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Title:Design and simulation of 2-D 2-dot quantum-dot cellular automata logic
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Abstract:The quantum-dot cellular automata (QCA) computing architecture has been proposed to not only offer scalability to the molecular level, extremely low power requirements, and THz switching, but also the promise to advance the forefront of computation beyond the conceptual limitations of current technologies. The conventional QCA architecture uses cells consisting of two electrons and four logically interacting quantum dots in constructing circuitry. While this approach has been well studied, certain details with the cell structure suggest that it may not be the most efficient and optimal QCA design. Therefore, this paper presents a new 2-D QCA architecture which is lattice structured and uses clocked cells consisting of only two logically interacting quantum dots. Compared to the conventional QCA architecture, this new approach to QCA circuit design improves the design and simulation reliability by reducing the total number of electrons and quantum dots in circuitry. In addition, the new architecture exhibits periodicity and symmetry characteristics that are widely found in naturally occurring and self-assembled materials, offering hopes for researching such nanoscale materials for fabrication. Along with this new architecture, simple and complex logical constructs are presented that were verified with new simulation tools specifically developed for this purpose. © 2010 IEEE.