

# Towards Automatic Patient Positioning and Scan Planning Using Continuously Moving Table Imaging

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## Introduction

With the increasing number of MRI scan parameters and protocols and the large variability of patients' anatomies and pathologies, the operation of a clinical MRI system has become very complex. Improvements in the ease of use and the workflow of these systems are increasingly important. The idea of this feasibility study is to reduce the operator interaction needed to set up an examination to just selecting the anatomy to be studied by "pushing a single button". While moving the patient into the MRI magnet, low-resolution isotropic 3D continuously moving table (CMT) imaging is performed [1,2]. In parallel, real-time image reconstruction and immediate organ identification is performed using fast image processing. Once the position and extent of the target organ is found, CMT scanning is terminated and the chosen anatomy is automatically positioned in the iso-center. The desired examinations can be started using the automatically derived geometry information without further operator's interaction.

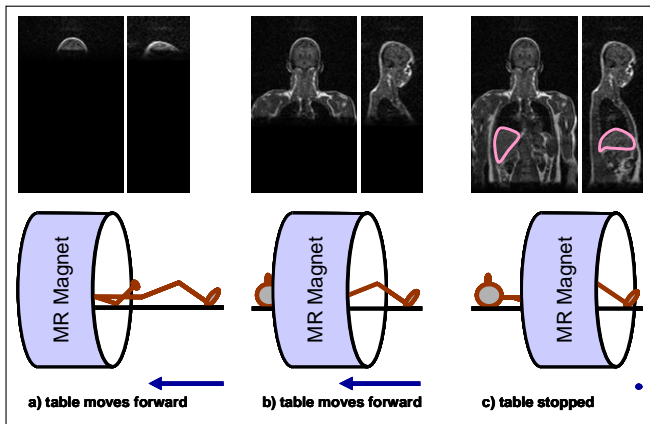
## Methods

The concept of fully automatic scan planning and patient positioning with CMT imaging was exemplified for liver examinations. Since the exact position and size cannot be predicted from the outside, planning examinations of inner organs like the liver can be difficult and time consuming, making patient repositioning necessary. In vivo experiments were performed in healthy volunteers, using a 1.5T clinical scanner (Achieva, Philips Medical Systems) equipped with a modified patient table, allowing data acquisition during continuous table movement at arbitrary speed. The body coil was used for RF transmission and signal reception. 3D CMT scanning with isotropic spatial resolution was applied using a spoiled gradient-echo pulse sequence with lateral frequency encoding [3] (TR=2.7 ms, TE=1.3 ms, flip angle=15°).

The new scouting approach proceeds as follows (Figure 1). After the volunteer is placed on the table, data acquisition is started, and the table is moved into the magnet with a constant velocity of 36 mm/s, resulting in a voxel size of 5.4<sup>3</sup> mm<sup>3</sup>. After every complete *k*-space cycle, the CMT real-time reconstruction produces 20 new slices, covering 108 mm of the anatomy in the motion direction, which are passed to the image processing liver identification. Image reconstruction and liver identification need overall computation time of approx. 2.5 seconds, which could be executed, until the acquisition of the next 3D *k*-space is completed. A coronal and a sagittal reformatted image slice are presented to the operator, updated after every complete 3D *k*-space cycle. Once the liver has been identified, the CMT scan is stopped immediately and the calculated size and position of the liver as well as the automatically identified patient orientation on the table are passed to the scan planning software of the MRI system immediately. The next scan can be started automatically with the proper geometry settings.

## Results

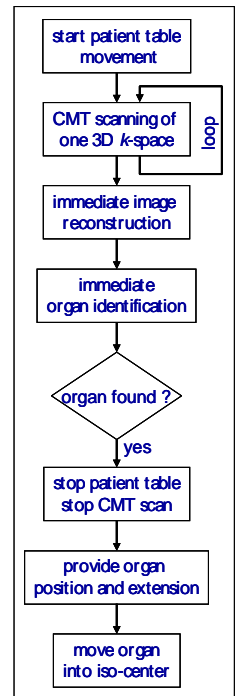
The new planning concept was successfully evaluated for seven volunteers. During all scout scans, the position and size of the liver were evaluated correctly. Figure 2 shows a coronal and a sagittal reformatted slice from 3D isotropic data as shown in the user interface for three different points in time during the procedure. The CMT imaging delivers good image quality, despite the high velocity. The pink shape superimposed in Figure 2c shows the proposed, automatically determined geometry. The whole procedure from starting the patient table until the liver was detected and placed in the iso-center, took 20 to 30 seconds.



**Figure 2:** Three points in time during the scouting procedure and corresponding image data shown to the operator. While the table moves into the magnet, 3D isotropic data is acquired and reconstructed (a,b). Once the target organ is identified, the scan and the table movement are stopped (c).

## References

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**Figure 1:** Automatic patient positioning flow chart.

## Discussion and Conclusion

The feasibility of automatic scan planning and patient positioning with CMT imaging has been demonstrated exemplarily for the liver. An optimal patient position at the central sensitive volume of the MRI system can be found without additional tools like the light visor used nowadays. The basic concept can be extended to further simplify scan planning and advance the examination workflow. First, it can be applied to other anatomies. This may be especially of interest for organs larger than the homogenous region of the MRI system, such as the spine or the lower extremity. Second, the acquired isotropic 3D data can also be used to identify potential anatomical abnormalities of the patient using a corresponding anatomical atlas. Only if nothing uncommon is detected, the subsequent examinations are started automatically without any interaction of the operator. Furthermore, fold-over directions, navigator positions, shim volumes or regional signal suppression volumes can be adjusted without user interaction according to a pre-defined protocol. When using massive parallel imaging, an automatic selection of an optimal coil subset can be implemented. In combination with an appropriate image based registration, the 3D data could allow to position a lesion identified by other modalities (CT, PET, etc) automatically in the iso-center of the MRI system. Low resolution CMT imaging while moving the patient into the MRI magnet could significantly improve the ease of use and efficiency of an MRI system.