ROAST: an open-source, fully-automated, Realistic vOlumetric-Approach-based Simulator for TES

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Background
Research in the area of transcranial electrical stimulation (TES) often relies on computational models of current flow in the brain. To build such a model, the magnetic resonance images (MRI) of the human head have to be segmented, electrodes have to be placed, the volume is then meshed into a finite element model and solved numerically to estimate the current flow. Various software tools are available for each step, and processing pipelines that connect these tools for batch processing. However, existing pipelines are either not fully automated or difficult to use. Recently SimNIBS [1] becomes popular for its ease of use, but it's based on the surface approach to represent the anatomy, which is limited to capture detailed structures such as the skull. Also it requires advanced computer skills to install and operate. Here we propose a new software, ROAST, to provide an easy end-to-end solution.

Methods
We put together the segmentation algorithm in SPM8 [2], our in-house Matlab script for segmentation touch-up and automatic electrode placement [3], the open-source finite element mesh generator iso2mesh [4] and solver getDP [5]. The complete pipeline is a Realistic vOlumetric Approach to Simulate Transcranial electric stimulation and has therefore been named ROAST. We tested it on the MNI-152 standard head [6] and compared the results with those obtained with a commercial mesher and solver (ScanIP and Abaqus), and with SimNIBS.

Results
ROAST only leads to a small difference of 9% in the estimated electric field in the brain compared to the results obtained with other commercial software (ScanIP, Abaqus). We obtain a larger difference of 47% when comparing with SimNIBS, mainly because SimNIBS builds the model based on the surface segmentation of the MRI, as opposed to the volumetric segmentation generated by SPM.

Conclusions
We release ROAST as a new, fully-automated TES simulator based on free software (except Matlab). It can be downloaded at https://www.parralab.org/roast/

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