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AN ADAPTIVE MESH REDISTRIBUTION ALGORITHM FOR CONVECTION-DOMINATED PROBLEMS

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Abstract. Convection-dominated problems are of practical applications and in general may require extremely fine meshes over a small portion of the physical domain. In this work an efficient adaptive mesh redistribution (AMR) algorithm will be developed for solving one- and two-dimensional convection-dominated problems. Several test problems are computed by using the proposed algorithm. The adaptive mesh results are compared with those obtained with uniform meshes to demonstrate the effectiveness and robustness of the proposed algorithm.

1. **Introduction.**

Adaptive mesh redistribution (AMR) methods have important applications in a variety of physical and engineering areas such as solid and fluid dynamics, combustion, heat transfer, material science etc. The physical phenomena in these areas develop dynamically singular or nearly singular solutions in fairly localized regions, such as shock waves, boundary layers, detonation waves etc. The numerical investigation of these physical problems may require extremely fine meshes over a small portion of the physical domain to resolve the large solution variations. One class of such problems is the convection-dominated problems, including viscous shocks and large Reynolds number incompressible flows [6, 8, 9]. In this work, we will develop an efficient and robust AMR algorithm to solve convection-diffusion problems with small viscosity.

It is a challenging problem to generate an efficient AMR algorithm for two or more dimensional problems, especially when the underlying solution develops complicated structures and becomes singular or nearly singular. The earliest work on adaptive methods, based on moving finite element approach (MFEM) was done by Millers [14]. There are many applications and extensions of Miller's moving finite element methods, see e.g. Baines [1], Cao et al. [3], and Moore and Flaherty [15]. On the other hand, several moving mesh techniques have been introduced based on solving elliptic PDEs first proposed by Winslow [20]. There are also many applications and extensions of Winslow's method, see e.g. Brackbill and Saltzman [2], Thompson et al. [19], Ren and Wang [16], Ceniceros and Hou [5], and Ceniceros [4]. Winslow's formulation requires the solution of a nonlinear, Poisson-like equation to generate a mapping from a regular domain in a parameter space to an irregularly shaped domain in physical space. By connecting points in the physical space corresponding

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