DIFFERENT DEEP LEARNING APPROACHES FOR SINGLE CLASS-LABELING: SHIP-DETECTION APPLICATION

Saziye Ozge Donmez (1), Dursun Zafer Seker (1), Cengizhan İpbüker (1)

[1] Istanbul Technical University, Sariyer-Istanbul, 34469, Turkey
Email: donmezsaz@itu.edu.tr; seker@itu.edu.tr; buker@itu.edu.tr

KEYWORDS: deep learning, single-class detection, Mask-R CNN, satellite images

ABSTRACT: Single-class detection on the satellite images is one of the most common applications that can be sorted under Deep Learning (DL) approaches. Many purposes (environmental monitoring, density of objects, military applications and so on) can further the usage of DL on remotely sensed data. Using convolutional neural networks (CNN) with different parameters in order to generate diverse deep-learning architectures. In this study, the aim is applying two different algorithms for ship detection on the satellite images. In one of the method, Mask-R CNN is determined to use for detection with using type of Res-Net. In the other method, network design includes two dimension (2D) convolution and Max-Pooling 2D phases. In both models, training and validation steps are performed. Then, after the predictions, the results are discussed according to the experiments. Second model, includes also defining the coordinates of the detected ships. After single class-labeling, accuracy assessment conducted about performances and comparisons are obtained. Port activity and supplying chain analysis can count as automatic ship detection applications benefits.

1.INTRODUCTION

Machine Learning (ML) algorithms are becoming more popular by time tremendously. Data analysists are widely use various algorithms in many industries. One of the benefits of developing technology is satellite images and monitoring systems time periods have been higher and more accurate in the last decades. This also came in monitoring the environment, natural disasters and military applications for security and so on. Accessibility of the high-resolution and very rapid data and images catalyzed for using satellite and scene images for object detection applications. In general, many classes such as maritime environments, plane, heliport etc. are some of the examples for object detection on the images. Moreover, automatic ship detection is one of the popular application subjects in this issue. Due to the importance of the objective, also big company such as AIRBUS are sponsor for the best algorithm competition in that case, as well. In computer vision tasks, this detection can be grouped under some sub objectives such as: for single object: classification, classification and localization for multiple objects: object detection and instance segmentation. Instance segmentation includes, on the images, more than one objects detection at the same attempts.
In the literature, there are samples One-Class Convolutional Neural Network as Abnormality Detection, User Active Authentication (such as face patterns), Novelty Detection [1].

Moreover, one-class experiments are examined under the groups as most normal and most anomalous. The target object's most different variations are aimed to be classified accurately. However, if the target of the application is not the about the changes (anomalies) on the object the algorithm can vary in different solutions to the problems such as speed, model accuracy and performance metrics.

A standard CNN (Convolutional Neural Network) may not suitable as single due to the output layer would not be a constant, would be a variable. On the images for detection, choosing the different region of interest from the image and different spatial locations is an approach and applied as R-CNN (Regions- with CNN features). According to Ross Girshick et al. who applied R-CNN algorithm, the best performing methods for object detection complex systems that integrates consistently high-level context with low-level image features [2]. Additionally, same author built a faster object detection algorithm, called Fast R-CNN. In that algorithm, there is identification step region of proposals with

RoI pooling layer in order to reshape into a fixed size. The citing reference for Fast R-CNN algorithm provide various advantageous object detection algorithms. The algorithm is developed by Ross Girschick [3].

Besides, there are some examples about usage of Fast R-CNN with rotation bounding box. According to authors experiments, usage of rotation anchors for ship detection has a significant positive effect on Recall analysis [4].

Ship detection applications are becoming widespread more by time. Many purposes can be the reason for monitoring port activities due to economic analysis and security concerns, vessels pass from the borders and so on.

In this study two different datasets and two models are used for ship detection in the satellite images. Additional to common shared referenced repositories in the second model, the same images are used for predictions accuracy tests as an improvement for seeing the differences on the results.

2. DATA AND METHODOLOGY USED

AIRBUS has made a competition on the Kaggle about building a model that detects all ships in satellite images as quickly as possible. Even in imagery with clouds or haze finding ships on the images is the aim. According to this aim, in the first model, the dataset is approximately 29 GB shared on Kaggle that includes train images, test images and sample data as ground truth for the training and test images separately [5]. The objective on that model study is based on locating the ships in images, and put an aligned bounding box segment around the ship that are located. Some images have ships inside, some have not with masking step. Moreover, the size of the ships is different image to image. The images do not include only sea and shores. Additionally, some images include harbor, pot and docks near urban areas.

