Computer Graphics -- Image Processing

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http://jjcao.github.io/ComputerGraphics/

Overview

- Image representation
  - What is an image?
- Problems
  - Sampling
  - Quantization, Halftoning and dithering
  - Filtering
  - Edge detection
  - [Line, circle detection]
  - Compression (Fourier, Harr)

What is an Image?

- An image is a 2D rectilinear array of pixels

Continuous image

Digital image

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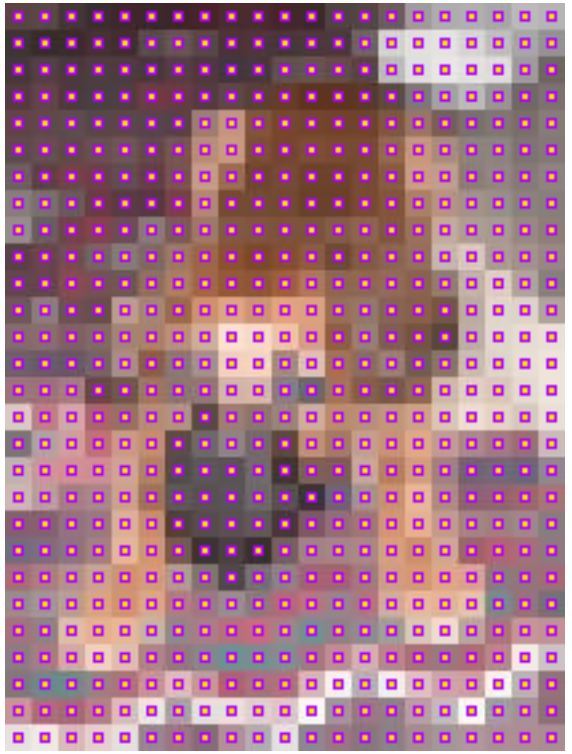
Continuous image



Digital image

A pixel is a sample, not a little square!

Image Acquisition

- Pixels are samples from continuous function
  - Photoreceptors in eye
  - CCD cells in digital camera
  - Rays in virtual camera

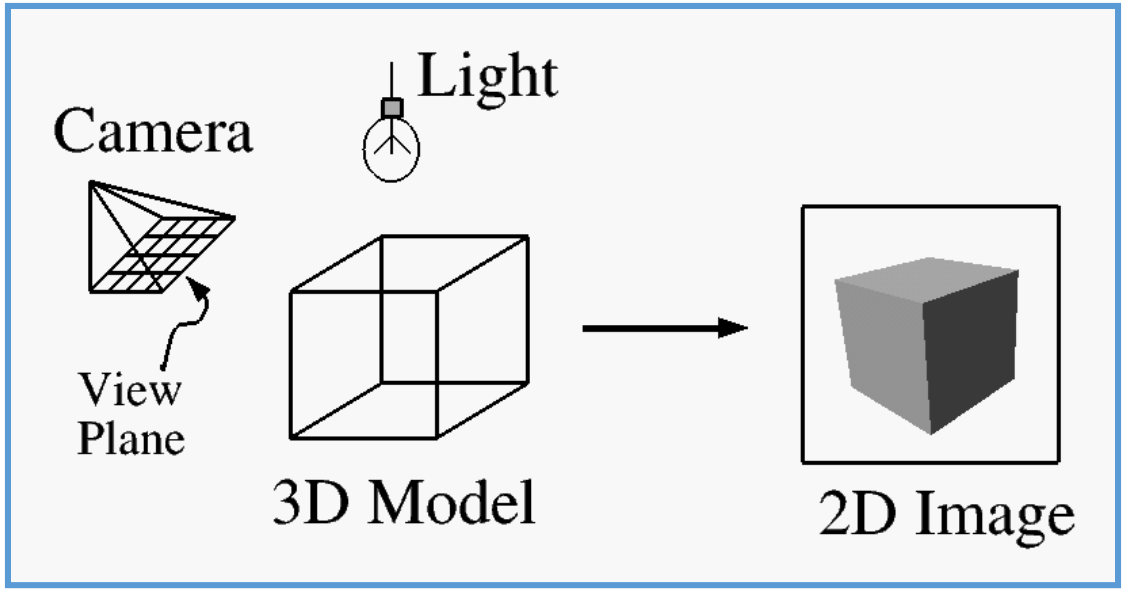
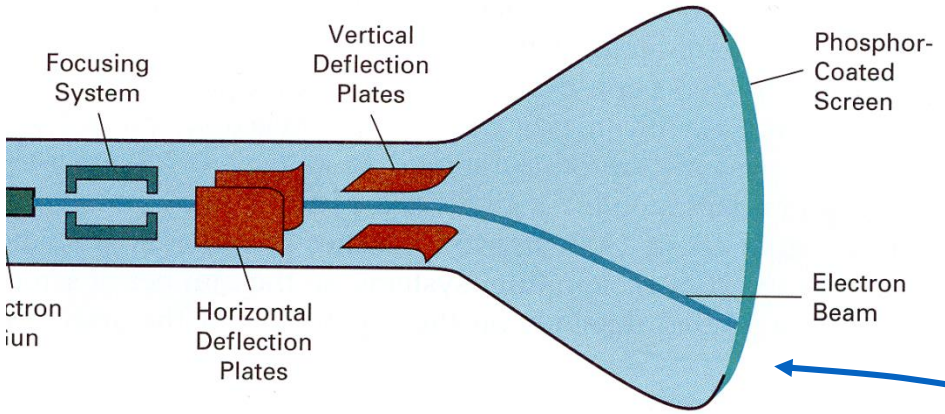


