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On Interpolation Methods Applied to Frequency Domain Antenna Responses

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Designing antennas with the use of frequency domain simulations can be a very time-consuming process. To speed up this process, it is possible to use interpolation together with cleverly chosen interpolation points, to determine their responses (*e.g.,* S-matrix) in the desired frequency band. This process requires an interpolation (or curve fitting) method, as well as a method to choose interpolation points. In previous work, we have benchmarked a number of interpolation methods on antenna frequency responses while also using different methods for choosing interpolation points. In this abstract, we summarize our findings, as well as bring out some results on adaptive frequency sampling using modified Nevanlinna-Pick (MNP) interpolation with arbitrary matrix parameters.

Well known benchmarked interpolation and curve fitting methods include vector fitting, the Loewner framework, Cauchy interpolation. Here, we also consider MNP interpolation. These methods are benchmarked on frequency domain S-matrix data from single and multiport antennas. Both dipole antennas and Vivaldi arrays are investigated. The main focus is each interpolation method's ability to accurately recreate the true frequency response with as few interpolation points as possible. The chosen interpolation points also impact the approximation error between the interpolant and the true frequency response, and methods for choosing these points were also benchmarked. From our benchmarking results, the Loewner framework and vector fitting performed the best, with the Loewner framework performing slightly better of the two. The considered adaptive frequency sampling algorithm compatible with the Loewner framework and vector fitting did not outperform predetermined frequency distributions such as Chebyshev and linear distributions. One adaptive frequency sampling algorithm that outperformed predetermined frequency distributions was based on the arbitrary matrix parameter in MNP (and thus solely compatible with MNP interpolation).

When creating the interpolant using MNP interpolation, we use an arbitrary matrix **G**, as in Eq. (18.2.1b) in [1]. Given a number of interpolation points, we construct multiple interpolants, each with a different matrix parameter **G**. The underlying idea in the proposed adaptive frequency sampling scheme is to select the next frequency point at the position where the interpolants differ the most. In Fig. 1, note that the difference among the interpolants decreases as we choose more and more interpolation points according to the rule of maximum difference.

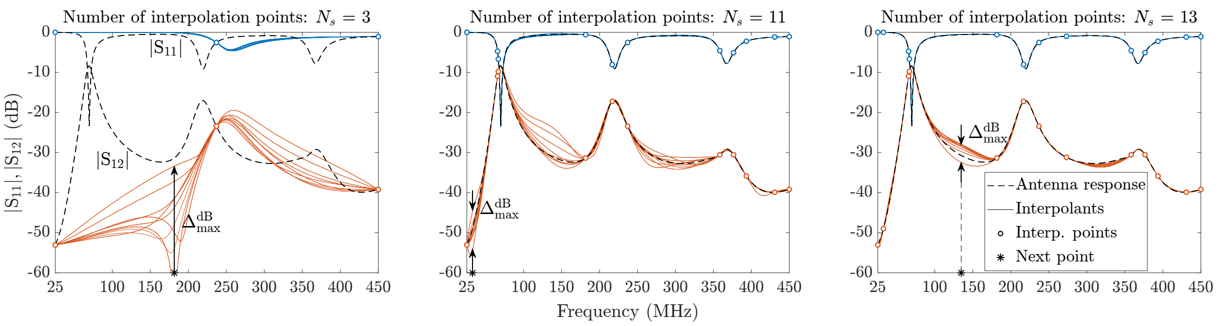

Figure 1. Interpolation on the S-matrix from two 2 m long parallel dipoles placed 1 m apart. Interpolants are generated by using MNP interpolation with different matrix parameters **G**. The maximum relative difference among the interpolants is highlighted with $\Delta^{\text{dB}}_{\text{max}}$.

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References

[1] J. A. Ball, I. Gohberg, and L. Rodman, *Interpolation of Rational Matrix Functions*. Birkhäuser Basel, 1990. [Online]. Available: https://doi.org/10.1007/978-3-0348-7709-1