CARNEGIE MELLON UNIVERSITY

ME 24-658 & BME 42-640: Special Topics
Computational Bio-Modeling and Visualization
Spring 2014

SYLLABUS

INSTRUCTOR: Professor Yongjie (Jessica) Zhang
Scaife Hall 303, 268-5332, jessicaz@andrew.cmu.edu
Office Hours: M 1:30pm-2:30pm and by appointment
Secretary: Michael Scampone
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TEACHING ASSISTANT: Tao Liao, taoliao@andrew.cmu.edu
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LECTURES: Monday and Wednesday 11:30am-1:20pm in WEH 5415

UNIVERSITY UNITS: 12

WEB PAGE: http://www.cmu.edu/blackboard

COURSE LEVEL: Graduate/undergraduate level

PREREQUISITES: None

OBJECTIVES:

- To introduce students the fundamentals of medical imaging, image processing, computational geometry, mesh generation, visualization and finite element analysis.
- To expose students novel and advanced applications in computational biomedicine and other engineering fields.

TOPICS:

This course integrates mechanical engineering, biomedical engineering, computer science and mathematics together. Topics to be studied include:

1. Bio-medical imaging: This course will introduce the techniques and processes used to create images, such as CT (Computed Tomography), MRI (Magnetic Resonance Imaging), Ultrasound, Fluorescence and Cryo-EM (Cryo-Electron Microscopy).
2. Image processing: This course will introduce various image processing techniques to improve the quality of imaging data, including contrast enhancement, filtering, classification, segmentation, and registration.
3. Geometric modeling and visualization: This course will introduce how to construct geometry and generate quality meshes from imaging data. Both volume rendering and geometry rendering will be covered.

4. Computational mechanics: This course will introduce some computational mechanics techniques such as finite element analysis and isogeometric analysis.
5. Bio-medical applications: The above techniques have been extensively used in bio-medical applications. Examples will be introduced in this class.

Approximate Plan of the Course

Date	**Topic**	**Reading**
Mon, Jan 13	Syllabus and Introduction	
Wed, Jan 15	Bio-Medical Imaging	1-4
Mon, Jan 20	No class after 12:30pm*-Martin Luther King Jr. Day	
Wed, Jan 22	Image Processing	1-4
Mon, Jan 27		
Wed, Jan 29		
Mon, Feb 3		
Wed, Feb 5		
Mon, Feb 10	Computational Geometry and Graphics	5-6
Wed, Feb 12		
Mon, Feb 17		
Wed, Feb 19		
Mon, Feb 24	Mesh Generation	7-8
Wed, Feb 26		
Mon, Mar 3		
Wed, Mar 5		
Mon, Mar 10	No class* -- Spring break	
Wed, Mar 12	No class* -- Spring break	
Mon, Mar 17		
Wed, Mar 19		
Mon, Mar 24		
Wed, Mar 26		
Mon, Mar 31	Finite Element Method	9-11
Wed, Apr 2		
Mon, Apr 7	**Guest Lecture**	
Wed, Apr 9	**On-site**	
Mon, Apr 14		
Wed, Apr 16		
Mon, Apr 21	Bio-medical Applications	
Wed, Apr 23	Student presentation	
Mon, Apr 28	Student presentation	
Wed, Apr 30	Student presentation	

GUEST DISTINGUISHED LECTURERS:
TBD.

COMPUTER:

Some homework and Project 1 have computing component. C/C++/Matlab will be used throughout the course.

GRADING:

Grading will be based on the following:

Homework	40%
Project 1 – programming	30%
Project 2 – survey	30%

HOMEWORK AND PROJECT POLICY:

There will be homework and two projects. All the homework and projects will be posted on the course website. Homework and projects are due at the beginning of class on the due date. No late homework or project will be accepted unless prior arrangements have been made with me. 20% off for one CMU class day, 50% off for two CMU class days, and no point afterward. For example, suppose the due date is 11:30am Monday morning, you will lose 20% if you hand it in by 11:30am Tuesday, 50% by 11:30am Wednesday, and 100% afterward.

EXAMINATIONS:

No exams will be given.

SUGGESTED READING MATERIALS:

1. http://en.wikipedia.org/wiki/Medical_imaging
2. Insight into Images. Yoo, Terry (Editor). A K Peters, 2004. ISBN 1-56881-217-5.
3. Digital Image Processing: An Algorithmic Approach Using Java. Wilhelm Burger and Mark J. Burge. Springer, 2007. ISBN 1846283795 and ISBN 3540309403.
4. Introduction to Mathematics of Medical Imaging, C. Epstein, Pearson Education Inc., Upper Saddle River, NJ07458.
5. Interactive Computer Graphics: A top-down approach using OpenGL. Edward Angel, 3rd Edition. Pearson Edition.
6. Computational Geometry: Algorithms and Applications, M. De Berg, M. Van Kreveld, M. Overmars, O. Schwarzkopf, Springer 1997.
7. Computational Grids: Generations, Adaptation and Solution Strategies. Graham F. Carey, Taylor and Francis, 1997. ISBN 9781560326359
8. Handbook of Grid Generation. Joe F. Thompson, B. K. Soni, N. P. Weatherill, CRC Press, 1999.
9. Finite Elements: A Second Course. J. T. Oden, G. F. Carey. Prentice Hall, Englewood Cliffs, 1983.
10. The Finite Element Method--Linear Static and Dynamic Finite Element Analysis. T.J.R. Hughes. Dover Publishers, New York, 2000.
11. Finite Element Methods with B-splines, K. Hollig, SIAM Frontier in App. Math., 2003.