Topology Optimization for Magnetic Circuits dedicated to Electric Propulsion

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Abstract

In this paper, we present a method to solve inverse problems of electromagnetic circuit design which are formulated as a topology optimization problem. Indeed, by imposing the magnetic field inside a region, we search a best material distribution into variable domains. In order to perform this, we minimize the quadratic error between the prescribed magnetic field and the one computed by a finite element method. A dedicated software was developed in MatLab using `fmincon` routine and `FEMM` software. In order to perform the first derivative of the objective function, we implemented an adjoint variable method. Indeed, this approach makes it possible to provide the derivative by only two uses of the finite element tool. Nevertheless, the problem is discrete because we take only two possibilities: with or without material. Thus, the Solid Isotropic Material with Penalization (SIMP) method was used to penalize intermediate values in order to have discrete solutions. Some numerical experiments with 40 and 800 variables concerning a circuit design, validated our approach. This represents a first study to design a Hall effect thruster.

Keywords: Topology Optimization, Magnetic Circuit Design, Inverse Problem, Sensitivity Analysis, Adjoint Variable Method, Intermediate Values, SIMP Method.

The full paper is in submission