Editorial

Bahrom B. Sanugi and Shaharuddin Salleh

Department of Mathematics,
Universiti Teknologi Malaysia, 81300 Skudai, Malaysia
Fax: +607-5566162 E-mail: bs@mel.fs.utm.my
E-mail: ss@mel.fs.utm.my

Stephan Olariu

Department of Computer Science,
Old Dominion University, Norfolk, VA23529, USA
E-mail: olariu@cs.odu.edu

Biographical notes: Bahrom B. Sanugi is a Professor of Computing at the Department of Mathematics, Universiti Teknologi Malaysia. He is a graduate of the National University of Malaysia and obtained his MSc in Mathematical Computation from Essex University, UK. He holds a PhD and has been a Visiting Research Associate at the Numerical Algorithms Research Centre, University of Loughborough, UK. He is Fellow of the Academy of Sciences, Malaysia and Editor in Chief of Matematika. He currently serves as Dean of Corporate Affairs at Universiti Teknologi Malaysia and is involved in a number of research projects in the areas of task scheduling, mobile computing and numerical integral equations. For more details see his website:http//institut.fs.utm.my/~bahrom.

Shaharuddin Salleh is an Associate Professor at the Department of Mathematics, Universiti Teknologi Malaysia. He obtained his PhD in Computational Mathematics in 1998 from Universiti Teknologi Malaysia. He has published more than 50 technical papers and four books, both in mathematics and in computing. His research areas include Parallel Computing, Mobile Computing, Routing and Numerical Methods. For more details see his website: http://institut.fs.utm.my/~ss.

Stephan Olariu is a Professor in the Computer Science Department at Old Dominion University. His research interests include wireless sensor networks, wireless communications and mobile computing, parallel and distributed systems, performance evaluation, and medical image processing.

1 Introduction

The subject of Mathematical Modelling and Simulation has always been important over the last century as an indispensable part of technology. It is an important element in the conceptualisation of scientific ideas in a variety of fields. Because of its wide applicability, many of its mathematical aspects have been explored broadly and refined to a high degree. Other avenues are just now beginning to be explored. The *International Journal of Simulation and Process Modelling* has invited research and case study papers devoted to Mathematical Modelling and Simulation for Industrial Applications, and has selected 14 contributions for this issue.

In this special issue we include papers that discuss the applicability of existing theory in industrial applications, covering areas such as ordinary and partial differential equations, integral equations, computational techniques, ad hoc networks, data mining, and physics. We hope this issue will contribute in the effort to make the subject reach its full potential as an aid to science and technology.

The modern development of numerical computing is driven by the rapid increase in computer performance, which in turn, enhances computer simulation. With deeper understanding of the computational processes, new algorithms have emerged. The development of numerical computing has been gradual and based on the improvements of both algorithms and computers. Hence we have also included papers that describe improvement in numerical algorithms and those which discuss new principles for computing, such as high performance computing using quantum tunnelling photons.

Numerical simulation has always been strongly linked to mathematics, its applications and the computer with the aim to solve real world problems from basic physics to practical engineering. Today, mathematical modelling and simulation receive tremendous amounts of input from those who are not specialised in mathematics, numerical analysis, or scientific computing. This includes simulations, in large part, in physics, chemistry, biology and material science, which has contributed to the development of new algorithms. The mix of the contributions in this issue

reflects the close collaboration that can be initiated for the common benefit of both the scientists and the experts in the areas covered.

2 Overview of the papers included in this issue

Sakhinah Abu Bakar et al. in their paper 'FRECAST: Message transmission model in dense graph for ad hoc networks' studied the routing problem for broadcasting a message in an ad hoc network. An ad hoc network is a self adapting wireless network formed from special function nodes. Each node in the network is 'intelligent' in the sense that it has a transceiver for receiving and transmitting messages. The nodes act as routers and are capable of forming a network in the absence of communication infrastructures such as base stations. Both the single casting and multicasting problems from one or more nodes in the graph require finding the shortest paths, in order to make the message transmission optimum. The multicasting and broadcasting methods in the model are based on the Prim's algorithm for finding the minimum spanning tree (MST) in a graph. A visualisation model called FRECAST has been developed using C++ on the Windows environment for computing the shortest path and the minimum spanning tree. This model is applied for transmitting a message in single casting, multicasting and broadcasting. FRECAST has been developed based on the routing protocol on the ad hoc networks called WRP.

Tianyi Jiang et al. in the paper 'Macro-models for high level area and power estimation on FPGAs' studies the complex applications of the Field-Programmable Gate Arrays (FPGA) in the area of VLSI design. This requires high level design tools for reducing the design time. An equation based macro modelling technique for high level area and power estimation on FPGAs has been presented. In the proposed power macro model, the average input signal probability is not selected. Instead, the focus is on the input bit width, with the average input transition density and the average input spatial correlation as the underlying parameters. Glitches are also taken into account and this technique can be applied for both combinational and sequential circuits. Experimental results show that the macro models are quite accurate and efficient. These macro models are being used in the PACT high level synthesis tool to perform area and power optimisations.

The paper 'An efficient approach to the Klein–Gordon equation: An application of the decomposition method' by Inc et al. studies a reliable numerical approximation of the linear and nonlinear Klein–Gordon equations by using the Adomian's decomposition method. The method avoids the difficulties and massive computational work by determining the analytical solution calculated in the form of a series with easily computable components. When the process is applied to the Klein–Gordon equation, the method is convergent, and in the examples worked out, rapid convergence was obtained.

