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PRESENTATION TYPE: Noninvasive Brain Stimulation Poster

CURRENT TOPIC: Bioengineering

TITLE: OPTIMIZED TDCS FOR TARGETING MULTIPLE BRAIN REGIONS: AN INTEGRATED IMPLEMENTATION

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ABSTRACT BODY:

Introduction: Transcranial direct current stimulation (tDCS) aims to deliver weak electric current into the brain to modulate neural activities [1]. Targeted stimulation can be achieved by using an optimal montage of small electrodes on the scalp, which is determined by optimization algorithms based on the head models [2,3]. They can guide the electric current to a specific brain region [4,5]. However, simultaneous targeting for multiple disconnected regions has never been implemented. Also, non-target areas can still be hit unexpectedly by the current flow. Moreover, there is no publicly available, user-friendly software package for the targeted tDCS.

Materials/Methods: Based on an earlier optimization algorithm [4], we provide an integrated implementation that is capable of achieving maximal focality or intensity of the electric field at multiple regions of interest (ROI) in the brain, with ROI being either a single point or a cortical structure. The same algorithm as [4] was applied to maximize the focality for multiple ROIs. For maximal intensity stimulation at multiple ROIs, the sum of absolute values of the electric fields (i.e., the L-1 norm) was maximized, instead of just maximizing the sum of the fields at these ROIs as in [4]. Users also have the option to select a certain non-target area in the brain where only minimal amount of current flow can reach when maximizing the intensity at the target region. The program was implemented in Matlab and will be made publicly available.

For testing, an MRI scan from ADNI30 dataset was used to build volume conductor model following previous routine [3]. The MRI was also labelled for cortical structures by Neuromorphometrics Inc. (Somerville, MA), which was used for targeting structural ROIs.

Results: Fig. 1 shows a summary of the optimized electric field on two ROIs. Benefits of maximizing L1-norm can be seen from the 2nd to 3rd column. Also shown is the result when constraining the power in a certain non-target area (indicated by the red X in the 4th column) that will hit by significant amount of current without such a constraint (2nd column). Targeting on cortical structures give similar results as to targeting on point-like regions (upper vs. lower panels). Fig. 2 is a summary of three ROIs.

Discussion: Although L-1 norm maximization can help achieve the highest possible current-flow intensity at multiple ROIs, the intensity at each ROI becomes lower when the number of ROIs increases. This is limited by the physics of the head anatomy and the HD electrodes setup. Also note that when the power of the non-target area is constrained, the intensity at the target is also reduced a bit, which is dictated by the focality-intensity trade-off [6].

Conclusions: We attempted to provide an integrated solution for optimized tDCS to target multiple brain regions (points or structures). The publicly available Matlab package will facilitate the modeling studies and optimization of tDCS for clinical applications.

Objectives (Please provide three objectives): Implementation of targeting algorithm for multi-focal tDCS.

Constraint of electric field intensity in user-selected brain regions.

Release of an integrated, user-friendly free software package for optimized tDCS.

