Review of Dissertation Thesis

Title: ACCELERATION OF 2D WAVELET TRANSFORM ON PARALLEL ARCHITECTURES

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I was given to review the above stated Ph.D. thesis dated from the year 2021. The thesis has 128 numbered pages and consists of twelve chapters (1. Introduction, 2. GPU Processing, 3. Discrete Wavelet Transform, 4. Goals of the Thesis, 5. Wavelet Transform Framework, 6. Article: 2-D Discrete Wavelet Transform Using GPU, 7. Article: Block-based Approach to 2-D Wavelet Transform on GPUs, 8. Article: Parallel Wavelet Schemes for Images, 9. Article: Accelerating Discrete Wavelet Transforms on Parallel Architectures, 10. Article: The Parallel Algorithm for the 2-D Discrete Wavelet Transform, 11. Summary, Applications and Future Work, 12. Conclusion).

The work focuses on the important and demanding problem. Discrete wavelet transform (DWT) is an important and frequently used operation, e.g. in JPEG 2000 compression. Up to now, the researches are striving to present efficient algorithms for DWT in various contexts.

The first chapters (1-3) summarise the needed background, which is done in an appropriate way. In Chapter 4, the goal of the thesis is presented, which is to achieve certain speedups of 2D DWT on parallel computing architectures. In Chapter 5, a certain framework is described; I understand it in such a way that this framework was used as an environment in which the particular algorithms presented in the thesis were developed and tested.

The contributions of the author are presented in Chapters 6-10. These chapters contain the papers of the author (possibly reformatted) from the conferences and journals with a short introduction summarising the content of the paper. The papers are dated from the years 2014, 2016, 2019, 2017, and 2017. The author of the thesis declares his contribution to the papers as 30%, 50%, 40%, 25%, and 20%, respectively. In one paper, he is the first author. In the remaining papers, his position varies from the second to the fourth place. The particular papers seem to be well written, with rational background, and with appropriate details, including evaluation of the results. From the papers, I came to the opinion that the author got perfectly acquainted with the details of 2D DWT and GPU programming. Since the papers have already been published, I do not comment on the details presented in them.

I regard this form of the thesis (a collection of papers) as possible (I leave the question of the declared contributions of the author aside for now). In spite of this, however, I would prefer a traditional text of the thesis presenting continuously what has been done (not particular papers). Such a text would not only be better readable, but also more interesting. For example, in such a text, the author could present his today's opinion (now, with his final "doctoral experience") on his previous activities/papers. Since the properties of the GPUs are still evolving, it is not excluded that the author could see the importance of his ideas from 2014 (for example) in a little bit different light today. Moreover, possibly improving quality of the compilers for GPUs might play a certain role too. It would also be possible to compare now (after inventing several methods) the importance of particular approaches and ideas that have been invented by the author and are presented in the papers etc. (such a final reflection should also be a part of doctoral study). Nevertheless, I must admit that I can see the effort for certain integration of the particular chapters at least in the conclusion.

I have the following questions: (i) Are the considerations and solutions that were carried out for the cards like GTX 580 (mentioned in the first paper) still valid also for the last cards like NVIDIA RTX 20.. or 30.. in today's CUDA environment? (ii) Are your algorithms running somewhere in practice? For example, did you try to integrate them into a J2K codec or viewer? Otherwise, what was the motivation for focusing on this particular topic (which seems to be relatively narrow, at least from the point of view of Ph.D. thesis)? (iii) If so (i.e. the algorithms were used somewhere), what benefits

did you see? For example, what would be the result of comparison with, for example, GPU JPEG2000 codec from Fastvideo (since they claim that they are very fast)?

Summary: The thesis focuses on the important and demanding topic. The author has proven his ability for research work. He proposed solutions to the problem that was opened in the thesis. The solutions have been evaluated experimentally, the experiments have shown that the solutions are useful. The ideas presented in the thesis have been presented in the journal and conference papers. In the SCOPUS database, 8 items for the author are registered; with 16 citations in total. On the basis of all this, *I recommend the thesis for the defense*.

Ostrava, August 29, 2022   doc. Dr. Ing. Eduard Sojka
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