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Continuous-time quantum walks as an efficient multi-qubit Toffoli gate WASHMA ANWAR, DMITRY SOLENOV, St Louis University — Non-local higher-energy auxiliary states have been successfully used to entangle pairs of qubits in different quantum computing systems. Typically a longer-span non-local state or sequential application of few-qubit entangling gates are needed to produce a non-trivial multiqubit gate. In many cases a single non-local state that spans over the entire system is difficult to use due to spectral crowding or impossible to have. At the same time, many multi-qubit systems can naturally develop multiple non-local higher-energy states that span over few qubits each. We show that continuous time quantum walks can be used to address this problem by involving multiple such states to perform local and entangling operations concurrently and efficiently on many qubits. This introduces an alternative approach to multiqubit gate compression based on available physical resources. We will present analytical and numerical results that demonstrate performance of such gates, focusing on multiqubit Toffoli gate operations.

Washma Anwar
St Louis Univ

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