MULTI-PHASE 3D ANGIOGRAPHY ROADMAPS FOR REAL-TIME MRI-GUIDED PROCEDURES

H. Saybasili[1,2], A. Z. Faranesh[1], C. E. Saikus[1], C. Ozturk[2], R. J. Lederman[1], and M. A. Guttman[1]

[1]Translational Medicine Branch National Heart Lung Blood Institute, National Institutes of Health, Bethesda, MD, United States, [2]Institute of Biomedical Engineering, Bogazici University, Istanbul, Turkey

Introduction: One challenge of real-time MRI guided vascular intervention is to distinguish vascular structures to insure the safety and efficacy of the procedure [1]. Real-time sequences often focus on increasing data acquisition speed by sacrificing spatial resolution and overall image quality. High resolution or time-resolved features of (non real-time) MRI are reduced during real-time imaging. The operator therefore may have difficulty uniquely identifying related vascular structures such as arteries, veins, and even biliary structures. In this work, we present a new software system that dynamically creates colored Maximum Intensity Projections (MIPs) in real-time using pre-acquired magnetic resonance angiography (MRA) and magnetic resonance cholangiopancreatography (MRCP) data, and displays them interactively within our in-house developed real-time system described in [2] by alpha-blending. In this way, conventional MRI advantages can be brought back into real-time MRI applications. With our system, the physician can easily visualize the anatomic location and orientation of devices in relation to important anatomic structures.

Methods: Time-resolved MRA, MRCP and real-time images of a pig were acquired using a short, wide bore Siemens Espree 1.5 T MRI scanner (Siemens Medical Solutions, Erlangen, Germany). During a breath hold, the MRA was acquired with a 3D flash sequence with the following parameters: TR = 2.79 ms, TE = 1.23 ms, flip angle = 24˚, bandwith = 820 Hz/pixel, FOV = 325x325 mm. For MRCP imaging, a respiratory gated fast spin echo sequence (HASTE) was used with the following parameters: TR = 2773.39 ms, TE = 620 ms, flip angle = 180˚, bandwith = 220 Hz/pixel, FOV = 102x102 mm. Real-time SSFP images were acquired with TR = 3.01ms, flip angle = 45˚, bandwith = 800 Hz/pixel, FOV = 340x255 mm with acquisition matrix of 192x108. 18 receiver coils were used during real-time imaging, and a hybrid TGRAPPA (HTGRAPPA) algorithm [3] was employed as a parallel imaging technique. MRA and MRCP data were exported as DICOM images and loaded into our in-house developed real-time reconstruction environment for rendering the appropriate MIPs. These MIPs were displayed interactively, alpha-blended with real-time multi-slice images on our reconstruction computer.

Results: The MIPs and real-time images are displayed in 3D as shown in Figure 1 and Figure 2. The HTGRAPPA algorithm was deployed for parallel imaging with acceleration factors of 2 and 3. Displaying each MIP with a different color makes it possible to differentiate hepatic arterial, biliary and venous structures.

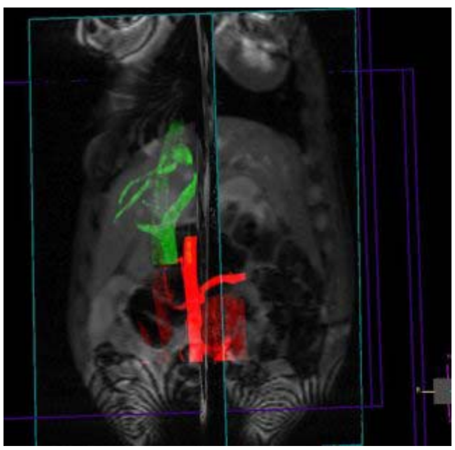

Figure 1. Alpha-Blended 3D MIPs showing hepatic artery in red, and both hepatic and portal veins in green.

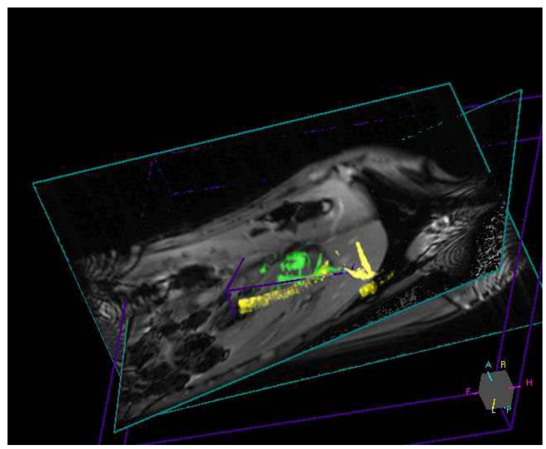

Figure 2. Alpha-Blended 3D MIPs showing biliary tree in green, and both hepatic and portal veins in yellow.

Discussion: Our software allows us to render and to display dynamically 3D MIPs with different colors in real-time, in an interactive manner by alpha-blending them with real-time reconstructed multi-slice images. The colorization improves the visibility of the vascular structures and can help identify the orientation and the location of devices in real-time during MRI guided procedures, such as TIPS, angioplasty, biopsy, stent placement, and electrophysiology applications. The integration of pre-acquired MRA data with real-time guidance has the potential of improving patient safety and procedure efficacy for MRI guided interventional applications.

Acknowledgments: We thank Victor Wright and Kathy Lucas for assistance in experiments.

References:

[1] Lederman RJ. Cardiovascular Interventional Magnetic Resonance Imaging. Circulation 112:3009-3017 (2005).
[2] Guttman MA et al. Interventional Cardiovascular Procedures Guided by Real-time MR Imaging: An Interactive Interface Using Multiple Slices, Adaptive Projection Modes and Live 3D Renderings. Journal of Magn Reson Imag 26:1429 –1435 (2007).
[3] Saybasili et al. Parallelized Hybrid TGRAPPA Reconstruction for Real-Time Interactive MRI. Proc. of MICCAI 2008, Lecture Notes in Computer Science, Springer-Verlag, 5242;163-170 (2008).