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A Multi-level Solution Technique for the Method of Fundamental Solutions

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The Method of Fundamental Solutions (MFS) is a popular, truly meshless method to solve 2D and 3D elliptic partial differential equations. In its original form, the method uses some external source points, which makes the discretized system ill-conditioned. If the source points are located on the boundary, singularities appear. Therefore special regularization and desingularization techniques are required. However, the matrix of the discretized system remains fully populated and often ill-conditioned. In this paper, the original problem supplied with mixed boundary conditions is converted to a sequence of pure Dirichlet and pure Neumann subproblems, the solution of which converging rapidly to the solution of the original (mixed) problem. These subproblems are solved in an economic way based on some regularized versions of the MFS. The method is embedded in a multi-level context, which significantly reduces the computational complexity. In addition to it, the problem of large, ill-conditioned matrices is also avoided.

Keywords: Meshless, Method of Fundamental Solutions, Multi-level, Regularization, Desingularization