Optimized transcranial direct current stimulation (tDCS) for simultaneous multi-region targeting

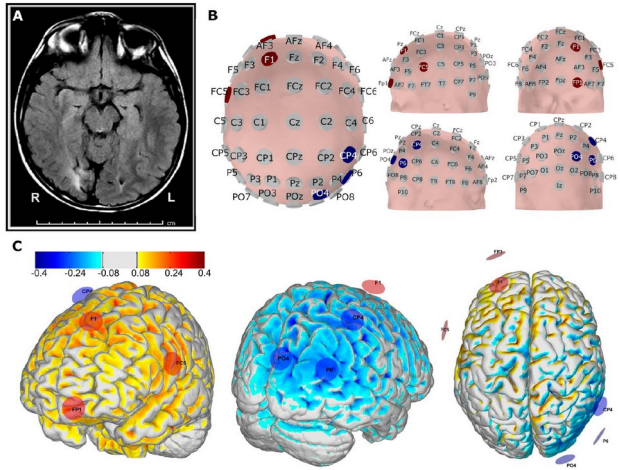
TECHNISCHE UNIVERSITÄT DARMSTADT

Proposal for a Master's or Bachelor's Thesis Topic

Transcranial direct current stimulation (tDCS) delivers weak electric currents to modulate neural activities in the brain. While existing tDCS montages primarily focus on single brain regions, the simultaneous targeting of multiple disconnected regions remains underexplored. In this study, we propose an integrated approach that combines volume conductor modeling and finite element analysis to optimize tDCS electrode placement. Our objective is to simultaneously stimulate multiple regions of interest (ROIs) while ensuring safety and efficacy. By bridging the gap between single-target and multi-target tDCS, we aim to enhance its precision and applicability.

Transcranial direct current stimulation (tDCS) is a non-invasive technique involving the application of low-intensity electrical currents to specific brain areas. Our primary objective is to develop an approach for optimized tDCS electrode placement and intensity that targets multiple brain regions simultaneously. To achieve this, we will:

- Construct a Volume Conductor Model: We will create a detailed head model that accurately represents the conductivity distribution of brain tissues. This model will serve as the basis for optimizing electrode placement.
- Finite Element Modeling (FEM): Using FEM, we will simulate the electric field distribution resulting from tDCS. By iteratively adjusting electrode positions, we aim to find optimal montages that effectively stimulate multiple ROIs.
- Trade-off Analysis: We recognize that there exists a trade-off between targeting accuracy and the number of electrodes needed. Our study will explore this trade-off and provide practical guidelines.



Our research contributes to advancing tDCS protocols, enabling more effective and personalized neuromodulation for various neurological conditions.

Requirements:

- Basic knowledge in modeling and finite element methods
- Proficiency in optimization schemes
- Strong skills in MATLAB or Python

Language: English

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CCPS Control and Cyber-Physical Systems