

Abstract

The discrete wavelet transform is a widely applied mathematical tool used among others fields in computer graphics and multimedia. With the start of its widespread use, the need for its efficient implementation in terms of performance and power consumption is becoming increasingly more important. Our research is focused on accelerating wavelet transform calculation on traditional processing units (CPU), modern graphics cards (GPU), and other platforms (FPGA). For this purpose we created several novel schemes. Speedup of the calculation using these schemes are evaluated by multicore CPU, Xeon Phi and GPU architectures.

Abstrakt

Diskrétní vlnková transformace je matematický aparát, který je používán napříč širokým spektrem odvětví, mezi které patří mimo jiné počítačová grafika a multimédia. Díky velkému rozšíření je kladen důraz na efektivní implementaci co se týče výkonu a spotřeby energie. Náš výzkum se zaměřuje na akceleraci výpočtu vlnkové transformace na klasických procesorech (CPU), moderních grafických adaptérech (GPU) a ostatních platformách (FPGA). Pro tento účel jsme vytvořili několik nových schémat. Urychlení výpočtu pomocí těchto schémat jsme ověřili na vícejádrových procesorech, koprocesoru Xeon Phi a grafických adaptérech.

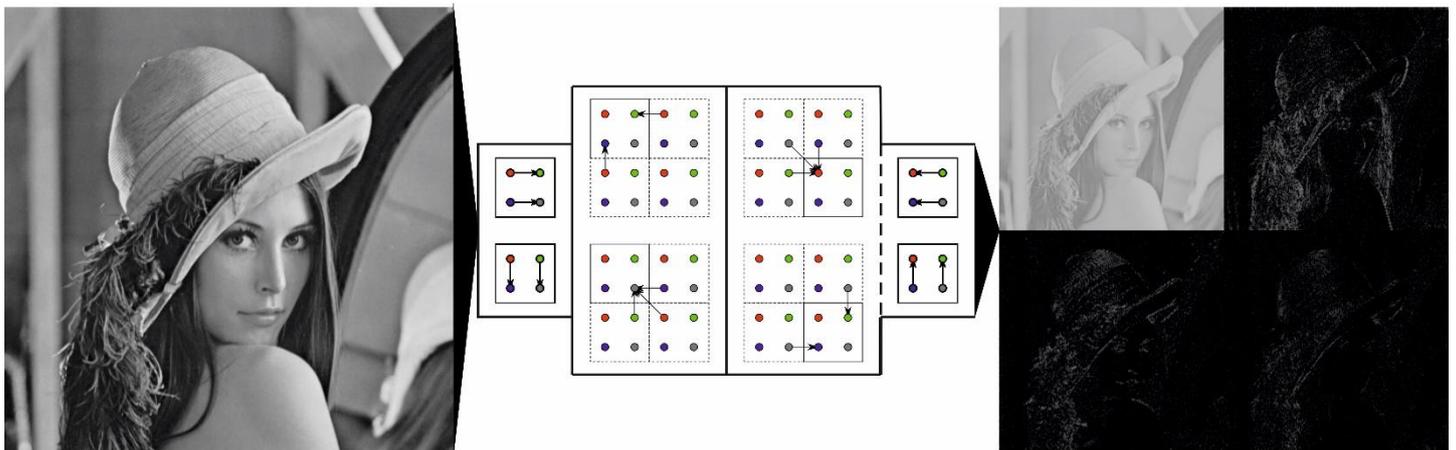


Figure 1: Single level of 2D wavelet transform.

The image processing applications of the wavelet transform include tone mapping, compression, contrast enhancement, watermarking, edge detection, or de-noising. Figure 1 demonstrates a single-level wavelet transform of a grayscale test image (Lena image). You can easily see four resulting sub-bands of the wavelet decomposition.

Our Research

Widely used methods that calculate responses of the wavelet transform includes bank of FIR filters (convolution scheme) and lifting scheme. These schemes are typically calculated separately for each dimension. We found this schemes as an extremes in the two dimensional field that contains number of arithmetic operations and number of steps. Number of steps is connected to number of synchronizations in parallel systems that is demanding typically on systems where price of synchronization is rather high. Number of arithmetic operation is limiting calculation speed due to device processing power. We found several novel schemas that is in-between these two extremes. These novel schemes are implemented in several parallel languages that is together suitable to run on almost all generally used platforms.

