Editorial

Advances in Antenna Array Processing for Radar

Hang Hu,¹ Ulrich Nickel,² and Krzysztof Kulpa³

¹ *Institute of Electronics and Information Engineering, Harbin Institute of Technology, Harbin 150001, China*

² *Fraunhofer Research Institute for Communication, Information Processing and Ergonomics (FKIE), 53343 Wachtberg, Germany*

³ *Institute of Electronic Systems, Warsaw University of Technology, 00-665 Warsaw, Poland*

Correspondence should be addressed to Hang Hu; huhang@hit.edu.cn

Received 21 November 2013; Accepted 21 November 2013

Copyright © 2013 Hang Hu et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Array processing is classically not considered as an antenna topic but more as a signal processing topic. So why did we publish a special issue on this topic for this journal? Today, with modern array antennas, the separation between the antenna and signal processing worlds becomes more and more obsolete. Printed antennas are often designed as arrays that are summed in an analog manner, which is already (analog) array processing. The flexibility that digital processing provides leads antenna engineers to design array antennas with digital summation of the element antennas. But with a digital array antenna all the possibilities of array signal processing are realizable which creates a broad scope for antenna design. This special issue is intended to provide the antenna community with a flavor of the multiple options that antenna array processing offers. This issue cannot cover the complete bandwidth of topics in radar antenna array processing as this would fill many textbooks and is a continuing process. But we hope that we can give some inspiration of what is possible.

Antenna arrays for radar systems, communication, and sonar installations are now an established technology. However, there are close links between the array and the different algorithms and techniques which are often not recognized. To fully exploit the advantages of array techniques it is necessary to account for these interrelations in the system design.

Ideally digital processing of array data should be done as close to the element as possible, if this is possible given the size, weight, and cost of the hardware. As a cost effective compromise hardwired analog summation of subarrays can be used to reduce cost and weight. This has created a realm of possibilities for building array hardware structures and

for multichannel processing schemes. Examples are not only many algorithms of nonlinear wave parameter estimation and adaptive interference suppression but also array configurations with sparse arrays and various types of subarrays. These configurations constitute special solutions of a hardware compromise between analog and digital processing. Furthermore, we have sophisticated processing methods involving higher order statistics and methods of compressed sensing, which both lead to virtual arrays of larger size and potentially better resolution properties. And finally, one can combine spatial and temporal processing (in particular space-time adaptive processing, STAP).

The purpose of this special issue is to bring together these antenna and processing related aspects, linking the theoretical possibilities with the operational aspects and hardware constraints. From the manifold submissions we have selected 18 interesting papers. Starting with a tutorial on achievements and challenges of array processing (U. Nickel) the papers then cover topics of array optimization and adaptive processing for thinned arrays and subarrayed arrays (P. Lombardo et al.), array configuration and adaptive interference cancellation for passive radar (M. Villano et al.).

Array design and array processing for multichannel input/multichannel output radar (MIMO radar) systems are a fascinating extension of array technology exploiting spatial diversity. We have two papers that consider this technique, that is, detection in compound-Gaussian clutter with hybrid MIMO (J. C. Ding et al.) and direction finding for bistatic MIMO with circular array (Y. H. Cao et al.). Space-time array processing (STAP) is another powerful extension of classical spatial array processing. We have contributions on

deterministic aided STAP detection (J. F. Degurse et al.), clutter suppression using cross beam (Y. L. Wang et al.), superresolution using adaptive incremental multiparameter estimator (Z. B. Wang et al.), and applications of STAP in the exciting field of surface wave radar (X. Zhang et al. and Y. J. Li et al.). A special case of STAP with a topical application is synthetic aperture radar (SAR). There are three papers that consider exemplary problems of this kind, that is, phase pattern calibration (M. Bachmann et al.), SAR in the presence of dictionary mismatch (A. S. Khwaja et al.), and in-flight antenna pattern characterization (G. C. Alfonzo et al.). And finally we have a number of papers that present novel ideas and extensions like parallel factor analysis (PARAFAC) for passive localization (J. Chen et al.), spectrum sensing under cognitive radar (M. S. Shbat et al.), transmit virtual aperture array for through the wall imaging radar (B. Y. Lu et al.), tracking compensation for phased array radar (J. Mar et al.) and operating frequency selection for high-frequency (HF) radar (S. Y. Yang et al.) that are made possible with array antennas.

We would like to thank all authors for their highly professional contributions and the reviewers for their time and effort. We hope that this collection of papers will activate the curiosity of the readers about these exciting new ideas. At least we hope that you will enjoy the compilation of such a broad and rich variety of ideas.

*Hang Hu
Ulrich Nickel
Krzysztof Kulpa*