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HIERARCHICAL GRID COARSENING FOR THE SOLUTION OF THE POISSON EQUATION IN FREE SPACE*

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Abstract. In many applications the solution of PDEs in infinite domains with vanishing boundary conditions at infinity is of interest. If the Green's function of the particular PDE is known, the solution can easily be obtained by folding it with the right hand side in a finite subvolume. Unfortunately this requires $\mathcal{O}(N^2)$ operations. Washio and Oosterlee presented an algorithm that rather than that uses hierarchically coarsened grids in order to solve the problem (Numer. Math. (2000) 86: 539–563). They use infinitely many grid levels for the error analysis. In this paper we present an extension of their work. Instead of continuing the refinement process up to infinitely many grid levels, we stop the refinement process at an arbitrary level and impose the Dirichlet boundary conditions of the original problem there. The error analysis shows that the proposed method still is of order h^2, as the original method with infinitely many refinements.

Key words. the Poisson equation, free boundary problems for PDE, multigrid method

AMS subject classifications. 35J05, 35R35, 65N55

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