AD-A137 006 ADAPTIVE GRID GENERATION USING ELLIPTIC GENERATING EQUATIONS WITH PRECISE..(U) ECODYNAMICS RESEARCH ASSOCIATES INC ALBUQUERQUE NM P J ROACHE 15 JUN 83 1/1

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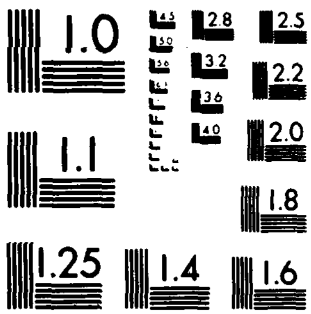

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7. AUTHOR(s) Patrick J. Roache		8. CONTRACT OR GRANT NUMBER(s) F49620-82-C-0064
9. PERFORMING ORGANIZATION NAME AND ADDRESS Ecodynamics Research Associates, Inc. P.O. Box 8172 Albuquerque NM 87198		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS PE61102F; 2304/A3
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18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The results previously reported have now been verified in a double precision code which removes any confusion due to machine round-off error. The results conclusively show no loss of order of accuracy from highly stretched grids, even with stretching parameters in an exponential-of-exponential stretch large enough to increase the size of the error by 6 orders of magnitude. Professor Joe Thompson of Mississippi State University is now in agreement with me, (SEE BACK)

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered) and clarified his position at the Mini-Symposium on Grid Generation held at the ASME meeting at the University of Houston, June 20-22.

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AFOSR-TR- 83 1019

ECODYNAMICS RESEARCH ASSOCIATES, INC.
P.O. Box 8172
Albuquerque, New Mexico 87198

15 June 1983

Major Carl Edward Oliver
AFOSR
Directorate of Math. & Info. Sciences
Building 410
Bolling AFB, DC 20332

SUBJECT: SECOND RESEARCH PROGRESS AND FORECAST REPORT (5/15/83) FOR CONTRACT ~~F49620-82-C~~, "ADAPTIVE GRID GENERATION USING ELLIPTIC GENERATING EQUATIONS WITH PRECISE COORDINATE CONTROLS"
F49620-82-C-0064

Dear Major Oliver:

This letter constitutes the required report on the subject contract, for the period 15 October 1982 through 14 May 1983.

1. ANALYSIS OF GRID-INDUCED TRUNCATION ERRORS

My results previously reported have now been verified in a double precision code which removes any confusion due to machine round-off error. The results conclusively show no loss of order of accuracy from highly stretched grids, even with stretching parameters in an exponential-of-exponential stretch large enough to increase the size of the error by 6 orders of magnitude. Professor Joe Thompson of Mississippi State University is now in agreement with me, and clarified his position at the Mini-Symposium on Grid Generation held at the ASME meeting at the University of Houston, June 20-22.

2. IMPROVEMENT OF MULTIGRID SOLVER

In using multigrid metnods to solve the elliptic grid generating equations, line SOR is needed for rapid convergence when grids are highly stretched, as in grids for boundary layer resolution. The direction for the implicit line solution depends on the direction of the grid skewness, being most efficient in the direction of strongest coupling (through the boundary layer). However, in cases where the gridding is adapted to more than one boundary layer, such as grids designed to resolve all four boundary layers in the model driven cavity problem, the skewness direction changes in different regions of the problem, and the line SOR will always be in the wrong direction in some region of the mesh. I have devised a multigrid algorithm which is efficient, even when the grid resolution changes skewness direction within the mesh, without requiring a pre-selection of parameters from the user. This is important for a true solution adaptive algorithm, since the user

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will not always know ahead of time the nature of the final grid. The initial testing of the algorithm verifies insensitivity to the grid skewness direction, but the penalty compared to a simple line SOR method for a simple case is significant. We will attempt to reduce the operation count of the new algorithm.

