**Electronic Transactions on Numerical Analysis.**
**Volume 31, pp. 68-85, 2008.**

**ISSN 1068-9613.**

**ETNA**
**Kent State University**
**http://etna.math.kent.edu**

# A ROBUST AND EFFICIENT PARALLEL SVD SOLVER BASED ON RESTARTED LANCZOS BIDIAGONALIZATION*

VICENTE HERNÁNDEZ†, JOSÉ E. ROMÁN†, AND ANDRÉS TOMÁS†

**Abstract.** Lanczos bidiagonalization is a competitive method for computing a partial singular value decomposition of a large sparse matrix, that is, when only a subset of the singular values and corresponding singular vectors are required. However, a straightforward implementation of the algorithm has the problem of loss of orthogonality between computed Lanczos vectors, and some reorthogonalization technique must be applied. Also, an effective restarting strategy must be used to prevent excessive growth of the cost of reorthogonalization per iteration. On the other hand, if the method is to be implemented on a distributed-memory parallel computer, then additional precautions are required so that parallel efficiency is maintained as the number of processors increases.

In this paper, we present a Lanczos bidiagonalization procedure implemented in SLEPc, a software library for the solution of large, sparse eigenvalue problems on parallel computers. The solver is numerically robust and scales well up to hundreds of processors.

**Key words.** Partial singular value decomposition, Lanczos bidiagonalization, thick restart, parallel computing.

**AMS subject classifications.** 65F15, 15A18, 65F50.

*Received November 30, 2007. Accepted July 18, 2008. Published online on January 19, 2009. Recommended by Daniel Kressner.

†Instituto ITACA, Universidad Politécnica de Valencia, Camino de Vera s/n, 46022 Valencia, Spain, ({vhernand,jroman,antodo}@itaca.upv.es). Work partially supported by the Valencia Regional Administration, Directorate of Research and Technology Transfer, under grant number GV06/091, by Universidad Politécnica de Valencia, under program number PAID-04-07, and by the Centro para el Desarrollo Tecnologico Industrial (CDTI) of the Spanish Ministry of Industry, Tourism and Commerce through the CDTEAM Project (Consortium for the Development of Advanced Medicine Technologies).