MR Imaging with a Continuously Rolling Table Platform and High-Precision Position Feedback

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Introduction

Emerging imaging techniques like 3D MR angiographic peripheral runoff studies up to whole-body (WB) MRA [1], WB MRI screening [2] as well as interventional MRA studies [3] require imaging beyond the constraints of a conventional field-of-view (FOV). The *AngioSURF* rolling table platform permits such WB MRI with surface coil image quality based on a multistation imaging approach. However, in multistation approaches, table translation between the discrete stations, and FOV overlap reduces the overall time efficiency of data acquisition and additionally, the data is only available as discrete 3D data sets. Recently, a robust reconstruction method was presented for continuously acquiring data during table movement that potentially overcomes the previously mentioned drawbacks [4]. This method requires feedback of the actual table position during data acquisition. In the present study, a MR-scanner triggered laser sensor was employed to detect the actual table position. This positional data was used to compensate for non-linear manual table translation in order to enable continuous 2D and 3D whole-body data acquisition during table movement.

Materials and Methods

Scanning was performed on a 1.5 T *Siemens Sonata* system (Siemens Medical Solutions, Erlangen, Germany) that was equipped with the *AngioSURF* rolling table platform (MR-Innovation GmbH, Essen, Germany). This platform uses one pair of multi-channel phased-array surface coils anterior and posterior to the patient, which remain stationary at the isocenter of the scanner while the patient can be manually moved in longitudinal direction between the two coils. Since the rolling table is shifted manually, the table translation generally is non-linear. Therefore, the position of the platform was detected by a *DME 5000* laser distance sensor (Sick AG, Waldkirch, Germany), which was mounted to the wall in the RF-cabin at the rear-end of the MR-scanner. The resolution *dx* of the sensor is 0.05 mm.

$$dx = v_{\text{ref}} \cdot TR = \frac{\text{FOV}_{\text{read}}}{N_{\text{phase}} N_{\text{slice}}}$$

Imaging was performed with a 2D gradient echo sequence (Slice thickness = 10 mm, TR = 14 msec, TE = 3.37 msec, N_{phase} = 256, N_{read} = 128, N_{tot} = 1280, FOV_{read} = 20 cm, FOV_{tot} = 180 cm), which in that case requires a resolution *dx* of at least 0.78 mm. The detection of the table position was triggered by the MR-system with a period of *TR*. The image reconstruction was performed off-line as described in [4]. This method accounts for identical directions of the read-gradient and table translation. After Fourier transformation in read-direction, the k-lines are sorted into a hybrid FOV by their actual table position. If the table velocity was less than the reference velocity $v_{\text{ref},}$ then the redundant data was averaged. For greater table speed zero filling was applied.

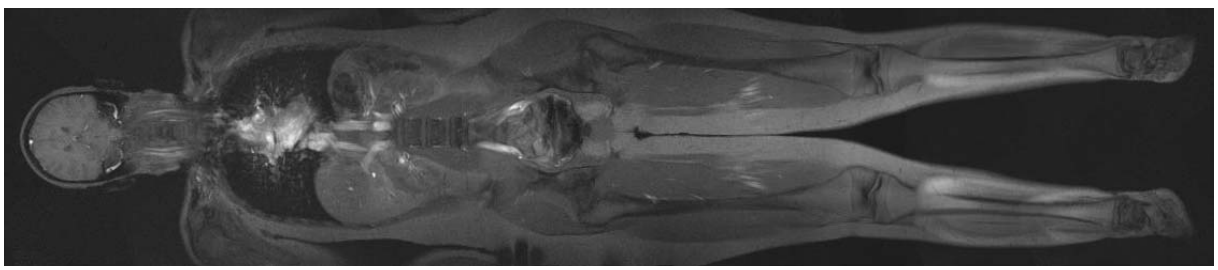

Fig. 1: Whole-Body gradient echo image (Slice thickness = 10 mm, TR = 14 msec, TE = 3.37 msec, N_{phase} = 256, N_{read} = 128, N_{tot} = 1280, FOV_{read} = 20 cm, FOV_{tot} = 180 cm) continuously acquired while manually shifting the rolling patient table. Sequence triggered position feedback enabled to compensate for any non-linearity of the table translation.

Results and Discussion

With sequence triggered laser sensor feedback of the actual table position it was feasible to correct any non-linearity of the table translation. This resulted in accurate anatomical images, Fig. 1. Nevertheless, in the case that the table speed exceeds the data acquisition speed, zero filling in the central region of the hybrid k-space generated streaking artifacts perpendicular to the table translation. This can be avoided by adapting the maximum table speed according to the data acquisition speed, or alternatively, missing data can be interpolated [4].

Conclusion

It has been shown, that the laser sensor precisely compensates for non-uniform table velocity. The combination of a rolling table platform and the laser position sensor enables continuous 2D and 3D whole-body imaging with surface coil image quality. Compared to traditional multistation acquisition techniques, the set-up enhances the data acquisition flexibility in a variety of whole-body 2D and 3D imaging applications. Moreover, this also might become a fundamental requirement for MR-guided interventions in short bore systems with limited FOVs.

References

[1] Goyen M, et al., Radiology 2002; 224:270.
[2] Lauenstein TC, et al., Eur Radiol 2002; 12:2091.
[3] Quick HH, et al., Radiology 2003; 229:598.
[4] Kruger DG, et al., MRM 2002; 47:224.