An optical motion feedback system significantly reduces head motion in an MRI study on 6-year-old children

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Introduction: In brain MRI, head motion results in artefacts and, thus, reduces the image quality. Especially for children it is difficult to be sufficiently still during an MRI examination. Unfortunately, the integrating of prospective motion correction is not readily available yet and/or requires substantial modification of MR sequences [1]. To provide an easy motion feedback system for an MRI study, children were watching a movie during the MR scans that stopped if a certain motion threshold was exceeded [2]. Motion was controlled by an embedded optical tracking camera developed in-house.

Figure 1: Photograph of the tracking camera setup above the head coil.

Methods: The tracking camera comprises an image sensor module as well as a microprocessor for image processing. One flat retroreflective marker was stuck on the video goggles that the children wear during the scan. The camera was fixed to a flexible tube to the patient table and positioned above the head coil such that it could track the marker [Figure 1]. The shielded data cable left the scanner through the back and was connected to the filter plate. The microprocessor calculated the position of the marker [Figure 2]. The distance to the camera was calculated from the diameter of the marker and the precision was about 10 times lower than in the other two directions. Only when a predefined motion with respect to a reference position (± 0.75 mm in x and y / ±1.25 mm in z) was exceeded, a data package with the new position of the marker in mm was send over the serial port to the PC that controlled the presentation of the motion picture. Whenever a data package was received, the movie was stopped for a few seconds. The new reference position was set to the current marker position.

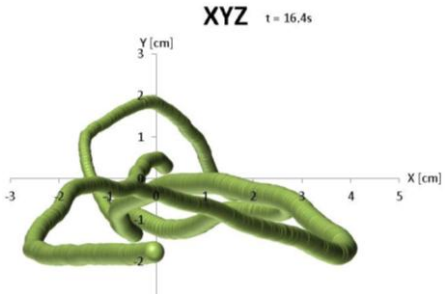

Figure 2: Example of a motion course tracked with the setup.

MR experiments were conducted on a 3T MR scanner on 20 children (6 years) using this feedback approach. Anatomical MP2RAGE and diffusion EPI data were acquired. A control group with age-matched children with the same MR protocol without motion feedback is available for comparison. To quantify the motion during the diffusion scans, EPI images were retrospectively realigned using SPM. Anova tests were performed to analyze differences between motion parameters with and without visual feedback.

Results: The tracking camera provided an easy feedback system. The set up was well tolerated by the children and the scientists conducting the measurements. Generally, children were eager to go on watching the movie and, therefore, tried to lie still. The statistical tests reveal a significant reduction of head motion in the children with visual feedback compared to children without motion feedback ($p<0.05$).

Conclusion: The optical motion feedback system was easy to integrate in our MRI setup and does not require changes to the MR sequences themselves. The children were given a negative feedback whenever they moved considerably by pausing the presentation of a movie. This approach significantly reduced head motion in 6-year old children. For further analysis, we are planning to compare the MR image quality between children with and without motion feedback.

Acknowledgements: Thomas Siegert and Jessica Schulz are funded by the BMWi.

References: [1] Julian Maclaren et al., Prospective motion correction in brain imaging: A review, MRM 69(3), 621–636 [2] Jens Brauer, User Report: Practical aspects of pediatric brain imaging, nnl & nil newsletter - 1/2007