Mathematica Package *QuantumCircuit* for Simulation of Quantum Computation

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In papers [1, 2, 3] we presented our Mathematica package *QuantumCircuit* for simulation of quantum computation based on the circuit model [4]. The package provides a user-friendly interface to specify a quantum circuit, to draw it, and to construct the corresponding unitary matrix for quantum computation defined by the circuit. Using this matrix, one can find the final state of the quantum memory register by its given initial state and to check the operation of the algorithm determined by the quantum circuit.

Here we present an application of the package *QuantumCircuit* to simulation of quantum circuits implementing such well-known quantum algorithm as the Shor algorithm for integer factorization. Besides, we analyze some examples of the circuits used for quantum error correction and entanglement simulation. The main purpose of the talk is to demonstrate that a proper extension of such powerful software system as Mathematica in order to simulate quantum circuits helps to better understanding of fundamental and applied aspects of quantum computation.

References

[1] V. P. Gerdt, R. Kragler, A. N. Prokopenya. A Mathematica Package for Simulation of Quantum Computation. *Computer Algebra in Scientific Computing CASC2009*, LNCS 5743, Springer (2009) pp. 106–117.

[2] V. P. Gerdt, A. N. Prokopenya. Some Algorithms for Calculating Unitary Matrices for Quantum Circuits. *Programming and Computer Software*, 36 (2010) 111–116.

[3] V. P. Gerdt, A. N. Prokopenya. The circuit model of quantum computation and its simulation with Mathematica. *Mathematical Modeling and Computational Science MMCP2012*, LNCS 7125, Springer (2012) pp. 43–55.

[4] M. Nielsen, I. Chuang *Quantum Computation and Quantum Information*, Cambridge University Press (2000).