EVOLUTIONARY LOGIC DESIGN OF REVERSIBLE/QUANTUM DEVICES

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In recent years, artificial intelligent methods have been widely used to solve optimization problems. In particular, the evolutionary logic design has proved to be fruitful enough in developing the reversible/quantum devices [1,2]. In the paper, we have used the genetic algorithms to synthesize such devices of ternary logic.

The idea of reversible computing is that the information in its processing, transmission, and storage does not lost at a logical level when mapping of the input to the output sets is bijective. Reversible calculations, as shown theoretically and recently confirmed experimentally, do not lead to a loss of the thermal energy [3]. Therefore, reversible devices can be successfully used in the low-power digital devices, bioinformatics, and quantum computing.

In this work, the adaptive genetic algorithm was used to find the optimal circuits of combinational and sequential reversible/quantum devices. In particular, we designed the schemes of full adders, subtractors, multiplexers, comparators, various latches and flip-flop devices. The method for encoding circuits (chromosomes) and automating the selection of fitness-function parameters are proposed. The basic gates are the permutative one- and two-inputs Muthukrishnan-Stroud ternary gates [4]. The selected gate basis is shown to be functionally complete and may be physically realized. The obtained devices have a minimum quantum cost, a minimum number of constant inputs and garbage outputs, a minimum delay time, and also do not contain fun-out, which follows from the no-cloning theorem in quantum circuits. The proposed method, simultaneously with the solution of the synthesis problem, allows testing of the obtained schemes. The latter circumstance is connected with the fact that the condition for the end of the genetic search is the absence of errors in the final truth table. A detailed comparison with the results of the other studies is made and the advantages of the chosen synthesis method are shown.

The use of the genetic algorithms in the search and testing of the optimal circuits for the reversible/quantum synthesis of ternary digital devices has shown several advantages over analytical and graphical methods.

Keywords: *Reversible computations, genetic algorithm, combinational and sequential circuits.*

References

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