

Localizing sources in the brain: How should we model the skull?

Victoria Eugenia Montes Restrepo

Electronics and Information Systems, Ghent University

Supervisor(s): Stefaan Vandenberghe

The electroencephalogram (EEG) is the primary tool in the diagnosis of epilepsy, a neurological disease affecting about 1% of the people worldwide. In most cases, epilepsy can be treated with anti-epileptic drugs. When patients do not respond to medication, one of the treatments to be considered is the surgical removal of the epileptogenic focus, i.e., the zone in the brain originating the epileptic events. To detect this focus and to decide whether surgery can be performed, a presurgical evaluation is needed. As part of this evaluation, engineers have developed a mathematical technique called EEG source localization (ESL), which aims at localizing the sources in the brain from the potentials measured on the scalp. In ESL, the scalp potentials for a given source are first computed (forward problem) and then the source parameters that best fit those potentials are estimated (inverse problem). Solving the forward problem requires an accurate model of the human head. The skull is a crucial part of this model due to its high resistivity and complex structure, compared to the other tissues in the head. However, the segmentation of the skull geometry remains unresolved due to the poor visualization of bone in magnetic resonance imaging (MRI). Computed tomography (CT) accurately images the skull but is not commonly performed on patients due to the ionizing radiation. In this work, we analyze the influence of using simplified models for the skull on ESL. For this purpose, MR and CT images of one patient are used. A head model with an accurately segmented skull, including spongy and compact bone as well as some air-filled cavities, is incorporated in the analysis as the reference model. Conductivity and geometrical simplifications are performed on the skull, generating different models. Based on the source estimation errors found for these models, we can determine guidelines for skull modeling in the generation of subject-specific head models in a clinical setup of epilepsy.