A Mixed-Integer PDE-Constrained Optimization (MIPDECO) Method for the Design of Electro-Magnetic Cloaking (Scatterer)

Scientific Achievement

Develop efficient numerical methods for solving mixed-integer PDE-constrained optimization (MIPDECO) problems and apply them to optimal topology design problems

Significance and Impact

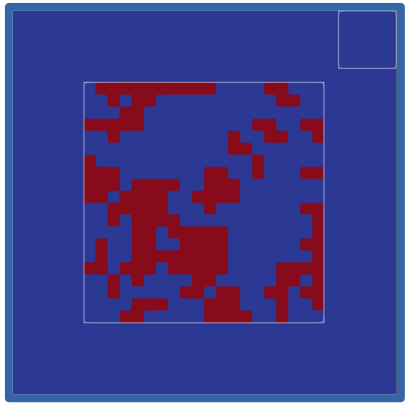
Formulated problem to design an electro-magnetic scatterer to cloak a region as a MIPDECO and used our new methods to compute an optimal design

$$\begin{aligned} \min_{u,w} \quad & \|u + u_0\|^2_{2,\Omega_0} \\ \text{s.t.} \quad & -\Delta u - k_0^2(1 + qw)u \\ & = k_0^2 q w u_0 \\ & w \in \{0, 1\} \end{aligned}$$

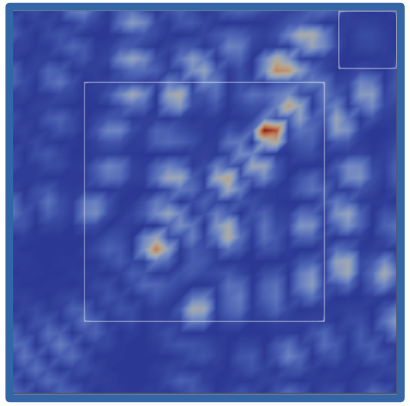
MIPDECO Formulation

Research Details

- Applied a new set-based steepest-descent trust-region method for MIPDECO with promising numerical results and theoretical foundations (first-order limit point with mesh refinement)
- Example: Design of electromagnetic scatterer (cloak)
  - Objective: Cloak the top-right corner
  - PDE: 2D Helmholtz equation
  - Discrete variables: 0-1 design of scatterer



Scatterer



Difference of Waves

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Work was performed at ANL.

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