

14. 11. 2013

**Report on the Examination of the Thesis by Dina YOUNES Entitled:**  
**RESIDUE NUMBER SYSTEM BASED BUILDING BLOCKS FOR APPLICATIONS**  
**IN DIGITAL SIGNAL PROCESSING**  
**(VYUŽITÍ SYSTÉMU ZBYTKOVÝCH TŘÍD PRO ZPRACOVÁNÍ DIGITÁLNÍCH**  
**SIGNÁLŮ)**

Submitted thesis deals with designing residue number system (RNS) based building blocks for applications in the field of digital signal processing (DSP). Though this method is very old and was worked out among others by Gauss and applied also in the first Czech computers Epos, lot of published papers during the last years make this theme very actual. Thesis by its alignment belongs to the branch Microelectronics and technology and is disposed on 106 pages, including appendix.

The first part – introduction – describes basic ideas and conceptions, advantages and disadvantages, basic architecture of RNS, and its history.

The second chapter presents a summary of the fundamental principles of the RNS and state of the art, mainly in the area of moduli set selection, RNS converters (binary to residue converters, residue to binary converters, residue arithmetic units) and RNS applications.

Aims of dissertation were given in the third chapter. The main objectives are in headline, realized by designing, simulation and FPGA implementation of RNS based building blocks for applications in the field of DSP, improving these building blocks by developing new algorithms and improving existing ones.

Next chapter deals with own results of dissertation. Most of the designs were implemented on FPGA boards. At first, study on the effect of the moduli number in the moduli set on the overall speed of the RNS is presented. Results of this part have been published in two international conferences. Other parts of this chapter are dealing with design and evaluation of forward and reverse converters and residue arithmetic units (modular adders, subtractors and multipliers) for different dynamic range. For reverse conversion two converters with different function principle were proposed and compared. The first was residue to binary converter based on a new CRT-I and the second one was mix radix convertor (MRC). Parameters of both converters were compared by means of FPGA. For an improvement of reverse conversion, novel algorithm was proposed and new connection of converter was designed and evaluated. Proposed algorithm for reverse conversion has been also used for comparison of residue numbers in their RNS representation. Obtained results were published in journal. Next parts of this chapter are devoted to the overflow detection. Proposed methods depend on a simple structure that provides fast and accurate detection and correction of the sign and overflow. Image processing application is presented in the last part of this section. The proposed solution proves that using the RNS results in faster and power-reduced image filtering applications. These designs are also published in international conferences and in ElectroScope journal.

Important contribution of this chapter is also given in this section, illustrating the main issues that should be taken into account when deciding to use RNS instead of BNS. The effect of the critical modulo within a moduli set has been studied with result that delay of the residue

arithmetic unit corresponding to the critical channel is less than the delay of its equivalent binary arithmetic unit. As well as RNS is more profitable in applications that have large and very large dynamic ranges and contain multiplications rather than only additions.

The fifth chapter presents summary of theoretical and practical results of dissertation, which can lead to new sights and solutions in the field of the residue number systems.

Dissertation thesis is written in English language by the clear form without any mistakes, its form responds to the requirements, also graphical elaboration is on very good level. Selected methods of solution are according the thesis requirements. The aims of thesis have been carried out.

The results achieved in the thesis were published in four journal articles and eight conference contributions, where candidate is coauthor. Except this, she is coauthor of other seven conference papers. These results were, according my opinion, sufficient put under control and their acceptance is indicative of proper level of subject and elaboration.

My question to the candidate is as follows:

In conclusions of your dissertation you mentioned term "super-efficient" applications. Can you explain what is meaning of this term and how it is possible to reach such system (sw and hw)?

Finally, I state that the submitted thesis has shown in a convincing manner that the candidate, Ing. Dina YOUNES is capable of performing good scientific work. It is therefore recommended without hesitation that the thesis be accepted by the faculty as a document satisfying the requirements for the award of a doctorate.

A handwritten signature in black ink, appearing to be 'Dina YOUNES', written in a cursive style.