CSE 564: Visualization

Image Operations

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Motivation

Provide the user (scientist, doctor, …) with some means to:

- enhance contrast of local features
- remove noise and other artifacts
- enhance edges and boundaries
- composite multiple images for a more comprehensive view

There are two basic operations: global and local

Global operations:

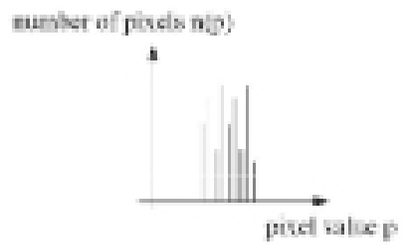
- operate on the entire set of pixels at once
- examples: brightness and contrast enhancement

Local operations:

- operate only on a subset of pixels (in a pixel neighborhood)
- examples: edge detection, contouring, image sharpening, blurring

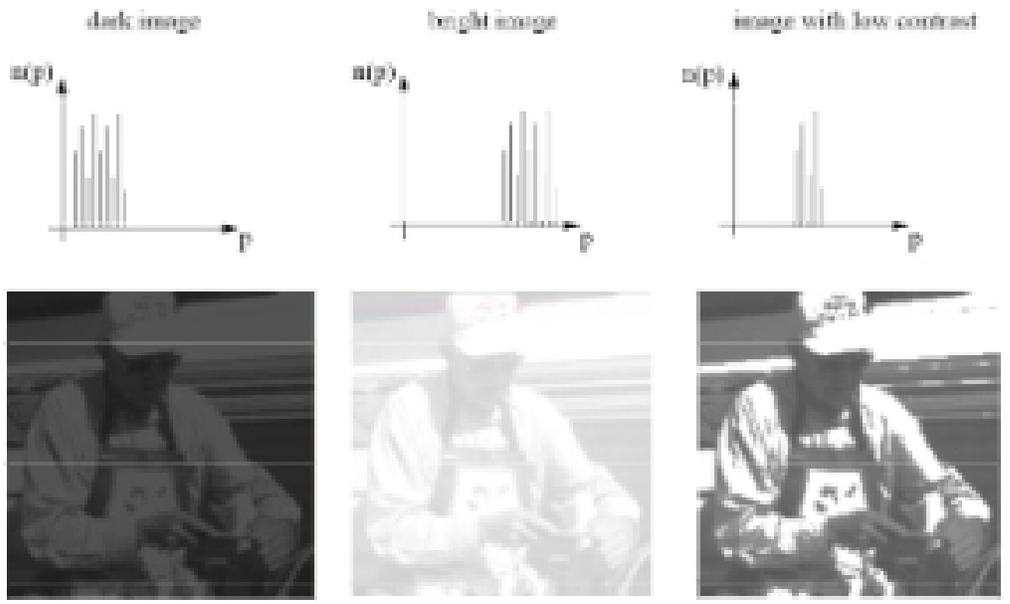
The Image Histogram

- A histogram lists the number of image pixels for each value



- The histogram reveals more insight about image contrast and brightness:

The Image Histogram



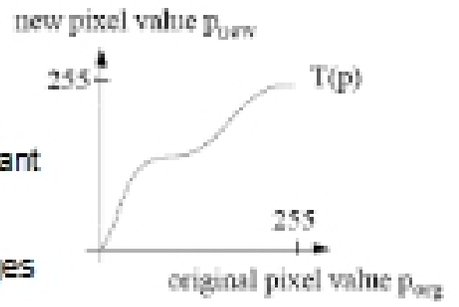
Grey Level Transformation: Basics

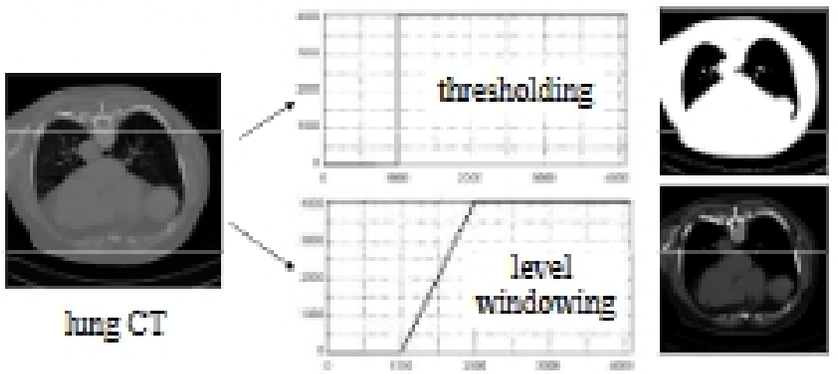
Problem: We only have a fixed number of grey levels (256) that can be displayed or perceived

- need to use this 'real estate' wisely to bring out the image features that we want

