Sub-Sampled Exponential Analysis in Antenna Applications

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The use of sub-sampled exponential analysis in antenna applications is appealing for multiple reasons. The computational time of simulations using sparse as opposed to dense sampling is significantly lower, and in the case of spatial sampling, sparse samples lead to an increased resolution. In this talk, we discuss the use of a sub-sampled exponential analysis method called VEXPA in three different antenna applications.

The first application is the use of one-bit data in the sparse direction-of-estimation (DOA) estimation problem. Sparse arrays are desirable for the fact that they have less mutual coupling and an increased resolution compared to a dense array with the same number of antenna elements. The quantisation step of converting the incoming analogue signals to their digital equivalents introduces another layer of complexity to the traditional problem. In Part 1 of this talk, we show how VEXPA can be applied to the one-bit DOA estimation problem, adding the feature of estimating the number of incoming signals.

Part 2 discusses the application of antenna position estimation using VEXPA, which is essentially the inverse of the DOA estimation problem. In sparse irregular arrays, it is helpful to have the ability to obtain the precise element positions after the installation phase, since this requires less accuracy when placing the elements. By accurately estimating the antenna positions, the accidental case of an antenna cable connected to the wrong receiver can also be detected and flagged. The method makes use of harmonically related signals transmitted from an unmanned aerial vehicle (UAV) at a known position in the sky.

Finally, the application of the characterisation of frequency ripple in reflector systems is discussed in Part 3. In small reflector systems, a ripple across frequency appears in the radiation pattern due to the interference of sub reflector diffracted fields and main reflector reflected fields. This ripple translates to figures of merit such as the sensitivity, antenna noise temperature and aperture efficiency and it is therefore important to be characterised. It is both shown how the electric fields can be sub-sampled and subsequently reconstructed, as well as how the frequency components can be identified from a densely sampled antenna noise temperature function.