DIGITAL IMAGE PROCESSING

Image Enhancement in Spatial Domain : Session 3

Dr. Mrinmoy Ghorai

Indian Institute of Information Technology
Sri City, Andhra Pradesh

Today's Lecture

- **Image Enhancement in Spatial Domain**
  - **Local Histogram Processing**
  - **Using Histogram Statistics for Image Enhancement**

Image Enhancement in Spatial Doma

Local Histogram Processing

- Define a neighborhood and move its center from pixel to pixel
- At each location, the histogram of the points in the neighborhood is computed. Either histogram equalization or histogram specification transformation function is obtained
- Map the intensity of the pixel centered in the neighborhood
- Move to the next location and repeat the procedure

Image Enhancement in Spatial Doma

Local Histogram Processing

Image Enhancement in Spatial Doma

Histogram Statistics for Image Enhancement

Average Intensity

Variance

Image Enhancement in Spatial Doma

Histogram Statistics for Image Enhancement

Image Enhancement in Spatial Doma

Histogram Statistics for Image Enhancement

Image Enhancement in Spatial Doma

Image Enhancement in Spatial Doma

Spatial Filtering

- The process of linear filtering is called convolution.
- The filter masks are sometimes called convolution masks or convolution kernel.

Image Enhancement in Spatial Doma

Smoothing Spatial Filters

- Smoothing filters are used for blurring and for noise reduction.
- Blurring is used in removal of small details and bridging of small gaps in lines or curves.
- Smoothing spatial filters include linear filters and nonlinear filters.
- These filters sometimes are called ***averaging filters.***
- They are also referred to a ***lowpass filters*** in frequency domain.

Image Enhancement in Spatial Doma

Smoothing Linear Spatial Filters

Image Enhancement in Spatial Doma

Two Smoothing Averaging Filter Masks

average

weighted average

Two Smoothing Averaging Filter Masks

Image Enhancement in Spatial Doma

Example: Gross Representation of Objects

Image Enhancement in Spatial Doma

Order-Statistic (Nonlinear) Filters

- Nonlinear
- Based on ordering (ranking) the pixels contained in the filter mask
- Replacing the value of the center pixel with the value determined by the ranking result
- E.g., median filter, max filter, min filter

Image Enhancement in Spatial Doma

Example: Use of Median Filtering for Noise Reduction

Image Enhancement in Spatial Doma

Sharpening Spatial Filters

- Foundation
- Laplacian Operator
- Unsharp Masking and Highboost Filtering
- Using First-Order Derivatives for Nonlinear Image Sharpening — The Gradient

Image Enhancement in Spatial Doma

Sharpening Spatial Filters: **Foundation**

- The first-order derivative of a one-dimensional function f(x) is the difference

- The second-order derivative of f(x) as the difference

Image Enhancement in Spatial Doma

Image Enhancement in Spatial Doma

Sharpening Spatial Filters: **Laplacian Operator**

Image Enhancement in Spatial Doma

Sharpening Spatial Filters: **Laplacian Operator**

Image sharpening in the way of using the Laplacian:

Image Enhancement in Spatial Doma

Unsharp Masking and Highboost Filtering

- **Unsharp masking**

  Sharpen images consists of subtracting an unsharp (smoothed) version of an image from the original image

  e.g., printing and publishing industry

- **Steps**

  I. Blur the original image

  II. Subtract the blurred image from the original

  III. Add the mask to the original

Image Enhancement in Spatial Doma

Unsharp Masking and Highboost Filtering

Image Enhancement in Spatial Doma

Unsharp Masking and Highboost Filtering

Image Enhancement in Spatial Domain

Unsharp Masking and Highboost Filtering: **Example**

Image Enhancement in Spatial Doma

Image Sharpening based on First-Order Derivatives

Gradient Image

Image Enhancement in Spatial Doma

Image Sharpening based on First-Order Derivatives

z_1	z_2	z_3
z_4	z_5	z_6
z_7	z_8	z_9

Image Sharpening based on First-Order Derivatives

Example

Combining
Spatial
Enhancement
Methods

Goal:
Enhance the
image by
sharpening it
and by bringing
out more of
the skeletal detail

Example

Combining
Spatial
Enhancement
Methods

Goal:
Enhance the
image by
sharpening it
and by bringing
out more of
the skeletal detail

Next Class

- **Image Enhancement in Frequency Domain**

Thank you:
Question?