Review of the Dissertation Thesis

Thesis Title: Automated Multi-Objective Parallel Evolutionary Circuit Design and Approximation
Author: Ing. Radek Hrbáček
Supervisor: Prof. Ing. Lukáš Sekanina, Ph.D.

The Dissertation thesis proposes a CGP-based approximate circuits design method. Particularly, the main contributions can be summarized as:

1. **Exploiting parallelism in Cartesian generic programming (CGP)**. Here the author uses parallelism at different levels, which includes the instruction (machine word) level parallelism, thread parallelism, using GPGPUs, and the Xeon Phi Coprocessor. As a result, s significant speedup and parallel efficiency is achieved.
2. **Extension of CGP for multi-objective optimization.** Here several quantitative aspects are assumed in the fitness function computation, to produce pareto-optimal solutions. This is especially important for the next contribution,
3. **CGP-based design of approximate circuits.** A big deal of work has been done here, ending up in a TMR-based approximate and fault-tolerant design method presented in highly impacted IEEE Transactions on Reliability.

From my point of view, "minor" contributions, in sense that they do not directly follow the main stream of the thesis, are:

1. **Extension of CGP to support real technology primitives (standard cells),**
2. **detailed and precise calculation of network delay and power consumption,**
3. **CGP-based design of bent functions.**

The thesis topic just follows the one of the most recent research areas: the design of approximate circuits. In this sense, the thesis topic is timely without doubt.

The contribution of the thesis is really significant, it advances the state-of-the-art in many aspects, as mentioned above.

The body of the dissertation thesis is constructed as a collection of papers, with a very good self-containing supplementary text. From the formal point of view, I have absolutely no objections. The text is very well written, in an excellent language, with just a few typos.

Chapter 1 brings the motivation, open problems in the field that are to be solved and the research objectives.

Chapter 2 summarizes the state-of-the-art of approximate computing and evolutionary design of circuits.

Chapter 3 presents the outcomes of the applicant's research, in terms of presenting abstracts of the papers with a short discussion provided.

Chapter 4 concludes the Thesis and proposes directions for further research.

Individual contributions of the work have been published in 6 papers at highly ranked conferences, one journal paper in IEEE Transactions on Reliability, 7 papers at other conferences, and 3 papers in internet journals. Therefore, the student's publication activity is very good. He also obtained 7 awards, either from the conference (best paper awards), or for his excellence in study.

Questions to the discussion

1. You have mentioned approximation of sequential circuits apart from combinational ones. Could you discuss it a little bit more? What are the differences?
2. Would CGP, in principle, be able to design sequential circuits too? If so, what modifications would have to be made for this purpose?

Judging from the above, it can be concluded that the applicant is highly scientifically qualified. He has proven the ability to conduct his own research and publish the results at very good conferences and impacted journals. Therefore,

I do recommend

the submitted thesis for the presentation and defense with the aim of receiving the Ph.D. degree.

In Prague, 17. 9. 2017

doc. Ing. Petr Fišer, Ph.D.
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