The paper 'An integral equation approach for the numerical solution of the Riemann problem on a simply connected region with corners' is a contribution from Munira Ismail et al. The paper considers a new integral equation for computing the numerical solution of the Riemann problem in a simply connected region bounded by a curve having a continuously turning tangent except possibly at a finite number of corners in the complex plane. The solution to this problem is characterised as the solution to a singular integral equation on the boundary. The authors have successfully extended the results of Hille and Muskhelishvili to include boundaries with corners; the resulting integral equation is a generalisation for the problem with arbitrary closed boundary.

In another paper, 'The decomposition method for one dimensional biharmonic equations', Khalifa studied the numerical solution of biharmonic equations in one dimension. Biharmonic equations appear frequently in many areas of engineering and physics, representing some phenomenon. The work is based on the Adomian polynomial for approximating the solution of such equations. The results obtained are presented, in which few terms are required to obtain a good approximation to the solution that is found to be accurate and efficient.

In the paper titled 'Collocation method using cubic B-spline for the generalised equal width wave equation', Raslan presented the finite element solution of generalised equal width (GEW) wave equation involving B-spline. The collocation method applied to the equation was found to be unconditionally stable and when applied to the test problems including the single soliton and the interaction of solitons, it was found to be accurate and efficient.

The paper from Sahimi et al. 'A high accuracy variant of the iterative alternating decomposition explicit method for solving the heat equation' considers a new three level iterative scheme called NVIADE using difference replacements of parabolic equations, in particular the heat equation in 2-D. The work was motivated by the well known fact of the parabolic-elliptic correspondence. The authors begin with deriving the two stage procedure, which uses fractional splitting strategy alternately at each intermediate time step. The result is an alternating direction implicit method, which is highly accurate and shows excellent stability properties. From the numerical results given, it shows that this new variant of the method is comparable to higher order method of Peaceman-Rachford and Mitchell-Fairweather variants.

David Al-Dabass et al. put forward a model for hybrid logic nets to model the complex behaviour of intelligent systems through the paper entitled 'Simulation of industrial knowledge mining algorithms using recurrent inference networks'. The paper presents a number of parameter tracking algorithms to abduct the values of the causal parameters. The developed algorithms were tested for their ability to track the input parameter for a reduced order model. The test involved the generation of a lightly damped second order recurrent net to illustrate the techniques, and the results showed that the algorithm maintains good tracking over an extended period of time.

High performance computation using quantum tunnelling photons is illustrated in a paper by Takaaki Musha. In this work, the energy limit of a computing system is studied. The system utilises quantum tunnelling photons, which shows that the computational energy loss by utilising tunnelling photons is much lower than the conventional silicon processor. The work implies that the human brain has the possibility to utilise this highly efficient computational mechanism for attaining a highly efficient computation process compared with silicon processors.

The paper 'An extended interpretation of the thermodynamic theory with including an additional energy associated with a decrease in mass' from Jean-Louis Tane and Volodymyr Krasnoholovets puts forward a theory that shows the mass-energy relation to the laws of thermodynamics. The authors have shown, by means of both conventional thermodynamic methods and the submicroscopic analysis, that the change in mass is a general law of evolution of physical systems. It was shown that the mass exchange is the fundamental property of any physical system, from a system of several canonical particles to that of cosmological objects. The research points to the necessity of including the phenomenon of the defect of mass even in tasks typical for condensed matter physics, which in the past have only been taken into account only in problems associated with nuclear physics.

In another paper entitled 'An iterative solution for the travelling salesman problem', Su and Nie presented an iterative process to solve the travelling salesman problem (TSP). Their new strategy lies on the fact that if we can show that a finite number of iterations are needed in the method then the iterative solution to TSP based on the isometric surface method is a well implied enumeration, which leads to the enumeration algorithm for TSP where each optimal H-cycle is formed by only a few serial weakly TSP.

Integral equation has wide applications almost in any branch of science and engineering. Often, problems described by systems of ordinary and partial differential equations can be transformed into a set of integral equations. Algorithms for differential equations are modified to become useful for solving Volterra integral equations. In the paper 'A generalised integral quadratic method: Improvement of the solution for one-dimensional Volterra integral equation using particle swarm optimisation', Zerarka et al. introduced the particle swarm optimisation (PSO) which is a new stochastic algorithm to improve the solution provided earlier using the generalised integral quadratic (GIQ) method for Volterra's integral equations. The results indicate that the PSO technique provides excellent results even for a large number of interpolating points, as in the case of nonlinear problems.

The physical world is a fabric of events with each event labelled by its space-time coordinates. Such events are prevalent in radar detection and photographic detection of the shape of moving objects, which have importance in theoretical and applied physics. The paper by Doru Paunescu and Bernhard Rothenstein 'Graphical aids for visualising the space-time coordinates of events created by light signals emitted by moving sources', presents space-time diagrams using the approach of the Lorentz-Einstein transformation which avoids paradox. The paper supports the idea that the reflection law on a plane mirror holds in all inertial reference frames in relative motion as all the true laws of physics do. The authors imply that the radar and the photographic detection are also associated with a rotation of the involved mirrors.

And last but not least, a new technique for solving large systems of ordinary differential equations was presented by Zanariah Abdul Majid and Mohamed Suleiman. Large problems in ODEs arise in a wide range of applications including fluid dynamic and in weather prediction. In their paper 'Parallel block codes for solving large systems of ordinary differential equations', the authors elaborate the development of two point, fully implicit block methods using variable step size on a parallel, shared memory computer. The strategy allows calculations to be made simultaneously at two equally spaced points within a block. The performance of the parallel implementation was found to be excellent as the workload increases while maintaining stability.

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