DAA/LANGLEY 5p.

A Semi-Annual Report

For the period March 1, 1986 - August 31, 1986

Grant No. NAG-1-46

NUMERICAL ALGORITHMS FOR FINITE ELEMENT COMPUTATIONS ON CONCURRENT PROCESSORS

Submitted to:

IN-30371

National Aeronautics and
Space Administration
Langley Research Center
Hampton, VA 23665

Attention: Dr. Olaf Storaasli
SDD M/S 246

Submitted by:

J. M. Ortega
Professor and Chairman

(NASA-CR-179822) NUMERICAL ALGORITHMS FOR FINITE ELEMENT COMPUTATIONS ON CONCURRENT PROCESSORS Semiannual Report, 1 Mar. - 31 Aug. 1986 (Virginia Univ.) 5 p CSCL 12A N87-11542

G3/64 Unclas 43789

Report No. UVA/528190/AM87/112

September 1986

SCHOOL OF ENGINEERING AND APPLIED SCIENCE

DEPARTMENT OF APPLIED MATHEMATICS

UNIVERSITY OF VIRGINIA
CHARLOTTESVILLE, VIRGINIA 22901

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This report summarizes work performed under NASA GRANT NAG1-46 during the period March 1, 1986 to August 31, 1986.

Prof. Ortega has been supervising the research of several graduate students who have been at least partly supported by this grant or by NASA Grant NAG1-142. This work of all of them relates to the general goals of this project.

Charles Romine completed his Ph.D. degree in August. He has given a detailed analysis of the so-called ijk forms of Gaussian elimination and Choleski factorization on concurrent processors. His work was motivated by the Finite Element Machine at NASA-Langley but pertains more generally to any message-passing machine with a global bus. The main results are the optimality of a particular form of Gaussian elimination as well as a detailed complexity analysis of this form. Similar, but not as complete, results are given for Choleski factorization. In addition, results are obtained for a column-oriented triangular equation solver which shows a much higher degree of parallelism than had been assumed possible; this result has been accepted for publication in Parallel Computing in a joint paper by Romine and Prof. Ortega. The analysis of the ijk forms will be the subject of another joint paper following a prior one by Prof. Ortega on the ijk forms for vector computers.

Eugene Poole completed his Ph.D. in May, 1986, with a thesis on the vectorization of the Incomplete Choleski Conjugate Gradient method on the Cyber 205. The implementations use multicoloring orderings and matrix multiplication by diagonals and give a very high degree of vectorization. The thesis has been published as a NASA contractor report and a paper by Poole and Ortega has been submitted for journal publication.

Andrew Cleary and David Harrar spent the summer at NASA-Langley implementing various versions of Gaussian elimination and Choleski factorization on the FLEX/32. A global memory version of Gaussian elimination for banded matrices and a corresponding global memory Choleski code are running and producing surprisingly large speed-ups on preliminary runs. A local memory Choleski code using profile storage is also running but hasn't been tested as extensively. All of these codes are designed to be used in the environment of NICE/SPAR, and the plan is to begin running different versions of the blade stiffened panel focus problem. A report on progress to date is now in preparation.

Courtenay Vaughan continued his development of SSOR preconditioned conjugate gradient methods, primarily on an Intel iPSC Hypercube at Oak Ridge National Laboratory, where he spent the summer, but also on the FLEX/32 at NASA-Langley. His model problems to date have included a generalized Poission equation and a plane stress problem but he will begin work shortly on the panel focus problem.

Eugene Poole has begun work on the panel focus problem on NICE/SPAR. His immediate goal is to extract stiffness matrices of several sizes to be used by Cleary and Vaughan in their direct and iterative codes. He will also use his multicolored ICCG method on this focus problem on the FLEX/32, the CRAY-2 and the CRAY X-MP.

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