Use *intensity transformations* T_p

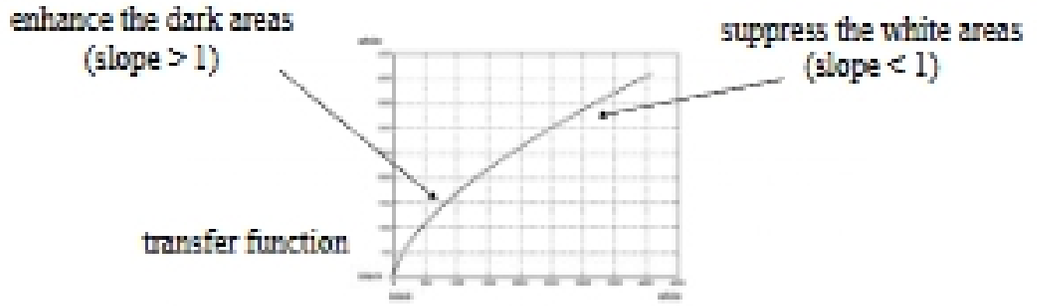
- enhance (remap) certain intensity ranges at the cost of compressing others

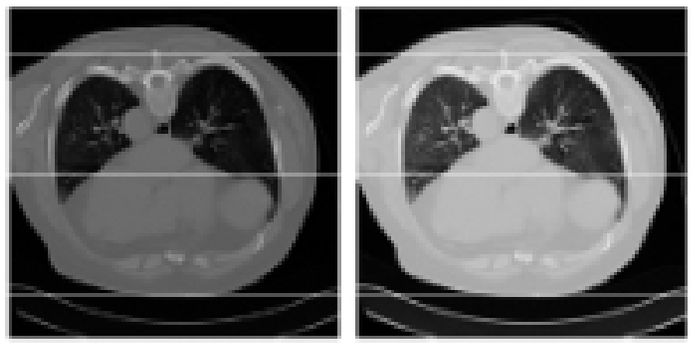




lung CT

Grey Level Transformation: Enhancements



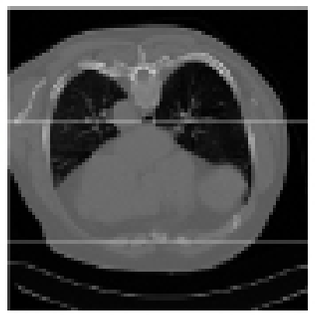


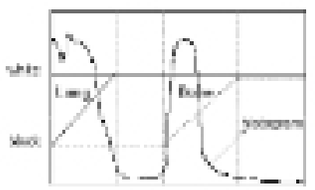
original enhanced

Grey Level Transformation: Windowing

Dedicate full contrast to either bone or lungs

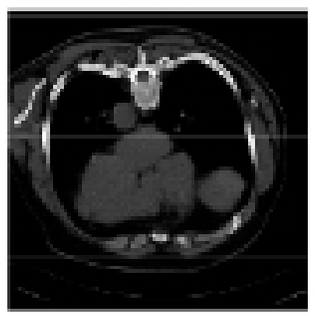
original lung CT image





bi-modal histogram

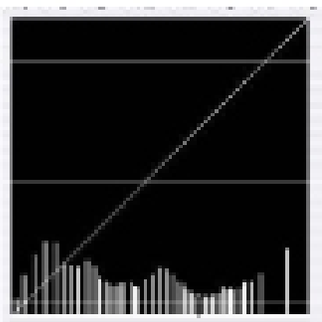
bone window



lung window

Histogram Revisited: Optimal Distribution

Using *histogram equalization*

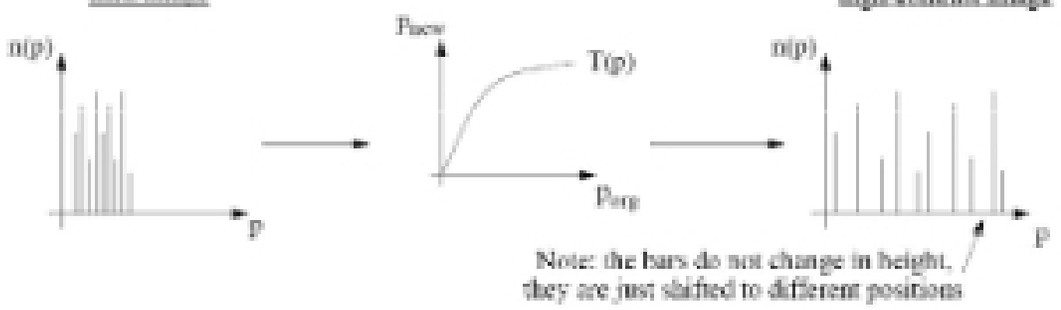


Histogram Equalization

- Image contrast and brightness may be improved by modifying the histogram
- The 'contrast stretching' operation requires the user to manipulate the image's histogram
- *Histogram equalization* is an automatic procedure to spread out the value distribution

