Welcome to

31540 Introduction to medical imaging

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Content

- Medical imaging and course objectives
- The plot
- Format of the course
- Break and team establishment
- Warnings
- SIS
- This afternoon
What is medical imaging?

Tomographic (tomo = slice) images of living tissue
Projection (or shadow) images of living tissue

What does the images show?

- **Structure or anatomy:**
  - Organs (lungs, heart, liver, bones, blood vessels, etc)

- **Functionality:**
  - Blood flow (occlusion in vessels, perfusion, etc)
What does medical imaging reveal?

- A broken bone
- Cancer
- Occlusion of blood vessels (Atherosclerosis)
- Heart (dis)functionality
- Muscle (dis)functionality
- Pregnancy follow-up
- Brain function
- and much more......
Imaging modalities

- Sound:
  -

- X-ray:
  -
  -

- Radioactive tracers (Nuclear medicine):
  -
  -

- Radio waves:
  -
Course objectives

After completion, the student should be able to:

- understand and explain the basic physical principles of the imaging modalities (to various degrees)
- be able to identify which imaging modality that was used to record a given image
- produce simple macroscopic anatomical photographs by tissue slicing
- understand and be able to work with metric 3D data sets (preferably in MATLAB)
- write a report that fulfils the requirements for scientific communication in medical imaging
Course objectives

So in short:

- Understand X-ray, CT, PET, US and MRI
- Be able to work with real images in MATLAB
- Do laboratory work
- Do independent and team-wise project work
- Write an impressive report
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Looking for the unknown
An image says a thousand words, but you need to know the words
The phantoms
Tissue in agar block

Phantom number in binary

Tube for radioactive tracer

Acrylic lid

Agar

Tissue

Fiducial markers
(or reference markers)

Phantom number
Production steps

• An appropriate piece of animal tissue is cut out
• This tissue block is fixed in formalin (Lilly's liquid)
• The tissue can be supported by sutures in the mould
• Lid with milled openings for fiducial markers is installed
• Liquid $1.5\%_{\text{weight}}$ agar is poured into the mould
• Solidification in vacuum
• Storage in demineralised water at 5°C and Rhodalon®
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The main flow of the course

- Make a photograph of the phantom surface
- Scan with medical imaging systems at a hospital and DTU
- Do image processing and analysis
- Slice the tissue to make a reference
- Final report with the above included based on 4 assignments
The important time line

Assignment
1 2 3 4 Final report

Project work

Data

MRI PET X-ray CT
MRI CT & PET
US MRI Slicing
X-ray

Time
Which objects to identify?
Which objects to identify?

All things within the limit of the acrylic box
Format of the course

- Lectures by the four teachers (see homepage)
  - Not all topics are introduced by lectures!!!
- Scannings at hospitals
  - X-ray, CT, MRI & PET
- Experimental work at DTU
  - Photographing top surface of phantom
  - Ultrasound scanning
  - Slicing of tissue and photographing this
- Analysis and visualisation with SIS in MATLAB
- Report writing
When?

See: bme.elektro.dtu.dk/31540
Language

• Normally English lectures

• A few lectures will be conducted as:
  • 12:30 - 13:00: English lecture
  • 13:00 - 14:00: Danish lecture

• All written material is in English

• During project work, guidance is in Danish/English

• Exam is in English

• Old exams from 2005 - 2015 with correct answer is available in English.

• Report language is your choice

• Please consider writing assignments 1 to 4 in English
Responsibilities at the hospital

At the hospital, you must:

- Be flexible and gentle due to patients and personnel
- Take photographs during the scanning
- Discuss observations with other team members
- Especially note how the phantoms were scanned:
  - Order of scanning
  - How the phantoms were stacked and orientated
Responsibilities in general

Be prepared!
Team sizes and rooms

We are 60 students and there are 11 phantoms

Teams of approx. 4 students (14 - 15 teams):
(One final report from each team)

Team work: Building 349, rooms 019, 025 & 034

Wet lab: Building 349, rooms 214 (prepare) 215 (work)
The course homepage

bme.elektro.dtu.dk/31540

Resources on homepage:

- Plan for the course (not Campusnet Calendar)
- Web book of medical imaging
- Practical guide
- SIS guide
- Report guide
- Data from the scannings
- Programs for reading, analysing and visualizing data
The Web Book of Medical Imaging

The Web Book of Medical Imaging

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Interactive graphics

Web book: Animations embedded in
  ● Ultrasound chapter
  ● X-ray chapter

Please be aware of system requirements:
  ● Works on all pdf-viewers and browsers allowing Adobe Flash embedded in PDF files
  ● Relative new version of Flash must be installed
  ● Verify Flash version on first page of ultrasound document
Peer-review

Background:
- A beta release of a peer-review module has been made available upon my request in Campusnet. At present, it is not functioning properly.

