M229: Advanced Topics in Magnetic Resonance Imaging

Spring 2023: 4 Units
Lectures: Tue/Thu 10:00 AM – 11:50 AM
Bauer Auditorium, CHS BH-173
https://mrrl.ucla.edu/pages/m229

Instructor: Holden Wu, PhD (holdenwu@mednet.ucla.edu)

Teaching Assistants: Shu-Fu Shih, Timoteo Delgado

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Course Description: This course will explore recent MRI developments that 1) have had high impact on the field, 2) involve novel pulse sequence design or image reconstruction, and/or 3) enable imaging of anatomy or function in a way that surpasses what is currently possible with any other modality. Simulations and programming exercises in MATLAB will provide hands-on experience for students. Students will propose and carry out a final project along current directions of advanced MRI research.

Prerequisites: This course is a follow-up to M219 (Principles and Applications of MRI) and is meant for students interested in pursuing research related to the development or translation of new MRI techniques.

Course Schedule:

1. April 4, Tue **Introduction** – Advanced MRI Techniques and Applications
2. April 6, Thu **Pulse Sequences** – Rapid GRE
3. April 11, Tue **Pulse Sequences** – RARE / Bloch Simulation MATLAB demo
4. April 13, Thu **Pulse Sequences** – Extended Phase Graphs (EPG) / MATLAB demo
5. April 18, Tue **RF Pulse Design** – Adiabatic Pulses
6. April 20, Thu **RF Pulse Design** – Excitation k-space / MATLAB Demo
7. April 25, Tue **Fast Imaging** – EPI, PROPELLER
8. April 27, Thu **Project Discussion**
9. May 2, Tue **Fast Imaging** – Non-Cartesian Sampling I
10. May 4, Thu **Fast Imaging** – Non-Cartesian Sampling II
11. May 9, Tue **Image Reconstruction** – Partial k-space (by Dr. Kyung Sung)
12. May 11, Thu **Image Reconstruction** – Parallel Imaging (by Dr. Kyung Sung)
13. May 16, Tue **Image Reconstruction** – Compressed Sensing (by Shu-Fu Shih)
14. May 18, Thu **Image Reconstruction** – Deep Learning (by Shu-Fu Shih)
15. May 23, Tue **Managing Motion in MRI**
16. May 25, Thu **Susceptibility and Conductivity Imaging** (by Dr. Jingwen Yao)
17. May 30, Tue **Advanced Application Topic** – **TBD** by Dr. Jingwen Yao
18. June 1, Thu **Advanced Application Topic** – **TBD** by Dr. Anthony Christodoulou
    [ISMRM: June 3 – June 8]
19. June 12-16, **Final Project Presentations**

Course Assignments:

- Reading book chapters and research papers
- Programming assignments x2 (MATLAB)
- Final project presentation (1-page abstract and 10+10 min oral presentation)

Grading Structure:

- Participation (10%), Homework (30%), Final Project (60%), Extra Points.

Reading List:

- Handbook of MRI Pulse Sequences. M. A. Bernstein, K. F. King, and X. J. Zhou. Elsevier Academic Press, 2004. ISBN-13: **978-0120928613**.
- Research papers as assigned