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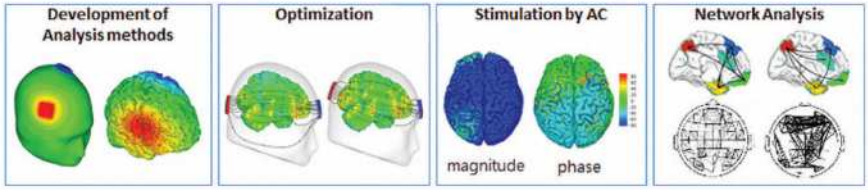
Numerical analysis on neuroelectromagnetics

NeuroEngineering laboratory researches electromagnetic phenomena and modulation of neuronal activities using the techniques of computer simulation based on numerical analysis so that people can understand functions and diseases of the human brain, ultimately. Electricity is an important tool for inter- and intra-regional communication of the brain. Neural activity involves the flow of ions which are charged particles, and the flow of charged particles is defined as electric current. According to electromagnetics, electric current accompanies electric and magnetic fields. Hence, we can guess where the activated regions are and how the regions correlate in the brain by measuring and analyzing electromagnetic fields. On the other hand, external electromagnetic fields influence the activity of the brain, because electric current can change membrane potential, which alters firing rate of the neural cell. To find out the characteristics of the measured biosignal, the position of the activated cortical area, and effective methods to modulate the target area, mathematical approaches are essential. In NeuroEngineering lab, algorithms and methods for solving neuroelectromagnetic problems are developed, and the software is implemented considering accuracy and efficiency of computation. Recently, research is focused on optimized electric stimulation for focal regions and deep regions using alternating current. In near future, optical stimulation using near infrared light will be considered as a new stimulation modality.

Aim	Modulating neuronal excitability by noninvasive stimulation
Tool	Computer-based simulation
TARGET	

Curriculum Vitae

2018~Present : Principal Investigator, KBRI
2014~2018 : Research Professor, Department of Biomedical Engineering, Hanyang University, Korea
2010~2013 : Research Professor, Neurology, Korea University Medical Center, Korea

Academic Credential

2010 : Ph.D., Department of Electrical and Computer Engineering, Seoul Nat'l University (MS/PhD Integrated program)
2003 : B.S., Department of Electrical Engineering, Seoul Nat'l University

Awards/Honors/Memberships

2018~present : Member of Korean Society of EEG and Neurophysiology

Research keywords

Electroencephalography (EEG), Magnetoencephalography (MEG), Transcranial electric stimulation (tES), Numerical analysis.

Key techniques

Signal processing of brain waves, Source localization, Inverse problem, Numerical analysis, Finite element method.

Research Interests/Topics

- Non-invasive neuromodulation by direct and alternating current and near infrared light.
- Brain network analysis and brain-machine interface based on EEG.

Research Publications (selected)

- Magis D, D'Ostilio Kevin, Lisicki M, **Lee C**, Schoenen J. Anodal frontal tDCS for chronic cluster headache treatment: a proof-of-concept trial targeting the anterior cingulate cortex and searching for nociceptive correlates. *J Headache Pain, 2018.*
- **Lee C**, Kim E, Im C-H. Techniques for efficient computation of electric field generated by transcranial direct-current stimulation. *IEEE Trans Magns, 54(5):1, 2018.*
- **Lee C**, Im C-H, Koo YS, et al. Altered network characteristics of spike-wave discharges in juvenile myoclonic epilepsy. *Clin EEG Neurosci, 48(2):111, 2017.*
- **Lee C**, Jung YJ, Lee SJ, Im C-H. COMETS2: An advanced MATLAB toolbox for the numerical analysis of electric field generated by transcranial direct current stimulation. *J Neurosci Methods, 277:56, 2017.*

Patents

- Im C-H, Lee S, **Lee C**, Methods and Apparatus for Estimating Electrical Conductivity of Eye. (10-2017-0044039)