Inverse source problem for Poisson's equation for identification of an epileptic focus from magnetic field measurements

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Abstract

In this talk, I will consider a biomagnetic inverse problem in which an epileptic focus in a brain is identified from the measured magnetic field outside the head. This is formulated as an inverse source problem for Poisson's equation. The conventional source models are categorized into two groups: one is a parametric source model which represents a focal source by an equivalent current dipole whose position and moment are treated as unknown parameters, and the other is a distributed source model which consists of elemental current dipoles fixed on grid points over a cortical surface whose moments only are unknown quantities. The parametric source model identifies the center of a focal source, but it cannot estimate its spatial extent and is affected by the background activities spread over the cortical surface. The distributed source model sometimes gives a result where a focal source is scattered even when using sparse regularization.

Based on this background, we propose a heterogeneous source model that combines the parametric and distributed source model to separately obtain a focal source and the background activities. For the parametric model, using a mapping from a cortex to a sphere, a patch source model that represents a focal region in terms of four parameters is introduced. The background activities are expressed by the elemental dipoles spread over the cortical surface. Both the optimal patch parameters and the distributed dipole moments are obtained using the maximum likelihood method.

The method was applied to the magnetoencephalography data of an epileptic patient. The region of an epileptic focus was identified, which coincided with the result obtained by using electrocorticography, while the background activities were separately obtained.

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