There are some popular convolutional networks like as R-CNN, Fast R-CNN, Faster R-CNN for such as applications. Mask R-CNN can count for generating high-quality segmentation mask for the objects. In general, Mask R-CNN has different versions of release additions as 1.0, 2.0 and 2.1. In this study 2.1 version is used that includes, automatic download of COCO (Common Objects in Context) weights and dataset and prediction step has TensorFlow operations. Inside the first model of the study, mask prediction branche is an additional besides Faster R-CNN bounding box and image class prediction. ResNet is used according to chosen architecture for making the model. In this study, as application firstly, Sam Lin's Mask R-CNN structure is used as base model and inside the algorithm there are parts with references Baseline U-net Model Part 1 and Run Length Encode and Decode [6].

In the second application, detection the ships on the images and the location of them (as image coordinates) and classifying ships in Planet satellite imagery. In the application as dataset 4000 images are used, 3000 of them has no-ship class includes 3000 images and 1000 of them have ship class [7]. A model is used named Keras for search ships in satellite image as base for experiment [8]. In that model, the output is boxes of the ships. In the first model, the output is masks of the ships. Additionally, after using the second model base, also after the training and tests, the same images chosen from the first model dataset (AIRBUS Challenge dataset) are used also the same images for accuracy analysis. This part (using the same images for test) is special to this paper study.

3. RESULTS AND DISCUSSION

In the first model, verifying the Model accuracy using performance metric is done and predictions has been made randomly chosen images when IoU = 0.5 (Intersection of Union) is taken for the step. On the experiment, mAP (Mean Average Precision) is calculated as 0.7 and Inference Time: 0.13 Minutes. These randomly chosen prediction images are also used in the end of the verifying the second model step, as well. The figure 1 and 2 below shows some selected different prediction results according to first model. The input is coming from database images and as the output of the predictions are masks of the ships and after masking showing in bounding boxes with scores.

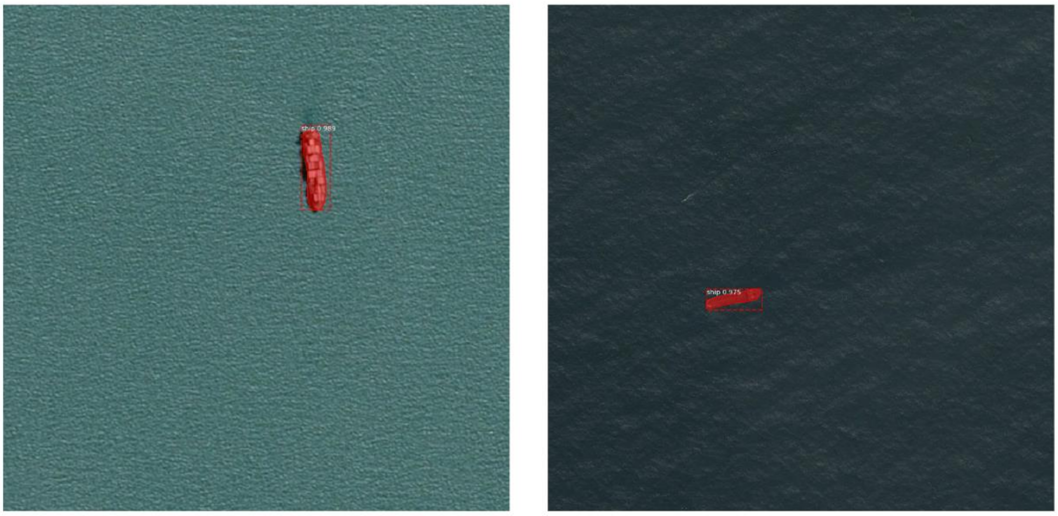

Figure 1 Selected examples of the prediction of Model 2 - I

Figure 2 Selected examples of the prediction of Model 2 - II

In the second model, network design includes two dimension (2D) convolution and Max-Pooling 2D phases. Epoch phase is done for 18 times and the accuracy – epoch number relationship has shown in Figure 3 below.

