Interactive Interventional Applications for the MRI Scan Room

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Introduction: Interventional MRI procedures can be very complicated, with numerous pieces of equipment that are used in synchrony, often controlled remotely because of the harsh environment that is a magnet room. Recent advances in mobile consumer electronics have created new technology that is less sensitive to the harsh conditions surrounding an MRI magnet and better yet are properly built and shielded to not introduce artifacts in imaging. The purpose of this work was to integrate mobile architecture into procedures to facilitate protocol setups including the running of scans while in the magnet room.

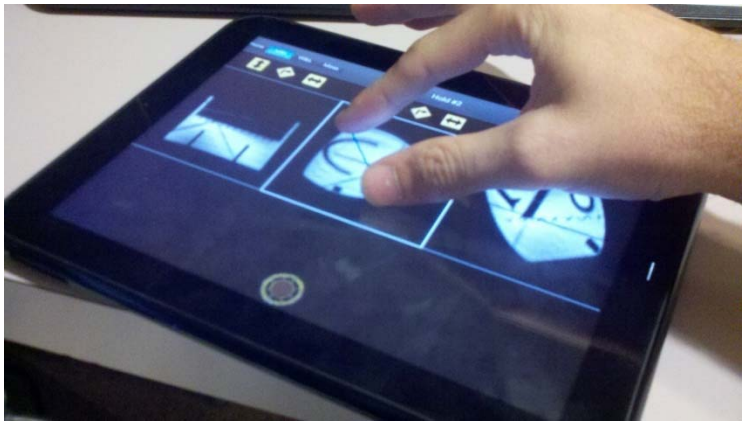

Figure 1: Real time MRI application running on tablet architecture. The scanner is controlled with touch and multi-touch gestures, on screen buttons, and physical keys such as the volume up/down keys for geometry control.

Methods: A WiFi router was set up in the MRI control room. The antenna was split using a 3dB splitter, with one antenna remaining in the control room, and the second antenna connected through the penetration panel via a 2.4GHz bandpass filter to the magnet room of our 3T Signa Excite magnet (GE Healthcare, Waukesha, WI). With this system, a single SSID WiFi network permeated both the magnet room and the control room.

With this network setup, three separate applications were created for an HP TouchPad (Hewlett Packard, Palo Alto, CA). The applications were meant for control or monitoring of various portions of a high intensity focused ultrasound (HIFU) procedure. They consisted of an application for monitoring respiratory information, an application for running HIFU reflection tests, and an application for controlling the MRI scan, interfacing through RTHawk, a real time imaging platform (HeartVista, Inc, Los Altos, CA). The respiration application was also ported to a smaller form factor: a Palm Pixi Plus (Hewlett Packard, Palo Alto, CA) modified to remove nearly all ferrous components inside.

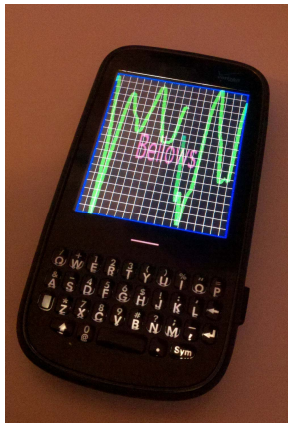

Figure 2: Real time respiration belt application. This app allows immediate feedback on the belt connection in a very portable form factor.

Results: Figure 1 shows a screen shot of the MRI control application. Three slices can be independently enabled and controlled during the scan. The scans are controlled via on-screen buttons, touch and multi-touch gestures directly on theimages themselves, and, via the "volume control" buttons on the side of the device, which page in and out of the currently activated slice. The TouchPad works well until a foot from the magnet bore opening.

Figures 2 and 3 show the two non-MR applications developed for our interventional procedures. Figure 2 shows a physiology app which connects to our respiration sensor on the mobile phone device. Figure 3 shows control mechanisms for controlling a common HIFU procedure for external transducer placement. Both of these applications allowed modification of positioning immediately from the patient bedside. In fact, the modified mobile phone could freely be used throughout the MRI room with minimal safety concerns, even picking up WiFi signals in the center of the 3T magnet bore.

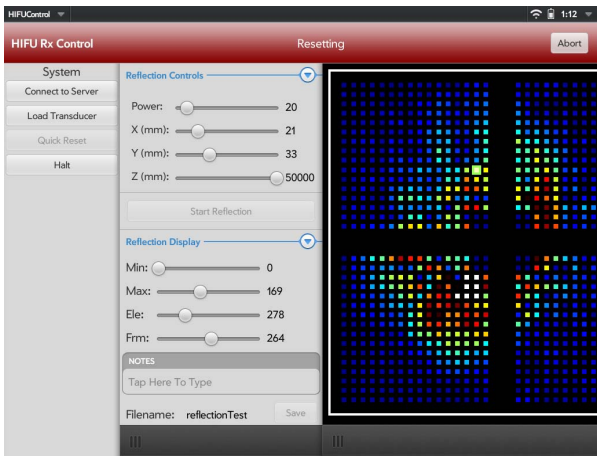

Figure 3: HIFU Reflection Test App. HIFU reflection tests can be performed and assessed directly at the magnet table with this application, allowing rapid repositioning when necessary.

Discussion: By building a dual room WiFi network and creating applications capable of interacting with the MRI scanner and other important devices, we have demonstrated a simple and intuitive means for improving workflow in the MR environment.

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