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Visualizing Hotspots and Thresholds in the Brain by Transcranial Magnetic Stimulation

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1. Extended Abstract

Brain mapping is used to localize functions areas for prevention of brain damage during tumor extraction. During surgery, direct electric stimulation (DES) of the exposed brain is used. Before surgery, brain mapping can also be conducted using transcranial magnetic stimulation (TMS) for planning purposes [1]. TMS is a technique that stimulates the brain in a noninvasive manner. However, the brain area under stimulation is different from the coil focal point because of the complex anatomy of the brain [2]. To estimate the exact location of the target area, it is essential to use medical images to construct a human head model. Moreover, artifacts of the hotspot should be reduced to pinpoint the specific stimulation site. The purpose of our study is to develop a computational model comprised of medical image processing and electromagnetic simulation of stimulation hotspots.

The human head model was obtained from MR images of the patients. During peritumoral mapping, the TMS coil is placed and rotated in different configurations while recording the motor evoked potential (MEP). The relative position of the coil, including the relative angle of the coil to the head surface, is stored with MEP information and used in the computational modeling [3]. The stimulation configurations that delivered the MEPs with the highest peaks were selected. The magnitude of the induced electric fields corresponding to each MEP was multiplied to enhance the hotspot area and reduce artifacts. Also, optimization of current distribution to activate a specific part of the brain was investigated by evaluating optimal coil performance for a group of subjects by registering the computed electric field in a brain template.

The results showed that the estimated target area of the hand motor area was in good agreement with that of DES (accuracy by several millimeter resolutions).

2. References

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