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Editorial

Editorial for Special Issue "Radar Systems for the Societal Challenges"

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The special issue (SI) "Radar Systems for the Societal Challenges" is an updated survey of recent advances in radar systems, encompassing several application fields and related to the impact on society. In fact, radar technology is now pervasive in society and is crucial for tackling social and economic issues for the wellbeing of the population. In fact, in addition to the classical application fields, i.e., navigation, air traffic control, and surveillance, emerging applications are now arising, which range from diagnostics and monitoring in civil engineering and cultural heritage, to medical applications, monitoring of environmental parameters, and security in urban areas. These new applications are possible thanks to the improved capabilities of radar systems, accompanied by new advanced modeling and data processing, able to tackle electromagnetically complex scenarios.

Most of the works present in this SI can be categorized according to the relevant application fields.

The first batch regards the use of radar systems in monitoring for environmental protection; in this area, a recent focus is on sea monitoring and observation, using radar systems on different platforms. In this frame, the first paper from Abileah et al. [1] investigates the possibilities offered by current and future satellite radar altimetry missions for the study of inland water bodies, probing into the peculiarities of the expected radar returns and their potential usage. Two other papers show the use of X-band radar systems for sea state monitoring. The first one presents a comparison between drifter and X-band wave radar for sea surface current estimation [2], while the other aims at improving the operational capabilities of X-band radar systems by performing advanced data processing for wind parameter estimation, starting from X-band radar collected in challenging rainy conditions [3]. The last paper of this batch regards the use of a new observation modality ensured by an X-Band airborne interferometric synthetic aperture radar (SAR) system for sea surface observation [4].

Radar systems are now a significant observational tool in the field of Cultural Heritage monitoring, as shown by the paper from Masini et al. [5], which presents a significant example of integration of ground penetrating radar and electrical resistivity tomography for the archaeological investigation in Kaifeng (Henan, China). In [6], the capabilities of SAR interferometry have been demonstrated for monitoring ground deformation and structural instabilities over the ancient city walls (Ming Dynasty) in Nanjing City, China.

Two recent fields of application of radar systems are security and healthcare. For these fields, different radar technologies are now under development and this SI presents a good survey of these research and technological efforts.

In particular, good examples of the development and adaptation of the CW Doppler radar to the human detection and activity classification in through-wall configuration and for vital signs monitoring are presented in [7,8], respectively.

The paper from Yang et al. [9] deals with the micro-Doppler radar signatures exploitation in order to identify passengers with different baggage, which is helpful to improve the efficiency of security checking in airports. In the same context the paper from Abdullah et al. [10] investigates how the micro-Doppler signatures can be exploited for target recognition under the forward scattering radar (FSR) configuration, which is little analyzed and investigated in the literature. The same problem is faced in [11], where the concept of a FSR system, with a rotational transmitter for target detection and localization, is exploited for achieving extra information carried by the Doppler due to the relative movement of the transmitter-target-receiver. The potential applications of the FSR system regards security and border surveillance, debris detection on an airport runway, ground aerial monitoring, intruder detection, etc.

In [12], the concept of ultra-wideband radar is exploited for the detection and recognition of human activities in not accessible environments; this has found various military applications in recent years, such as urban warfare, hostage rescue, and earthquake post-disaster rescue.

Another batch of papers regard scientific advances in radar systems and imaging that will be very useful in the future for different application fields.

In [13], a three-dimensional localization method based on multistatic SAR, exploiting the numerical range-Doppler (RD) algorithm and the entropy minimization principle, is presented, which also offers improved localization accuracy in the 3D case. The paper from Yu et al. [14] deals with the problem to analyze the internal structure of objects and to identify and classify their shapes based on ultra-wideband signals, by proposing and exploiting a reconstruction approach directly in the time domain.

The paper from Falconi et al. [15] is a good effort in the field of the electromagnetic modeling in order to predict the response of FSR systems for air-target surveillance applications, in both far-field and near-field conditions. The outcomes of this study can pave the way for significant extensions on the applicability of the FSR technique.

Two papers deal with the use of passive radar systems for surveillance and target detection. The first one, from del-Rey-Maestre et al. [16], deals with the design of an antenna array for the problem of ground target detection, which is of interest in urban and semi-urban area surveillance. The paper for Zhang et al. [17] regards the use of compressive sensing for improving resolution in systems exploiting multiple illuminators of opportunity (IOs) and a rotation angle.

The use of compressive sensing (CS) is now a well-assessed option in the development of radar imaging approaches. In this SI, two significant examples of the use of CS are presented. The first regards a novel algorithm, called two-dimensional (2D) normalized iterative hard thresholding (NIHT), to directly reconstruct radar images in the matrix domain [18]. However, the computation complexity of CS-based methods limits its wide applications in SAR imaging. In [19], a novel sparse SAR imaging method using the multiple measurement vectors model is presented in order to reduce the computational cost and enhance the imaging results.

The paper by Persico et al. [20] presents a new strategy to improve the computational effectiveness of a microwave tomography-based approach so as to deal with a large investigation domain, as in GPR surveys. The last paper [21] presents an algorithm for improving the mitigation of interference in the development of a new reconfigurable stepped frequency GPR system.

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