Numerical evaluation of electrostimulation effects

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Electrical or magnetic stimulation of the central nervous system or peripheral system can help in not only the assessment of neural function but also for therapeutic applications. In the central nervous system, non-invasive brain stimulation techniques are used to stimulate or change the neural activity (neuromodulation) of brain regions as a treatment/rehabilitation of neurological diseases/conditions. It has been reported that perception of electrostimulation occurs at frequencies lower than 5 MHz [1] and 10 MHz [2]. The threshold assessment for the pain or sensory effect is limited in the intermediate-frequencies (300 Hz to 10 MHz) range where the stimulation is attributable to axon activation. The reason is that at a higher frequency, the membrane potential of the nerve has a short time to reach a minimum threshold of stimulation that requires higher stimulation intensity, which makes more difficult stimulation, and where thermal effects become dominant. On the other hand, highly focalized exposure at higher frequencies (e.g., Millimeter waves or MMWs) is increasingly used. Therefore, it is important to analyze the effect of electrostimulation on small fiber terminals located in the epidermis and dermis [3].

In this work, we computed the effects of neural stimulation on brain tissues at intermedia-frequency (see figure 1). We investigated the mechanism of transcranial magnetic stimulation based on the computation of the induced electric field on human head models. Also, we investigated the potential effects on stimulation at MMWs wave for peripheral stimulation. A good prediction was achieved for determining the stimulation site and intensity in brain stimulation, but we could only find stimulation effects of MMWs at unpractical stimulation intensities.

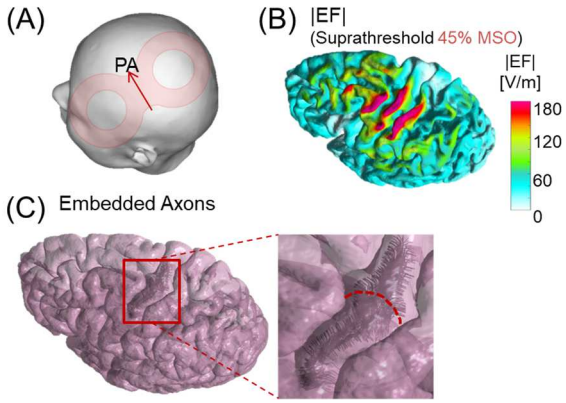

Figure 1. TMS computational method to determine effects of cortical neurons

References

[1] IEEE, *IEEE standard for safety levels with respect to human exposure to electromagnetic fields, 0-3kHz*. Institute of Electrical and Electronics Engineers, 2002.

[2] ICNIRP, "Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz). International Commission on Non-Ionizing Radiation Protection," *Health Phys.*, vol. 74, no. 4, pp. 494–522, 1998.

[3] S. I. Alekseev, A. A. Radzievsky, M. K. Logani, and M. C. Ziskin, "Millimeter wave dosimetry of human skin," *Bioelectromagnetics*, vol. 29, no. 1, pp. 65–70, 2008, doi: 10.1002/bem.20363.