Improved Excitation Fields for Magnetic Induction Tomography

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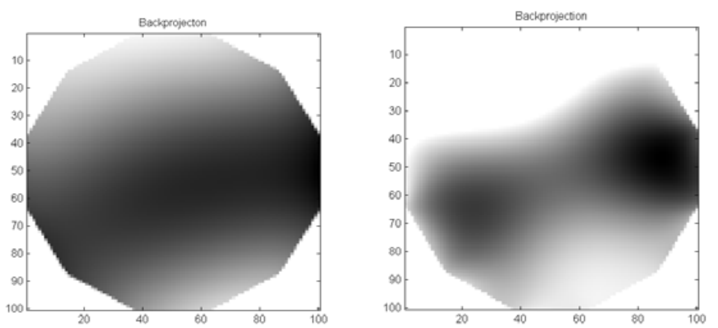
Abstract – Magnetic Induction Tomography (MIT) is – in principle – a non-contacting, potentially mobile, cost effective and harmless technology for examining the internal human body. It is based on low-energy magnetic induction fields, which readily permeate the human body.
An MIT system typically consists of a circular arrangement of multiple transmitter and receiver coils, which are placed around a volume of interest; see e.g. the review off Zakaria et al [1].
As an emergency medic application example, the specific type of a cerebral stroke could be determined via a mobile MIT system, as early as possible [2]. In addition to noninvasive medical inspections, an MIT method could also be applied for the detection of prohibited or critical materials inside the body, e.g., for purposes of airport safety control.
Despite of all these potential advantages, it is – even with the latest electronics and computerization – still very difficult to reconstruct something like a tomographic image from the multiple induction signals. Although common computer tomography (CT) seems to be technically similar, there is a fundamental difference: X-rays in the CT pass through the space and test volume in straight lines and these x-rays (potentially harmful to humans) can be absorbed – more or less – by the test specimen. In contrast, the field lines of electromagnetic induction are usually curved and they cannot simply be absorbed. Therefore, an image reconstruction in MIT is a much more delicate task [3] with respect to an ordinary X-ray CT [4].

Herein we propose a new strategy for creating potentially superior induction field topologies. The fields are intentionally shaped in a way that the spatial sensing characteristics obtain a more stretched and “optical” behavior which means with a lower axial gradient and with a higher radial gradient. Then, the received signals contain more valuable information and the inverse problem is gradually alleviated.
As a first step we chose a coaxial aligned excitation setup of two circular coils [5]. In basic simulations we could confirm an improvement towards a classical setup with a single excitation coil. An advantage is obtained for two fundamental different reconstruction methods: a straight back-projection procedure and a forward method that is weighted by correlation. Especially the separation of objects is superior on equal terms. An example of a simple back-projection for two separate objects is given in Fig. 1.



a) b)
Fig.1: Simple back-projection of a setup with 2 objects located at y=70, x = 25 and y=50, x=90 on equal terms. Simple one coil excitation is shown in a), the improved case with two coaxial excitation coils is shown in b).

As the shaping of the excitation field can – as shown – improve the reconstruction abilities, we can go a step further and use more than just two excitation coils. Although the experimental realization may be more delicate, this could be a way for further improvements. Another possibility is to reject the coaxial circular alignment of the coils for a new kind of current shape to achieve a better excitation field, delivering better signals for the reconstruction.

References

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