Résumé of the thesis

The topic of the thesis is this Segmentwise Discrete Wavelet Transform, segDWT. The segDWT was originally created by Mgr. Pavel Rajmic, and the topic of this thesis are several extensions of the segDWT.

In Chapter 1 the author presents an overview of general wavelet theory. He presents the Mallat algorithm, the relation to filterbanks, the typical border extensions, the lifting scheme and multi-dimensional signal processing using tensor products of wavelets.

In Chapter 2, the author does a thorough literature review of existing methods, and states his motivation for the rest of thesis, namely that classical approaches to segmenting a wavelet transform leads to distortion at the borders, except for the segDWT algorithm, which is then described and extended in the rest of it chapters.

In Chapter 3, he presents several shortcomings of the segDWT, whose solution for the work of the thesis:

• Generalize the length of the left extension $n_{L_{\text{max}}}$
• Shortening of the overlap between segments
• Allowing for segments of arbitrary sizes, which are important for the extension to multi-dimensional signals
• Extension to causal signal processing by removal of the right border extension

Chapter 4 contains the main extensions of the original segDWT, forming the main work in the thesis. It adresses the challenges of Chapter 3 in all relevant details.

Chapter 5 contains the extension of the ideas in Chapter 4 to use the lifting scheme.

The extremely short Chapter 6 contains the extension to multidimensional systems using tensor product wavelets.
Chapter 7 presents two applications of the improved segDWT: a real-time processing plugin for the VST framework, and a parallel implementation of the segDWT using the Intel TBB library. For both applications, the additional flexibility offered by the new segDWT is the enabling factor in making the implementations possible. Specifically, Figures 7.3 - 7.5 display actual timings of the algorithm in a multi-processor framework.

Overall, the thesis covers the motivation and extensions of the segDWT in all details. It presents the previous state of the art, the motivation for the proposed changes, and generally goes through all possible variations of OLA algorithms, filterbank vs. lifting schemes etc. The thesis provides a complete "manual" of the segDWT algorithm for anyone wishing to understand or tailor the algorithm to a specific need. However, more explicit comparisons to previous methods could have been included, as only figures 2.1 and 2.3 provide actual references to other methods. Also, there are no explicit flop counts in the thesis.

Questions

1. On page 28, problems are described in the papers [39] and [41]. Please choose one of the papers and present some justification of the encountered problems in form of figures or demonstrations.

2. Please provide some flop counts:
   
   (a) In Section 4.1.1, what is the effect on the computational complexity of the segDWT of varying the left and right extensions?
   
   (b) Please provide a count of the computational complexity of the generalized segDWT algorithm. Compare the flop-count to the standard Mallat algorithm. What is the general cost of segmentation?
   
   (c) Please provide a count of the computational complexity of the generalized lifting segDWT algorithm. Compare the flop-count to the standard lifting algorithm. What is the general cost of segmentation? What is the computational benefit of the lifting segDWT algorithm as compared to the filterbank segDWT?

3. On Figure 7.5, please explain why there is hardly any speedup from 1 to 2 processors. It seems that if the running time for 1 processor was calibrated differently, there would be an almost linear speedup with the number of processors. Please elaborate.

Recommendation

This reviewer wholeheartedly recommends that Zdeněk Pruša is awarded the Ph.D. degree on a successful defense.