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Abstract

Design of complex coil geometries for magnetic particle imaging using additive manufacturing

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Field-generating coils are extensively used in different areas of medical imaging. They are employed not only in well-established clinical applications (magnetic resonance imaging (MRI)) but also in areas where preclinical research is ongoing (magnetic particle imaging (MPI), magnetoencephalography (MEG), magnetic induction tomography, and others). Depending on the application and technical requirements, it may be necessary to develop complex windings that follow the anatomy of the specific area of the human body. In this case, traditional manufacturing methods turn out to be too expensive or limited in their capabilities, while additive manufacturing grants the freedom to create almost any shape.

In our work we developed a set of the coils for human head MPI scanner [1]. These coils generate high-intensity magnetic fields inside the brain, so it is critical for their operation to reduce their internal volume to prevent high power consumption and obtain satisfactory levels of field amplitudes. As a basis for this, we used an averaged model of the head, synthesized from statistical datasets [2] and employ it as a base for the coil holder synthesis. We printed resulted helmet-like structure from ABS plastic on a Stratasys F370 printer. Based on this shape, we calculated the optimal coil patterns using the stream function approach [3].

The coils conduct remarkably high currents (>180 A, 25 kHz), and twisting of ten parallel wires was also required to preserve their performance. We manufactured the mounting and wire guiding parts using stereolithography 3D printing on a Formlabs Form 3B printer and Clear V4 and Rigid 10k resins. These parts were inserted into the helmet and fixed the coils' windings in the specified locations predicted by the optimization. Testing of the coil set showed good agreement with the simulations and reduced power consumption compared to previously demonstrated cylindrical shapes [1].

AUTHOR'S STATEMENT

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