ACOUSTICS2008/2656
Transverse vectorization of fast Fourier transforms on multicore architectures

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Single-instruction, multiple-data (SIMD) multicore computing architectures, such as the IBM Cell Broadband Engine Architecture, offer new opportunities for quickly and efficiently calculating the 1D-FFT of acoustic signals, as time-sampled data arrays can be naturally partitioned across the multiple cores on which vectorized implementations of the FFT operate. Building on this parallel pipeline model, we consider the case that M data arrays of length N reside within each core. Whereas the cost of sequentially executing these M FFT's conventionally scales as $\alpha MN\log_2 N$, we demonstrate a transverse vectorization solution whose cost scales as $\alpha\beta N\log_2 N$, where α and β are constant scaling factors. Our approach makes use of the SIMD instruction set and large vector register file inherent to each core of the IBM Cell in order to calculate the FFT of M data arrays simultaneously. By efficiently using all the available vector registers in performing the FFT, this transverse SIMD vectorization solution further reduces the computational complexity of the conventional parallel pipeline model.