The effect of anisotropic tissues on the reconstructed images of magnetic induction tomography

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1. Introduction

Magnetic induction tomography (MIT) is an imaging modality which aims at mapping the conductivity of the body (Griffiths 2001). Solvers for the related image reconstruction process are so far based on the assumption of isotropic conductivities which is not true for many biological tissues. Theoretical investigations of anisotropy were mainly carried out for electrical impedance tomography (Lee *et al* 1989, Sylvester 1990, Lionheart 1997), but there have not been research studies concerning MIT. The aim of the study is two-fold. First, to investigate the capability of the currently used isotropic solvers when anisotropy is present in the body, i.e. thorax. Second, to reconstruct the image of each tensor component using an anisotropic solver and comparing the resulting images.

2. Methods

The simulations were realized using the coil configuration of the Mk2 Graz 16 channel MIT system (Scharfetter *et al* 2008). The thorax was modelled as a cylindrical phantom of 25 cm height and 20 cm diameter. An anisotropic layer of 1 cm thickness was assumed in the outermost shell of the cylinder in order to reflect the muscle anisotropy. Considering the alignment of the muscle fibers, the main axis of the conductivity tensor was assumed to lie in the transverse plane and to be tangential to the surface. The conductivity ratio of the longitudinal direction to the transverse direction along the muscle fibers were selected as 1.2:1 (Rigaud *et al* 1996). As the target object for the reconstruction, a spherical, isotropic inhomogenetity of 3 cm diameter located at [5, 0, 0] cm was chosen. The induced voltages in the receiving coils were simulated by using the adjoint field formulation using the anisotropic finite element method (Gençer *et al* 1999), (Abascal *et al* 2007). For the image reconstruction, the sensitivity maps were formed using the reciprocity theorem and the conductivity tensor distribution was reconstructed using truncated singular value decomposition of different sensitivity maps.

3. Results

Various conductivity distribution estimations of the central slice obtained by applying different initializations and sensitivity maps, i.e. using anisotropic and isotropic

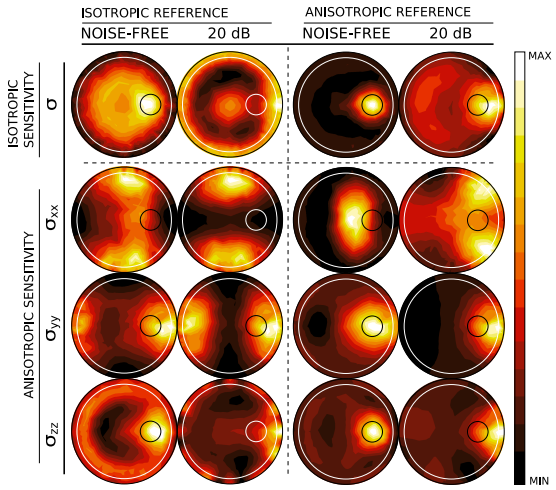

Figure 1. The images in the first and the remaining rows were reconstructed using an isotropic and anisotropic sensitivity maps, respectively. The columns are divided into 2 groups of 2 columns each. Each group corresponds to the images where the reference data were simulated using the same model properties as for calculating the associated sensitivity matrix. The left column of each group presents the noise-free reconstructions and the right column shows the images obtained by adding a Gaussian noise of 20 dB SNR to the difference voltage data.

models, are presented in figure 1. The perturbation is hardly recognizable and spurious artifacts appeared, particularly when the reference data was acquired from a different conductivity distribution than the measurement data. This emphasizes the importance of accurate reference data in order to reconstruct feasible and reliable images. In state differential or frequency differential variants of MIT this is accomplished naturally, however, absolute imaging methods or user initialized inversion algorithms are found to be very poor even in the existence of a very mild anisotropy. Interestingly, the selection of the sensitivity map, whether isotropic or anisotropic, did not directly influence the results and sometimes the isotropic sensitivity showed even better quality in images. This may be due to the strong effect of the longitidunal tensor component which is also the most accurate one.

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