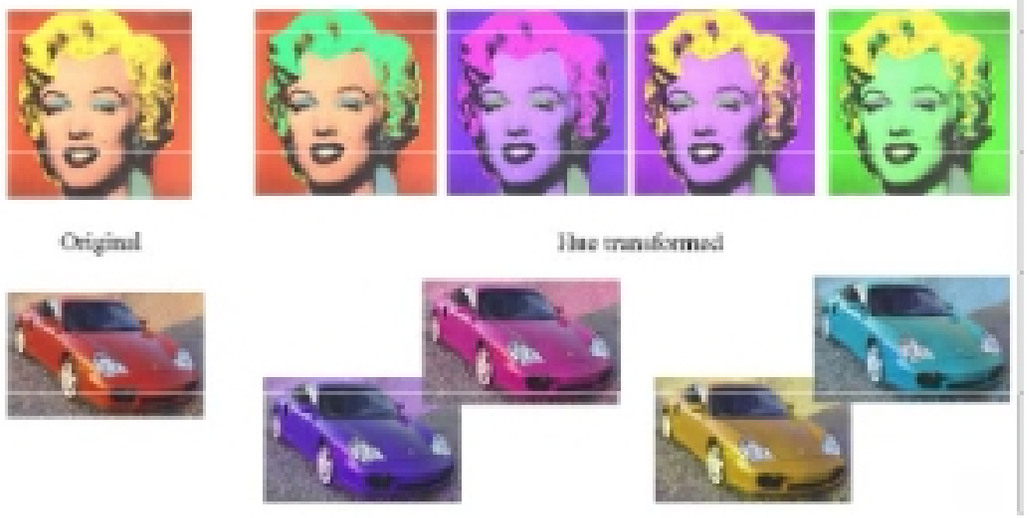
The discrete histogram equalization equation is: $P_{out}(k) = \sum_{j=0}^{k} \frac{n(p_{orig}(j))}{n_{total}} \cdot p_{max}$ (255)

- For example, the equalization transformation for a dark image would be:



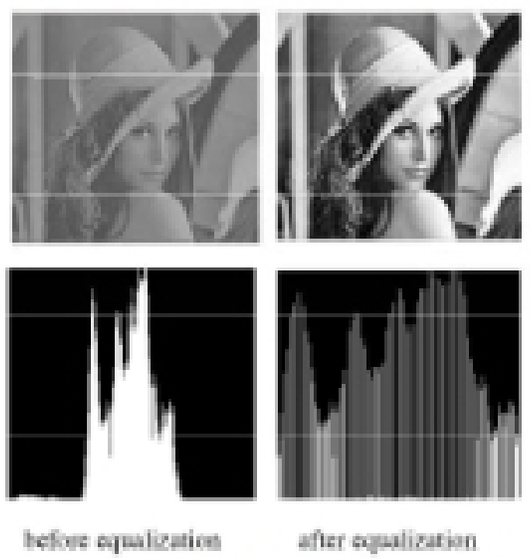
Color Image Processing

- Convert the image from RGB to HSV space
- Perform transformations of pixel H, S, V values via transfer functions
- Convert the transformed HSV image back into RGB space and display

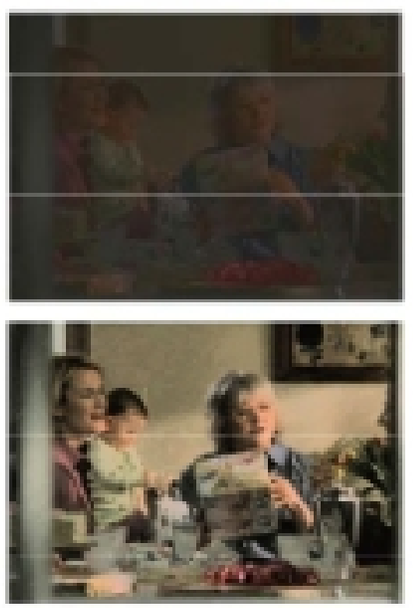


Color Image Histogram Equalization

Equalize the V channel, and then convert back to RGB



color



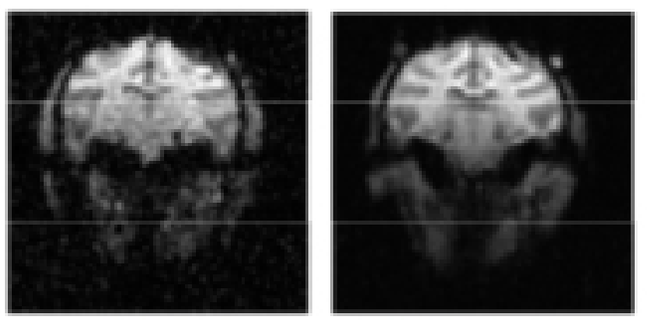
before and after - guess which

Multi-Image Operations: Noise Averaging

Assume a pixel value *p* is given by: *p* = *signal* + *noise*

- E(*signal*) = *signal*
- E(*noise*) = 0, when noise is random

Thus, averaging (adding) multiple images of a steady noisy object will eliminate, or at least reduce, the noise



original

after averaging 16 subsequently acquired images