복잡한 해안 환경 SAR 영상에서 YOLOv5 기반 선박 탐지 기법

유초시, 신요안*
숭실대학교 전자정보공학부
csyu@soongsil.ac.kr, *yashin@ssu.ac.kr

YOLOv5 Based Ship Detection Scheme in SAR Images under Complex Inshore Background

Chushi Yu and Yoan Shin*
School of Electronic Engineering, Soongsil University
(*Corresponding author)

Abstract

Synthetic aperture radar (SAR) is one of the most important active imaging technologies in remote sensing. SAR images can provide useful and complementary information for many applications including climate change, environmental and ship monitoring. In SAR images, ship types are diverse, especially inshore ships are seriously disturbed by surrounding buildings. In order to solve the problem that ships and the background are difficult to distinguish correctly in the inshore scene, we propose a YOLOv5-based SAR ship detection method under complex background. The experimental results in SAR ship detection dataset show that the method can effectively detect ship targets, which proves the feasibility of the method.

Ⅰ. Introduction

In recent years, synthetic aperture radar (SAR) imaging technology has played an important role in monitoring and rescue by virtue of its all-day and all-weather target perception capability[1]. Ship detection in SAR images has broad prospects in both military and civilian fields. Traditional SAR ship detection methods have certain difficulties in detecting small ships and avoiding complex background interference near shore. Meanwhile, ship detection requires real-time performance, and the detection speed need be ensured while improving accuracy.

The you only look once (YOLO) is a single-stage target recognition and localization algorithm based on the deep neural network, which has the advantage of fast processing and can be used in real-time system[2]. This paper introduces YOLOv5 into SAR ship detection, and exploits the powerful learning ability and model versatility of deep neural network model to achieve accurate, reliable and fast automatic target detection and recognition.

Ⅱ. Main Method

We propose a YOLOv5 based SAR ship detection scheme as shown in Fig. 1. The YOLOv5 is a single-stage method that consists of backbone network, neck, and detect head as shown in Fig. 2. The backbone network uses CSPDarknet53 for feature extraction. The neck part adopts the combination of a feature pyramid network and a path aggregation network[3]. Up-sampling operations enlarge feature maps with low resolution and strong semantic information in the high level network, and fuse them with high resolution feature maps with rich spatial information in the shallow network. At the same time, the positioning information is transmitted from top to bottom to enhance the entire feature hierarchy. The output of the detect will be used to calculate the loss value and establish an optimizer through gradient descent to complete the training. Considering the regression aspect ratio, the training process uses complete intersection over union (CIoU) loss instead of generalized intersection over union (GIoU) loss function of the bounding box.

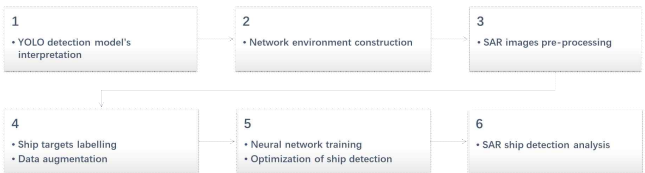


Fig. 1. The proposed YOLOv5 based SAR ship detection scheme.

Ⅲ. Experiment Results

The experiment is run under PyTorch framework of Python. We use SAR ship detection dataset (SSDD) as training dataset consists of 1,160 images with 2,456 ship targets[4]. The training process is preprocessed by data augmentation and transfer learning in order to increase the robustness of the network. The batch size is set to 4 and training epoch is set to 300. Mean average precision (MAP) is used as the performance index.

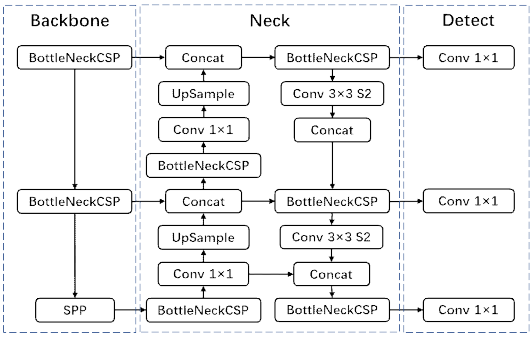


Fig. 2. Architecture of YOLOv5.

