DOA Estimation with Vector Circular Array in Colored Gaussian Noise

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High resolution DOA methods (such as MUSIC, ESPRIT) have very good performance in white Gaussian noise but degraded performance in colored noise. These methods require prior knowledge of noise characteristics. In practice, however, noise characteristics are usually not very well known and are mostly colored instead of white. Fourth order cumulants (FOC) based methods have been demonstrated to be asymptotically blind to Gaussian process, making it unnecessary to model noise characteristics prior to estimation process. By combining FOC with MUSIC algorithm, the new method FOC-MUSIC (B. Porat, B. Friedlander, IEEE Trans. Signal Processing, 39, 2016–2024, 1991) is able to achieve high resolution estimation in both white and colored Gaussian noise. Since fourth order statistics requires higher computational complexity than second order statistics, a modified FOC-MUSIC (MFOC-MUSIC) is commonly used due to its improved computational efficiency and reduced computational complexity.

Vector circular array (VCA) for DOA estimation (Y. Lu, S. Yang, 2012 IEEE APS/URSI Int. Symp., 8-13 Jul 2012) has been investigated in white Gaussian noise but its performance has not been examined in colored Gaussian noise. To make the investigation possible, we apply MFOC-MUSIC methods to our VCA estimation process. Since it has been proved that FOC based MUSIC methods have property of array aperture extension and noise suppression ability, it is expected that MFOC-MUSIC has lower estimation error than MUSIC.

We have studied of single source elevation and azimuth angles estimations using MFOC-MUSIC and compared the results with that using MUSIC. As shown in Fig. 1, a 4-element VCA example is considered and the RMS errors show that MFOC-MUSIC has better performance than MUSIC in both white and colored Gaussian noise and significant improvement in colored Gaussian noise.

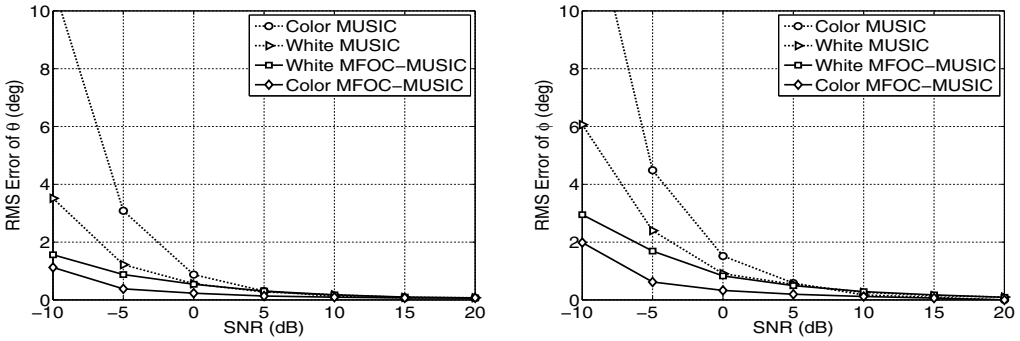

Fig. 1. Comparisons of (a) RMS errors of elevation angle and (b) RMS errors of azimuth angle using MUSIC and MFOC-MUSIC in both white and colored Gaussian noise.