A Fast Algorithm for Two-Dimensional Elliptic Problems

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In this paper, we extend the work of Daripa et al. ([15], [16], [17], [8]) to a larger class of elliptic problems in a variety of domains. In particular, analysis-based fast algorithms to solve inhomogeneous elliptic equations of three different types in three different two-dimensional domains are derived. Dirichlet, Neumann and mixed boundary value problems are treated in all these cases. Three different domains considered are: (i) interior of a circle, (ii) exterior of a circle, and (iii) circular annulus. Three different types of elliptic problems considered are: (i) Poisson equation, (ii) Helmholtz equation (oscillatory case), and (iii) Helmholtz equation (monotone case). These algorithms are derived from an exact formulae for the solution of a large class of elliptic equations (the coefficients of the equation do not depend on the polar angle when written in polar coordinates) based on Fourier series expansion and one-dimensional ordinary differential equation. The performance of these algorithms are illustrated on several of these problems. Numerical results are presented.

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