A Computationally Efficient Multi-coset Wideband Radar ESM Receiver

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Abstract

The problem of efficient sampling of wideband Radar signals for Electronic Support Measures (ESM) using a parallel sampling structure is investigated in this paper. Wideband radio frequency sampling, which is a necessary component of modern Radar surveillance systems, generally needs a sampling rate at least twice the maximum frequency of the signal, *i.e.* Nyquist rate, which is generally very high. However, when the signal is highly structured, like Radar signals, we can use the fact that signals do not occupy the whole spectrum and instead, there exists a parsimonious structure in the time-frequency domain. Here, we characterise a novel low-complexity sampling system with a recovery guarantee, assuming that received RF signals have a particular structure. The proposed technique is inspired by the compressive sampling (CS) of sparse signals and it uses a multi-coset sampling setting, while it does not involve a computationally expensive reconstruction step. The new framework is comparable with current rapid frequency sweeping technique, while it continuously monitors the spectrum. It is thus affected from short pulse misidentification. On the other hand, like other CS based sub-Nyquist sampling techniques, it suffers from noise folding effect.

I. Introduction of the New Framework

The Radar ESM signals are wideband and they normally exceed the sampling-rate/dynamic-range specifications of standard (single-unit) ADC's. One approach to sample such signals, is to use a bank of sub-Nyquist ADC's, each delayed with a distinct factor. We here use only a few ADC's, called a multi-coset sampling system [1], and propose a low-complexity algorithm for the recovery of full-band input signals. The schematic of such a system is shown in Figure 1, where TF can be an appropriate Gabor Time-Frequency transform, which includes a large class of TF transforms, and subband classifier includes a linear transform, followed by a simple max-absolute operator. The fractional delay filters can be implemented very efficiently, by absorbing into the TF transform. The delays in the proposed framework are selected to guarantee a robustness to the misdetection, due to the input noise, using the parameters of a maximally incoherent harmonic frame.

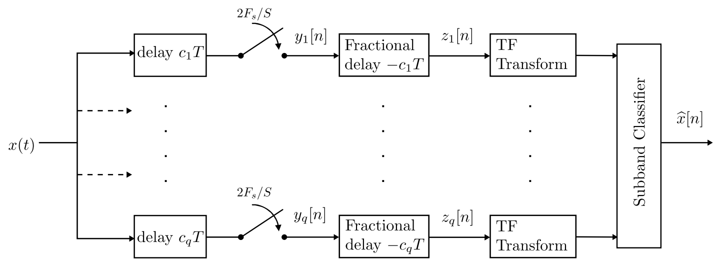

Fig. 1. The proposed low-complexity sub-Nyquist sampling system.

For the demonstration, we used 4 channels and a simulated ESM signal[1], which was undersampled with a factor of 13 in each channel. In Figure 2, we have shown the original noisy signal in left panel (a), the reconstructed signals using the proposed and a subspace method, which is proposed in [1], in the middle (b) and right (c) panels, respectively. While the proposed method is computationally cheaper, it performs better than the canonical method, in the SNR of sampled ESM signals.

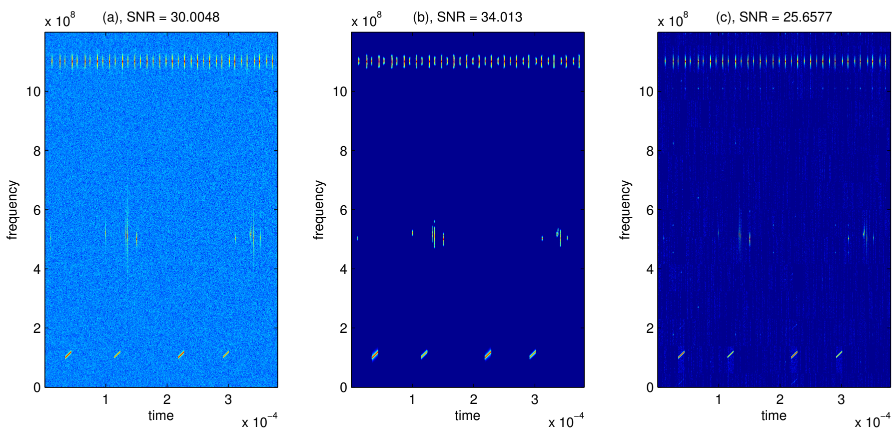

Fig. 2. ESM signal reconstruction using proposed method (b) and a subspace method(c). The original noisy signal is shown in (a).

References

[1] P. Feng and Y. Bresler, "Spectrum-blind minimum-rate sampling and reconstruction of multiband signals," in *IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP)*, vol. 3, 1996, pp. 1688–1691.

[1]The pulse information was kindly provided by Thales UK.