1. OpenCL implementation is made for modern unified GPU architectures.
2. Shader implementation is made for all GPU architectures including Non-unified mobile GPUs like widely used Mali 4xx.

3. OpenMP implementation with SIMD extension is made for modern processors and Xeon Phi coprocessor

Results

Comparison of our best scheme (denoted by optimized non-separable lifting) with separable lifting scheme on 4 different platforms can be found on Figure 2.

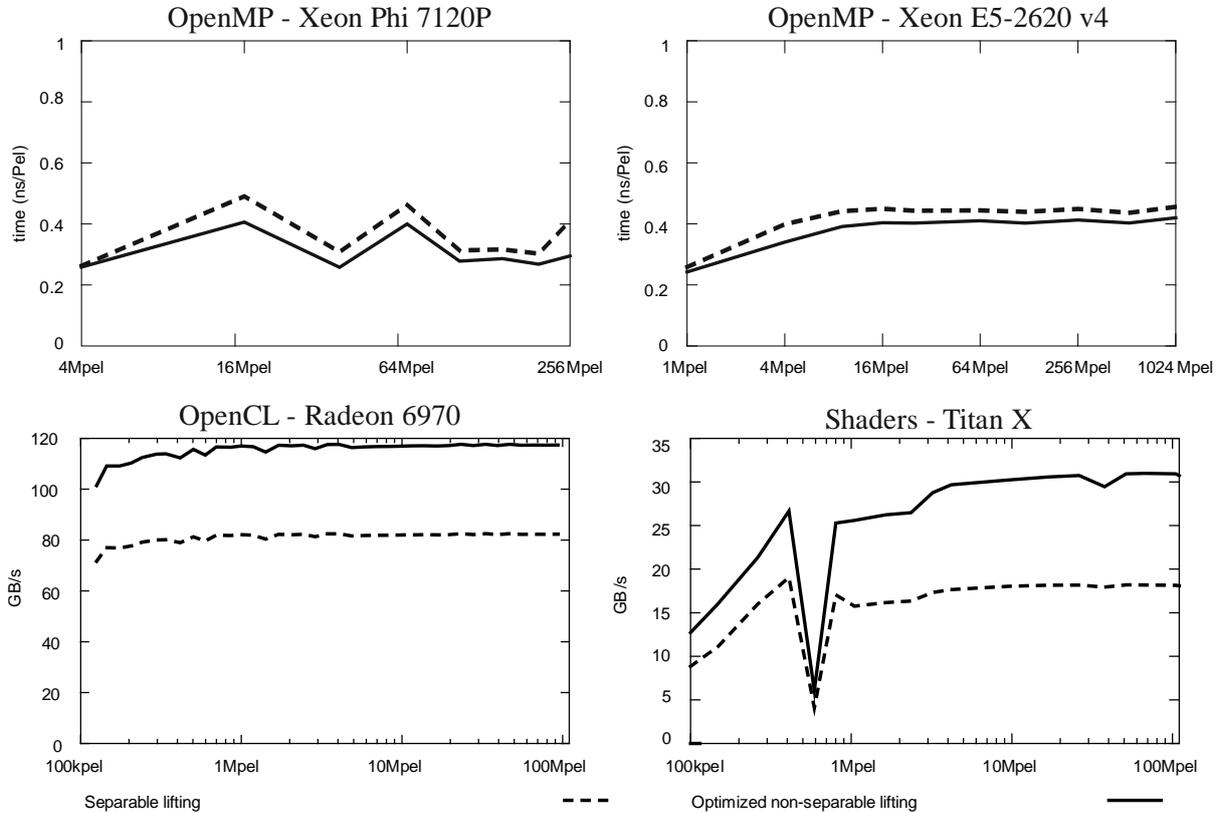


Figure 2: Comparison of wavelet transform schemes

Title: New schemes for 2D Wavelet transform
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