Editorial

Sanyou Zeng

School of Computer Science,
China University of Geosciences,
Wuhan 030024, Hubei, China
Email: sanyouzeng@gmail.com

Biographical notes: Sanyou Zeng is a Professor of Computer Science in China University of Geosciences, Wuhan, China. He received his BSc in Mathematics from Hunan University of Science and Technology, China in 1983, MSc in Mathematics from Hunan University, China, majored in solving elliptic partial differential equations of second order in 1995, and PhD in Computer Science from Wuhan University, China, majored in evolutionary computation in 2002. His research interests include evolutionary computation. He has published over 100 journal papers and proceedings articles. He is currently involved in multi-objective/constrained/dynamic evolutionary optimisation researches and their application in evolvable hardware, and evolvable antennas specifically.

Bio-inspired hardware offers much for the complex system design. Bio-inspired techniques not only give the potential to explore larger solution spaces, but when implemented on hardware allow system designs to adapt to changes in the environment, including failures in system components.

The guest editor believes that the series of works in this special issue provide a useful reference for learning the current progress on bio-inspired hardware. Three papers have been selected for this purpose. The contents of these studies are briefly described as follows.

Systemic computation (SC) is a bio-inspired computational paradigm designed to model the behaviour of natural systems and processes. It adopts a holistic view, meaning that apart from a sum of its constituents, the definition of a system should also include the interaction of its elements. SC implies an unconventional massively parallel computer architecture. However, existing software implementations have been limited in terms of performance, flexibility and programmability. In the paper, 'Demonstrating the performance, flexibility and programmability of the hardware architecture of systemic computation modelling cancer growth', Christos Sakellariou and Peter J. Bentley present various software enhancements, resulting in a complete and efficient SC programming platform. An SC application modelling the effect of genetic abnormalities and therapeutic approaches on tumour development is demonstrated, confirming that the suggested general-purpose platform performance, flexibility and programmability advantages over a dedicated software model.

FPGA-based genetic algorithms (GAs) are effective in optimisation of complex applications, but require extensive customisation of the hardware architecture. To promote these accelerated GAs to potential users without hardware design experience. The paper, 'A general-purpose framework for FPGA-accelerated genetic algorithms' by Liucheng Guo et al., proposes an automated framework for creating and executing general-purpose GA system in FPGAs. The framework contains a scalable and customisable hardware architecture, which provides a unified platform for different kinds of chromosomes. At compile-time, a user only needs to provide a high-level inputs of the target application, without writing any hardware-specific code in low-level description languages such as VHDL or Verilog. At run-time, a user can tune application inputs and GA parameters without time-consuming recompilation, in order to find a good configuration for further GA executions. In this paper, the framework on a high performance FPGA platform solves six problems and benchmarks, including travelling salesman problem, a locating problem and the NP-hard set covering problem. Experiments show the custom GA system is more flexible and easier to use compared to existing FPGA-based GAs, and achieves an average speed-up of 30 times compared to a multi-core CPU.

Recently, a new insight about applying molecular computing systems has led researchers toward designing more complicated biochemical combinational circuits. The paper, 'Design and simulation of a molecular arithmetic logic unit using seesaw-gate method' by Vida Abedi Ferizani et al., introduces the structure of a simple seesaw gate which uses DNA strand displacement method. This structure has been used by researchers to design combinational circuits. In order to investigate the application of this structure in designing and simulating the molecular combinational circuits through AND and OR gates, the authors have attempted to model such combinational circuits as adder, subtractor, and 2-bit comparator; the proposed design can lead to development of a molecular arithmetic logic unit.

This special issue on *bio-inspired hardware* presents the latest research and development in bio-inspired hardware areas. The guest editors expect that the readers will benefit from the papers presented in the special issue. Actually, the bio-inspired hardware pursues much several aims. One is to identify possible modules/access points in modern electronic systems, such as embedded mobile systems, robots, parallel processing platforms (GPUs, FPGAs), where bio-inspired optimisation could improve performance and reliability. The second is to identify and tackle current challenges of electronic design on different levels, and to assess feasibility in academic research environments, for examples, design optimisation at future technology nodes, power distribution/optimisation, scheduling, robustness, fault-detection and recovery. The third is to improve existing technologies in order to earn the trust of industry for achieving a more widely adoption of bio-inspired solutions, for examples, extending the ability of a robot platform to act autonomously and to adapt to unknown (hazardous) environments. The fourth is to explore novel, unconventional substrates and platforms that could become tomorrow superior replacements for existing technology, for examples, organic displays, plastic semiconductors, molecular computing architectures. The fifth is to implement and advance optimisation techniques, to successfully tackle real-world problems, for examples, multi-objective optimisation, suitable representations of complex hardware architectures, fault tolerance, dynamic routing/power management/ resource allocation. And the final aim but not the least is to design high performance (including high-gain, wide band, low-profile, small, robust, adaptive, reconfigurable, and so on) antennas and antenna arrays by using bio-inspired techniques. The guest editor also expects that the special issue could arouse the readers' interest in all areas of the bio-inspired hardware research.

The guest editor of this special issue would like to thank all authors for submitting their interesting work. He is grateful to the reviewers for their great contributions to this special issue. He would like to express his sincere appreciation to the Editor-in-Chief, Professor Zhihua Cui, for his suggestion and support. This special issue has been supported by National Natural Science Foundation of China under Grant 61271140.