Review of PhD Thesis

Author: **Ing. Dina Younis**

Title: **Residue Number System Based Building Blocks for Applications in Digital Signal Processing**

Reviewer: **Prof. Ing. Jaromir Brzobohaty, CSc.**

The thesis deals in detail with the advantages of the residue number systems (RNS), their implementations, analysis of the main criteria and the cases in which the system is more advantageous than the standard binary systems for the use in digital signal processing (DSP).

The subject of the thesis well corresponds to the field of the thesis and still belongs among the up-to-date research interests of the world scientific community of this field in spite of the fact that the discipline and its main progress culminated long time ago. It can be now considered as certain re-discovering of this subject matter and the main attention is now paid to the new structures and applications. From this point of view the dissertation deals with up-to-date facts and brings new insight into some of them.

The aims of the thesis are clearly stated and the main of them consists in the design, simulation and FPGA implementation of the RNS based building blocks for applications in DSP, e.g. binary- to- residue converter, residue-to- binary converter, residue adder and residue converter. All the details of the aims are defined on the page 6 of the shortened version.

The core of the thesis is presented mainly in the chapter 3. This chapter analyses especially the most efficient modulus sets for various dynamic ranges, which is studied in details, the enhancement of the performance of binary-to-residue converters, the novel proposal of residue arithmetic units, the novel algorithm for reverse conversion including an efficient reverse converter based on this idea, the residue comparator implemented on Virtex FPGA for various dynamic range representation, the universal and efficient approaches to overflow and sign

detection and correction in the addition of two numbers, the RNS-based image processing application using a number of filters in spatial domain on a gray-scale image and the most important binary vs. RNS detailed considerations, especially those concerning the timing performance of additions and multiplications. The main conclusion of this consideration is that using the RNS is more advantageous in the applications having large and very large dynamic ranges and contain more multiplications rather than only additions. The iterated operations are also evaluated.

The thesis also discusses the differences and improvements in the designed algorithms in comparison with the used standard solutions but it also shows the disadvantages in some complex arithmetic operations.

In detail the thesis describes some examples of the RNS applications and demonstrates not only their advantages but also their disadvantages.

When evaluating the overall results, novelties, and contributions of the thesis I can conclude that it does not bring one great novel solution of the problem but a considerably large set of "smaller" but original contributions of great importance namely for the practical implementation of RNS in modern DSP.

In the thesis I did not find any negative or incorrect parts except for some minorities in terminology and, on the contrary, I must very positively evaluate the good level of technical English in the thesis.

Regarding the publication activities of the author I can summarize that a great part of the thesis was presented on several international and local conferences and some selected part were published I reviewed journals. In total 11such contributions are presented and some others are in review.

All the above mentioned positive facts prove that the candidate has a very good scientific erudition and well balanced approach to the scientific and practical problems. In addition of that I have to emphasize even the very good pedagogical results of the candidate in teaching the practicals in the field of digital circuits in both Czech and English languages. Also the fluent knowledge of 5 languages-Czech, English, Russian, German and Arabic is rather unusual in our community.

As a conclusion I can declare that Ing. Dina Younis meets all the requirements given by the rules in force for awarding the title PhD and for this I give my full recommendation .

I ask the following questions:

1. In the design of the overflow detection you recommend to avoid using it. Could you clarify the reasons?
2. In the thesis you have tendency to use modulo (2n-1) instead of (2n+1). Why do you not prefer the most common (2n-1, 2n, 2n+1)?
3. Do you know any idea about the integer division in RNS?

In Brno, November 17, 2013,

Prof. Ing. Jaromir Brzobohaty, CSc

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