INTRODUCTION – Due to its prolonged acquisition time, motion correction is essential for diffusion tensor imaging (DTI). Retrospective correction using low resolution 2D navigator images has been suggested [1], but this technique cannot correct for through plane motion. On the other hand, aside from non-linear phase errors, patient motion has two effects in the case of DTI acquisition: Pixel misregistration and change in effective diffusion encoding direction (i.e., the b-matrix). In the case of multi-shot DTI, correction for the change of b-matrix between successive interleaves requires non-linear optimization, which can be time consuming [1] and in case of a limited number of encoding directions, rank-deficient. Real-time prospective optical motion correction systems have been proposed as an alternative to navigator based methods [2,3] and they have the advantage of being able to correct for through plane motion. For DTI even more important, the system follows the position of the subject and thus diffusion tensor encoding directions will remain consistent with the orientation relative to the patients. In this study, we demonstrate the application of our real-time optical motion correction system [4] to perform motion correction for DTI.

MATERIALS and METHODS – The real-time optical motion correction system used in this study consisted of a single camera and a planar marker that contains a checkerboard pattern [4] (Fig 1). The camera was mounted on an 8 channel head coil and the checkerboard marker was attached to the patient’s head. Each frame obtained from the camera was processed on an external laptop and the relative pose of the planar marker with respect to the camera frame of reference was calculated using planar homography [5]. Since the marker was attached to the patient’s head, the relative positional change of the marker was also an indication of the relative positional change of the patient’s head. Then, the updated geometry info that must be applied to the scanner’s gradient and RF waveforms were calculated, which was transferred to the RF and gradient hardware controller via rtHAWK protocol in real time [6]. Due to the delay between successive gradient and RF waveform updates and signal dropouts that are caused by motion during diffusion encoding gradients, some readouts were repeated if the detected motion was larger than a certain threshold. In order to eliminate random phase errors that change from show to shot, SENSE reconstruction was employed [7].

RESULTS – Figure 2 shows the FA maps corresponding to two different slices and Figure 3 shows the motion detected by the real-time system. The FA maps obtained when real-time motion correction was turned off and on. An additional dataset was obtained to be used as a reference where the subject was asked to stay still. In this study, we demonstrated the application of rigid head motion correction using a real-time optical monovision system for DTI. The preliminary results show that the proposed system is effective in removing motion related artifacts. It must be noted that, due to the motion sensitivity of diffusion encoding gradients, subject motion can also cause significant signal dropouts in some interleaves, which is usually irreversible (Fig 4). One advantage of our system is that if the detected motion is larger than a certain threshold (1° rotation or 1mm translation), the interleaves that are affected by such signal dropouts are reacquired.