Interventional MRI, Cardiac Imaging, and Kidney Functional Imaging

My primary research interest is in interventional Magnetic Resonance Imaging (iMRI), in particular developing novel MRI-trackable and visible therapeutic intravascular devices and ultrafast device tracking and imaging techniques for MRI-guided endovascular Interventions. Further development is necessary and goal is to develop and extend the capabilities of MRI as a tool for the guidance of minimally invasive endovascular procedures.

MRI-guided interventional procedures offer unique opportunities as well as challenges. Endovascular therapy refers to a general class of minimally invasive interventional techniques that allow treatment of a variety of abnormalities by accessing and treating diseases from within the vasculature. A catheter with the help of a guidewire is manipulated under fluoroscopic image guidance to the area of interest to deploy stents, coils, embolic agents, or drugs through the catheter. Currently, the device or agent delivery is performed under X-ray fluoroscopic guidance. Conventional X-ray fluoroscopy provides high spatial and temporal resolution but requires iodinated contrast material and ionizing radiation. MRI on the other hand offers several advantages over X-ray, including excellent soft-tissue contrast and 3D multiplanar imaging capability. The use of MRI for image-guided therapy (or interventional MRI) has, however, developed more slowly due to limitations of temporal and spatial resolution. Recent advances in MRI acquisition hardware and software, real-time image reconstruction and visualization, and devices will help extend the capabilities of MRI as a guidance tool so that wholly MRI-guided minimally invasive endovascular procedures can be performed.

My other area of interest is to develop MR imaging and quantitative analysis techniques for myocardial perfusion and viability. Coronary artery disease (CAD) is the number one killer of men and women in the United States. Obstructive CAD may lead to ventricular impairment (damage to heart's lower chambers), congestive heart failure, and death. In addition, assessing myocardial viability in patients with coronary artery disease and left ventricular dysfunction can be critical to determine which patients might benefit from revascularization (restoration of blood flow to an area). We hope to establish that magnetic resonance imaging can help assess how the heart receives blood and how it might be used to help patients at risk for heart attacks. Goal is to determine whether some aspects of MRI studies can provide information whether a portion of heart tissue is alive or not. This is a very important question for patients who might be candidates for heart surgery but have significant risk for such a procedure.

I’m currently looking for a few (1-2) motivated graduate students who have the right combination of physics/engineering background, computer programming (c/c++), and some hands-on (RF) hardware experience that would fit well my research program in MRI-guided interventions and cardiac imaging and want to work towards a PhD degree in Medical Physics. I’ve a few projects currently underway. One of my research projects, recently funded for $1.5 Million by the National Institutes of Health (NIH), is to develop MRI-guided RF Ablation treatment platform for Atrial Fibrillation. This research project will provide unique opportunities to work on developing not only ultrafast MRI imaging and device tracking techniques using HYPR and CSI, other novel image reconstruction algorithms, and MR thermometry techniques, but also developing intravascular catheter-based imaging, tracking, and ablation probes for real-time MRI-guided therapeutic interventions.