THE SOLUTION OF SINGULAR-VALUE AND SYMMETRIC EIGENVALUE PROBLEMS ON MULTIPROCESSOR ARRAYS

R. P. BRENT AND F. T. LUK

Abstract

Parallel Jacobi-like algorithms are presented for computing a singular-value decomposition of an $m \times n$ matrix ($m \geq n$) and an eigenvalue decomposition of an $n \times n$ symmetric matrix. A linear array of $O(n)$ processors is proposed for the singular-value problem; the associated algorithm requires time $O(mnS)$, where S is the number of sweeps (typically $S \leq 10$). A square array of $O(n^2)$ processors with nearest-neighbour communication is proposed for the eigenvalue problem; the associated algorithm requires time $O(nS)$.

Comments

Only the Abstract is given here. The full paper appeared as [6], which combined results in the earlier reports [1, 2]. For related work and generalisations, see [3, 4, 5]. It is conjectured in [6, page 83] that $S(n) = O(\log n)$.

References

[1] R. P. Brent and F. T. Luk, *A systolic architecture for the singular value decomposition*, Report TR-CS-82-09, DCS, ANU; Report TR 82-522, DCS, Cornell University; Report CMA-R02-82, ANU, August 1982, 12 pp. rpb075.

[2] R. P. Brent and F. T. Luk, *A systolic architecture for almost linear-time solution of the symmetric eigenvalue problem*, Report TR-CS-82-10, DCS, ANU; Report TR 82-525, DCS, Cornell University; Report CMA-R03-82, CMA, ANU, August 1982, 23 pp. rpb076.

[3] R. P. Brent, H. T. Kung and F. T. Luk, "Some linear-time algorithms for systolic arrays" (invited paper), in *Information Processing 83* (edited by R. E. A. Mason), North-Holland, Amsterdam, 1983, 865–876. rpb079.

[4] R. P. Brent, F. T. Luk and C. F. Van Loan, "Computation of the singular value decomposition using mesh-connected processors", *J. of VLSI and Computer Systems* 1, 3 (1983–1985), 242–270. MR 86m:65033. rpb080.

[5] R. P. Brent, F. T. Luk and C. F. Van Loan, "Computation of the generalized singular value decomposition using mesh-connected processors", *Proceedings SPIE, Volume 431, Real Time Signal Processing VI* (edited by Keith Bromley), SPIE, Bellingham, Washington, 1983, 66–71. rpb083.

[6] R. P. Brent and F. T. Luk, "The solution of singular-value and symmetric eigenvalue problems on multiprocessor arrays", *SIAM J. Scientific and Statistical Computing* 6 (1985), 69–84. Also appeared as Report TR 83-562, Department of Computer Science, Cornell University, July 1983, 34 pp. MR 86i:65089. A preliminary version appeared in *Proceedings of a Workshop on Mathematical Programming and Numerical Analysis* (edited

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