BME 42-731 / ECE 18-795/CB 02-740: Bioimage Informatics (12 Units)

Spring 2011

Instructor

Ge Yang, Ph.D.
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Instructor Contact Information

- Email – geyang@andrew.cmu.edu
- Telephone – 412-268-3186
- Office Location – Mellon Institute 403
- Preferred communication approach is by email. Please include Bioimage Informatics in the subject.

Instructor Office Hour & Location

1:00PM – 2:00PM Friday or by appointment
Mellon Institute 403

Pre-requisite or Co-requisite

- Image processing; Training in computer vision is very helpful but not essential.
- Proficiency in programming; Familiarity with MATLAB is very helpful but not essential.

Class Times & Locations

- Monday & Wednesday, 3:00PM - 4:20PM, Doherty Hall 1209

Class Website

- http://www.andrew.cmu.edu/course/42-731/

Teaching Assistant(s) and Contact Information:

Anuparma Kuruvilla
Email: anupamak@andrew.cmu.edu
Office: C119 Hamerschlag Hall
Directions: http://www.cbi.cmu.edu/contact/directions/index.html
Office hour: Not assigned.

Course description & objectives

Development of biology over the past half a century has made it possible to identify the complete set of genes and proteins of a live organism. The complex interactions between these molecules in space and time define life. These interactions can now be visualized using fluorescence microscopy techniques, whose development represents one of the most fundamental and exciting advances in biomedical science and engineering over the past two decades. However, without quantitative measurement, fluorescence microscopy is merely a tool of visualization. The field of bioimage informatics is created over the past few years with the goal of applying computation, statistical analysis, and engineering techniques to effectively manage, visualize, analyze, and eventually understand the tremendous amount of image data generated routinely using fluorescence microscopy in contemporary biomedical research. Highly interdisciplinary in nature, bioimage informatics provides exciting opportunities for

students with solid analytical and/or engineering skills to make fundamental contributions in research and development. The main purpose of this class is to prepare students for such opportunities through course training. Specifically, by completing the training of this course, the students should be able to

- Master basic concepts and principles of bioimage informatics.
- Understand fundamentals of fluorescent microscopy.
- Apply basic image processing and computer vision techniques in fluorescence image data analysis.
- Apply basic statistical analysis and information extraction techniques in fluorescence image data understanding.

Required Textbook(s)

Digital image processing, 3rd ed., R.C. Gonzalez & R.E. Woods, Prentice Hall, 2007.

References

Optics

- Hecht, *Optics*, 4th ed. (or 3rd ed), Addison Wesley, 2001.
- Born & Wolf, *Principles of optics*, 7th ed., Cambridge University Press, 1999.

Light & fluorescence microscopy

- Herman, *Fluorescence microscopy*, 2nd ed., Taylor & Francis, 1998.
- Inoue & Spring, *Video microscopy*, 2nd ed., Plenum Press, 1997.

Image processing & computer vision

- Gonzalez & Woods, *Digital image processing*, 3rd ed., Prentice Hall, 2007.
- Snyder & Qi, *Machine vision*, Cambridge University Press, 2004.

This list is by no means exhaustive. In fact, there are many other excellent references. A substantial collection of additional reference materials, including research papers and online information, will be distributed in class or posted on the course web page.

Classroom Policy

- Lectures will start and end on time. If you are late, please enter the class without disruptions.

- Use of cell phones and pagers during class and laboratories is not allowed.

- Class participation, performance effort and improvement are considered in grading, especially when a student's grade is borderline between letter grade$^+$ and the next higher letter grade (e.g. C$^+$, and B$^+$)

Academic Integrity

- University regulations will be followed. See http://www.studentaffairs.cmu.edu/acad_integ/acad_integ_text.html

Reading and Project Assignments:

- Reading and project assignments are handed out in class.
- Completed reading and project assignments should be handed in before class on due dates.

Grading

Reading assignment (5 in total)	40%
Project assignment (4-5 in total)	50%
Class participation*	10%
Total	**100%**

* Students will be graded based on their engagement and performance in class activities such as asking questions, participating in discussions, and giving presentations.

Topics Schedule

(preliminary; please be sure to check the class website for schedule updates)

Lecture	**Topics**
Lecture 1	Introduction
Lecture 2	Fundamentals of light microscopy
Lecture 3	Practical issues in bioimage informatics
Lecture 4	Fundamentals of fluorescence microscopy
Lecture 5	Applications of fluorescence microscopy (I)
Lecture 6	Literature review
Lecture 7	**Lab visit: fluorescence microscope**
Lecture 8	Class canceled due to weather
Lecture 9	Bioimaging data analysis: point feature detection
Lecture 10	Bioimaging data analysis: line/curve detection
Lecture 11	Project 1 presentation & review
Lecture 12	Bioimaging data analysis: registration
Lecture 13	Bioimaging data analysis: segmentation
Lecture 14	**Literature review**
Spring break;	

No class	
Spring break; No class	Bioimaging data analysis: tracking
Lecture 15	Project 2 presentation & review
Lecture 16	Project 2 presentation & review
Lecture 17	Bioimaging data analysis: image database
Lecture 18	Bioimage analysis: information extraction
Lecture 19	Bioimage analysis: data mining
Lecture 20	Special focus I: Statistical methods for bioimaging informatics
Lecture 21	Special focus II: High-throughput screening
Lecture 22	**Literature review**
Lecture 23	Project 3 presentation & review
Lecture 24	Project 3 presentation & review
Lecture 25	Special focus III: analysis of protein dynamics
Lecture 26	Electron microscopy
Lecture 27	Other molecular imaging modalities
Lecture 28	**Literature review; Outlook; Course** **evaluation**
Final exam week	Project 4 presentation & review