Point Processing
Lecture 2
GW 3.1-3.4
Spring 2006
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Previous Lecture
Digitization
- sampling in space (x,y)
- sampling in amplitude (intensity)
Sample in space twice as often as the smallest detail you want to see

Image Processing

\[ f(x,y) \rightarrow T \rightarrow g(x,y) \]

- We want to create an image which is "better" in some sense.
  - Weigh example
    - Image restoration (reduce noise)
    - Image enhancement (enhance edges, lines etc.)
    - Make the image more suitable for visual interpretation

Image processing does NOT increase image information

Image processing can be performed in the
- Spatial domain (lectures 2 and 3)
  - brightness transforms, works per pixel => point processing
  - spatial filters, local transforms, works on small neighborhood.
- Geometric transforms, interpolation
  - Frequency domain (lectures 4, 11 and 12)

Gray Level Transform

\[ s = \text{gray level in} \]
\[ r = \text{gray level out} \]

- change the gray level for each individual pixel
- compare to TV:
  - brightness: addition
  - contrast: multiplication

> 45° → increased contrast
< 45° → decreased contrast
up  → increased brightness
down → decreased brightness

Brightness: subtract
add
Contrast: multiply

Image Histograms

- A gray scale histogram shows how many pixels there are at each intensity level.

Gray level transformations

Original image

Inverse transform (Negative)

Logarithmic transform

Negative or Inverse

Log transformation to visualize patterns in the dark regions of an image
Histogram Equalization

Idea: create an image with evenly distributed gray levels, for visual contrast enhancement

- The normalized gray level histogram gives the probability for a pixel to have a certain gray level
- Transform the image using the cumulative normalized histogram
- The histogram for the output image is uniform (THEORETICALLY in the continuous case), why not in the case with our digital images?

More examples of histogram equalization

Transformations for image 1-4. Note that the transform for figure 4 (dashed) is close to the neutral transform (thin line).

Histogram equalization is not always “optimal” for visual quality

Arithmetic/Logical Operations

- Information from two different images with the same size can be combined by adding, subtracting, multiplying or comparing the pixel values, pixel by pixel.
- For enhancement, segmentation, change detection
Reduction of noise by averaging

Noise can be reduced by observing the same scene over a long period of time, and averaging the images. Image from DSR, averaging 8, 16, 64 and 128 times.