

Spiral Phased Array Antenna Distribution for Enhanced Sidelobe Suppression

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Abstract— Traditional square phased array antennas require a half-wavelength emitter spacing to prevent secondary orders of emission. Achieving such small distances in many cases is impractical. This study focuses on the alias-free spiral array optimization, which allows for high level of sidelobe suppression.

Phased array antenna is a promising technology for cutting-edge applications [1, 2]. Their ability to steer and manipulate light beams with precision and speed makes them a crucial tool for LiDAR, RADAR, medical and communication systems. Unfortunately such antennas suffer from the sidelobe problem — i.e., additional parasitic beams of high intensity that are formed in the directionality diagram due to its interferometric nature.

To solve this problem, extensive work has been conducted, where authors propose various numerically generated and non-uniform emitter distributions and quantify their efficacy by using Side-Lobe-Levels (SLL) [3, 4]. Moreover, previous work demonstrate that the spiral array consistently provides lower SLL and remains a contender for the best emitter distribution [4, 5]. This nature-inspired emitter distribution (Vogel spiral), coming from the packaging of seeds in sunflowers [6], demonstrated an immediate and considerable reduction of the SLL. However, due to its origin, this design is best for packaging, and not necessarily for the emission pattern. This suggests that further optimization is feasible. More specifically, using the general definition of a spiral, we identify its free parameters — namely spiral power p , spiral step angle α and the spiral start n_s to perform optimization in wide range of inter-emitter distance (d) and number of elements (N). Thanks to introduction of the n_s parameter, we demonstrate more than 5 dB SLL advantage of optimized spiral over Vogel pattern even for large inter-emitter distances $d \gg \lambda$. We also observe that the SLL is monotonically decreasing with emitter number N beyond Vogel spiral limit of -17.56 dBc.

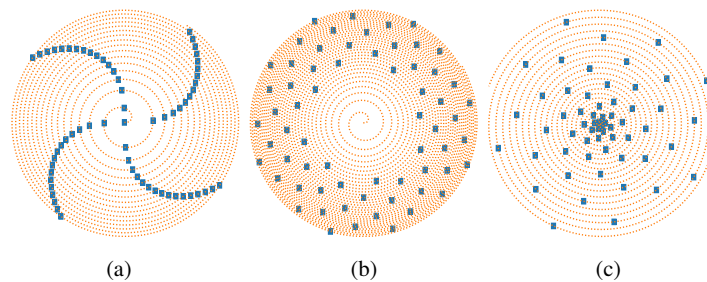


Figure 1: Illustration of several 64-element spirals. (a) Fermat spiral with angular step $\alpha = 1.01\pi/2$. (b) Vogel spiral with spiral start $n_s = 20$. (c) General spiral with power $p = 1.5$, $\alpha = 2.4$, $n_s = 1$. Orange dotted line is guide for the eye showing underlying continuous spiral.

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