SPIRAL: A Generator for Platform-Adapted Libraries of Signal Processing Algorithms*

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Abstract

SPIRAL is a generator of libraries for fast software implementations of signal processing transforms. These libraries are adapted to the computing platform and can be re-optimized as the hardware is upgraded or replaced. In this overview talk we explain SPIRAL's infrastructure and its main components: the mathematical framework that concisely describes signal transforms and their fast algorithms, the formula generator that captures at the algorithmic level the degrees of freedom in expressing a particular signal processing transform; the formula translator that encapsulates the compilation degrees of freedom when translating a specific algorithm into an actual code implementation; and, finally, an intelligent search engine that finds within the large space of alternative formulas and implementations the "best" match to the given computing platform. In summary, SPIRAL automatically co-optimizes the implementation in the mathematical domain (space of algorithm, or formulas) and in the implementation domain, and thus, in a sense, mimics an algorithm expert and an expert programmer, collaborating to find the best implementation.

Figure 1 compares the runtimes of fast Fourier transform (FFT) implementations of FFTW (C-code), SPIRAL generated C-code, SPIRAL generated short-vector code (SSE), and the Intel Math Kernel Library (short-vector code). For sizes 2^n, $n < 10$, SPIRAL generated short-vector code is fastest, even outperforming the hand-coded Intel vendor library.

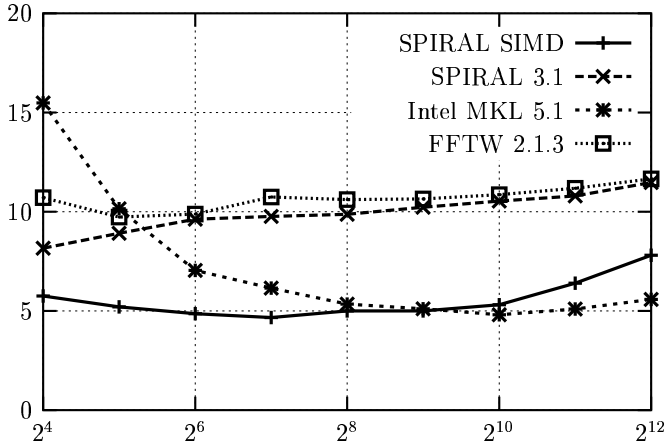

Figure 1: Normalized runtime ($t/(N\log(N))$) for a complex FFT of size $N = 2^n$, $4 \leq n \leq 12$. The platform is a Pentium III, running Windows 2000, using the Intel C compiler 5.0.

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