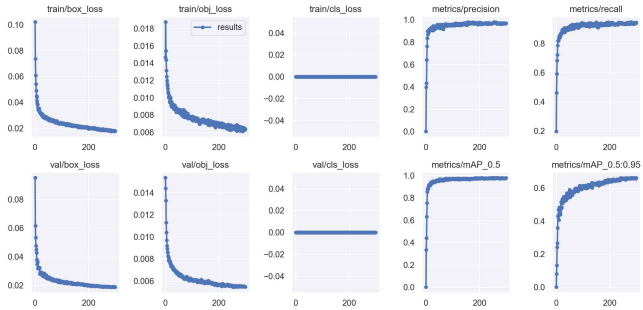
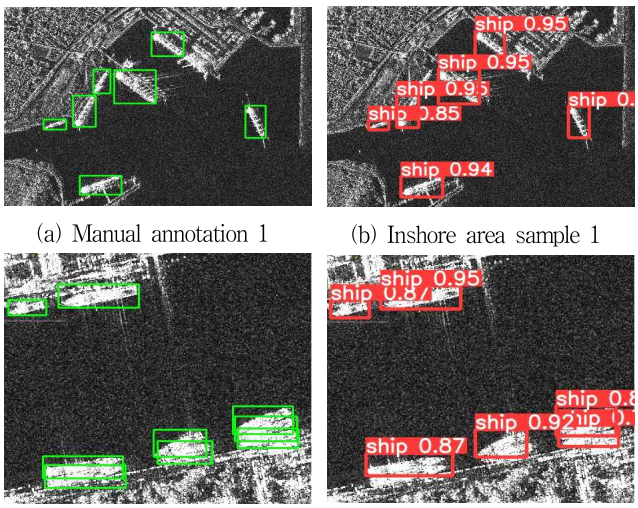


Fig. 3. Learning curves.



(a) Manual annotation 1 (b) Inshore area sample 1

(c) Manual annotation 2 (d) Inshore area sample 2

Fig. 4. Sample results of ship detection in the SSDD.

Figure 3 summarizes the learning curves of the loss and MAP as the number of iterations grows. Figure 4 visualizes some sample results of inshore area, and images show that most of ship targets can be accurately identified based on YOLOv5 method under complex background.

Aiming at the distribution characteristics of close-arranged near-shore ship targets, we propose a YOLOv5 based method for SAR ship detection under complex background. Although some ships are miss-detected due to overlaps, the method in this paper has certain practical significance in applications. In follow-up work, we will design suitable rotation detection frames to solve the above problem and train the neural network to further optimize the network structure and improve the detection accuracy.

ACKNOWLEDGMENT

This work was supported in part by the NRF of Korea grant funded by the MSIT (2020R1A2C2010006), and by the MSIT under the ITRC support program (IITP-2022-2018-0-01424) supervised by the IITP.

REFERENCES

[1] A. Moreira, P. Prats-Iraola, M. Younis, G. Krieger, I. Hajnsek, and K. P. Papathanassiou, "A tutorial on synthetic aperture radar," *IEEE Geosci. & Remote Sensing Mag.*, vol. 1, no. 1, pp. 6-43, Mar. 2013.

[2] J. Redmon, S. Divvala, R. Girshick, and A. Farhadi, "You only look once: Unified, real-time object detection," *Proc. IEEE CVPR 2016*, pp. 779-788, Las Vegas, USA, Dec. 2016.

[3] T. Lin, P. Dollar, R. Girshick, K. He, B. Hariharan, and S. Belongie, "Feature pyramid networks for object detection," *Proc. IEEE CVPR 2017*, pp. 2117-2125, Honolulu, USA, July 2017.

[4] J. Li, C. Qu, and J. Shao, "Ship detection in SAR images based on an improved faster R-CNN," *Proc. BIGSARDATA 2017*, pp. 1-6, Beijing, China, Nov. 2017.