Bioengineering 508: Physical Aspects of Medical Imaging
(http://courses.washington.edu/bioen508)

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Text:  Fundamentals of Medical Imaging, by Paul Suetens, $110.00 Publisher: Cambridge University Press; ISBN: 0521803624

Labs: Optional demonstrations of actual imaging devices will be arranged outside of regular class hours, to include MRI, X-ray CT, nuclear medicine, and ultrasound.

Grading:  40% course project, 20% home work assignments (4), 20% Exam 1, 20% Exam 2

Meeting Times and Locations:  Wednesdays, 6:30-9:50 p.m., Sept. 27-Dec. 6, 2006  Bellevue at 2445 140th Ave. NE, in the Overlake area.

Lectures:  
6:30 - 7:30 Lecture 1  
7:40 - 8:40 Lecture 2  
8:50 - 9:50 Lecture 3

Schedule:  

<table>
<thead>
<tr>
<th>Date</th>
<th>Subjects to be covered</th>
<th>Chapter</th>
<th>Instructor</th>
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<tbody>
<tr>
<td>Sep 27</td>
<td>Introduction to medical imaging and image quality. Mathematical preliminaries. Basic Image display and image processing</td>
<td>1,2,3</td>
<td>Alessio</td>
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| Oct 4  | X-ray physics.  
Projection radiography - part 1  
Projection radiography - part 2 | 4       | Schmitz    |
| Oct 11 | Computed Tomography Principles.  
X-ray CT - part 1  
X-ray CT - part 2 | 5       | Kinahan    |
| Oct 18 | Radiation physics.  
Nuclear medicine detectors  
Nuclear medicine systems | 8       | MacDonald  |
| Oct 25 | Tomographic nuclear systems SPECT  
Tomographic nuclear systems PET  
Hybrid imaging systems (PET/CT) | 8       | Kinahan    |
| Nov 1  | EXAM 1:  
Guest lecture | TBA     |            |
| Nov 8  | Ultrasound physics.  
Ultrasound imaging - part 1  
Ultrasound imaging - part 2 | 7       | Kinahan    |
| Nov 15 | MRI physics  
MRI Imaging - part 1  
MRI Imaging - part 2 | 6       | Kinahan    |
| Nov 22 | No Lecture - Thanksgiving break |         |            |
| Nov 29 | EXAM 2:  
Image quality  
Image-guided intervention | 9,10  | Kinahan    |
| Dec 6  | ORAL PRESENTATION OF PROJECTS | Class members |            |

Labs: Demonstrations of actual imaging devices will be arranged outside of regular class hours, to include MRI, X-ray CT, nuclear medicine, and ultrasound.

Lecture Notes: All powerpoint slides and homework solutions will be available at http://courses.washington.edu/bioen508/
Work in groups. I will assign groups if you like.

Investigate a specific problem involving medical imaging and present your conclusions in a written report and 15 minute oral presentation (on Dec 8th). The investigation should have the following three components: 1) it should target a specific organ, disease, and/or other condition, 2) it should specify one or more of the imaging modalities discussed in class, and 3) it should define the objective behind the use of medical imaging. Examples of each of these components are:

<table>
<thead>
<tr>
<th>Organ / Disease</th>
<th>Modality</th>
<th>Objective</th>
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<tbody>
<tr>
<td>Brain tumor</td>
<td>x-ray</td>
<td>Detection / diagnosis</td>
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<tr>
<td>Lung cancer, breast cancer, etc.</td>
<td>CT</td>
<td>Progression</td>
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<tr>
<td>Coronary artery disease</td>
<td>Nuclear medicine</td>
<td>Registration</td>
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<tr>
<td>Stroke</td>
<td>Ultrasound</td>
<td>Image guided surgery</td>
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<tr>
<td>Joint injuries</td>
<td>MRI</td>
<td>Segmentation</td>
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Your report should address these questions:

1. What is the problem being investigated and why is it important?
2. Why is the chosen modality or modalities the best choice to address the problem? This should be an argument based on the technical benefits (e.g. resolution, SNR, speed, etc.) of your choice as compared to other options.
3. How is the problem currently addressed using this modality? What image processing is required? Cite appropriate references from the literature.
4. What could be done to better address this problem in the future? What about the peripheral or support equipment? That is, if you were asked to improve the methodology, what avenues would you pursue first?

Some examples are:

Brain tumor / MRI / Progression – The goal is to measure changes in tumor size (progression) over time. This can be used to assess the response of the tumor to treatment. MRI provides good soft tissue definition necessary to identify tumor boundaries.

Liver disease / CT and ultrasound / Registration – The goal is to align the CT and ultrasound images (registration) so they can be displayed in a combined image. This can be useful in minimally invasive surgery where the ultrasound is used in real time to guide the surgeon and the CT provides high definition images of the anatomy.

**Deadlines:**

- Nov 1: Outline due
- Nov 29: Final report due
- Dec 6: Class presentation