Preliminary results on motion correction in pediatric MRI using an electromagnetic tracker

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Purpose: MRI is inherently sensitive to motion, and motion induced artifacts can significantly degrade image quality. While the effects of motion can be eliminated or reduced to an insignificant level when cooperative subjects are scanned, they remain a major problem during scans of non-cooperative subjects such as children. It is common practice for a high percentage of children to only be scanned when under general anesthesia or full sedation. Unfortunately, sedation and anesthesia in children can have substantial risks and also significantly increase the cost of each scan. A method that successfully reduces the effects of motion could potentially eliminate the need for sedation, resulting in both reduced costs and reduced risks to patient health. In this work we will report our preliminary results on using motion measurements from an electromagnetic tracker (Robin Medical Inc.) [1][2] to create a motion robust imaging protocol to be used in pediatric MRI studies.

Methods & Materials: The protocol has been tested in 26 volunteer studies and have recently been started to be used in clinical studies. All the methods were developed for Siemens TRIO scanners but are adaptable to any scanner. Our protocol combines different prospective and retrospective motion correction strategies due to our large database of children with different age and conditions. For retrospective motion correction we have developed techniques that combines multiple low resolution images into a high resolution image[1]. This method has been shown [2] to be succesful in children that are able to stay still inside the scanner for short periods of time (30-60 seconds). For our prospective motion correction, the location and orientation of an EM tracker were measured in real-time, updated every TR, from which 6 rigid body motion parameters were estimated and fed back into the scanner to orient the FOV. For fMRI and diffusion MRI scans we have adapted a motion detection combined with a reacquisition strategy [3].

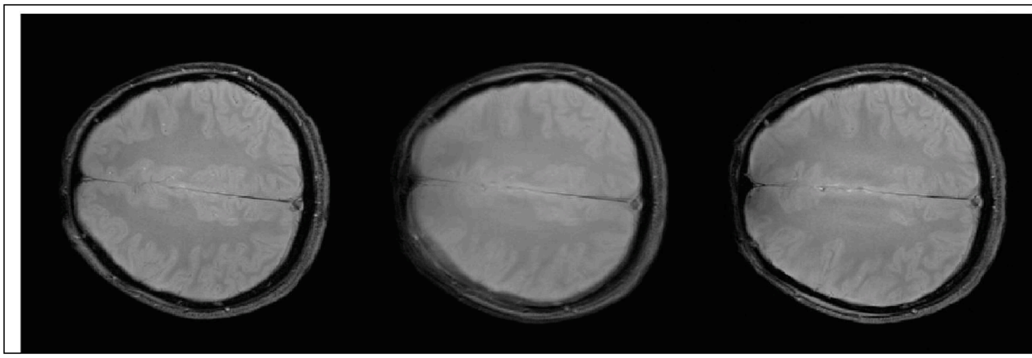

Figure 1- Results from a volunteer study where the volunteer was instructed to not move in the first scan (left), was instructed to move in the second scan (middle) and the second scan corrected for motion using our retrospective correction algorithm. PSNR improved from 28.3dB to 36.5dB [2]

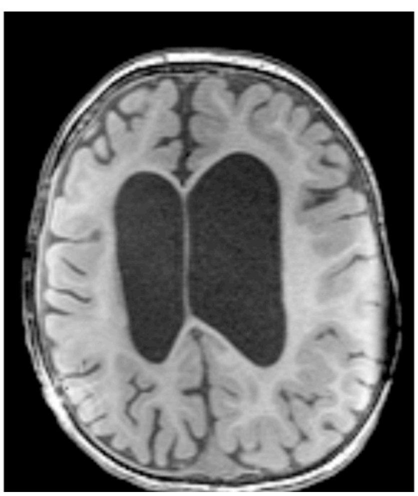

Figure 2- A T1 weighted gradient echo image of a 2 year old tumor patient, acquired using our motion correction protocol.

Results: An example of retrospective motion correction can be seen in Figure 1, where a 3D gradient recalled echo (GRE) sequence (modified with additional gradient activations to enable real-time tracking) was used to acquire low resolution images of a volunteer moving his head. Figure 2 shows an example where a 2 year old patient was successfully scanned with our prospective motion correction protocol.

Discussions and Conclusions: More clinical data will be acquired and presented. The effects of sensor location and skin motion will be investigated.

References: 1. Gholipour A., et. al 'Motion-robust MRI through real-time motion tracking and retrospective super-resolution volume reconstruction", *EMBS 2011*, **2.**Afacan O., et al. "Motion robust high resolution FLASH", ISMRM 2013 **3.** Afacan O., et al. Motion detection for diffusion weighted MRI using EPI phase correction lines", ISMRM 2013