Administrative Basics

Lecture  ERB 129 | Monday and Wednesday 4:00-5:20 PM

Instructor  Junzhou Huang | ERB 650 | Office hours: Monday and Wednesday 2:00-4:00 PM

Textbook  Required: None

Recommended:


Work  Two homework sets. (20%)
Class presentations. (20%)
Writing final reports (that will be posted in this website) or using alternate programming projects (a short presentation is required in class). (40%)
Participation. (20%)

Request  Basic math and programming background, for undergraduate student, CSE 2320 are requested

Course Description

This course presents an introduction to the mathematical, physical, and computational principles underlying modern medical imaging informatics systems. It will cover fundamentals of magnetic resonance imaging (MRI), and functional MRI (fMRI), X-ray computed tomography (CT), ultrasonic imaging, as well as more general concepts required for these, such as linear systems theory, the Fourier Transform, wavelet Transform and the emerging compressive sensing techniques. Popular techniques for the registration, segmentation, and analysis of medical image data will also be discussed, as well as applications of medical imaging to image-guided intervention and healthcare.

The course is application-driven and includes topics in medical imaging and medical informatics, such as different imaging techniques and advanced image analysis tools in medical applications and healthcare. It will also include selected hot topics relating to the emerging compressive sensing theory and techniques. The course will provide the participants with a thorough background in current research in these areas, as well as to promote
greater awareness and interaction between multiple research groups within the university. The course material is well suited for students in computer science, biomedical engineering, and electrical engineering. It will be of appropriate difficulty for both undergraduate and graduate students.

Assignments

Homework 1 (Due in class)
Homework 2 (Due in class)

Final Programming Project -- Compressive Sensing Magnetic Resonance Imaging

Project Requirements:
MATLAB - Programming language
Writing code by yourself

Project Description:

Compressive Sensing (CS) aims to reconstruct signals and images from significantly fewer measurements than were traditionally thought necessary. Magnetic resonance imaging (MRI) is an essential medical imaging tool with an inherently slow data acquisition process. Applying CS to MRI offers potentially significant scan time reductions, with benefits for patients and health care economics. MRI obeys two key requirements for successful application of CS: 1) medical imagery is naturally compressible by sparse coding in an appropriate transform domain (e.g., by wavelet transform), and 2) MRI scanners naturally acquire encoded samples, rather than direct pixel samples (e.g., in spatial-frequency encoding). This project will help to review the requirements for the successful application of compressed sensing to the MRI. The students emphasize on an intuitive understanding of CS MRI by describing the CS reconstruction as a process of interference cancellation in MRI. There is also an emphasis on the understanding of the driving factors in applications, including limitations imposed by MRI hardware and by clinical concerns.

Due on May 1st.

Final Report Project

Please select one of the following topics as your final report:

1) Compressive Sensing;
2) Compressive Sensing MRI;
3) Medical image segmentation;
4) Medical image registration.

You should study and summarize several popular methods in your selected topic from above and talk about their advantages and disadvantages in different cases. No more than 8 pages.

Due on .

Outline of Lectures

| Week 1. | Wed Jan 18: Introduction, Course Objectives (Slides) |
| Week 2. | Mon Jan 23: Math Basics. ([Slides](#)) ([Reading materials: Matrix Algebra](#))  
Wed Jan 25: Least Square ([Slides](#)) |
| Week 3. | Mon Jan 30: SVD ([Slides](#)) ([Reading materials: Gaussian Identities](#))  
Wed Feb 01: Principles of Medical Imaging ([Slides](#)) |
| Week 4. | Mon Feb 06: Medical Image Modalities ([Slides](#))  
Wed Feb 08: MRI Physics ([Slides](#)) ([Reading materials: The Basics of MRI](#)) |
| Week 5. | Mon Feb 13: Magnetic Resonance Imaging (I) ([Slides](#))  
Wed Feb 15: Magnetic Resonance Imaging (II) ([Slides](#)) |
| Week 6. | Mon Feb 20: Computed Tomography (I) ([Slides](#))  
Wed Feb 22: Computed Tomography (II) ([Slides](#)) |
| Week 7. | Mon Feb 27: Ultrasound Imaging (I) ([Slides](#))  
Wed Feb 29: Ultrasound Imaging (II) ([Slides](#)) |
| Week 8. | Mon Mar 05: Discrete Fourier Transform ([Slides](#))  
Wed Mar 07: Fast Fourier Transform ([Slides](#)) |
| Week 9. | Spring Break |
| Week 10. | Mon Mar 19: Wavelet Transform (I) ([Slides](#))  
Wed Mar 21: Wavelet Transform (II) ([Slides](#)) |
| Week 11. | Mon Mar 26: Compressive Sensing: Introduction ([Slides](#)) ([HW1 Due on Class](#))  
Wed Mar 28: Compressive Sensing: Sampling ([Slides](#)) |
| Week 12. | Mon Apr 02: Compressive Sensing: Theory ([Slides](#))  
Wed Apr 04: Compressive Sensing: Geometry ([Slides](#)) |
| Week 13. | Mon Apr 09: Compressive Sensing: Algorithm ([Slides](#))  
Wed Apr 11: Compressive Sensing: CS MRI ([Slides](#)) |
| Week 14. | Mon Apr 16: Medical Image Segmentation ([Slides](#))  
Wed Apr 18: Medical Image Registration ([Slides](#)) |
| Week 15. | Mon Apr 23: Support Vector Machine ([Slides](#)) ([HW2 Due on Class](#)) (Class Presentation: Jin Huang: "Compressed sensing: MRI"; Harshan Ravi: "Compressed sensing: MRI") |

