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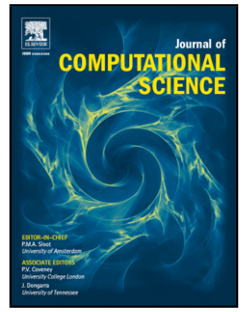

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Towards single layer quantum-dot cellular automata adders based on explicit interaction of cells

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ABSTARCT

Quantum-dot cellular automata is one of the most prominent nanotechnologies considered to continue scaling-down trend of sub-micron electronics. Therefore, numerous combinational and sequential circuits have been redesigned and implemented using this new technology. Considering QCA full adder cell as the basic building block in designing arithmetic circuits, great deals of attention have been paid to this research field targeting to diminish circuit latency and complexity. In this paper, contrary to conventional gate-level implementation approaches used in QCA technology, a new explicit interaction approach is utilized for designing QCA circuits. Thus, in the first step, a new well-optimized structure for three-input Exclusive-OR gate (TIEO) is proposed that is based on cell interaction. Accordingly, a low complexity and ultra-high speed QCA one-bit full-adder cell is designed employing this structure. In the next step, a comprehensive energy consumption analysis and comparison is performed over previously published QCA full-adder cells and the proposed design. QCADesigner and QCAPro tools are used for verifying circuit functioning and estimating dissipated energy.

Keywords: Quantum-dot Cellular Automata, XOR gate, Full adder design, Low power circuit, Single layer circuit.

1. Introduction

CMOS technology has encountered serious challenges in terms of power consumption, physical dimensions, and leakage current [1]. These deficiencies have led to significant efforts to find appropriate alternatives and among the proposed solutions, nanoscale technologies such as tunneling phase logic (TPL), single electron tunneling (SET) and Quantum Cellular Automata (QCA) have received considerable attention [2,3].

QCA would be of significant interest to researchers due to its attractive characteristics such as low power consumption, high speed operation and small dimensions. QCA circuits are made up of QCA cells which contain electrons and binary information is encoded by these electrons rather than current (CMOS is current based). Based on various arrangements of the cells, widespread range of QCA logic gates and circuits are realizable [4,10,12,21-24].

Full adder is one of the most frequently utilized components in arithmetic units. In addition to its regular usage (addition), it is employed in other arithmetic operations like subtraction, division, and multiplication. For instance, multiplication could be implemented using successive additions. Hence, designing efficient QCA full adders is a key issue in QCA arithmetic circuitry [5,6,8,13,17].

Although power consumption is low in QCA technology, constructing QCA logic gates and circuits with lower power consumption has gained more importance recently. In order to measure this factor in QCA,