PROCEEDINGS

of the

Society of Magnetic Resonance

Volume 2

Second Meeting
August 6 - 12, 1994
San Francisco, California USA

ISSN 1065-9889

Planar-Motion Correction Using K-Space Data Acquired by Fourier MR Imaging

M.L. Wood[1,2], M.J. Shivji[2], and P.L. Stanchev[2]
[1]Depts. of Radiology and Medical Biophysics, University of Toronto and St. Michael's Hospital, Toronto, Canada
[2]Imaging Research Program, Sunnybrook Health Science Centre, Toronto, Canada

INTRODUCTION

The most common Fourier-imaging techniques collect the entire range of k_x from one echo, but take several minutes for the entire range of k_y, during which time motion can occur. We hypothesize that body movements can be identified and measured through analysis of k-space and the measurements can be used to correct k-space. This hypothesis has led to a motion-correction method, which is demonstrated below.

METHODS

The following method is proposed to correct for planar rigid-body motion (see Fig. 1). First, k-space is made as Hermitian as possible through a phase correction based on the largest symmetric range of low k_y acquired without displacement. (Otherwise, correcting multiple k-space segments differently causes artifacts). Data from the closely-Hermitian k-space acquired during the same position are copied to a blank array the same size as k-space. This array is given Hermitian symmetry by synthesizing the opposite half of k-space and adding it to the array. The array is inverse-Fourier transformed into the spatial domain, rotated by the desired amount using nearest-neighbor or cubic-spline interpolation, and then Fourier transformed back to k-space. (Rotations applied directly to k-space cause artifacts). A linear phase shift is applied to correct for translation. The corrected data are copied to an array that becomes the corrected k-space.

The procedure above is repeated for data acquired during different displacements. Data not to be corrected are copied to the corrected k-space last to overwrite data that were rotated onto k_x and k_y coordinates unaffected by motion. Finally, data corrupted by rotation are replaced by the complex conjugate of data corresponding to opposite-sign k_x and k_y, provided that the latter data were not also corrupted by rotation.

The planar motion-correction method is demonstrated below for a single-slice sagittal MR image through the head of a patient nodding "yes". For reference, k-space data were acquired under the same conditions while the patient remained stationary. The data were obtained from a commercial 1.5 tesla MRI system. A pillow helped prevent displacements out of the sagittal plane. The k-space was filled linearly along the k_y direction.

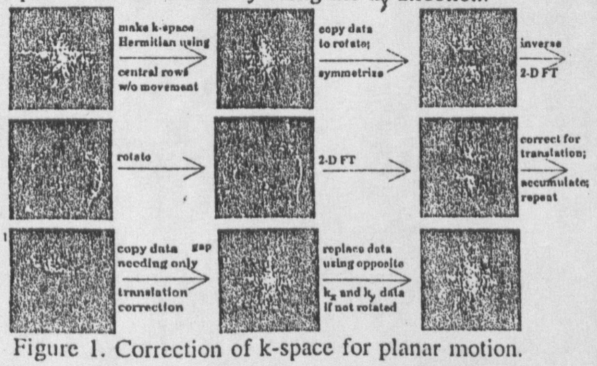

Figure 1. Correction of k-space for planar motion.

RESULTS

Analysis of k-space acquired during motion found distinct segments along k_y (Fig. 2). Images reconstructed from each segment showed the head in different states of flexion. The image from k-space before correction had conspicuous ghosts and blurring (Fig. 3a). The correction reduced the ghosts and blurring (Fig. 3c). Data replacement filled the gap in the corrected k-space (Fig. 3d) and reduced ghosts and blurring further (Fig. 3e).

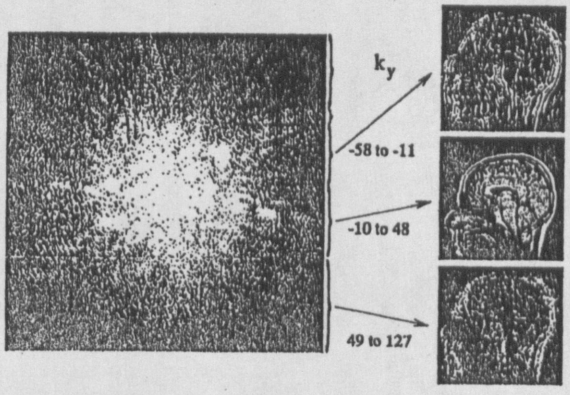

Figure 2. K-space acquired while patient nodded "yes". Images from three of five identifiable k-space segments show head movement in the sagittal plane.

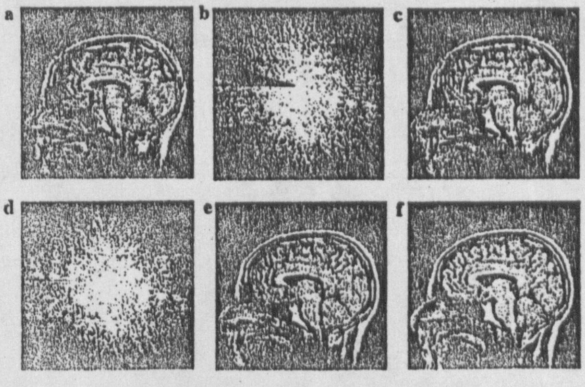

Figure 3. (a) Image degraded by motion; (b) and (c) k-space and image after correction; (d) and (e) correction followed by possible replacement of corrupted data with data corresponding to k_x and k_y of the opposite sign; (f) reference image acquired while head remained stationary.

CONCLUSIONS

Planar rotation and translation can be detected and measured through analysis of k-space. The method for estimating displacement and then correcting k-space for it achieved excellent motion-artifact reduction for a patient nodding "yes", although the performance would have been less satisfactory if the motion was not confined to a plane or if the patient moved more frequently.

This work was supported in part by the Medical Research Council of Canada (MT-11574).

(56.) Wood M., Shivji M., Stanchev P., "Planar-Motion Correction Using K-Space Data Acquired by Fourier MR Imaging", ***Proceedings of the Society of Magnetic Resonance,*** Second Meeting, August 1994, 841.