Project Title: Multimodal Liver MR Imaging in NAFLD and Healthy Cohorts

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Summary: Nonalcoholic fatty liver disease (NAFLD) is one of the most common chronic liver conditions worldwide and can progress to fibrosis, cirrhosis, and liver failure if left untreated. Quantitative magnetic resonance imaging (MRI) techniques offer powerful, noninvasive tools for assessing liver health. Magnetic Resonance Elastography (MRE) measures liver stiffness as a marker of fibrosis, Proton Density Fat Fraction (PDFF) quantifies hepatic fat, and Chemical Exchange Saturation Transfer (CEST) MRI has emerging potential to probe molecular changes related to inflammation and metabolism.

This summer project will focus on image analysis of liver MRI data acquired from individuals with NAFLD and healthy controls. The student will help develop and implement a reproducible pipeline for multimodal image processing, including segmentation, coregistration, and quantitative analysis. The project provides an excellent opportunity to gain hands-on experience in translational medical imaging research.

Objectives:

- Learn liver segmentation techniques on multi-contrast MRI datasets.
- Generate quantitative maps: liver stiffness, fat-fraction maps, and CEST contrast maps (e.g., APT-weighted).
- Establish a standardized pipeline for liver segmentation and coregistration across MRE, PDFF, and CEST datasets.
- Perform region-of-interest (ROI) and whole-liver analyses.
- Evaluate relationships among fat, stiffness, fat fraction, and CEST measures.

Methods: The student will work with de-identified MRI datasets under close mentorship and learn liver anatomy, MRI principles, and image processing. Using platforms such as Python, or MATLAB, the student will:

- Conduct manual, semi-automated, or automated liver segmentation to define ROIs while avoiding vessels and artifacts.
- Apply rigid and/or deformable registration methods to align MRE stiffness maps, PDFF fat maps, and CEST images.
- Perform quality control to assess segmentation accuracy and registration performance.
- Compute summary statistics and generate visualizations of parametric maps.

Impact: By integrating MRE, PDFF, and CEST imaging, this project supports ongoing efforts to improve noninvasive characterization of liver disease. The work may help identify imaging biomarkers that distinguish NAFLD from healthy liver tissue, advance quantitative approaches for clinical research, and provide the student with meaningful experience in cutting-edge MRI methodologies.