Visual Computing

Contents

The Digital Image

Image

An image is a pattern of a value varying in space and time.

Mathematically, an image can be represented as a function:

$$f : \mathbb{R}^n \to S$$

A pixel is *not* a square, but rather a value in a point in space and time.

Image Resolution

Geometric Resolution	How many pixels per area
Radiometric Resolution	How many bits per pixel

Image Noise

Additive Gaussian Noise	$I(x,y) = f(x,y) + c$**, where** $c \sim \mathcal{N}(0, \sigma^2)$
Poisson Noise	$I(x,y) = f(x,y)+c$**, where** $c \sim \mathcal{P}(\lambda)$

Rician Noise Multiplicative Noise Quantization Errors Salt-and-Pepper Noise	$I(x,y) = f(x,y) + f_c(x,y)$

The *signal to noise ratio* is an index of image quality:

$$s = \frac{F}{\sigma}, \textbf{ where } F = \frac{1}{XY}\sum_{x=1}^{X}\sum_{y=1}^{Y} f(x,y)$$

The *peak signal to noise* ratio:

$$s_{peak} = \frac{F_{max}}{\sigma}$$

Sampling

Continuous functions can be stored by sampling some points of the function. If we *undersample*, some information can get lost.

The continuous signal can be reconstructed by using methods of interpolation.

Bilinear Interpolation

$$f(x,y) = (1-a)(1-b) + a(1-b) + ab + (1-a)b$$

Nyquist Frequency

Quantization

Real valued function will be mapped to digital values. Information will always be lost, unlike sampling.

Image Segmentation

The goal is to partition an image into regions of interest.

Thresholding

Lable each pixel in or out of the region of interest by comparing the greylevel with some threshold.

$$B(x,y) = \begin{cases} 1 & I(x,y) \geq T \\ 0 & I(x,y) < T \end{cases}$$

ROC Analysis An ROC (Receiver Operating Characteristic) characterizes the performance of a binary classifier.

$$P = \textbf{total positives} N = \textbf{total negatives} TP = \frac{\textbf{true positive count}}{P} FP = \frac{\textbf{false positive count}}{N}$$

Region Growing

Start from a seed point or region and add neighboring pixels that satisfy the criteria defining a region until there are no satisfying pixels left.

Convolution and Filtering

Image Features

Fourier Transforms