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Correction for Planar Rotational Movements of Patients during MRI

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INTRODUCTION

Most MR images arise from the Fourier method, in which the k-space representation of an image is acquired as MR data. It usually takes several minutes to acquire the range of k_y values for a two-dimensional (2-D) image and even longer for a three-dimensional (3-D) image. Motion during data acquisition can cause blurring and ghost-like artifacts. One of the many examples of motion that degrades MR images is nodding of the head in the transverse plane. This pattern of movement consists of rigid-body translation and rotation. Corrections for translation have been examined thoroughly, but rotational motion remains more challenging (1,2). Our hypothesis is that rotational movements of the head in the transverse plane can be detected from the k-space data and then a correction can be applied to reduce the degradation. We have developed a method to correct for rotational movements in evaluating the above hypothesis.

METHODS

The method is founded on the observation that the head in transverse section is approximately elliptical and that rotation alters the width of the head's projection onto the frequency-encoding direction (see Fig. 1). Projections are obtained by Fourier transforming each echo of k-space data. For each value of k_y, the angle of rotation, α, is determined from the width, x, of each projection and the major and minor axes of the ellipse, a and b, respectively. For rotation about the center of an image, Fig. 2 shows the relationship between α, x, a and b.

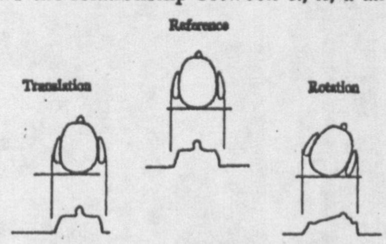

Figure 1. Changes in width of projections along frequency-encoding direction as a result of head rotation.

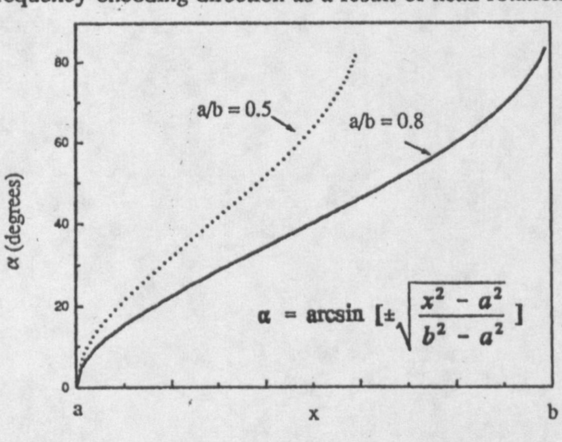

Figure 2. Angle of rotation determined from width of projection for ellipses with ratio of major axis to minor axis equal to 0.5 or 0.8.

The MR data can be corrected through rotations in k-space or in the image domain (2). The data are first corrected for any translational motion. Then, we identify segments of k-space data to be rotated the same amount, transform the data into the image domain, rotate the image, and then inverse transform back to k-space. This procedure is repeated on all of the data. Rotations in the image domain seem preferable, because adjacent samples are more similar than in k-space. The method has been tested on data from phantoms and human patients.

RESULTS

It was possible to measure the width of the projections for every value of k_y. Surprisingly, projections for the most extreme k_y (128) became visible with a narrow display window. A control experiment with head images from a patient in different positions found excellent agreement between the angle of rotation determined from the width of the projections and the position measured from the images. Note the change in width of certain projections in Fig. 3b. The shifted center of certain projections signified that translation had also occured. The rotation measured from these projections agreed with the known position to within 5 degrees. Following a correction for the rotation, the image had weaker ghosts and less blurring (Fig. 3c).

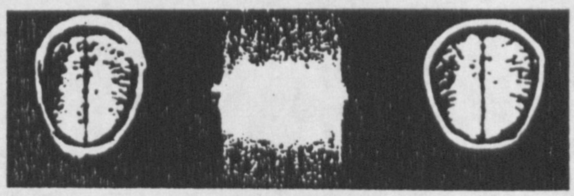

Figure 3. (a) Image of head degraded by rotation. (b) K-space data inverse-Fourier transformed along frequency-encoding direction for measuring width of projections. (c) Same image as (a) after estimating rotation from (b) and correcting data.

CONCLUSIONS

A method to reduce the ghosts and blurring caused by rotational movements of restless patients has been proposed and tested experimentally for the case of nodding of the head. The method applies to movements within the imaging plane. The timing and amount of rotation can be measured from the k-space data without needing navigator echoes or external markers. The method is being refined to improve its accuracy and extend its scope to other rigid-body movements.

REFERENCES

1. Felmlee, J.P., Ehman, R.L., Riederer, et al., *Radiology*, 179(1), 139, 1991.
2. Korin, H.W., Felmlee, J.P., Ehman ,R.L., et al., *Book of Abstracts for SMRM 9th Annual Meeting*, 560, 1990.

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(58.) Stanchev P., Shivji M., Wood M., "Correction for Planar Rotational Movements of Patients during MRI", ***Twelfth Annual Scientific Meeting, Society of Magnetic Resonance in Medicine*****,** New York, NY, August 14-20, 1993, 713.