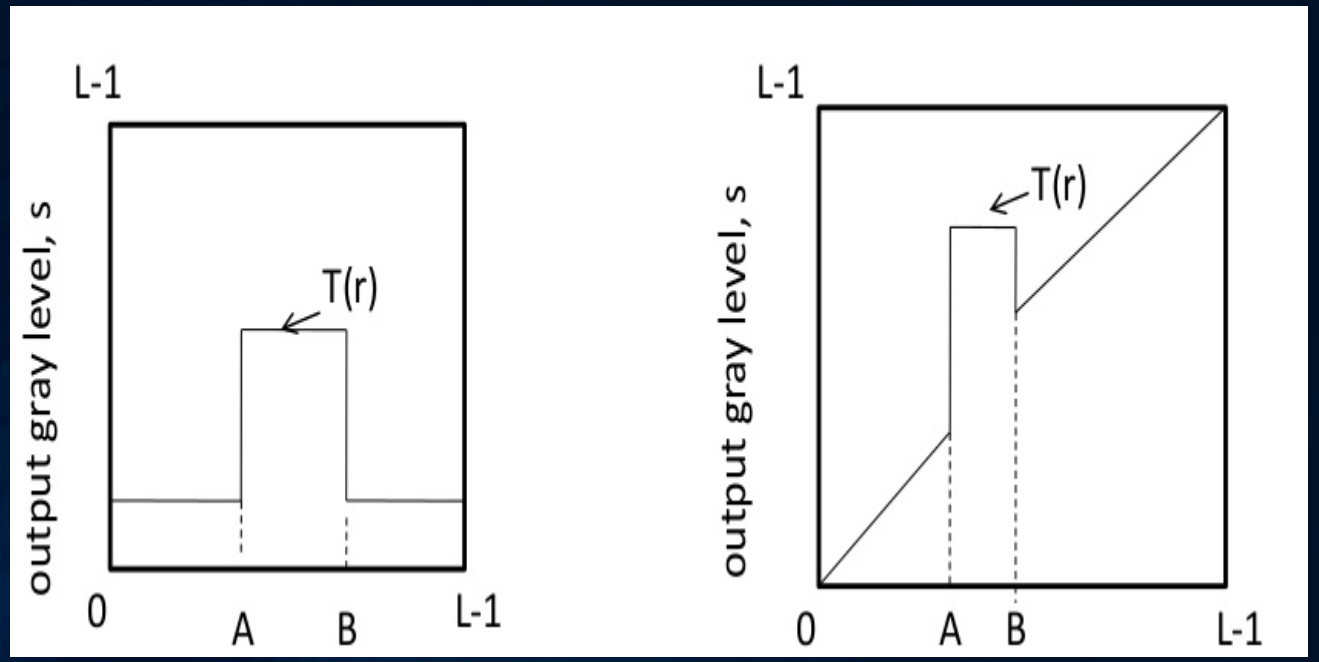
Let m_G is global mean intensity:

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

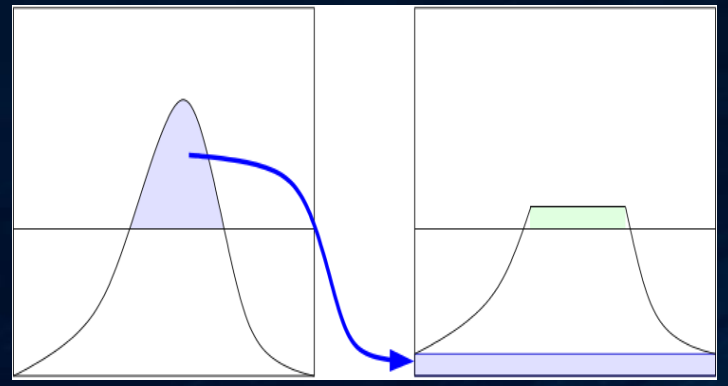
Step 3: Find k that $\sigma_B(k) = \Pi_1(k) * \left(1 - \Pi_1(k)\right) * (m_1(k) - m_2(k))^2$ is max.

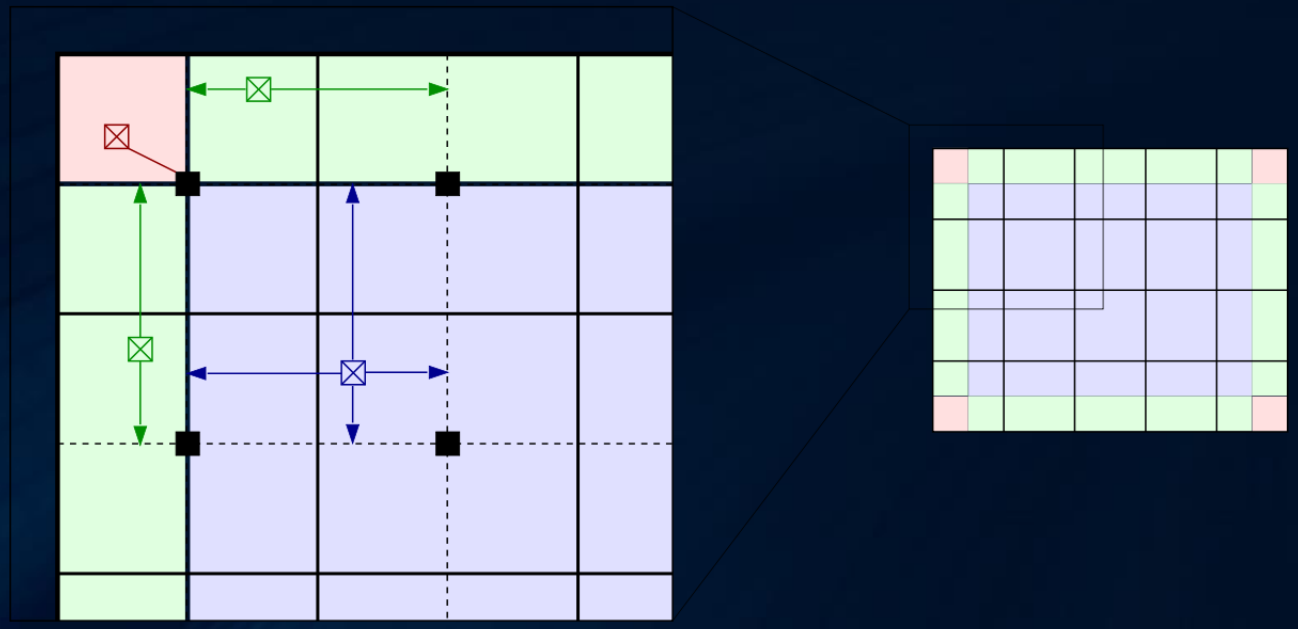
Contrast Stretching and Gray level Slicing





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		
	Advantage	*Disadvantage*
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 Commnunication 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