



Optimally segmented magnetic structures

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TITLE: Optimally segmented magnetic structures

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ABSTRACT BODY:

Abstract Body: We present a semi-analytical algorithm for magnet design problems, which calculates the optimal way to subdivide a given design region into uniformly magnetized segments.

The availability of powerful rare-earth magnetic materials such as Nd-Fe-B has broadened the range of applications of permanent magnets[1][2]. However, the powerful rare-earth magnets are generally expensive, so both the scientific and industrial communities have devoted a lot of effort into developing suitable design methods. Even so, many magnet optimization algorithms either are based on heuristic approaches[3], or are applicable only to analytically solvable geometries[4]. In addition, some questions remained fundamentally unanswered, such as how to segment a given design into N uniformly magnetized pieces.

Our method calculates the globally optimal shape and magnetization direction of each segment inside a certain design area with an optional constraint on the total amount of magnetic material. The method can be applied to any objective functional which is linear respect to the field, and with any combination of linear materials. Being based on an analytical-optimization approach, the algorithm is not computationally intensive and provides the global optimum with respect to the considered problem without the need for a starting guess. The approach can be used in combination with finite element method calculations, and can therefore be applied also to problems for which an analytical solution to the magnetic field is not available.

We will illustrate the results for magnet design problems from different areas, such as electric motors/generators (as the example in the picture), beam focusing for particle accelerators and magnetic refrigeration devices.

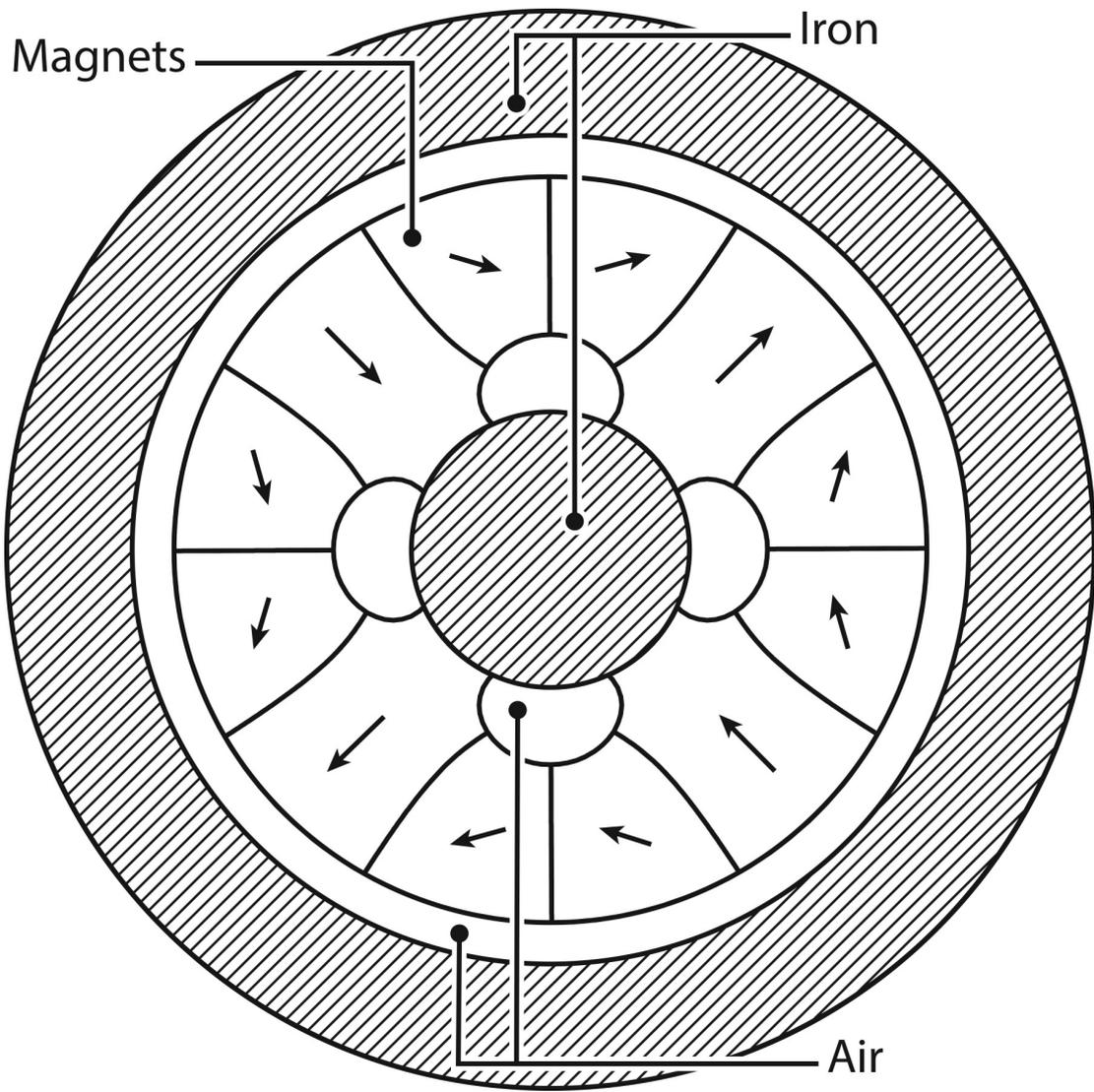
References: [1] J.M.D. Coey, *Permanent magnet applications*, J. Magn. Mater. 248 (2002), 441-456.

[2] O. Gutfleisch, M. A. Willard, E. Brück, C. H. Chen, S.G. Sankar, and J.P. Liu, *Magnetic Materials and Devices for the 21st Century: Stronger, Lighter, and More Energy Efficient*, Adv. Mater. 23 (7) (2011), 821-42.

[3] S. Cheng and D. P. Arnold, *Optimization of Permanent Magnet Assemblies Using Genetic Algorithms*, IEEE Trans. Magn., 47 (10), (2011), 4104-4107.

[4] M. Markovic and Y.Perriard, *Optimization Design of a Segmented Halbach Permanent-Magnet Motor Using an Analytical Model*, IEEE Trans. Magn., 45 (7), (2009), 2955-2960.

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Optimized permanent magnet electric motor

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