Comparison of Sparse Planar Arrays with Random and Periodic Element Configurations

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Providing estimation for the direction of arrival (DOA) has been studied in signal processing for several decades. Many algorithms have been proposed for this purpose and their performance has been studied in a variety of ways. The multiple signal classification (MUSIC) algorithm remains quite popular for this since it provides a very robust eigen-based decomposition of the signal space. In most investigations related to this the analysis remains limited to periodic or rotationally symmetric (circular) element distributions. These periodic element distributions have demonstrated the effectiveness of the MUSIC algorithm and provide very good resolution. However, there are some unavoidable drawbacks (namely aliasing) that may present significant challenges when the spacing among elements is large.

This study investigates the sparse planar arrays and the random element configurations to overcome aliasing and enhance the accuracy of DOA estimation. Due to the large spacing, the sparse planar arrays has the advantage of mitigating mutual coupling, reducing shielding and lowering the cost, but suffering serious aliasing. Multi-frequency signal is used to mitigate the aliasing. The bandwidth of signal is divided into multiple sub-band and MUSIC spectrum is obtained from the center frequency of each sub-band and finally all spectrums are integrated to find DOA. With the wideband signal sources technique, the sparse antenna array is able to achieve a desired DOA estimation with the minimum number of antenna elements. In random element configurations, all of elements can be used to perform DOA estimation, or some of elements can be selected. This enhances the flexibility of antenna configurations. Resorting to the averaging method and multi-frequency, the random antenna arrays improves the accuracy and robustness of DOA further. Aspects of each in different DOA scenarios are examined through analytical and measured results.