INTERNATIONAL CENTRE OF EXCELLENCE FOR EDUCATION IN MATHEMATICS

Finite Volume Techniques Applied to the Non-Linear Coupled Systems of Parabolic Partial Differential Equations

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My summer vacation project involved the development of a Finite Volume Method (FVM) designed to solve a coupled system of nonlinear parabolic partial differential equations (PDEs). The finite volume discretisation produces a system of nonlinear algebraic equations that requires solution at each discrete time level. This system was solved using a globally convergent inexact Newton method whereby the banded Jacobian matrix was generated and stored in an efficient manner. Using this strategy we were able to significantly reduce the number of function evaluations required to solve the finite volume equations.

A number of test problems were solved using the computational algorithm to assess its accuracy and efficiency. A particularly important application of the work was the prediction of pattern development on sea shells using the activator-inhibitor scheme presented by Hans Meinhardt [1]. A sample output from the model is shown below in Figure 1, where a pattern of stripes was successfully generated with the pattern laid out in time, as expected.

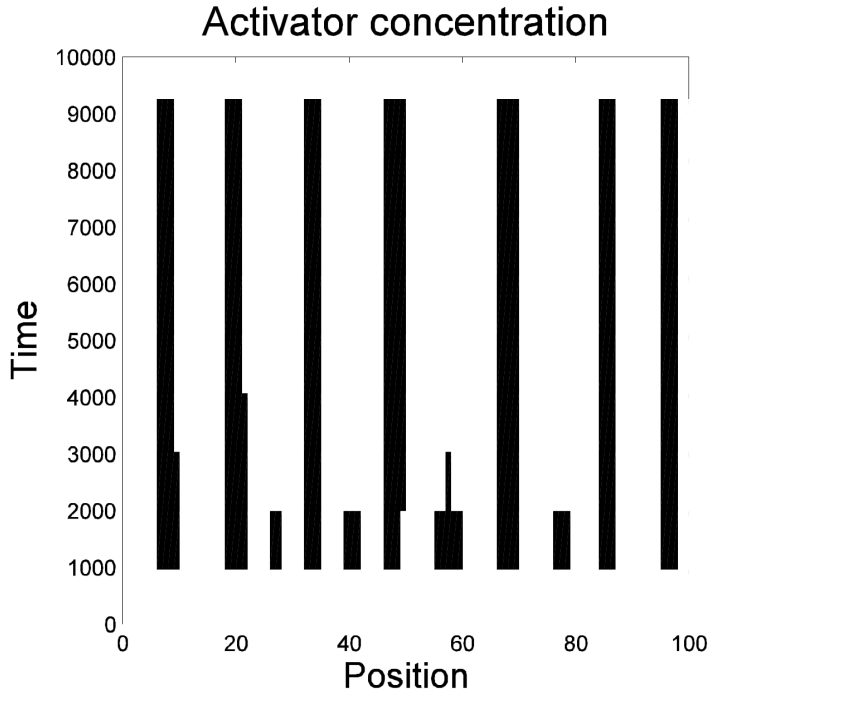

Figure 1: The stable stripe pattern generated from Meinhardt's model by the Finite Volume Method.

I found the vacation scholarship program not only worthwhile but also highly enjoyable. I learnt about the research process and, by attending the Big Day In, gained practise in giving presentations. I would highly recommend both.

Reference

1. Hans Meinhardt, *The Algorithmic Beauty of Sea Shells* (3rd edn., Berlin: Springer-Verlag, 2003).

Jen received an ICE-EM Vacation Scholarship in December 2005.
See www.ice-em.org.au/students.html#scholarships05