Project Discussion

M229 Advanced Topics in MRI

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MRI Research

Technical Developments	Clinical Applications
Physics	Anatomical imaging
Contrast mechanisms	Functional imaging
Mathematical models	Multi-modal imaging
Hardware	Quantitative imaging
Data acquisition	
Data reconstruction	for
Data processing	Diagnosis / screening
Quantitative analysis	Treatment planning
Data integration	Procedural guidance
Software	Treatment assessment
	Monitoring

Course Topics

- RF Pulse Design

- Pulse Sequences

- Fast Imaging Trajectories

- Parallel Imaging

- Compressed Sensing

- Deep Learning Recon

- Motion in MRI

- Susceptibility Imaging

- Invited Speakers

  - Body MRI

  - Lung MRI

Final Project

- ~5 weeks; start thinking now!
  - come to office hours

- Can be your own research
  - incorporate course topics

- Can be from list of ideas
  - can combine several ideas

- Components
  - Proposal (1 page), due 5/10 Fri by 5 pm
  - Abstract (1 page), due 6/7 Fri by 5 pm
  - Presentation + Q&A, 6/11 Tue 10-12

Project Ideas

- Pulse sequences
  - bSSFP catalyzation
  - bSSFP banding artifact reduction
  - Design of variable flip-angle TSE
  - Simulation of diffusion-weighted SSFP
  - RF + seq simulator (Bloch, EPG)
  - MR fingerprinting
  - Motion and flow encoding
  - Gradient waveform optimization

Project Ideas

- RF pulse design
  - Low SAR / wide bandwidth adiabatic pulse
  - Velocity selective RF pulse
  - 2D excitation RF pulse
  - Spectral-2D spatial pulse design (e.g., fat suppression + 2D excitation)
  - Low SAR multi-band RF pulse (e.g., for simultaneous multi-slice imaging)

Project Ideas

- Fast imaging
  - Trajectory design (EPI, PROP, spiral, etc.)
  - Gradient waveform optimization
  - Fast 3D re/gridding (or nuFFT) recon
  - Gradient measurement / calibration
  - Off-resonance correction

- Motion compensation
  - Self navigation
  - Model-based reconstruction

Project Ideas

- Image reconstruction
  - Coil combination (preserve phase, etc.)
  - Parallel imaging (e.g., GRAPPA vs. SENSE)
  - Sparsity and low-rank constraints
  - k-t methods

- Image analysis
  - Measure/reduce geometric distortion in DWI
  - B_1+ mapping with improved spatial interpolation
  - Denoising
  - Multi-component tissue signal modeling

Project Ideas

- Deep learning / machine learning
    - Image enhancement / reconstruction
    - Super-resolution MRI
    - Texture analysis for multi-parametric MRI
    - Prediction models for disease diagnosis
    - Image segmentation
    - Contrast synthesis

Project Ideas

- Quantitative imaging
  - Relaxometry (T_1, T_2, T_2^* mapping)
  - Diffusion
  - Perfusion
  - Fat/water
  - Temperature
  - Tissue stiffness
  - Acquisition and signal modeling/fitting

Final Project

- Proposal due 5/10 Fri by email
  - Template on course webpage
  - Scope should be feasible in 4-5 weeks

- Titles of past projects listed in Lecture 1

- Ask about sample datasets

- Come to office hours!
  - Email to make an appointment

Thanks!

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