Image Processing for Bioinformatics

AA 2008-2009 Facoltà di Scienze MM, FF e NN Dipartimento di Informatica Università di Verona

General information

- Teacher: Gloria Menegaz
- Assistant: Giulia Paggetti
- Scheduling
 - Theory
 - Wednesday 13.00 to 14.3
 - Thursday 11.30 to 13.00
 - Laboratory
 - Thursday 13.30 to 14.30
 - Tutoring (ricevimento)
 - by appointment (email)
 - Start and end dates
 - Jan. 27, 2009 March 26, 2009

- Exam
 - TBD
- Support
 - Slides of the course
 - Books
 - "A Wavelet tour of signal processing", S. Mallat
 - "Color theory and applications", D. Malacara
 - Matlab documentation (Image processing toolbox, Wavelet toolbox)

Contents

Classical IP

- 2D Discrete Fourier Transform (2D-DFT)
- Sampling and quanization
- Edge detection
 - Model-based, region-based
- Filtering
 - denoising, deblurring, image enhancement
- Morphological operations
- Segmentation techniques
- Basics of pattern recognition
 - Clustering, classification

Advanced Topics

- Discrete Wavelet Transform (DWT)
- Color imaging
- Introduction to stochastic processes
- Microarray image analysis

Why do we process images?

- To facilitate their storage and transmission
- To prepare them for display or printing
- To enhance or restore them
- To extract information from them
- To hide information in them

Image types

img ottica (CCD)











img radar (SAR)

img MRI



Microarray images



• Image Restoration



Original image

Blurred

Restored by Wiener filter

Noise Removal





Noisy image

Denoised by Median filter

• Image Enhancement







Histogram equalization



• Artifact Reduction in Digital Cameras



Original scene

Captured by a digital camera

Processed to reduce artifacts

• Image Compression



Original image 64 KB JPEG compressed 15 KB JPEG compressed 9 KB

• Object Segmentation



"Rice" image



Edges detected using Canny filter

Resolution Enhancement





• Watermarking



• Face Recognition

• Fingerprint Matching

• Segmentation

• Texture Analysis and Synthesis

Photo

Pattern repeated

Computer generated

• Face detection and tracking

http://www-2.cs.cmu.edu/~har/faces.html

• Face Tracking

• Object Tracking

• Virtual Controls

• Visually Guided Surgery

Computer graphics

- Algorithms allowing to generate *artificial* images and scenes
- Model-based
 - Scenes are created based on models
- Visualization often rests on 2D projections
- Hot topic: generate perceptually credible scenes
 - Image-based modeling & rendering

DNA

VIRUS - Herpes

HEARTH (interior)

BRAIN (visual cortex)

Computer vision

- Methods for estimating the geometrical and dynamical properties of the imaged scene based on the acquired images
 - Scene description based on image features
- Complementary to computer graphics
 - Get information about the 3D real world based on its 2D projections in order to automatically perform predefined tasks

Pattern Recognition

- Image interpretation
- Identification of basic and/or complex structures
 - implies pre-processing to reduce the intrinsic redundancy in the input data
 - knowledge-based
 - use of a-priori knowledge on the real world
 - stochastic inference to compensate for partial data
- Key to clustering and classification
- Applications
 - medical image analysis
 - microarray analysis
 - multimedia applications

Pattern Recognition

- Cluster analysis
 - analisi dei dati per trovare inter-relazioni e discriminarli in gruppi (senza conoscenza a priori)
- Feature extraction and selection
 - reduction of data dimensionality
- Classification
 - Structural (based on a predefined "syntax"):
 - each pattern is considered as a set of primitives
 - clustering in the form of parsing
 - Stochastic
 - Based on statistics (region-based descriptors)

Applications

- Efficiently manage different types of images
 - Satellite, radar, optical..
 - Medical (MRI, CT, US), microarrays
- Image representation and modeling
- Quality enhancement
 - Image restoration, denoising
- Image analysis
 - Feature extraction and exploitation
- Image reconstruction from projections
 - scene reconstruction, CT, MRI
- Compression and coding

Typical issues

Multimedia

- Image resampling and interpolation
- Visualization and rendering
- Multispectral imaging
 - Satellite, color
- Multiscale analysis
- Motion detection, tracking
- Automatic quality assessment
- Data mining
 - query by example

Medical imaging

- Image analysis
 - optical devices, MRI, CT, PET, US (2D to 4D)
- Image modeling
 - Analysis of hearth motion, models of tumor growth, computer assisted surgery
- Telemedicine
 - remote diagnosis, distributed systems, medical databases

other applications

- Quality control
- Reverse engineering
- Surveillance (monitoring and detection of potentially dangerous situations)
- Social computing (face and gesture recognition for biometrics and behavioural analysis)
- Robotics (machine vision)
- Virtual reality
- Telepresence

Query by example

Segmentation

Medical Image Analysis

Sequence analysis

Face recognition

Stereo pairs

Coppia di immagini stereo (immagini ottiche)

Immagine di disparità: i punti più chiari rappresentano oggetti più vicini all'osservatore

Medical stereo movies

Medical textures

Scalability by quality

Object-based processing

Mosaicing

