Supplemental Materials

This document provides additional experiments that supplement those presented in Section IV.A.

A. Verification with BPSK signal

Fig. 1 is validated through the use of a noise-free BPSK signal with a symbol rate of 0.1 and a carrier offset of 0.05. We compare the cyclic frequency at 0, 0.1, 0.2 and 0.3 with reference to theoretical expectations. In Fig. 1, the result of conventional strip spectral correlation analyzer is denoted as SSCA, and S^{3}CA represents the sparse strip spectral correlation analyzer. The reference is the theoretical expectations at each cyclic frequency.[1] In the implementation, we set N to 2^{16} and N_P to 2^6 for both SSCA and S^{3}CA, and κ to 40 for S^{3}CA. The rest of the parameters for S^{3}CA are selected in the same way as in the paper.

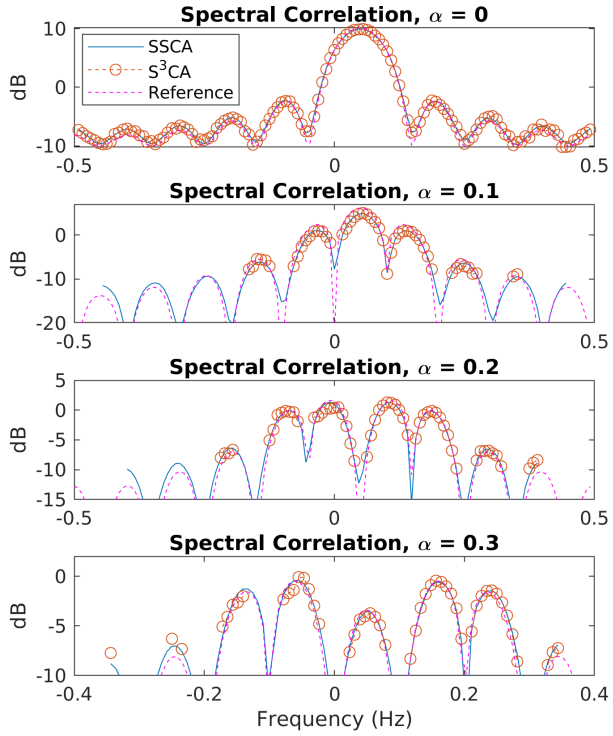

Fig. 1. Convertional SSCA, reference and S^{3}CA at four different cyclic frequencies. All three are very similar.

For more details, we present the outputs in dB, and the output of S^{3}CA successfully captures the peaks of the SSCA at each cyclic frequency.

[1]Detailed on the cyclostationary.blog (https://cyclostationary.blog/2016/02/24/second-order-estimator-verification-guide/).

B. SCD estimation of BPSK signal

We also compare the SCD estimation of a BPSK signal with a 10 dB signal to noise ratio and the same symbol rate and carrier offset as the previous example. We increase N to 2^{20} for both SSCA and S^{3}CA, and keep N_P and κ unchanged. Fig. 2(a) shows a 3-D plot of the largest κN_P magnitude SSCA outputs, $S_{X_{SSCA}}$, with its alpha profile corresponding to the largest alpha value over all frequencies below. Fig. 2(b) shows the S^{3}CA output, $S_{X_{S^3CA}}$, with sparsity parameter $\kappa = 40$, and its alpha profile in Fig. 2(d). In Fig. 2(c), the residual with the average L^1-norm of the residue below in Fig. 2(f).

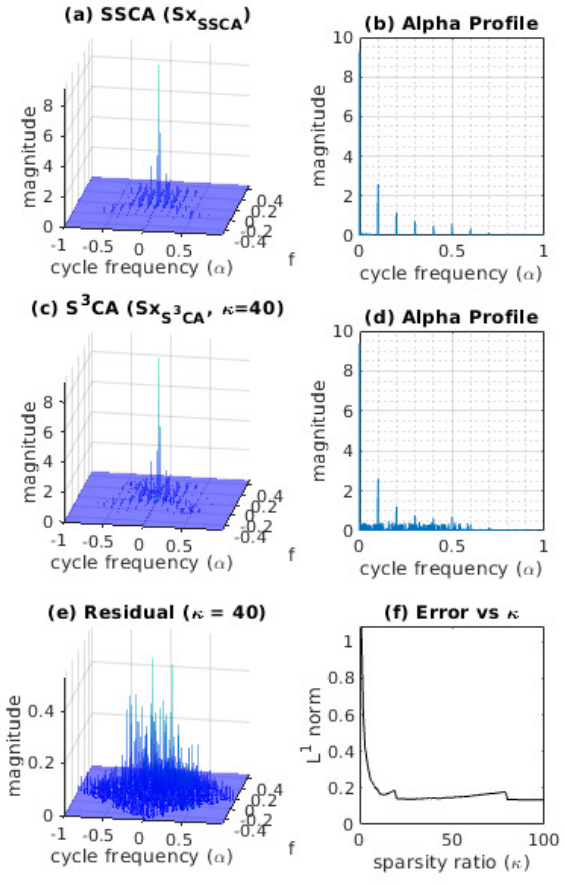

Fig. 2. SCD estimates and alpha profiles using SSCA (a) and (b), and S^{3}CA (c) and (d), their residual (e), and L^1-norm of the residue for different κ (f).

The symbol rate of 0.1 is easily discernible from the alpha profile presented in Fig. 2.