

Polymorphic circuit design

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Polymorphic circuits consist of common gates (e.g. NAND, NOR) and polymorphic gates. These gates are unconventional logic components which can switch their logic functions according to a changing environment. The environment can be a temperature, a light, a power supply etc. So, the polymorphic circuits can also change their character according to the environment.

A common example of a real polymorphic gate is component which realises NAND function when the power supply is 5V and realises NOR function when the power supply is 3.3V. So, a couple of these gates can be utilized in a circuit which realises a multiplication or a binary sorting depending on the power supply.

A polymorphic circuit research takes place in two main areas: 1. multifunctional polymorphic circuits and 2. polymorphic circuits with diagnostic features. Ad 1., the circuits realise two or more logic functions. The functions are selected by an environment. Ad 2., these circuits usually provide only one logical function. Polymorphic gates save area of a checking mechanism in these circuits.

My area of interest is focused to the multifunctional polymorphic circuit design. The design is not trivial task. There is not a mathematical equipment which covers all area of the design. An easy way to design is to use an evolutionary design. Cartesian Genetic Programming method which is well-established in a circuit design on gate-level. This method can design effective circuits but has its limitations. The main limitation of the method is a scalability problem. It means that evolutionary design can evolve small circuits. Large circuits cannot be evolve because of a huge search space and a computational power consuming validation.

A conventional design can deal with the scalability problem. Nowadays, there are known two methods: 1. method which uses combinational circuit design methods and 2. method which is derived from a knowledge of Binary Decision Diagram construction. Ad 1., there are designed two or more separated circuits which implement required functions. The circuits are composed into a circuit in a way where outputs of circuits are connected to polymorphic multiplexers. Ad 2., simple one-input one-output polymorphic circuits are connected to a net of multiplexers there.

The polymorphic circuit design is introduced in the journal [1].

References

1. Sekanina Lukáš, Stareček Lukáš, Kotásek Zdeněk, Gajda Zbyšek: Polymorphic Gates in Design and Test of Digital Circuits, In: International Journal of Unconventional Computing, Vol. 4, No. 2, 2008, Philadelphia, US, p. 125-142, ISSN 1548-7199