Projection-based Correction of Intensity Nonuniformity of Phased-Array Coil Image for Parallel Imaging

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Introduction

The nonuniform sensitivity profile of each component surface coil of phased-array results in images with very high signal near the phased-array and decreased signal far from the array. The intensity nonuniformity can be corrected by dividing the image by an estimate of the surface coil's sensitivity profile. In this study, a projection-based algorithm is presented to estimate the coil sensitivity profile. The nonuniformity-corrected image is also useful when it is used as reference image for calculating sensitivity maps in parallel imaging [2]. No additional scan or prior knowledge of the coil's parameter is required for this algorithm. The estimation of the coil sensitivity profile based on the projection was found to be robust method for finding the slowly varying spatial sensitivity pattern even if the original data is noisy or has many complex anatomical structures. The proposed algorithm was applied to several phased-array coil images to verify its validity.

Methods

We can describe the projection profile of the original MR image as a smoothly varying envelope added by small random noise which is shown in Fig.1c. The proposed method uses the non-linear curve fitting algorithm to reduce the random noise from the original projection profile. Then, we can obtain only the smoothly varying envelope. This is the projection profile of the sensitivity map of the component surface coil. Then, if the filtered back projection (FBP) algorithm [3] is applied to the noise-reduced projection data (Fig.1d), we can obtain the image which has only sensitivity profile (Fig.1b). The whole process of the proposed method is shown as following procedure with graphical description (Fig.1).

1. Projection data of a surface coil image (Fig.1a) was calculated at view angles from 0° to 179° with increment of 1° (Radon transform [3]).
2. We segment the projection profile into two parts based on peak point for effective fitting. And Gaussian and 4th polynomial were used as fitting functions (Fig.1d). If the peak position was deviated from the center, 4th polynomial and Gaussian were used, otherwise only Gaussian was used for fitting.
3. The sensitivity profile of the surface coil image was obtained by applying the FBP algorithm to the curve fitted projection data (Fig.1b).
4. Dividing the surface coil image (Fig.1a) by the obtained sensitivity profile (Fig.1b) produced the uniformity- corrected image.
5. The above steps (1~4) were repeated for the other surface coil images of the phased-array. Therefore, we could obtain the same number of intensity corrected images as the number of phased-array channels. These were averaged to obtain single intensity corrected image.

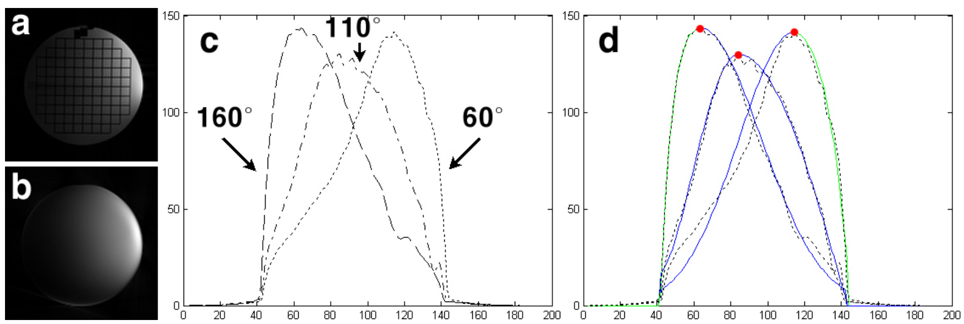

Fig. 1 **(a)** Original image, **(b)** Sensitivity profile, **(c)** Projection profiles at 3 view angles **(d)** Curve fitted profile, red point: peak point, green line: Fitted profile using 4th-polymomial, blue line: Fitted profile using Gaussian

Results

The proposed algorithm was applied to the data sets such as phantom with 8 channel coils (Fig.2a) and human brain with 4 channel coils (Fig.2c). The comparison result between original phased-array images and the intensity corrected images are shown in Fig 2. The performance of the uniformity correction was measured by a vertical profile (Fig.2e, 2f) and intensity variance of the homogeneous phantom (Fig.2a-β, b-β). Selected vertical line is displayed as blue and red line in Fig.2. The intensity variance of the homogeneous phantom was calculated only in the object region. The variance reduction percentage of the corrected image (Fig.2b-β) compared to the original image (Fig.2a-β) was about 92%.

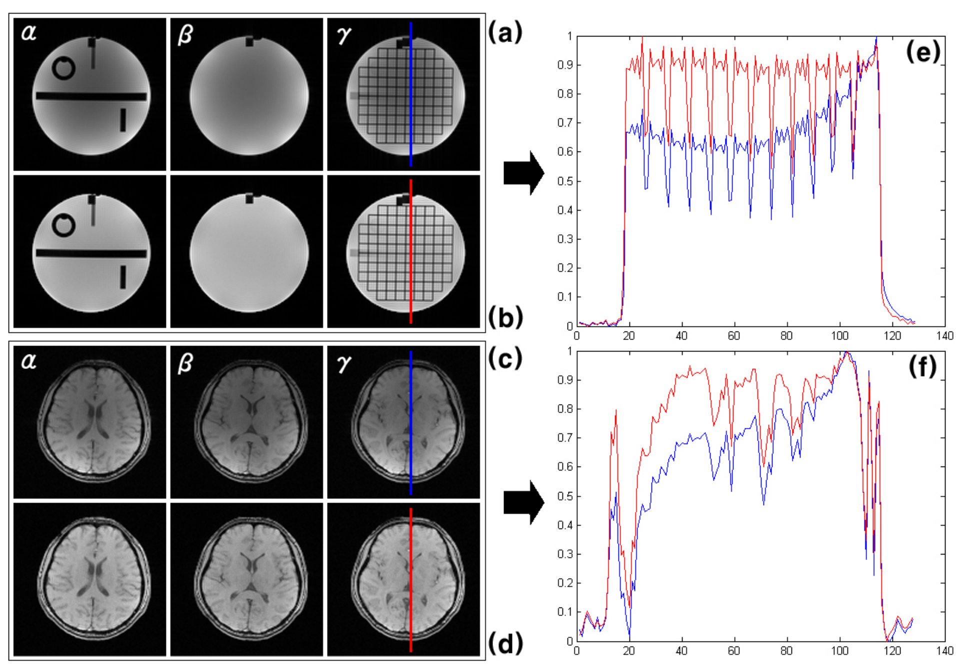

Fig. 2 **(a)** Original phased-array images (phantom with 8channel coils), **(b)** Intensity corrected result of (a), **(c)** Original phased-array image (human brain with 4channel coils) **(d)** Intensity corrected result of (c), **(e)** Vertical profiles of (a)-γ and (b)-γ, blue: non-uniform profile, red: intensity corrected profile, **(f)** Vertical profiles of (c)-γ and (d)-γ

Conclusion

The projection-based estimation of the sensitivity profile had the advantage of robustness to complex anatomical structures and noise in image.

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