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EDITORIAL

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Special issue: advanced techniques for radar signal processing

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Recent advances in technology have led to the development of low-cost sensing devices capable of providing high performances in terms of both computational resources and measurement precision. More important, the reduced size of such devices have allowed to exploit them in diverse application fields (as, for instance, medical, military, manufacturing, transportation, and safety systems). However, in the context of military applications (e.g., radar and communication systems), the downside of this technology is that it is available for terrorist attacks aimed at denying targeting information and using radar-guided missiles or small drones carrying dangerous (e.g., explosive or chemical) substances. Thus, it stems the need for innovative signal processing solutions to counteract these threats. Such techniques are applicable in ship and aircraft monitoring (for defense purposes), coastal surveillance, and, generally speaking, homeland security.

This special issue focuses on radar signal processing techniques (target detection and tracking, interference estimation and suppression, adaptive beamforming, electronic warfare) that benefit from the mentioned advances to face the new challenging operating scenarios that naturally arise from nowadays technology advantages and disadvantages. More specifically, the emphasis is on (possibly distributed) radar systems equipped with arrays of sensors, which enable to capitalize the spatial diversity and power integration enabling significant improvements in performance.

In general, radar systems perform three general functions, which are search, track, and imaging. The most important operation of a search radar is target detection. As a matter of fact, once the system declares the presence of a target, its resources are scheduled to estimate target parameters [1, 2] or for target tracking [3] which consists in the fine estimation of parameters as range, azimuth angle, elevation angle, and Doppler frequency offset. Moreover, it is worth underlining that range resolution can be increased by means of pulse compression techniques which exploit coded signals [4, 5].

Thus, it is clear that the reduction and/or the control of the number of false alarms, which waste hardware resources, is of primary concern in radar signal processing. The main sources generating false targets are clutter (unwanted echoes from the environment), thermal noise, and intentional interferences also known as electronic countermeasures (ECM) (coherent and/or noise-like jammers). In this respect, several contributions presented here are aimed at mitigating the effects of these interfering signals [6–11]. Some of these describe algorithms which clean acquired data from intentional interference components and feed the following detection algorithms, whereas other papers devise detection algorithms providing the so-called constant false alarm rate (CFAR) property with respect to the clutter and thermal noise [9, 12]. The former techniques are classified as electronic counter-countermeasures (ECCM) (see also [13–17]). Further contributions deal with distributed systems (bistatic, multistatic, or sensor networks) [10, 12], which, due to the additional number of degrees of freedom, are more effective against the deleterious effects due to false alarms, stealth targets, shadowing, multipath, and intentional or unintentional interference. Finally, waveform design and compressive sensing techniques applied to MIMO radars [18–20] and signal reconstruction techniques [21–23] are also considered here.

Once a target is detected in track, the imaging function comes in handy for target classification, discrimination, and/or identification purposes. As a matter of fact, it provides high-resolution data in range, azimuth, elevation, and sometimes Doppler. A well-known example of imaging radar is represented by the Synthetic Aperture Radar (SAR), which provides a fine-resolution two-dimensional intensity image of the illuminated scene. SAR images can be exploited for mapping and land-use surveying, detection, location, and identification of fixed targets [24–31]. Some of the above aspects are considered in several contributions collected here. Another delicate issue related

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to SAR systems is the image focalization which is made difficult by undesired platform movements. Techniques aimed at the compensation of these effects are herein considered also in the context of compressive processing [24, 25, 28, 29].

The final topic addressed in this special issue concerns the electronic warfare and in particular signal processing techniques for electronic-signals intelligence [32, 33].

Competing interests

The authors declare that they have no competing interests.

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