Boundary element based multiresolution shape optimisation in electrostatics

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We consider the shape optimisation of high-voltage devices subject to electrostatic field equations by combining fast boundary elements with multiresolution subdivision surfaces. The geometry of the domain is described with subdivision surfaces and different resolutions of the same geometry are used for optimisation and analysis. The primal and adjoint problems are discretised with the boundary element method using a sufficiently fine control mesh. For shape optimisation the geometry is updated starting from the coarsest control mesh with increasingly finer control meshes. The multiresolution approach effectively prevents the appearance of non-physical geometry oscillations in the optimised shapes. Moreover, there is no need for mesh regeneration or smoothing during the optimisation due to the absence of a volume mesh. We present several numerical experiments and one industrial application to demonstrate the robustness and versatility of the developed approach.