Modeling and Simulation of a Magnetic Induction Method for Determining Passive Electrical Property Changes of Human Trunk Due to Vital Activities

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Abstract

The human body consists of many different types of tissues each with specific passive electrical properties. Vital activities (like breathing or cardiac activity) lead to a characteristic change of these properties and geometrical changes. Magnetic induction is a non-contact method which can be used to determine these changes and, as a result, to monitor these vital signs. The method is based on the creation of a primary magnetic field that will produce eddy currents in the trunk, these currents will produce a secondary magnetic field that has to be detected somewhere around the trunk. The objective of the study is to know the sensitivity of such a method in front of geometric and impedance changes in the trunk. To simulate the method, a simplified anatomical 3D model of the human trunk (lungs and heart) was designed with COMSOL Multiphysics by using the Magnetic Fields physics interface. A current carrying coil (excitation coil) is located in front of the chest to generate the primary magnetic field. By using the parametric sweep tool of the software, different solutions were obtained for various excitation coil positions, inflation and deflation of the lungs, conductivity changes due to the inspiration and expiration and frequency changes. In addition, we evaluated the specific absorption rate (SAR) in different conditions to ensure that the system accomplishes the safety standards regarding electric and magnetic exposure of humans.

Reference

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[2] H. Griffiths, “Magnetic induction tomography,” Measurement Science and Technology, vol. 12, no. 8, pp. 1126-1131, 2001.
[3] International Commission on Non-Ionizing Radiation, “ICNIRP Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic and Electromagnetic Fields (up to 300 GHz),” Health Physics, vol. 74, no. 4, pp. 494-522, 1998.

Figures used in the abstract

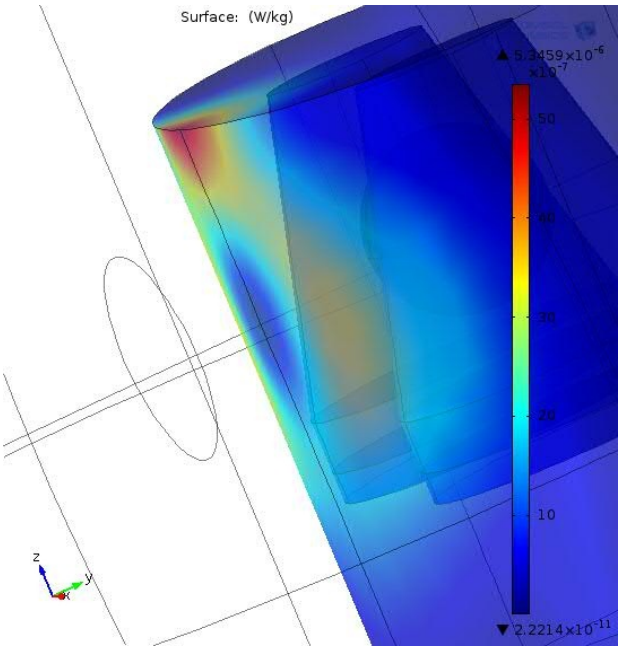

Figure 1: Specific absorption rate (W/Kg) at a distance of 10 cm from the chest.

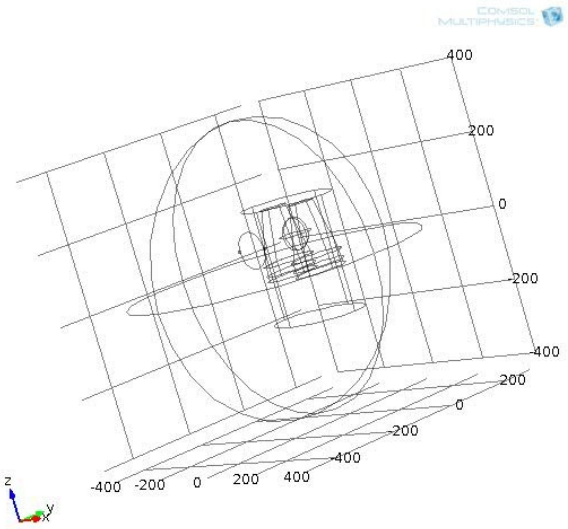

Figure 2: General view of the model geometry.