NUMERICAL SOLUTION OF THE 3D POISSON EQUATION: AN APPLICATION OF GRAVIMETRY IN GEOPHYSICS

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In this paper, we solve the ill-posed Cauchy problem for the three-dimensional Poisson equation with the data given on a part of the boundary (continuation problem) in a cube using Finite difference method. The solution of Poisson's equation is the potential field caused by a mass density distribution; with the potential field known, one can calculate the corresponding gravitational (force) field. Gravimetry is associated with analysis of the gravitational field. Direct gravimetry problems involve the determination of the potential of the gravitational field in a given region. The inverse problems of gravimetry imply the restoration of the structure of a given area from the results of measuring the characteristics of the gravitational field. Such studies are needed to assess on the basis of gravimetric geodynamic events occurring in oil and gas fields. The relevance of the inverse problems of gravimetry needs to be considered because in the process of long-term operation of deposits of different minerals, significant changes occur which may lead to negative consequences.

The Finite difference method is the most widely known numerical technique for solving Elliptic PDEs by discretizing the given domain into finite number of regions. The basic idea behind the method is that the governing equations are turned into a system of linear algebraic equations. Simple implementation, less complexity and computational inexpensiveness are some of the main advantages of the scheme. A MATLAB code is developed to implement numerical solution of this approach and discuss about efficient solution of dense system of equations using the Jacobi, Gauss-Seidel and SOR(w_{opt}) iterative methods to improve computational efficiency and establish the convergence properties of the proposed method. Finally, numerical examples have demonstrated high accuracy, stability, and efficiency of our method. This motivates the use of numerical methods in order to provide accurate results for real-world systems.

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