Interactive Frontend (IFE): A Platform for Graphical MR Scanner Control and Scan Automation

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Introduction

Interventional cardiovascular MR requires real time update and visualization of planes to guide procedures. In addition, selection of parameters for cardiovascular MR imaging, especially with the time contraints of interventional CMR, can be challenging to take into account multiple forms of image contrast, and parameters related to cardiac timing. Many groups have developed approaches to real time scanner control [1-3] for various applications, but in general these have been limited to scan plane control and direct parameter manipulation. There is a further opportunity for scan automation if algorithms for image processing and feature extraction can also be incorporated in such a platform. Therefore we have developed a scanning frontend that allows both control of the scan plane orientation and also allows selection of imaging parameters based on feature extraction from previously acquired images, or from any general parameter optimization algorithm. Initial applications to real time slice prescription and selection of parameters for morphologic and functional imaging are presented.

Methods

The frontend was developed using a combination of MeVisLab (Mevis, Bremen, Germany), OpenInventor, and C++ and was embedded in a rapid application development framework with links to *syngo*, the Siemens common operating environment. A family of manipulators was created in Open Inventor to limit motion of the slices in the 3D window to constrained motion to prevent the user from losing orientation while moving the slices (Figure 1). Slice manipulation is allowed in one of several modes: free rotation and translation, in plane rotation, rotation about slice center, and translation along the slice normal.

The frontend application can run on an independent workstation connected via ethernet to the scanner host computer (Siemens Avanto), or can run directly on the scanner host computer. The frontend application can communicate with the current open running protocol via socket communications to a custom application running on the host. Through this application, slice manipulation performed graphically in 3D on the frontend application is transformed into scanner coordinates and sent to the running protocol to update the slice position. After image acquisition the image reconstruction program sends the image data both to the standard database and also via socket communication back to the frontend application.

To demonstrate the ability to change sequence parameters based on features extracted from the images, a second application running in the frontend was created. This application, referred to as the TSE-Helper loads a short axis cine series, automatically segments the endo and epicardial borders, and generates a time-volume curve. This curve in combination with estimated T1 relaxation times and sequence parameters, is used to optimize timing in the cardiac cycle for dark blood turbo spin echo imaging. Updated parameters can be sent to the open protocol from the frontend application.

Figure 1. Manipulators for slice control

Results

Figure 2 shows the current UI of the interactive frontend. The main viewing window can be used for visualizing renderings made from previously acquired images in addition to display of newly acquired slices in real time. The windows on the left are used for two dimensional slice positioning and viewing of both previous images and realtime updates. The small windows on the bottom contain a history of acquisitions already made, and these images can be moved to the lefthand windows or the main viewing/manipulating window as needed. The frontend has two modes of operation: (1) visualization, where movement of the imaging planes in the main window does not result in any scanner update, and (2) active slice manipulation where movement of the scan planes.
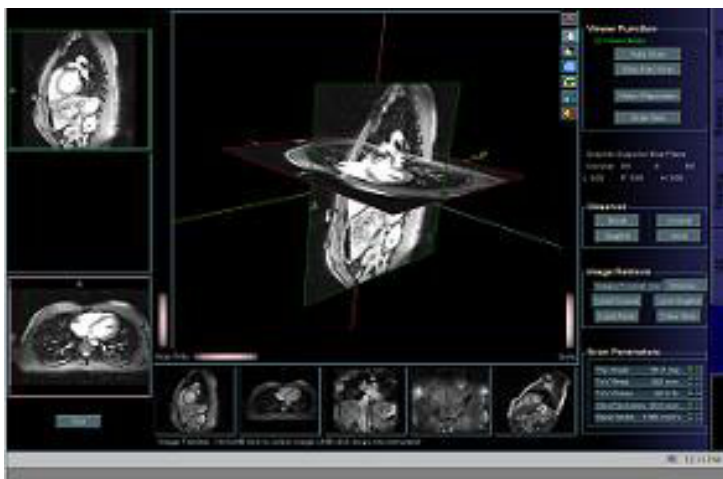

Figure 2: Main interactive interface.

Figure 3 shows the interface for the TSE-Helper. The original and segmented images from the cine sequence are shown on the left. The blood and myocardial T1 relaxation curves are shown on the bottom right, and the time-volume curve with estimated timing for the acquisition (optimized between cardiac motion, position and T1 relaxation is shown on the upper right).

Figure 3. TSE Helper UI

Discussion and conclusions

This platform for visual scan control combined with the ability to use image features to guide parameter selection is the basis for development of new methods for automated general scanning, and for simplified scanning during interventional procedures.

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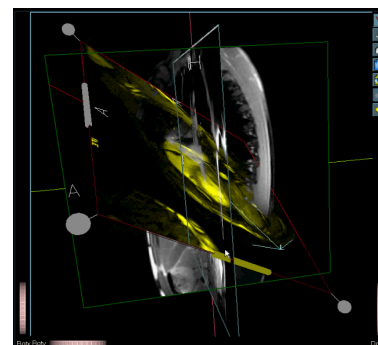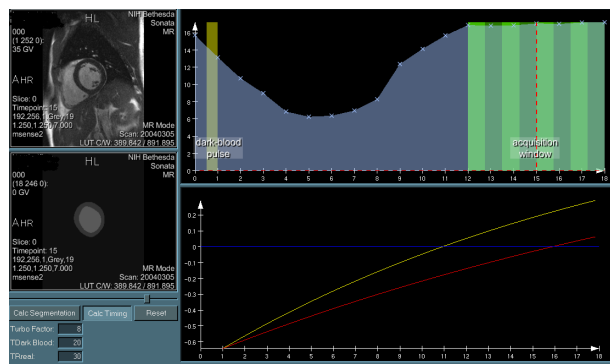[3] Buecker A et al. J Magn Reson Imaging. 2002;16(2):201-8