Conflicts resolving by symmetry breaking

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Abstract - In this report is examined an algorithm for conflict resolution by symmetry breaking, which requires the exchange of only one pair of qubits in order to be reached to a solution of the problem related to conflict resolution by symmetry breaking.

Index Terms — boolean function, circuit, composition, encoding, gate, quantum.

1 INTRODUCTION

The quantum logarithm for conflict resolution by symmetry breaking shows the ability to detect correct decisions, which cannot be similarly achieved through the laws of the classical physics.

The algorithms for conflict resolution have been implemented as quantum logic circuits, which include paired qubits, which can be represented as unitary matrices. The solution can be found through the restrictions, on which these matrices must comply. The algorithm is implemented and simulated with the developed by the author of the article quantum simulator [11, 12, 13, 14, 15].

2 QUANTUM ALGORITHM FOR CONFLICT RESOLUTION BY SYMMETRY BREAKING

One of the many primitives used by the distributed algorithms is the primitive for conflict resolution by symmetry breaking. This primitive is used when there are two nodes with the same values, its purpose is to set a value of 1 to one of the nodes, and a value of 0 to the other. The algorithms for conflict resolution by symmetry breaking usually rely on some form of chance. For example, it may be necessary to go round the circle in a cycle, in which each node selects a random value between 0 and 1, after which the result shall be determined. Each time, when the random selection of the nodes coincides, the cycle is repeated. Once the nodes have already chosen different random values in a given cycle, one of the nodes receives a value of 1, and the other receives a value of 0. Until a satisfactory solution is found to this problem, may be needed hundreds of inversions of the cycle in each message. The quantum algorithms are able to coordinate better similar problems in many esoteric cases such as this one.

Solution with a quantum algorithm

For the solution of this problem is needed a quantum circuit, which should comply with the following two conditions:

1. Symmetry. On both sides must be applied identical quantum gates. All the operations, which are performed on the lines A1 and A2 must be performed also on the lines B1 and B2.
2. Anti correlation. The exit should not contain amplitudes in the states, where A1 and B1 are the same.
It should be noted that the described solution would not work completely identically upon implementation of a quantum computer. ISISKA approximatively minimizes the interferences, which would have been optionally bigger upon implementation with a quantum computer. However, the thus established quantum algorithm (scheme) ensures at 100%, that the sought solution will be found only after one cycle, as is also the goal. In addition, the algorithm needs only one exchange of qubit.

Working solution
Detailed examination of the solution and monitoring of the development/change of states of the system during the implementation of the circuit. In order to simplify the verification will be ignored the factors from $\sqrt{2}$.

The initial state is: $|0000\rangle$

The first operation, which each side performs is: the creation of a twisted pair. In this way first and the last two qubits are initialized in the same superposition on two- qubit space. This is the only communication step in the algorithm:

$\rightarrow$split1$(|1\rangle|0\rangle|0000\rangle+(1+i)|0110\rangle|1010\rangle|0000\rangle$  
$\rightarrow$split2$-(i)|0000\rangle+(1+i)|1010\rangle$,$(1010\rangle|0011\rangle|1101\rangle+(1+i)|0000\rangle$  
$|1|0000\rangle+(1+i)|1010\rangle|$,$(1010\rangle|0011\rangle|1101\rangle+(1+i)|0000\rangle$  
$|1|0000\rangle+(1+i)|1010\rangle$,$(1010\rangle|0011\rangle|1101\rangle+(1+i)|0000\rangle$  
$|1|0000\rangle+(1+i)|1010\rangleurchases$  
$|1|0000\rangle+(1+i)|1010\rangle$,$(1010\rangle|0011\rangle|1101\rangle+(1+i)|0000\rangle$

As can be seen from the above described scheme, at the final state of the first and third qubit - both sides always differ

3 Conclusion
This report describes the quantum algorithm that require the exchange of only a single pair qubits to reach the solution to the problem associated with the resolution of conflicts by symmetry breaking.

References