remote sensing

Editorial

Editorial for the Special Issue "Remote Sensing of Target Detection in Marine Environment"

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Remote sensing is a powerful tool used to obtain an unprecedented amount of information about the ocean from a distance, usually from satellites or aircrafts. Measurements collected by active and passive remote sensing instruments can be used for both marine and maritime applications. They allow monitoring of vast areas of the Earth that are difficult to access and sample using traditional methods. Within this context, the observation of targets at sea, e.g.; man-made targets (ships or oil/gas rigs/platforms and wind turbines) and natural targets (icebergs, surfactants, etc.) is nowadays a very hot-topic in the field of global monitoring of environment and security.

Among the remote sensing tools, Synthetic Aperture Radar (SAR) is one of the most used since it allows all-day and almost all-weather observations with a moderate-to-fine spatial resolution. SAR imagery gives the possibility to overcome the limits of maritime patrol allowing non-cooperative all-day target surveillance, over wide regions and under almost all-weather conditions. An increasing number of SAR satellites have become available since the early 1990s. This unprecedented development in SAR sensors requires the definition of new techniques and algorithms to detect marine targets, as well as in the assessment of existing methods. Hence, although there is a great deal of literature that concerns SAR methods for detecting targets at sea, there is still room to improve both models and methods.

Within this context, methods and models are proposed in this Special Issue (SI) to exploit single- and multi-polarization SAR measurements for observation of targets at sea, with special interest for vessels.

In ref. [1] the complex coherence between the two channels of the dual-polarized Sentinel-1 SAR imagery is exploited to detect ships in a timely manner using the entire image. The proposed rationale is verified against real SAR imagery that includes a large number of vessels of different sizes. In addition, Automatic Identification System (AIS) data are used for an extensive and large-scale cross-comparison with the SAR-based detections. Experimental results clearly point out the remarkable detection rate of the SAR-based method and its complementarity with respect to AIS information.

In ref. [2] fishing vessels detection is addressed with reference to the problem of global overfishing. A method is here developed to deal with the discrimination between fishing and non-fishing vessels and a showcase is presented. The method, which is based on the Random Forest (RF) classifier, takes as input the vessel's length, longitude, and latitude, its distance to the nearest shore, and the time of the measurement (am or pm). The classifier is trained and tested on data from the AIS and Sentinel-1 SAR imagery that refers to the North Sea.

In ref. [3] a system to monitor illegal fishing activities is proposed. The approach, which is developed in the framework of a cooperation between the Plymouth Marine Laboratory (PML) and the Economic Community of West African States Coastal and Marine Resources Management Centre (ECOWAS Marine Centre), uses freely available Sentinel-1 SAR and Sentinel-2 Multispectral Instrument (MSI) optical data. The designed algorithms deliver the vessel information to customers through a dedicated web portal interface. The system merges vessel detections in satellite images with AIS data to identify non-cooperative vessels that can be involved in illegal fishing activities.

In ref. [4] ship detection at sea is addressed using dual-polarimetric SAR measurements. A detection scheme that is based on the Geometrical Perturbation-Polarimetric Notch Filter (GP-PNF) is used to detect ships in dual-polarimetric Sentinel-1 SAR scenes. The proposed rationale consists of building a new feature vector, which is richer than the conventional one in terms of polarimetric descriptors, and using it to enhance the target to clutter ratio (TCR).

In ref. [5] a new method is proposed to address ship classification in SAR imagery that is based on the combination of an improved SAR–HOG method and a manifold learning methodology to reduce the dimensionality of the problem. Experiments undertaken on actual TerraSAR-X scenes confirm the soundness of the proposed rationale.

Although the contributions to this SI are mainly focused on methods to detect/classify marine vessels using SAR measurements, additional microwave observation techniques are also discussed.

In ref. [6] a fast and effective approach is developed to detect ship in range-compressed radar data acquired by an airborne radar sensor during linear, circular, and arbitrary flight tracks. The approach is developed to work in a real-time-oriented way by exploiting a constant false alarm rate (CFAR) detection threshold that is computed in the range-Doppler domain together with an automatic ocean training data extraction procedure. The soundness of the proposed approach is validated against linearly and circularly acquired measurements collected by the DLR's (Deutsches Zentrum für Luft- und Raumfahrt) airborne F-SAR system.

In ref. [7] target detection at over the horizon (OTH) distances is addressed using a network of high frequency surface-wave-radars (HFSWR). Since a vessel is typically observed by multiple HFSWR, there may be very often situations in which multiple tracks for a vessel are present. Hence, in this study, a method is proposed to merge radar tracks obtained and elaborated at the single radar level into a unique data stream. Experiments, undertaken on actual HFSWR measurements and verified using AIS ancillary information, demonstrate that the proposed approach provides accurate tracking, preventing the creation of duplicate targets and it delivers a unique and very computationally efficient radar picture at OTH distances.

In ref. [8] the accuracy of some of the most well-known models for statistical distribution of sea clutter amplitude are verified against a broad range of environmental conditions, radar geometries and configurations. This is done using actual measurements collected by mono- and bi-static ground-based and airborne multi-polarization radars operating at different frequencies. The model's accuracy is assessed using state-of-the-art metrics.

In addition to microwave remote sensing instruments, acoustic probes are also exploited by proposing new methods to process Side Scan Sonar (SSS) imagery and acoustic waveguide measurements for vessels observation purposes.

In ref. [9] shipwreck recognition in side-scan sonar (SSS) maps is addressed and a processing chain that consists of feature extraction, feature selection, and shipwreck recognition is proposed and verified using real SSS sample measurements.

In ref. [10] ships and submerged marine vehicles are observed via passive ocean acoustic waveguide remote sensing. They provide time-frequency characteristics of the dominant narrowband signals received from a number of distinct ocean vessels detected at varying ranges from the coherent hydrophone array. The detections are verified using GPS information provided by an historical AIS database.

In ref. [11] a novel algorithm based on a neutrosophic set (NS) and diffusion maps (DMs) is proposed to deal with target detection in SSS imagery. The accuracy and effectiveness of the proposed algorithm is verified using actual SSS imagery showing that the proposed rationale succeeds in detecting targets even against complicated backgrounds.

In addition to sea vessels observation, two contributions addressed topics that are closely related to vessels monitoring: the observation of icebergs and blooms.

In ref. [12] remotely sensed measurements collected by both SAR and radar altimeter are used to observe the giant tabular iceberg A68 that broke away from the Larsen C Ice Shelf, Antarctic Peninsula, in July 2017. The initial evolution of iceberg A68A—the largest originating from A68—in terms of changes in its area, drift speed, rotation, and freeboard is analyzed using Sentinel-1 SAR imagery and CryoSat-2 SAR/Interferometric Radar Altimeter observations.

In ref. [13] the effect of Ekman pumping, wind-induced mixing parameters, and the pre-typhoon mixed layer depth on typhoon-induced phytoplankton blooms is analyzed in the Northwest Pacific (NWP) and the South China Sea (SCS) using satellite remotely sensed data collected by different sensors.

Conflicts of Interest: The authors declare no conflict of interest.

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