

“Design, Evaluation and Optimization of the Wavelet Transform for Medical Video Coding in Single Processor Architectures”

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In the last few years, there has been a considerable increase in the volume of medical images and video generated in hospitals. The medical multimedia information is different from other multimedia data because of its particular properties (integrity, confidentiality, security, quality, etc). There are legal and strict regulations applied to medical multimedia information, since the health of a patient depends on the correctness and accuracy of this information. Most of the medical history of a patient must be kept and stored since legislation requires all captured healthcare information to be preserved for a certain period of time (typically 5-10 years) before it can be deleted. Thus, hospitals must deal with very high storage requirements and bandwidth networks.

In this work, we present a new lossy video compression scheme, based on the use of the 3D Fast Wavelet Transform (3D-FWT). This encoder achieves high compression ratio and a quality excellent from the point of medical view, because there are no differences between the original and the reconstructed video. On the other hand, we propose several techniques to allow the real-time video compression and transmission of the 3D-FWT in single processor architectures. We mitigate the memory problem by exploiting the memory hierarchy of the processor using the blocking techniques. We also put forward the reuse of previous computations in order to decrease the number of memory accesses and floating point operations. Afterwards, we present several optimizations that cannot be applied by the compiler due to the characteristics of the algorithm. On the one hand, the Streaming SIMD Extensions (SSE) are used for some of the dimensions of the sequence (y and time), to reduce the number of floating point instructions, exploiting Data Level Parallelism. Then, we apply loop unrolling and data prefetching to specific parts of the code. On the other hand, the algorithm is vectorized by columns, allowing the use of SIMD instructions for the y dimension. The integration of the previous proposals involve a first step to the automatization of the convergence between multimedia applications and multimedia extensions. Moreover, this work evaluates the 3D Wavelet Transform Encoder on a Simultaneous Multithreading (SMT) architecture like Intel's processors with HyperThreading Technology. In particular, we present two approaches: data-domain and functional, that differ in the way the decomposition of the application is performed. The first approach is based on data division, where the same task is performed simultaneously by each thread on an independent part of the data. In the second approach, the processing is splitted in different tasks that are executed concurrently on the same data set. The functional decomposition obtains better results than the data decomposition. This conclusion may apply to similar applications such as MPEG-2 or MPEG-4.

The 3D-FWT encoder shows an increment in the compression ratio between 40% and 70%, maintaining the same video quality. On the other hand, the different proposals reduce the execution time of up to 363%.