World Academy of Science, Engineering and Technology
International Journal of Electrical and Computer Engineering
Vol:18, No:10, 2024

A Generalized Space-Efficient Algorithm for Quantum Bit String Comparators

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Abstract : Quantum bit string comparators (QBSC) operate on two sequences of n-qubits, enabling the determination of their relationships, such as equality, greater than, or less than. This is analogous to the way conditional statements are used in programming languages. Consequently, QBSCs play a crucial role in various algorithms that can be executed or adapted for quantum computers. The development of efficient and generalized comparators for any n-qubit length has long posed a challenge, as they have a high-cost footprint and lead to quantum delays. Comparators that are efficient are associated with inputs of fixed length. As a result, comparators without a generalized circuit cannot be employed at a higher level, though they are well-suited for problems with limited size requirements. In this paper, we introduce a generalized design for the comparison of two n-qubit logic states using just two ancillary bits. The design is examined on the basis of qubit requirements, ancillary bit usage, quantum cost, quantum delay, gate operations, and circuit complexity and is tested comprehensively on various input lengths. The work allows for sufficient flexibility in the design of quantum algorithms, which can accelerate quantum algorithm development.

Keywords : quantum comparator, quantum algorithm, space-efficient comparator, comparator
Conference Title : ICQISET 2024 : International Conference on Quantum Information Science, Engineering and Technology
Conference Location : Los Angeles, United States
Conference Dates : October 28-29, 2024