URSI GASS 2023, Sapporo, Japan, 19 – 26 August 2023

Computer-Aided Fast Brain Function Mapping by Transcranial Magnetic Stimulation

Keigo Hikita [(1)], Keita Iijima [(1)], Sachiko Kodera [(1)], Shoogo Ueno [(2)], and Akimasa Hirata* [(1)]
(1) Nagoya Institute of Technology, Nagoya, Japan; e-mail: ahirata@nitech.ac.jp
(2) The University of Tokyo, Tokyo, Japan

Transcranial magnetic stimulation (TMS) is used for mapping motor functions in cortex. In clinical applications, TMS is used as a preoperative diagnosis for surgical resection in patients with brain tumor, and its noninvasive and accurate localization may reduce the time for awake craniotomy [1]. The complexity of the brain anatomy, however, prevents the determination of the exact location of the stimulated sites, resulting in the limitation of the spatial resolution for identifying multiple targets. This study proposes a fast mapping of two adjacent muscles in cortical motor areas using computational simulation in individualized head models.

In the physiological experiments, multiple stimuli pulses were applied to the participants using a navigated TMS to measure the motor-evoked potentials (MEPs) in the corresponding muscles. As shown in Figure 1, the individual head models were constructed from magnetic resonance images. The induced electric field (EF) in the brain of each head model was then computed using a volume conductor model considering the experimental condition such as coil position, angle and current intensity. A multiply method was implemented to determine a TMS hotspot using EF corresponding to multiple stimuli, considering the amplitude of the measured MEPs. The dependence of the computationally estimated hotspot distribution on two target muscles was evaluated for subjects (n = 11). The center of gravity of the first dorsal interosseous cortical representation was lateral to the abductor digiti minimi by a minimum of 2 mm. The estimated localizations were consistent with the putative sites obtained from previous EF-based studies and fMRI studies. The simultaneous cortical mapping of two finger muscles was achieved with only several stimuli, which is one or two orders of magnitude smaller than that in previous studies. Our proposal would be useful for mapping of motor or speech areas to plan brain surgery interventions.

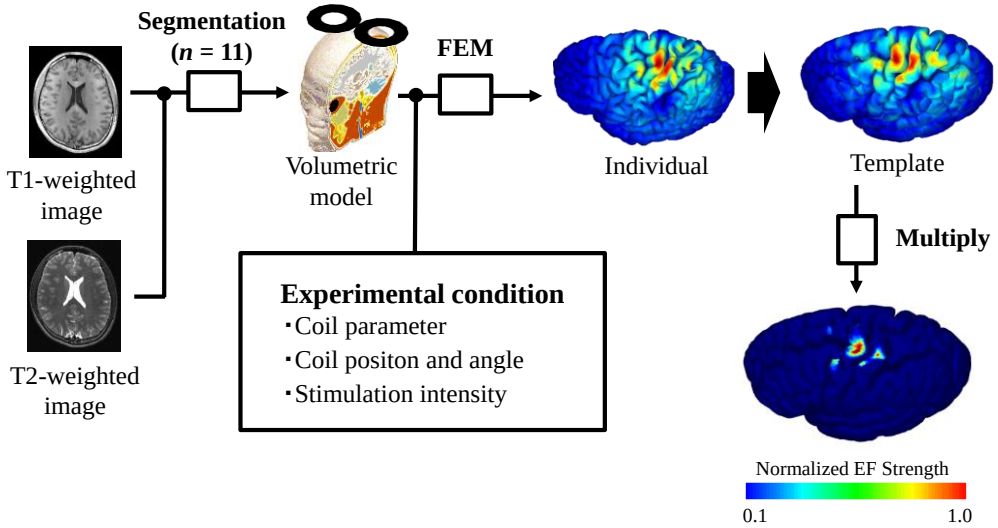

Figure 1. Brain function mapping method combining physiological experiments and numerical computations.

References

[1] A. Opitz, N. Zafar, V. Bockermann, V. Rohde, and W. Paulus, "Validating computationally predicted TMS stimulation areas using direct electrical stimulation in patients with brain tumors near precentral regions," NeuroImage Clin., vol. 4, pp. 500–507, Jan. 2014.

This paper's copyright is held by the author(s). It is published in these proceedings and included in any archive such as IEEE Xplore under the license granted by the "Agreement Granting URSI and IEICE Rights Related to Publication of Scholarly Work."