Image Point Operations

C306
Fall 2001
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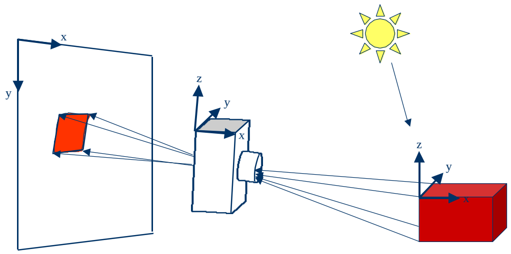
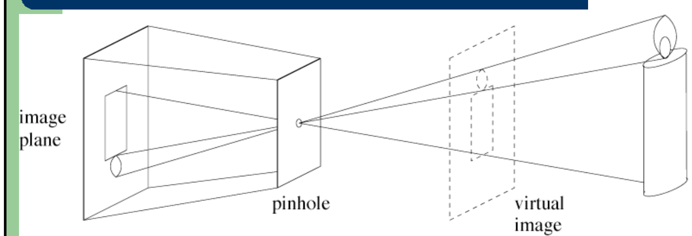
Last time: 3D reality -> captured 2D image



Pinhole cameras



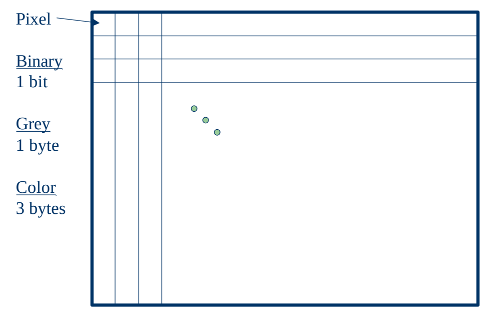
Examples of image sources:

- Analog cameras
- Digital cameras
- Optic Scanners (linear image sensors)
- Laser scanners (2 and 3D images)
- Radar
- X-ray
- NMRI

Image display

- VDU
  - Raster
  - Vector
- LCD
- Printer
- Photo process
- Plotter (x-y table type)

THE ORGANIZATION OF A 2D IMAGE



Mathematical / Computational image models

- Continuous mathematical:

  I = f(x,y)
- Discrete (in computer) adressable 2D array:

  I = matrix(i,j)
- Discrete (in file) e.g. ascii or binary sequence:

  023 233 132 232

  125 134 134 212

Image representation for display

- True color, RGB, ….

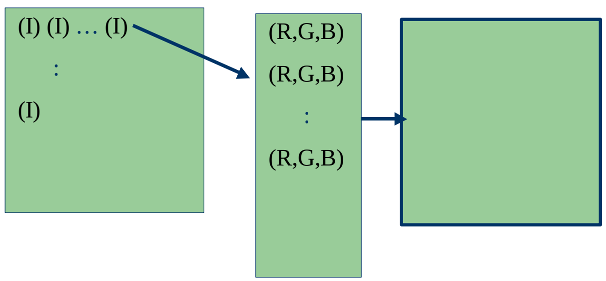
(R,G,B) (R,G,B) … (R,G,B)

:

(R,G,B)

Image representation for display

- Indexed image



Point operations on images

- Point operations perform some operation on one pixel at a time (independent on the neighboring pixels)

  For each (x,y)

  $I_2(x,y) = f(I(x,y))$

- Contrast to image transforms (later in course) perform operations on the whole image

Common point operations

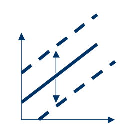
- Brightness adjustment
- Contrast adjustment
  - Dynamic range compression
  - Gray level slicing
- Histogram equalization
- Image (sequence) averaging
- Background subtraction

Linear brightness and contrast adjustment

- As seen on TV!
- Brightness

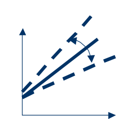
  For each (x,y)

  $I_2(x,y) = I(x,y)+const$

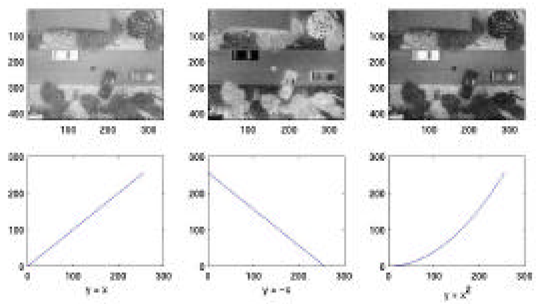


- Contrast

  $I_2(x,y) = const*I(x,y)$



Contrast adjustment example



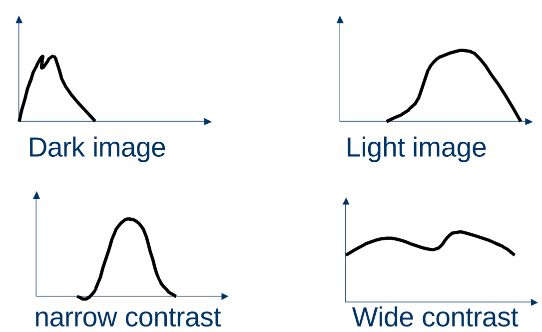
Special purpose contrast adjustments

- Dynamic range limitation
  - $I_2(x,y) = \mathrm{sqrt}(I(x,y))$
  - $I_2(x,y) = \log(I(x,y))$
- Inverted image
  - $I_2(x,y) = 1-I(x,y)$
- Gray level slicing

Image histogram

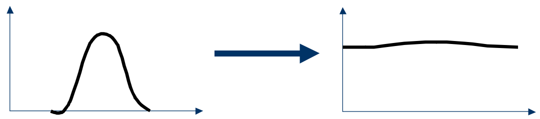
- For a discrete image quantized e.g. on [0..255]
  - Let n = total number of pixels
  - Let n_k = number of pixels with value k
  - Histogram: $p_k = n_k / n$
- Analogy: Consider the image a sample of a random variable. Then p_k is probability of a pixel having value k

Histogram examples



Histogram equalization

- Let p(k) = image histogram on k = [0..1]
- Goal: find a contrast stretching transform T(k) so that $I_2 = T(I)$ and $p_2 = 1$(uniform)



Next time:

- Derive histogram equalization formula
- Finish up with point operations