and the boundary condition. The coercive case is considered and the external perturbation is given in a concrete form. We consider the model of the external perturbation in the special analytical form that has not been studied for the Lavrent'ev problem. The existence of a semiregular solution is proved by the variational method. In addition, if variational functional has no more countable number of points of a global minimum, then there is the regular solution of the problem, i.e. the semiregular solution with the property of correctness. The regular solutions of the Lavrent'ev problem have not been investigated.

The problem on conductor heating is considered under constant voltage and constant temperature on the conductor surface when electroconductivity of material changes with a jump upon transition through certain temperatures. The results obtained earlier for problems with a spectral parameter for equations of elliptic type with discontinuous nonlinearities are applied to this problem of electrophysics. Restrictions on the gap points of nonlinearity are weaken (nonlinearity is electroductivity of the conductor). The theorem on both the existence of the nonzero semiregular solution and the estimates for the differential operator of the problem under consideration is established.

We summarize the results of [1–3] for applications to equations of elliptic type with a spectral parameter and nonlinearity discontinuous with respect to the phase variable.

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FINITE-DIFFERENCE ITERATIVE SOLVER WITH SPECTRALLY EQUIVALENT PRECONDITIONER FOR ANISOTROPIC ELECTRICAL IMPEDANCE TOMOGRAPHY PROBLEMS

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The electrical impedance tomortaphy (EIT) problems in anisotropic inhomogeneous media like head tissues belongs to the class of the three-dimensional boundary value problems for elliptic equations with mixed derivatives. The efficiency of the most discussed and usable in practice numerical methods in context of modeling EIT problems is reviewed in [1,2], where it is shown that the best performance is demonstrated by the algebraic multi-grid (AMG) methods.

We present a novel type of the anisotropic bi-conjugate gradient iterative solver for 3D elliptic equations with mixed derivatives. The proposed numerical scheme is based on the finite-difference approximation of the problem in an arbitrary three-dimensional computational domain, augmented to a cuboid with non-conducting claddings and the Dirichlet type boundary conditions defined at the facets of the cuboid. The rectangular uniform finite difference grid is assumed to have high enough resolution across the characteristic layers of inhomogeneity. The nonconductive claddings imitate the Neumann boundary condition on the arbitrarily shaped surface of the embedded object. The discrete problem is reduced to solving a system of linear algebraic equations with a 19-diagonal sparse matrix.

Iterative methods from the BiCG family is most effective with the adequate choice of preconditioners. As a preconditioner, we employed combined spectrally-optimal preconditioning Fourier-Jacobi (FJ). The key advantages of the proposed technique is to eliminate the dependence of the convergence rate on the spatial grid resolution and the heterogeneity ratio of the discrete model. As a result, the number of iterations to achieve the desired accuracy is almost independent of the grid resolution, which puts the proposed technique in line with the popular multigrid iterative methods. The proposed numerical algorithm includes the standard arithmetic operations with sparse matrices and vectors, as well as FFT, making it easy to implement and readily eligible for the effective parallel implementation.

The proposed algorithm has been validated against analytics in a spherical model and tested on the anatomically accurate MRI based human head geometry [3]. Simulation results show high efficiency of the developed approach. It is capable to solve 128x128x128 voxels anisotropic problems with the extreme conductivity tensor eigenvalues ratio of 10:1 and the heterogeneity ratio of the piecewise constant coefficients up to 10^{16} (including explicitly titanium clips and air pockets modeling) within a minute runtime in the Matlab implementation.

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