INF01046 Fundamentals of Image Processing

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Image and Digital Image

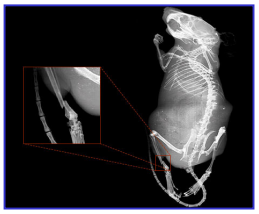
- **Image**
  - Function $f(x,y)$: $U \rightarrow C$
    - where $U \subset \Re^2$ and C is a vector space
- **Digital Image**
  - Discrete
    - f defined over discrete values of U
  - Quantized
    - f assumes a finite and discrete set of values
  - Essential Elements
    - Coordinates and color of each pixel

Digital Image Processing

- **Main Aplication Areas**
  - Improvement of image presentation to facilitate its interpretation by humans
  - Storage and transmission of images (compression)
  - Extraction of information in a way that is appropriate for machine processing (used in machine perception and vision)
    - Ex.: Coefficients of the Fourier transform, statistic moments.
- **Image Types**
  - Binary, gray scale, multispectral

Digital Image Processing

- **Main Sources of Energy**
  - Eletromagnetic Radiation
    - Visible Spectrum
    - X-Rays
    - Gamma rays
    - Ultraviolet
    - Infrared
    - Ultrasound



Digital X-Raio, courtesy of XCounter (http://www.xcounter.se/)

Examples of IP Aplications

- Filtering of noisy images
- Brightness enhancement (Ajuste de brilho)
- Contrast enhancement (Ajuste de Contraste)
- Histogram Equalization
- Image and Video Compression
- Object Segmentation and Representation
- Image Restoration
- Object Identification and Measurement
- Etc...

Brigthness Enhancement

- Example

Contrast Enhancement

- Example

Histogram Equalization

- Example

original | after equalization

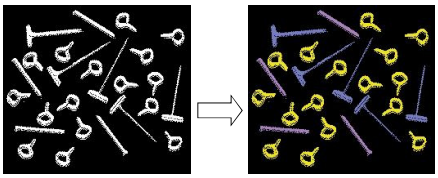
Image Compression

- Example (JPEG Compression)

Original image (326 Kb) | Compressed image (15 Kb)

Object Classification

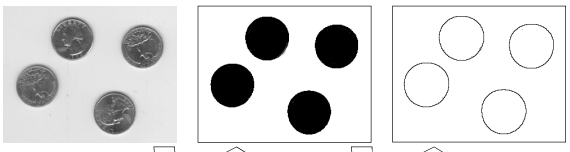
- Example



Binary image | Objects classified by shape identified by colors

Object Segmentation

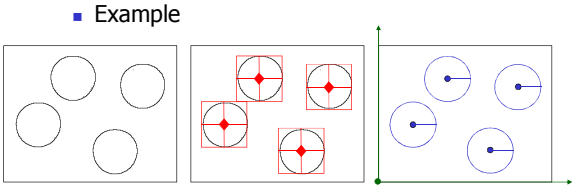
- Example



Segmentation | Edge detection

Representation of Segmented Objects

- Example



Recognition | Modeling

Image Restoration (inpainting)

- Example

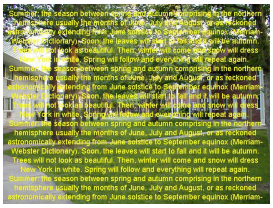



Image Restoration (inpainting)

- Example


High Dynamic Range (HDR) Images and Tone Mapping



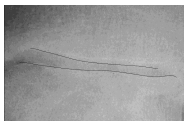
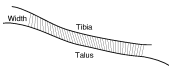

Exposure: 1/500 s | Exposure: 1/125 s | Exposure: 1/30 s | Tone mapping of the resulting HDR image

Combine images to produce a HDR image

Images courtesy of HDRsoft (http://www.hdrsoft.com/)

Object Identification and Measurements

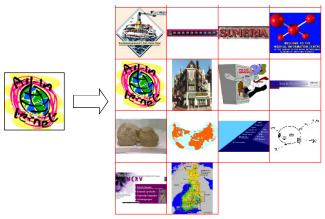
- Example

(S. Olabarriaga, Doctoral Thesis, Amsterdam/1999)

Visual Information Retrieval

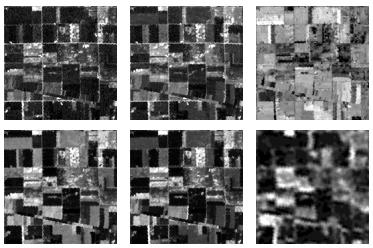
- Example



(courtesy of Jeroen Vendrig, ISIS/UvA, 2000)

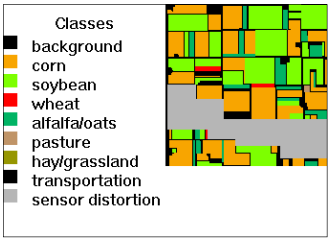
Remote Sensing

- Example



Remote Sensing

- Example (Cont.)



In this Course ...

- Image acquisition and representation
- Operations and transformations on images
- Enhancement on espace and frequency domain
- Image restoration
- HDR image and video
- Segmentation and analysis
- Image and video compression