The code development of the 2D and 3D multigrid methods was accomplished on a Corvus Concept MC 68000 machine, a "super-microcomputer". Our experience is that code development is even more efficient on this machine than on a time-shared VAX, due to the better editor, the 61 line display screen, and the display rate of 9600 baud. In the course of this work, we performed timing tests for floating point calculations on a wide range of computers, in collaboration with Prof. R. T. Davis of the University of Cincinnati. These results and experiences will be presented at the Open Forum session of the AIAA 6th Computational Fluid Dynamics Meeting (see below).

3. LASER/SWITCH CODE FOR AFWL

Under separate contract, we have incorporated most of the grid generation methods developed under the present contract into our 2D and 3D electric field calculation codes for laser and switch electrode design work at AFWL. These are user-oriented design tools which have created much interest in the pulsed-power community. Two papers on this work were presented at a recent IEEE Pulsed Power Conference (see below).

4. INTERNAL GRID CONTROL ALGORITHMS

Our internal grid control algorithm has been only partially succesful so far. Although the procedure works, in the sense of allowing precise control and achieving a smooth grid through an interior boundary in the solution field, it produces unacceptable grids unless the user correctly distributes the points on the interior boundary. We can produce nice looking grids for our own work and publications, but the procedure is not practical for general users or for solution adaptive calculations. Also, the convergence is slow and undependable for more difficult geometries, due to the larger non-homogeneous terms.

We are now working (with Prof. S. Steinberg, under separate partial funding from ARO) to generalize the approach of Brackbill and Saltzmann. Expanding from our previous work on Symbolic Manipulation (see below) we should be able to have the user specify his own variational principle and have the Symbol Manipulation code then produce Fortran code for the 2D and 3D problems without further human coding.

5. ADAPTIVE GRID GENERATION ON NONPLANAR SURFACES

We have generalized the surface-adaptive grid method, in which the grid distribution adapts to resolve the extreme value in the electric field or other solution variable, from 2D to 3D. Coding and validation are in progress.

6. PAPERS, PRESENTATIONS, MEETINGS

"Symbolic Manipulation and Computational Fluid Dynamics", S. Steinberg and Patrick J. Roache, paper submitted to Journal of Computational Physics.

"Symbolic Manipulation and Computational Fluid Dynamics", Patrick J. Roache and S. Steinberg, invited paper to be presented by P. J. Roache at the AIAA Computational Fluid Dynamics Conference, 13-15 July 1983, Danvers Mass. To be submitted to AIAA Journal.

"Timing Studies of Super-Microcomputers", R. T. Davis and Patrick J. Roache, to be presented by P. J. Roache at the Open Forum Session II at the above AIAA Conference.

"3D Electric Field Solutions an Boundary-Fitted Coordinates", Patrick J. Roache, S. Steinberg, H. J. Happ, and W. M. Moeny, presented by P. J. Roache at 4th IEEE Pulsed Power Conference, Albuquerque, New Mexico, 6-8 June 1983. Paper to appear in the Proceedings.

"Unsteady 2D Electric Field Modeling with High Accuracy on Conductor Surfaces", Patrick J. Roache, H. J. Happ and W. M. Moeny, presented by P. J. Roache at the above IEEE Conference. Paper to appear in the Proceedings.

P. J. Roache attended the Multigrid Conference organized by Colorado State University and held at Copper Mountain, Colorado on 5-8 April 1983.

P. J. Roache attended the ASME MiniSymposium on Grid Generation held at the University of Houston on 20-22 June 1983, and chaired the Open Forum Session.

(7) BUDGET

All expenditures, both direct charge and overhead items, are within the budget for this contract. We do not anticipate any changes in the expenditures or time allotments from the contract budget and SOW.

If you have any suggestions or instructions regarding the direction of this research, please contact me at the above address or by phone at (505) 262-0440.

Thank you for your continued interest and support.

Respectfully,

Patrick J. Roache

Dr. Patrick J. Roache
President and Principal Investigator

c. Dr. James D. Wilson