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EMERGING AND SELECTED TOPICS IN CIRCUITS AND SYSTEMS

Call for Papers

Design and Automation for Quantum Computation and Quantum Technologies

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Scope and Purpose

Quantum computation is a new computing paradigm in post-Moore information technology. The extraordinary quantum properties offer computation and information processing power beyond the reach of classical computers. Even though quantum computers are not expected to replace classical computers entirely, they are crucial technologies for certain computation accelerations. Consequently, the promise of quantum algorithms has primarily motivated the extensive developments of quantum hardware and quantum software.

For quantum hardware, both universal quantum processors and special-purpose quantum processors are under active development. Various physical implementations of quantum processors based on different technologies have been proposed and demonstrated. Each competing technology has its advantages and disadvantages. To fully explore the potentials of various realization means, circuits and systems need to be built based on different technologies. Also, circuits and systems interfacing quantum and classical data processing are crucial. The first focus of this special issue is to address the design and automation for quantum hardware realization.

For quantum software, a full stack of software engineering is indispensable to release the full power of quantum computing. To date, quantum computation programming languages, operating systems, compilers, and application programs are emerging. Quantum software engineering requires domain knowledge at different abstraction levels. In particular, compiling a quantum algorithm or application into a format executable on a quantum processor requires transforming a high-level programming language code into a low-level quantum assembly code, which consists of a sequence of unitary operations represented as quantum circuits. The compilation requires high-level, logic-gate-level, and physical-level synthesis of design automation techniques. Also, the design of quantum algorithms and circuits have to be verified for correctness. Formal verification, simulation, and emulation are vital, especially because quantum computers are intrinsically probabilistic and noisy. Many conventional electronic design automation (EDA) techniques for integrated circuit

design can be applied and extended for quantum circuit compilation. The second focus of this special issue is to address the design automation for quantum circuit compilation.

In addition to the hardware and software aspects of quantum computing, one important thread of development is quantum-inspired computing systems. Even though fault-tolerant quantum computers are not yet ready, the concept of quantum computation itself has triggered innovative solutions that overcome conventional computation barriers. There are quantum-inspired architectures and algorithms that improve classical computers and algorithms. Classical and quantum computations together may mutually fertilize each other and further advance our knowledge and practice of computation. The third focus of this special issue is to address the design and automation for quantum-inspired systems.

Topics of interest

Topics of interest to this special issue include, but are not limited to:

- **Quantum circuit synthesis and optimization**
- **Quantum circuit simulation**
- **Quantum program verification (e.g., assertion checking, deductive verification tools and methods)**
- **Quantum program compilation (e.g., program mapping, program decomposition, program scheduling, unitary synthesis, low-level optimization)**
- **Quantum architecture**
- **Quantum programming languages (e.g., hardware runtime systems, pulse-level integration, specification languages)**
- **Design automation tools for quantum technology**
- **Quantum annealing systems and tools**
- **Quantum-inspired circuits and systems (e.g., hardware and software for simulated quantum annealing, applications of quantum-inspired optimization)**
- **Quantum computer interface circuits and systems (e.g., cryogenic systems, control engineering)**
- **Quantum-classical coprocessing**
- **Quantum error correction (e.g., implementations, syndrome decoding methods)**

Submission procedure

Prospective authors are invited to submit their papers following the instructions provided on the JETCAS website: https://mc.manuscriptcentral.com/jetcas. The submitted manuscripts should not have been previously published, nor should they be currently under consideration for publication elsewhere.

Important dates

- **Manuscript submissions due** **2022-05-20**
- **First round of reviews completed** **2022-06-20**
- **Revised manuscripts due** **2022-07-10**
- **Second round of reviews completed** **2022-07-30**
- **Final manuscripts due** **2022-08-15**
- **Target publication date** **2022-09-30**

Request for information

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