Image Display

- Re-create continuous function from samples
  - Example: cathode ray tube



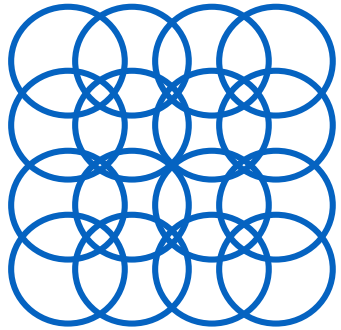


Image is reconstructed by displaying pixels with finite area (Gaussian)

Image Resolution

- Intensity resolution
  - Each pixel has only “Depth” bits for colors/intensities
- Spatial resolution
  - Image has only “Width” x “Height” pixels
- Temporal resolution
  - Monitor refreshes images at only “Rate” Hz

Typical Resolutions

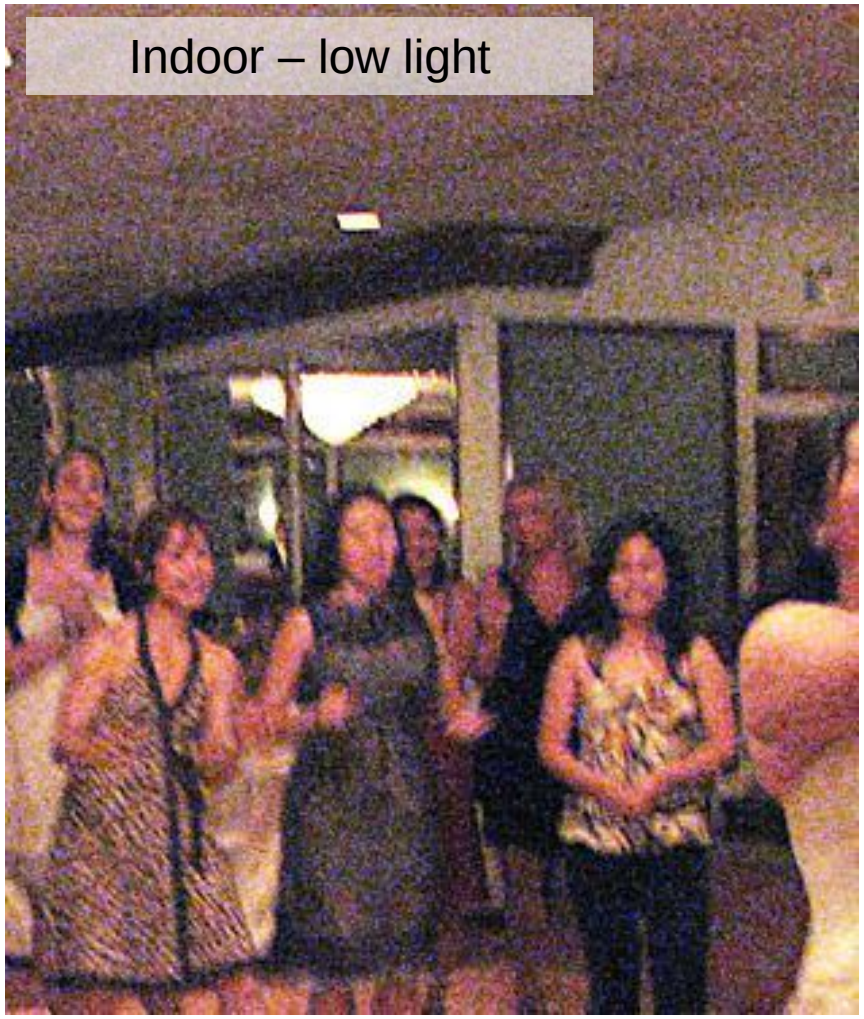
	Width x Height	Depth	Rate
NTSC	640 x 480	8	30
Workstation	1280 x 1024	24	75
Film	3000 x 2000	12	24
Laser Printer	6600 x 5100	1	-

