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# Algorithm for computer-aided design of geometric shapes for electromagnetic devices

Researchers from Stanford University have developed an algorithm for electromagnetic device prototyping which optimizes geometric shape based on physical functionality. The resulting shapes are better suited for a user-defined objective, particularly for applications in charged-particle optics and trapped ion quantum computing hardware.

Optimization of geometric shapes to improve the performance of electromagnetic devices is a challenging problem. While lens design optimization packages are widely used for the design of optical devices, similar tools are not available for electron devices. Current prototyping processes for electromagnetic devices often rely primarily on the intuition of the scientist or engineer. Available simulation packages commonly calculate the device performance based on an existing shape, but have limited optimization capabilities. Thus, users often must manually vary the device shape before determining device performance. However, manual efforts are inherently hindered by the vast number of parameters that can be varied and the computational burden, particularly for complex shapes.

The algorithm developed in this technology offers a more rigorous and scalable shape optimization by utilizing a differentiated Boundary Element Method (BEM) and mesh processing. Compared to other core physics algorithms, such as Finite Element Method (FEM) or Finite Difference Method (FDM), BEM produces more accurate gradients, enabling successful optimization. Further, mesh-based processing has few limitations to shapes that can be optimized, allowing the algorithm to be applied to a wide range of shapes and resulting electromagnetic devices.

**Stage of Development** Prototype

## Applications

- Numerical simulation software packages for prototyping & optimization of electromagnetic devices, such as in charged-particle optics and trapped ion computing hardware
- Physics designs where all or part of the underlying physics equations can be solved by a Boundary Element Method (BEM)

## Advantages

- Rigorous and scalable optimization capabilities
- Fast execution speeds
- Compatibility with GPU clusters

## Patents

- Published Application: 20230376650

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