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Professor Sung Chan Jun's research team identifies electrical current distribution to improve brain function with electrical stimulation

□ GIST (Acting President Hor-Gil Hur) – A research team led by Professor Sung Chan Jun of the School of Electrical Engineering and Computer Science has put forward an accurate computer-based simulation guideline that predicts the influence of electric stimulation, which is widely used to improve brain function and to treat brain diseases.

◦ The research team predicted and identified at macroscopic and microscopic levels the effects non-invasive brain stimulation * among the electrical brain stimulation techniques that have been attracting attention to improve brain function, such as memory or learning ability, and to treat brain diseases, such as stroke, Parkinson's, and depression.

* Electrical brain stimulation: a form of electrotherapy and technique used in research and clinical neurobiology to stimulate a neuron or neural network in the brain through the direct or indirect excitation of its cell membrane by using an electric current

□ Electrical brain stimulation is applied in a number of areas related to brain function such as improvement of memory, creativity, computing

ability, improvement of symptoms of depression, epilepsy, and dementia. Despite its high utilization, however, it is not yet known which area of the brain is stimulated and how the neurons in that area are reacting. Therefore, inconsistent effects are reported for each individual and are being implemented without exact guidelines.

□ New imaging systems are most actively used to predict the effects of electrical stimulation. To predict the effects of electrical stimulation, most research teams have used magnetic resonance imaging (MRI) to predict the effects of electrical stimulation and reconstructed the brain's structural features and have implemented a neural computing model with an electrode attached to the scalp.

□ To more precisely predict the effect of electrical stimulation, a multiscale modeling technique has been proposed that combines a neural cell model with a brain computing model to simulate activation by stimulation. However, some research teams report the result only because the structure of the anatomically sophisticated brain model is complicated and the coupling with the neuron model is not simple, requiring complex processing and calculation time.

□ By building a multi-scale model for non-invasive electric stimulation, Professor Sung Chan Jun's research team studied the effect of electric stimulation not only on current distribution corresponding to macroscopic analysis but also on neural activation response, which requires microscopic analysis, and established a system of correlation.

  ◦ For this study, the reseaerches used three types of neuron models (star shape or pyramid shape) to simulate the effect of induced current on neuronal activity. As a result, the Pearson correlation coefficient * between the current distribution and the response of the neuron to the stimulation below the threshold to change the membrane potential without causing the activation of the neuron was highly correlated to 0.8 or more. In addition, they confirmed the importance of multi-scale modeling by showing complex nerve cell

activation patterns in the case of stimulation above the inverse value.

* Pearson correlation coefficient: a measure of the linear correlation between two variables X and Y

□ Professor Sung Chan Jun said, "The study will contribute to understanding and enhancing brain function by identifying the effects of computer-based brain stimulation at the cellular level. This can be applied to improve various brain functions as well as to enhance the therapeutic effect by presenting guidelines for electric stimulation to help treat brain related diseases that affects an aging population."

□ This research was led by Professor Sung Chan Jun (corresponding author) and Hyeon Seo (first author) of the School of Electrical Engineering and Computer Science and was supported by the GIST Research Institute, the National Research Foundation of Korea, and the Institute for Information & Communications Technology Promotion. The research was published in *Brain Simulation* (IF: 6.12, top 9% in JCR) on January 22, 2019.

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