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Special Issue on

Advanced Antenna Array Development for mm-Wave Communications 2024

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Antenna arrays have attracted growing attention in many applications relevant to wireless communications, making array antenna technology a cornerstone of electrical engineering. With the rapid development of technology in modern radio systems, such as the upcoming deployment of 5G networks operating at sub-centimetre and millimetre-wave frequencies, antenna arrays are required to meet progressively more stringent specifications in terms of architecture complexity, broadband behaviour, high-gain multi-beam characteristics, and low scan losses. These are instrumental to achieving satisfactory system performance and reliable quality of service, while compensating for the detrimental effect of the significant path losses experienced at said frequencies.

To achieve multi-functional operation and high data rates, wideband and/or multiband antenna arrays are key. The overall system cost can be reduced if the integrated antenna array can operate at multiple bands concurrently with electronically controllable radiation pattern characteristics. Furthermore, beam scanning over a broad angular range with a stable gain is highly desirable. To realise broadband and wide-angle scanning arrays, grating, lobe suppression, active reflection coefficient minimisation, and gain ripple reduction are the main design challenges. A wide beamwidth at the embedded antenna or sub-array element is beneficial for keeping gain fluctuation low while reducing scan losses but can cause degradation of the active reflection coefficient and poor antenna isolation. Parasitic coupling phenomena also depend on the host body dimensions and relative curvature. These conflicting requirements are to be addressed concurrently using suitable design solutions and approaches.

The synthesis of general antenna arrays is a challenging problem because of the nonlinearity between the electromagnetic field distribution in the Fraunhofer region and the unknowns, primarily the number and position of the array elements. Where local optimisation algorithms are adopted in the design procedure, these are likely to be trapped into local minima. The use of global minimisation techniques, such as stochastic evolutionary algorithms, allows asymptotic obtaining of the optimal solution of the problem but at the expense of a typically longer synthesis time that increases exponentially as the number of unknowns becomes large. In this context, deterministic synthesis methodologies based on analytical formulations may provide a compelling advantage. Besides, array sparseness can be exploited as an additional degree of freedom to satisfy demanding system architecture constraints in terms of the number of radiating elements, minimum interelement spacing, and, more importantly, peak sidelobe level. This can be useful also to enable a more effective thermal management of antenna array modules.

The optimal design of an antenna array also requires the implementation of a suitable calibration technique. Accurate calibration is critical to preserve the main beam direction and shape, as well as to control the sidelobe level of a given antenna array. In practice, the beamforming network of an antenna array is often affected by electronic drift, as well as temperature and environmental conditions; thus, calibration of a fielded array system can be essential to ensure the desired system performance.

This Special Issue provides a forum for researchers to disseminate their achievements and ideas tackling challenging research problems concerning antenna array development. Particular emphasis is put on array synthesis, design, and measurement techniques, in particular, solutions for advanced 5G or WiGig millimetre-wave communication systems, such as those operating at 28GHz, 39GHz, 60GHz, 77GHz, or 95GHz. We welcome both original research and review articles.

Potential topics include but are not limited to the following:

- Array antenna technology
- Numerical modelling and analysis of planar and conformal arrays
- Near- and far-field synthesis techniques for regular and aperiodic arrays
- Antenna mutual coupling
- Array beamforming network design
- Array measurements and calibration
- mm-Wave communication systems

Authors can submit their manuscripts through the Manuscript Tracking System at https://review.wiley.com/submit?specialIssue=735824.

Papers are published upon acceptance, regardless of the Special Issue publication date.

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