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Sparse Interpolation: design sparse antenna arrays for estimating directions of arriving signals

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Estimating the directions of simultaneously arriving signals plays an important role in radar, remote sensing, radio frequency interference mitigation, wireless networks, machine perception of unmanned aerial vehicles or self-driving cars. In signal processing, antenna array systems have been designed to solve the problem of estimating the direction of arrival (DOA). A main constraint in designing regularly spaced antenna systems is the spatial Nyquist criterion, which requires the space between two sensors to be less than half of the signal wavelength. A disadvantage of densely spaced antenna elements is the effect of mutual coupling, normally reduced through costly extensive calibration of the system.

Using a regularly spaced antenna system for DOA estimation can be formulated as an exponential analysis problem, which can be tackled by the classical Prony method from approximation theory. Interestingly, the Ben-Or/Tiwari sparse interpolation algorithm in computer algebra is closely related to Prony's method. This connection has led to a major development in exponential analysis that can circumvent the Nyquist constraint [1], hence allow us to completely remove the dense Nyquist spacing requirement for DOA in antenna design [2].

Keywords
direction of arrival, exponential analysis, sparse interpolation

References

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