

A $\Theta(\sqrt{n})$ -Depth Quantum Adder on the 2D NTC Quantum Computer Architecture

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In this work, we propose an adder for the 2-Dimensional Nearest-Neighbor, Two-Qubit gate, Concurrent (2D NTC) architecture, designed to match the architectural constraints of many quantum computing technologies. The chosen architecture allows the layout of logical qubits in two dimensions with \sqrt{n} columns where each column has \sqrt{n} qubits and the concurrent execution of one- and two-qubit gates with nearest-neighbor interaction only. The proposed adder works in three phases. In the first phase, the first column generates the summation output and the other columns do the carry-lookahead operations. In the second phase, these intermediate values are propagated from column to column, preparing for computation of the final carry for each register position. In the last phase, each column, except the first one, generates the summation output using this column-level carry. The depth and the number of qubits of the proposed adder are $\Theta(\sqrt{n})$ and $O(n)$, respectively. The proposed adder executes faster than the adders designed for the 1D NTC architecture when the length of the input registers n is larger than 51.

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1. INTRODUCTION

Quantum computers have been proposed to exploit the exotic properties of quantum mechanics for information processing. Among many potential uses, two quantum algorithms have received the bulk of the attention. One is Shor's large number factoring algorithm [Shor 1997], and the other is Grover's unstructured database search algorithm [Grover 1996], though there has also been much progress recently on other

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