Dynamic 3D gastric imaging using *k-t* BLAST and image processing of the 4D MRI data of the human stomach

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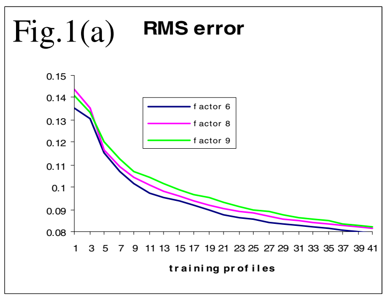
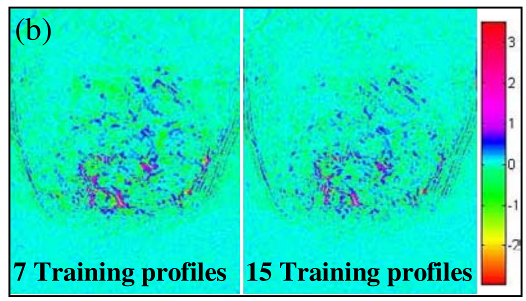
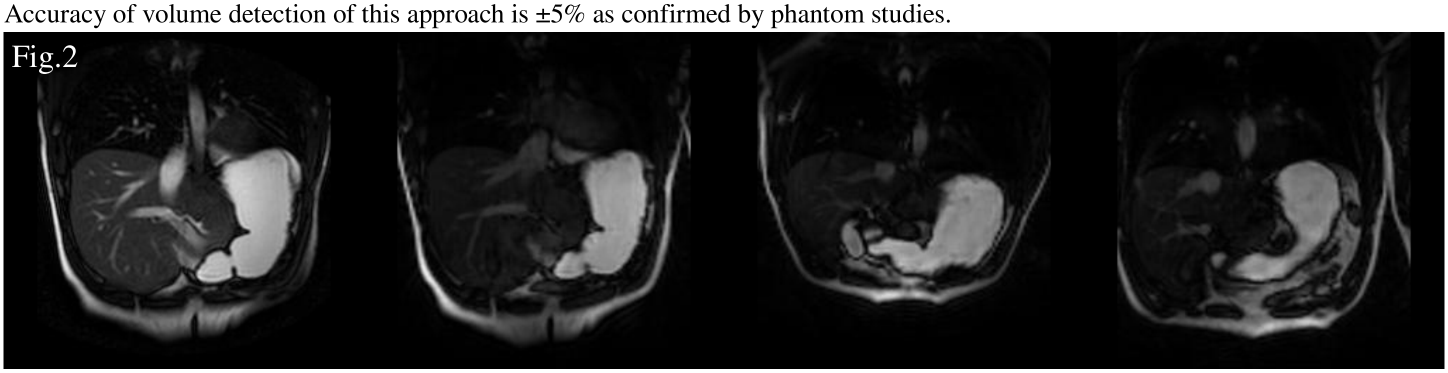
Introduction: Due to the complex structure of the human gastrointestinal tract and the required large field of view, functional imaging of the human stomach has so far been limited to two dimensions. Recently developed accelerated acquisition methods for dynamic MRI (*k-t* BLAST and *k-t* SENSE) (1) now allow the visualization of the complete abdominal volume at high temporal and spatial resolutions. In this work, the *k-t* BLAST method was evaluated and optimized for dynamic 3D gastric MRI and an automated segmentation tool was implemented to extract gastric volume and emptying information.

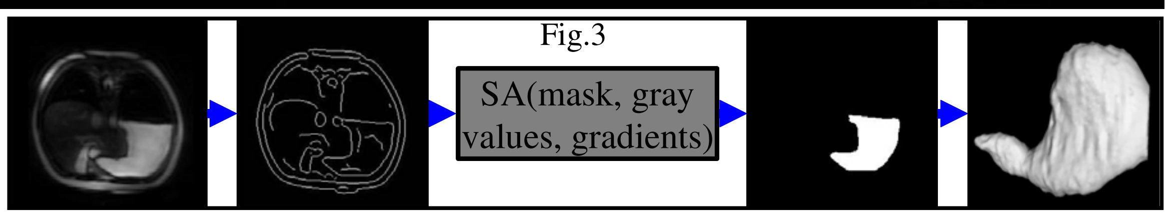
Methods: A 2D dynamic gastric MRI data set was recorded as reference data for analyzing temporal frequency content and simulation of *k-t* BLAST reconstruction. Simulation was performed for different acceleration factors (*k-t* factors) and training profiles and the root-mean-square (RMS) errors calculated for each data set. The simulated findings were confirmed in pilot studies and MRI sequence parameters for optimal temporal and spatial resolution as well as image contrast were derived. Dynamic 3D gastric volume data (12 coronal slices of 6mm, prone body position, 3D-bSSFP, flip 60°, TR/TE=3.1/1.8ms, FOV=400mm, matrix=128x128) were acquired in 3 volunteers (1.5 T Intera, Philips Medical Systems, Best, The Netherlands) with 8-fold acceleration yielding a temporal resolution of 600ms. A segmentation algorithm (SA) was developed in MATLAB for automatic detection of ingested and Gd-DOTA (DOTAREM®, Laboratoire Guerbet, Aulnay-sous-Bois, France) marked meal volumes over time.

Results: The error analysis shows the increase of the RMS error for higher *k-t* factors and decrease by higher number of training profiles (Fig.1 (a)). Difference images (reference image – *k-t* BLAST image) for different training profiles are depicted in Fig.1 (b) and show that errors occur predominantly in regions of frequent motion. Fig.2 displays the 2D reference data (a) and a representing image slice of dynamically acquired 3D data sets (k-t factor 8, training profiles 9/9, resolution=3.6*3.6*6mm^3). Temporal blurring is most pronounced at the gastric wall. The automated SA combining Canny-Filter (2) results and additional image information (distribution of gray values and image gradients) proved a robust segmentation tool (Fig.3). More than 90% of dynamic 3D image data were successfully segmented for all volunteers. Accuracy of volume detection of this approach is ±5% as confirmed by phantom studies.









Conclusion: This work presents a method for analyzing human gastric motor function in three dimensions. Using combined k-t and parallel imaging methods together with larger phased array coils will allow faster acquisition of even higher quality image data in the near future. This will also necessitate the improvement of the proposed segmentation algorithm in order to exploit available image information more efficiently.

References: (1) J. Tsao et al., *Magn Reson Med*, 2003, 50(5), 1031-42; (2) J. Canny, *Ieee Transactions on Pattern Analysis and Machine Intelligence*, 1986, 8(6), 679-698