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VERIFICATION OF THE ONBOARD SAR SHIP DETECTION USING YOLO.

Abstract

Ship detection is important for maritime safety and security, logistics, and the detection of illegal activities. Synthetic aperture radar (SAR) is the most suitable sensor for this task due to its ability to capture images regardless of weather conditions, day or night. Recently, with the advance of deep learning, SAR object detection studies have significantly improved. At the same time, more and more commercial satellites have been launched over the last decade, a large volume of data is now accessible. However, transmission costs to the ground are expensive, which hinders rapid response. Therefore, we will develop a two-phase AI prediction framework that reduces data without losing crucial information. In this method, SAR data will be processed and filtered via onboard computing, and only the necessary data will be transmitted to the Earth. To evaluate the ship detection performance, we acquired multiple commercial SAR satellite images and applied the tiny ship detection model that can be deployed onboard. For the training dataset, we used the SAR-Ship-Dataset, which consists of 40,000 ship chips from C-band satellites Sentinel-1 and Gaofen-3. The images vary in polarization, resolution, incidence angle, imaging mode, and background. YOLO was employed for the object detection model because it is a one-stage object detection model and has a remarkable balance of speed and accuracy. We confirmed the YOLO tiny model achieved mAP at around 0.5 on validation data while keeping milliseconds of frame rate per 256×256 pixel chip. For the test data, we used X-band SAR satellite images from Umbra Space, Capella Space, and ICEYE. Despite domain differences among satellites, our model demonstrated high precision in ship detection, indicating robustness and adaptation capability to multi-modal SAR images without additional learning. This study is the first verification phase of our framework in space computing, and we confirmed the feasibility of application to ship detection from different SAR satellite images with limited computational resources. Our method will enable faster, real-time monitoring for rapid decision-making.