Mon Apr 30: (Report Due on Class) Class Presentations: Ismat Jahan "Snakes: Active Contour Models"; Soheil Shafiee "Robust Face Recognition via Sparse Representation"; Chen Chen "Efficient MR Image Reconstruction for Compressed MR Imaging"

Wed May 02: Sparse Learning and Beyond (Slides)

Paper List for Presentation

Presentation:

Every student selects one paper from the following list and presents the paper (25 min ~ 40 min) in class. Grade: slides preparation 50%, oral presentation 25%, and answer questions 25%.

Segmentation:

Snakes: Active Contour Models

Deformable Models in Medical Image Analysis: A Survey

Metamorphs: Deformable Shape and Appearance Models

Registration:

Image Registration Methods: A Survey

Multimodality Image Registration by Maximization of Mutual Information

Shape Registration in Implicit Spaces using Information Theory and Free Form Deformations

Compressive Sensing:

Compressive Sampling

Compressive Sensing

Model-Based Compressive Sensing

Learning with Structured Sparsity

Compressive Sensing MRI:

Compressed Sensing MRI

Sparse MRI: The Application of Compressed Sensing for Rapid MR Imaging

Efficient MR Image Reconstruction for Compressed MR Imaging
Other Information

Americans with Disabilities Act

The University of Texas at Arlington is on record as being committed to both the spirit and letter of federal equal opportunity legislation; reference Public Law 93112 -- The Rehabilitation Act of 1973 as amended. With the passage of new federal legislation entitled Americans With Disabilities Act - (ADA), pursuant to section 504 of The Rehabilitation Act, there is renewed focus on providing this population with the same opportunities enjoyed by all citizens. As a faculty member, I am required by law to provide "reasonable accommodation" to students with disabilities, so as not to discriminate on the basis of that disability. Student responsibility primarily rests with informing faculty at the beginning of the semester and in providing authorized documentation through designated administrative channels.

Academic Integrity

It is the philosophy of The University of Texas at Arlington that academic dishonesty is a completely unacceptable mode of conduct and will not be tolerated in any form. All persons involved in academic dishonesty will be disciplined in accordance with University regulations and procedures. Discipline may include suspension or expulsion from the University. "Scholastic dishonesty includes but is not limited to cheating, plagiarism, collusion, the submission for credit of any work or materials that are attributable in whole or in part to another person, taking an examination for another person, any act designed to give unfair advantage to a student or the attempt to commit such acts." (Regents' Rules and Regulations, Part One, Chapter VI, Section 3, Subsection 3.2, Subdivision 3.22)

Grade Appeal Policy

If you do not believe a grade on a particular assignment is correct, you may appeal the grade in writing (email) within 5 class days. Grade appeals must be appealed to the appropriate GTA firstly, then to your instructor if necessary. Please refer to the UTA Catalog for the detailed guide of grade appeals.

Student Support Services Available

The University of Texas at Arlington provides a variety of resources and programs to help you develop academic skills, deal with personal situations, better understand concepts and information related to their courses, and achieve academic success. These programs include major-based learning centers, developmental education, advising and mentoring, personal counseling, admission and transition, and federally funded programs. Students requiring assistance academically, personally, or socially should contact the Office of Student Success Programs at 817-272-6107 or visit www.uta.edu/resources for more information and appropriate referrals.

Academic Integrity