Idea:
- All students hand in Assignment 1
- Each hand-in is then sent to three different students:
  - Each student then have to use a scoring sheet (Rubric) to score each of the three "identical" assignment
  - All reviews are meant to be double-blinded
  - I will then evaluate the whole process

Question: Should we try, if the beta release becomes operational?
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Short break and team establishment

Procedure:

- If you are a bachelor from MedTek, try to form a team.
- If not a bachelor from MedTek OR not forming a team with only MedTek:
  - Come to me right now
  - Presentation round
  - Forming of teams

All teams:

- Within 1 hour, submit to jw@elektro.dtu.dk a mail with:
  - Team members name and study ID
  - Team title, if you so desire
Break

My basic philosophy:
- I hear, and I forget
- I see, and I know where to look for it later
- I write & draw, and I remember
- I do, and I understand
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Warnings

- This is a course full of frustrations (but hopefully also a lot of learning).
- Not all information appears to be given when you need it.
- You will need to use the detailed course homepage every day and navigate though it.
- What you have to do and prepare will not always be told by mouth. You need to read the plan.
- You also need to read the notes yourself: you will not necesssary understand it the first time, the second nor the third. But the fourth time, you probably will!
Warnings

Your comfort zone

Where 31540 takes place
Warnings

Kitchen next to group rooms:

- Keep it completely clean and tidy
Warnings

Never have anyone else do the work for you!
Report writing

• Reading and writing reports have to be separate processes.

• If citing text, there is only one way: In quotes (that is: "bla bla") with reference immediately after the end-quote. Otherwise, it will be considered plagiarism and treated as such!
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The SIS toolbox
(self-contained image structure)
SIS: zoom on 2D example
The SIS structure

Main fields:

- Data.Images: [100x200x50 double]
- Data.ImageType: 'intensity'
- Data.Axes: [1x3 struct]
- Data.ImagesLabel: 'Magnitude'
- Data.ImagesSymbol: 'HV'
- Data.ImagesUnit: 'HU'
- Data.Date: 7.3329e+005
- Data.Object: 'Phantom 1'
- Data.Operator: 'mnl'
- Data.Where: 'Bispebjerg Hospital'
- Data.ScannerType: 'CT'
- Data.Settings: (e.g. DICOM header)
SIS: 3D example
SIS: 3D example
SIS: 3D example

Data.Images(1, 2, 3)

* By sis_zoom

3* is fixed for this image
SIS: 3D example

Data.Images( 1, 2, 3)

* By sis_zoom
SIS: 3D example

Data.Images(1, 2, 3)

* By sis_zoom

(New image)
SIS: 3D example

DataOut = sis_zoom( DataIn, [45 1 1], [45 50 25], 'iii')

output        input        start        stop        mode

DataIn.Images is 100 by 50 by 25
SIS: 3D example

DataIn.Images is
100 by 50 by 25

DataOut = sis_zoom(DataIn, [45 1 1], [45 50 25], 'iii')

DataOut.Images is:
1 by 50 by 25 which is changed to 50 by 25
  Dimension 1 disappears
  Dimension 2 becomes dimension 1
  Dimension 3 becomes dimension 2
(50 by 25 can be changed to 25 by 50 via sis_reorder)
SIS: What do you need?

MATLAB (not too old)
Image processing toolbox (plus more?)
Teaching assistants
-how can they help?

Here you need Oraculus:
MyImage = ones(3,3);
MyImage = 3*MyImage;

Here you might need a teaching assistant (TA):
MyImage = ones(3,3);
imagesc( [1 5 6], [22 23 50], MyImage); colorbar;
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349.214 & 215
(two phantoms at a time, starting with teams 1 and 2)

Optical scanning of phantom

Jens E. Wilhjelm

349.019,025,034
(all other teams)

Treasure hunt
Try examples in SIS guide
Work with data from optical scanning

Line Marcussen & Anders Emil H. Jakobsen

17:00