Image Processing and Data Visualization with MATLAB

Introduction

Hansrudi Noser

June 28-29, 2010

UZH, Multimedia and Robotics Summer School

Who

- PD Dr. Hansrudi Noser
  - Dipl. Phys ETHZ
  - ing. info. dipl. EPFL
  - docteur ès sciences EPFL (Computer Graphics)
  - venia legendi in computer science, University of Zurich
- Since October 2004 project leader at the AO Foundation (Arbeitsgemeinschaft für Osteosynthesefragen) in Davos
- Management of the Human Morphology Services (HMS) that maintains a CT (Computed Tomography) image database and offers services concerning shape analysis of 3D virtual human bones for various medical projects in the field of trauma and musculoskeletal surgery
- eMail: hansrudi.noser@aofoundation.org

Goal of the Course

- To learn basic theory on data visualization and image processing
- To learn to apply this theory with MATLAB, a state of the art tool in the domain
- To increase personal productivity and efficiency in studies and future profession

What

- Overview of course
- Presentation of a typical image analysis project example
- Introduction to MATLAB
- Data visualization
- Image processing
- MALAB exercises

Documentation

- Course script
- MATLAB documentation
  - Thousands of pages !
  - Many examples !
  - See introduction to MATLAB

Exercise 1: First Steps with MATLAB

- Login and start MATLAB
- Familiarize yourself with the interactive MATLAB environment
- Write an M-file with simple code and execute it (for example plot of sinus function)

Exercise 2: Basic matrix operations

- Given:
  - A=[1 2 3; 4 5 6]
  - b=[1 2 3]
  - c=[4 5 6]'
- Compute by hand and verify with MATLAB
  - b * b'
  - b' * b
  - c * b
  - 2*b
  - A * A'
  - A' * A
  - sum(A)

Exercise 3: Publishing of an M-file

- Go through the following example in MATLAB Help:
  - MATLAB / User Guide / Desktop Tools and Development Environment / Publishing M-Files / Overview of Publishing M-Files / Example of a Published M-File
- Publish the M-file to html and PDF

Exercise 4: Cosinus function plot

- Write an M-File the produces the plot of a discrete cosine function in the range of -360 to 360 degrees. The step is 5 degrees.
- The unit of the x-Axis should be 'degrees', not radians.
- Label the axes and add a title to the figure.
- The color of the data should be green and the line width 3 points (3 * 1/72 inch).
- Publish the m file to a HTML file containing a title, the content section, an equation indicating the range the code, the figure, label also the axes of the figure and add a figure title

Exercise 5: Unit roots

- Plot the following complex numbers for N=3, 4, 5, 20

$$e^{i \cdot 2 \cdot \pi \frac{k}{N}}, k = 0, \ldots, N$$

Exercise 6: Fourier analysis

- Compute the DFT of the discrete signal:
  - x = [4 3 7 -9 1 0 0 0]';
  - and the inverse DFT of the result
  - What do you observe?
- Read in the Help of MATLAB the *fft* description and execute the example

Exercise 7: Image Registration

- Execute the image registration example in
  - Image Processing Toolbox / Spatial Transformation / Example: Performing Image Registration

Exercise 8: Movie

- Produce with an appropriate M-File an educational movie in AVI format that shows the influence of the parameter T in the function:

$$y(t,T) = \frac{1}{T} e^{-\pi\left(\frac{t}{T}\right)^2}$$

Exercise 9: Animated GIF

- Implement the animated GIF example given in the course with an M-file