A STREAMING APPROACH FOR SPARSE MATRIX PRODUCTS AND ITS APPLICATION IN GALERKIN MULTIGRID METHODS

JOACHIM GEORGI & RÜDIGER WESTERMANN

Abstract. In this paper, we present a numerical algorithm for computing products of the form $R K R^T$, where $R$, $R^T$, and $K$ are sparse matrices. By reformulating the problem into the simultaneous processing of a sequential data and control stream, cache miss penalties are significantly reduced. Even though the algorithm increases memory requirements, it accelerates sparse matrix products on recent processor architectures by a factor of up to 4 compared to previous approaches. We apply the algorithm to compute consistent system matrices at different resolution levels in a dynamic multigrid elasticity simulation, and we show its efficiency for nested and non-nested mesh hierarchies.

Key words. sparse matrix products, cache-awareness, multigrid, Galerkin update

AMS subject classifications. 65F50, 65M55, 65M60, 65Y20, 68W01, 74B99, 74H15

Received December 7, 2007. Accepted for publication April 29, 2010. Published online September 7, 2010.

Computer Graphics & Visualization Group, Technische Universität München, Germany ([georgii, westermann]@tum.de).