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KARHUNEN-LOEVE TRANSFORM ON GPU COMPUTING

Abstract

In recent years, the Graphics Processing Unit (GPU) has gone from being a limited and specialized computer peripheral, to processors that have found application in a wide variety of fields from image and signal processing to physics and biological simulations, Signal processing in particular is one area in which implementation on the General-Purpose Computation on Graphics Processing Units (GPGPU) could dramatically improve the performance of algorithm that often require parallelism in processing input data, like for example FFT or PBF (Polyphase Bank Filter), and in particular Karhunen Loeve Transform (KLT), that is the focus of this work. This mathematical algorithm running in KLT is superior to the classical FFT in that: 1) The KLT can filter signals out of the background noise over both wide and narrow bands. On the contrary, the FFT rigorously applies to narrow-band signals only. 2) The KLT can be applied to random functions that are non-stationary in time, i.e. whose autocorrelation is a function of the two independent time variables t1 and t2 separately. Again, this is a great advantage of the KLT over the FFT, since the FFT rigorously applies to stationary processes only, i.e. when the autocorrelation is a function of the absolute value of the difference of t1 and t2. The KLT can detect signals embedded in noise to unbelievably small values of the Signal-to-Noise Ratio (SNR), like 103 or so, that is the most important application for SETI post-processing and near real time application. The purpose of this work is to study an optimized way to implement KLT algorithms on GPU units, analyzing both synthetic and real spectral line radio signal with very low SNR (Signal to Noise Ratio).