

Student project proposal

Project title

Study the Relative Convergence Phenomenon that Arises when Solving Infinite Set of Equations

Project type ☒ MSc thesis ☐ BA semester project ☒ MSc semester project

Project responsible and e-mail

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Project description

The proposed project is part of the epfloop team's research into the electrification of high-speed transportation systems, and more specifically into the propulsion of high-speed electromagnetic levitated vehicles. In this respect, electromagnetic analytical models are developed to study the performance of linear electric motors, and to optimise their design for specific applications.

Subdomain modelling is a powerful and accurate field-based method to represent the magnetic field distribution in the motor. It solves Maxwell's equations in rectangular domains where material properties are constant, interfaced with appropriate boundary conditions. This leads to an infinite set of equations. In some cases, the relative convergence phenomenon arises when solving this set of equations and causes the problem to converge towards a unique, but incorrect solution.

The purpose of the project is to study the causes of this phenomenon, and to propose a convergence criterion, which will ensure that the problem converged towards the correct solution.

Tasks of the student

- Conduct a literature review on the field (subdomain modelling, mode matching method, waveguide theory, ...).
- Define a simple problem that exhibits the relative convergence phenomenon.
- Understand the problem through linear algebra and analysis manipulations.
- Define a rigorous or heuristic convergence criterion that ensures the correctness of the solution.

Requirements

- Analysis, numerical analysis, linear algebra.

Literature

- [1] R. Mittra, "Relative convergence of the solution of a doubly infinite set of equations," J. RES. NATL. BUR. STAN. SECT. D. RAD. PROP., vol. 67D, no. 2, p. 245, Mar. 1963, doi: 10.6028/jres.067D.027.
- [2] R. Mittra, T. Itoh, and T.-S. Li, "Analytical and Numerical Studies of the Relative Convergence Phenomenon Arising in the Solution of an Integral Equation by the Moment Method," IEEE Transactions on Microwave Theory and Techniques, vol. 20, no. 2, pp. 96–104, Feb. 1972, doi: 10.1109/TMTT.1972.1127691.
- [3] Filippas, Afroditi & Itoh, Tatsuo. (1989). Mode Matching Analysis of the Coplanar Microstripline on a Layered Dielectric Substrate. 88.