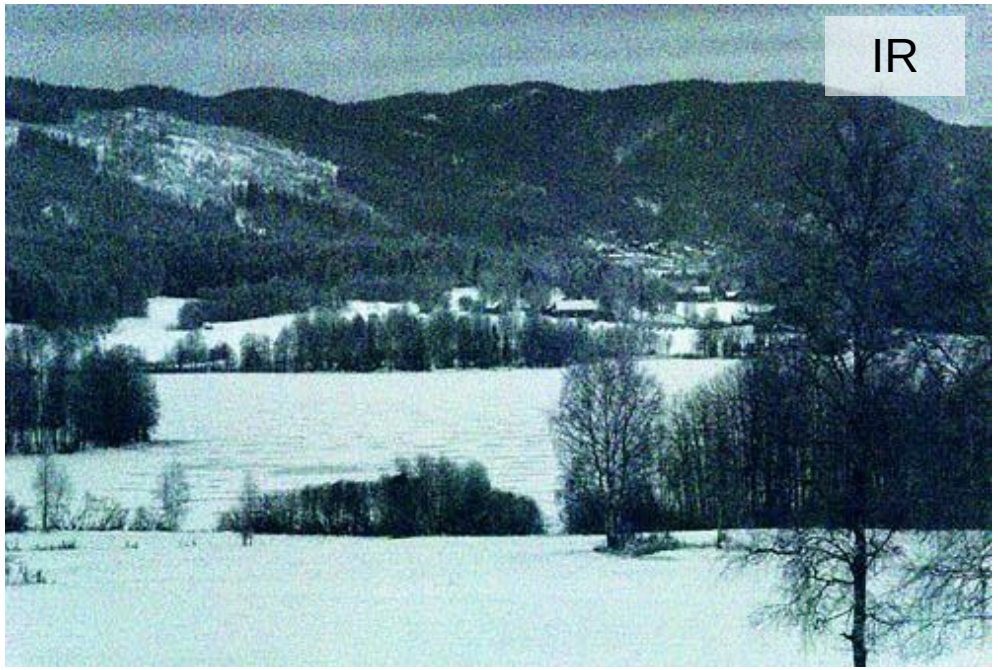
Sources of Error

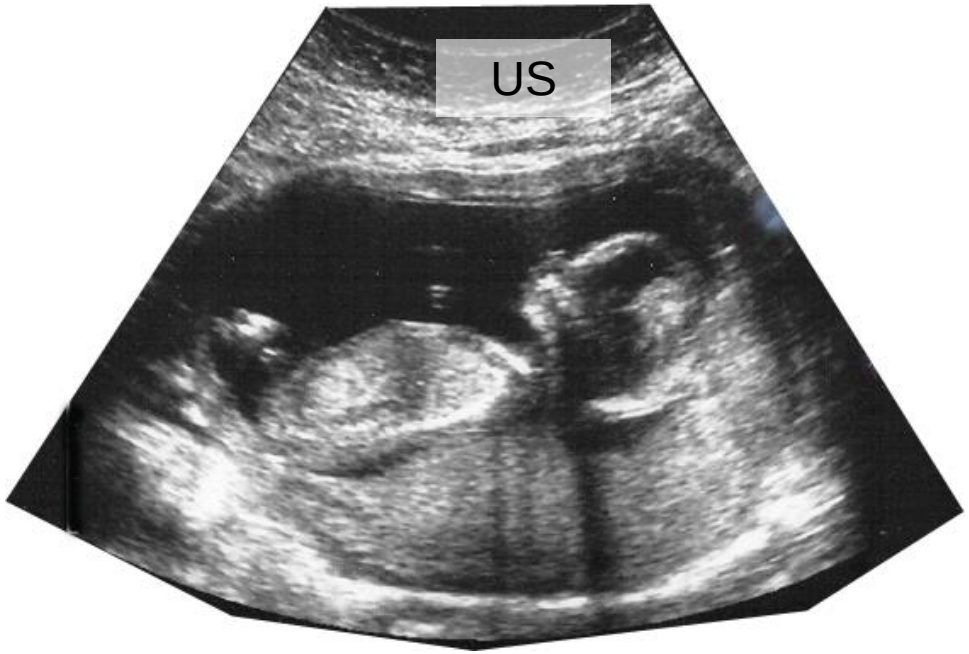
- Intensity quantization
  - Not enough intensity resolution
- Spatial aliasing
  - Not enough spatial resolution
- Temporal aliasing
  - Not enough temporal resolution

$$E^2 = \sum_{(x,y)} \left(I(x,y) - P(x,y) \right)^2$$

Noise







Basic denoising

Noisy input

Bilateral filter 7x7 window

Bilateral filtering

- todo