GREIT is sensitive to training targets near boundary

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Abstract: It has been observed that the distribution of the training targets used to calculate the GREIT reconstruction matrix has a strong impact on its chief figure of merit, the amplitude response (AR). We found that uniform AR requires a minimum target distance to the domain boundary, and target density gradient toward the centre has less impact on uniform AR.

1 Introduction

In the GREIT framework [1], the reconstruction matrix for linear difference EIT is calculated based on a training set of simulated measurements of small single-target conductivity perturbations and the corresponding desired images, constructed based on specified consensus figures of merit. Chief among the requirements is that equal conductivity changes have equal effects on the image regardless of their position, i.e. uniform amplitude response (AR).

Originally, GREIT was proposed for cylindrical domains and used a centre-heavy spiral distribution of training targets in the plane of electrodes. After extruded shapes of arbitrary contour were introduced to GREIT [2], the default distribution of training targets was changed to a uniform grid pattern, since the original spiral was not generalizable and random distributions were deemed not suitable. It was later observed that this distribution produces a less uniform amplitude response (AR) than the original formulation.

Since the fluctuation of AR becomes stronger close to the domain boundary, we investigated 2 properties in the present study: i) target density gradient toward the centre, and ii) minimum target distance to the boundary.

2 Methods

The plane of electrodes is divided into concentric ring-shaped layers by binary image erosion. Within each layer, training targets are distributed in a uniform gird. The target density in each layer is defined by the ratio between two consecutive layers (denoted as R2L). We analyse three distributions for 5 layers with i) equal density in each layer (R2L=1), ii) moderate density gradient towards the centre (R2L=1.2), and iii) strong density gradient (R2L=3). At the same time, we varied the target distance to the boundary (D2B) from 0 to 2 times of target radius in steps of 0.5. For each distribution, we calculate a GREIT matrix for EIDORS's adult thorax model such that noise figure in the centre equals 0.5. Results are compared by calculating the figures of merit defined in [1] for a set of uniformly distributed targets in the electrode plane.

3 Discussion

Figure 1 shows part of the results due to limited space. AR was more homogeneous when R2L=3 (Fig. 1, middle) compared to R2L=1 (Fig. 1, left) due to the fact that the density of targets near the boundary was strongly reduced. AR became even more uniform by simply adding target distance to the boundary (Fig. 1, right). We found that uniform AR requires a minimum target distance to the domain boundary, and target density gradient toward the centre has less impact on uniform AR.

References

[1] Adler A, et al. *Physiol Meas.* **30**:S35-55, 2009
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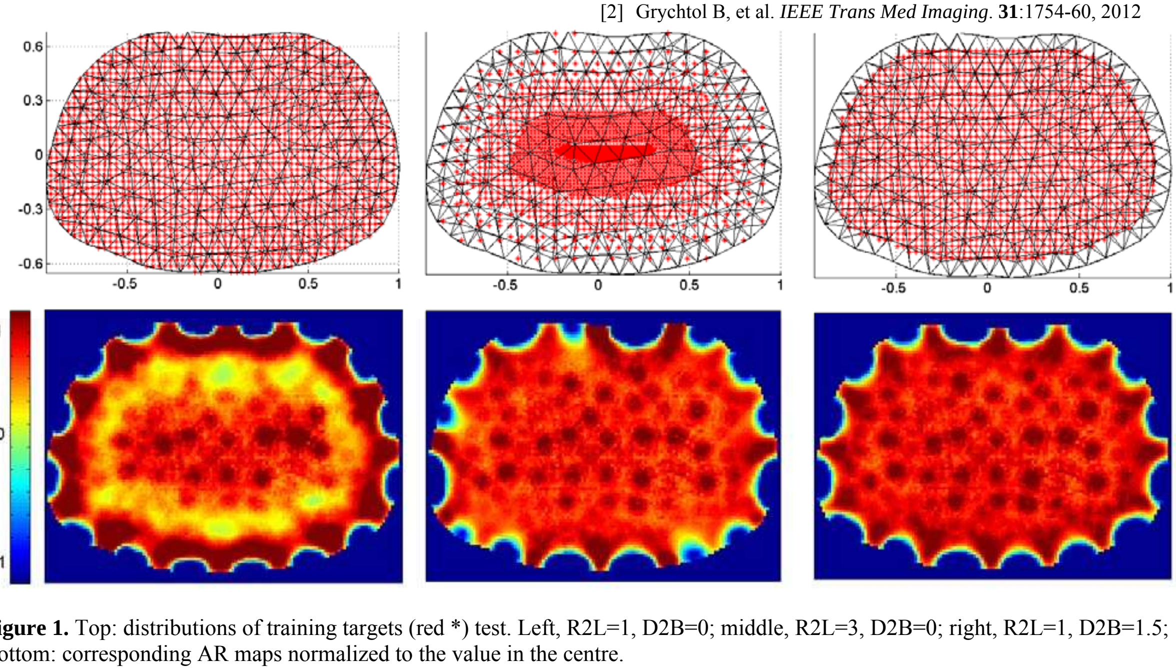

Figure 1. Top: distributions of training targets (red *) test. Left, R2L=1, D2B=0; middle, R2L=3, D2B=0; right, R2L=1, D2B=1.5; Bottom: corresponding AR maps normalized to the value in the centre.