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KEYWORDS: transcranial electrical stimulation, computational modeling, optimization.
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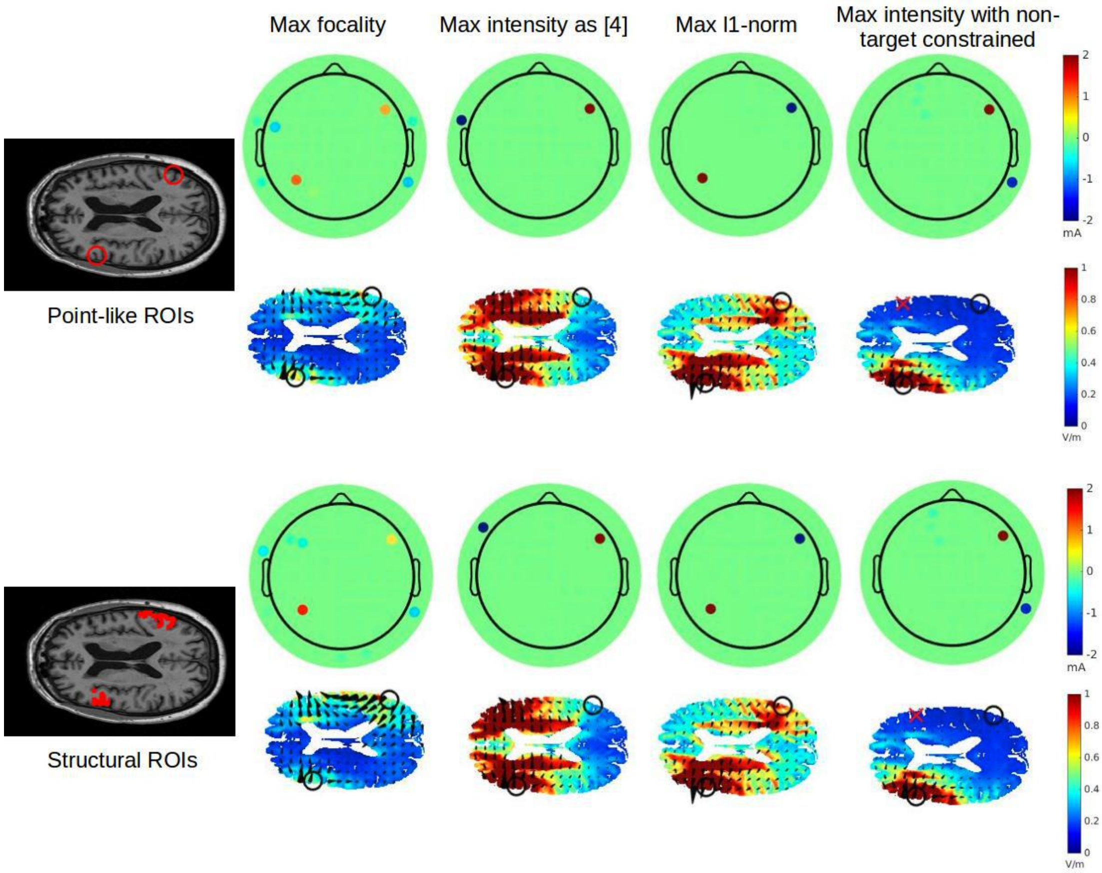
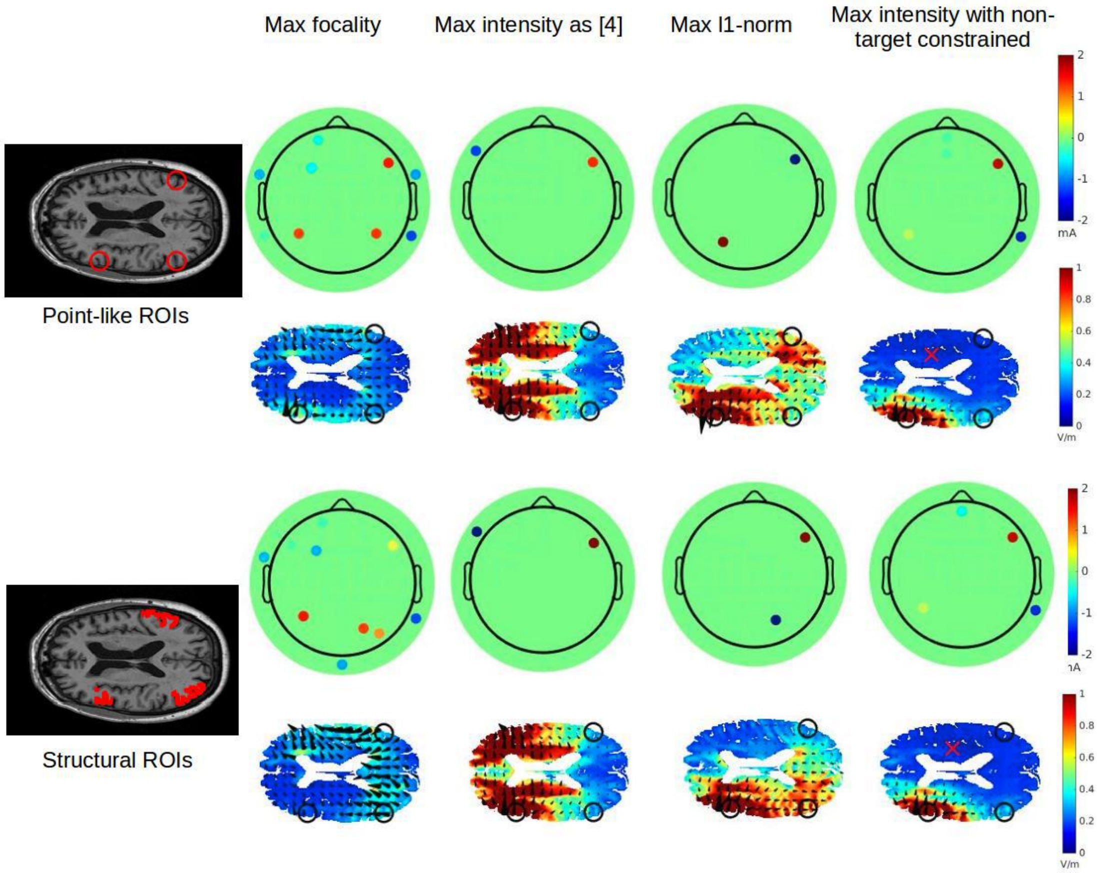
(no table selected)



Multi-focal targeting results on 2 ROIs, indicated by the red circles for point ROIs and red areas for structures in the MRI. The upper and lower panels show the results for point-like and structural ROIs, respectively. Each column corresponds to different algorithms used. Red X indicates non-target areas whose power needs to be constrained.



Similar to Fig. 1, but for 3 ROIs.

SUBMISSION ROLE: Noninvasive Neuromodulation