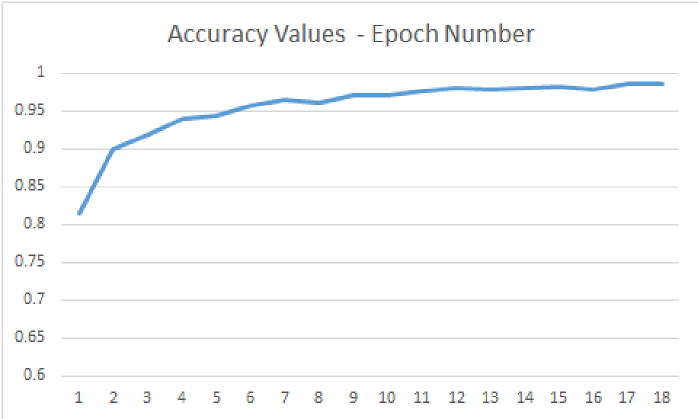

Figure 3Accuracy Values and Epoch Number

There is an example of how second model is working and producing the output below as Figure 4. Input is an RGB image as three bands of satellite image. Then, the algorithm is detecting the ships on the image in the prediction phase. Calculating and plotting the image coordinates of the extracted ship with cutting. Finally, showing the ship on the image using bounding box. As numerically, the algorithm is giving the coordinates of the ships and area as well.

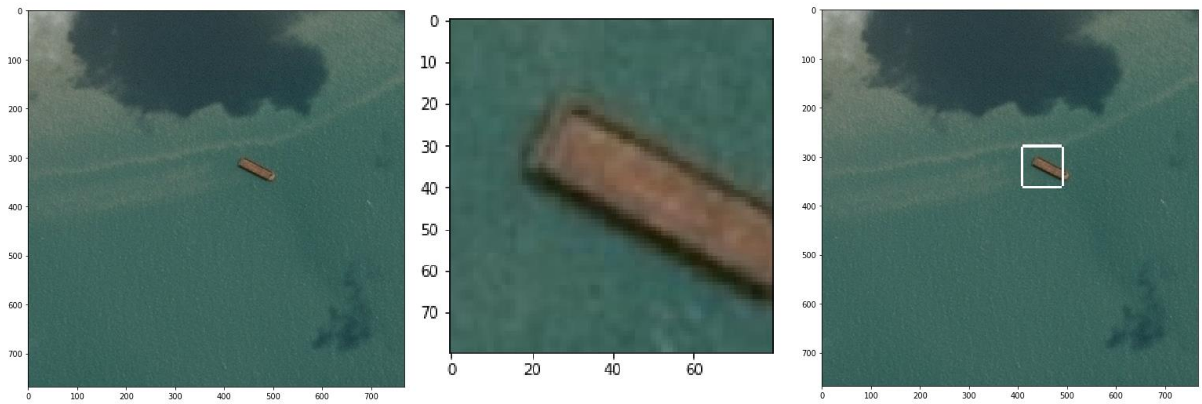

Figure 4 Input and Output Samples of Model 2

4. CONCLUSIONS

Over the years, ML algorithms are becoming more and more popular and useful for lots of areas. Studies are becoming more inclusive every day and geomatics engineering applications also embodies several ML experiments and convolutional networks for object detections on aerial and/or satellite images. Single or Multi Class Object Detection is one of the trend topics in these applications. Automatic ship detection can count one of the main experiments in the main. Many different algorithms and architectures can be used for that type of detections.

As suggestion for future works, rotation bounding box can be used as parallel to Fast R-CNN for better recall results. Also, Transfer Learning algorithm can be incorporated into the model for learning about pre-learnt model.

Acknowledgments: The authors would like to thank dataset sharing (AIRBUS and Planet), who generously provided their image dataset with the ground truth. The authors would also like to thank to GitHub algorithm repositories owners as mentioned above. Also, thank to our colleague Muhammed Enes Atik for his very competent comments and helpful suggestions about performing the experiments in this paper.

REFERENCES

[1] Oza, P., & Patel, V. M. (2018). One-class convolutional neural network. IEEE Signal Processing Letters, 26(2), 277-281.

[2] Girshick, Ross, et al. "Rich feature hierarchies for accurate object detection and semantic segmentation." Proceedings of the IEEE conference on computer vision and pattern recognition. 2014.

[3] Ross Girshick, Fast R-CNN, International Conference on Computer Vision (ICCV), 2015.

[4] Yang, X., Sun, H., Fu, K., Yang, J., Sun, X., Yan, M., & Guo, Z. (2018). Automatic ship detection in remote sensing images from google earth of complex scenes based on multiscale rotation dense feature pyramid networks. Remote Sensing, 10(1), 132.

[5] Airbus Ship Detection Challenge Dataset, 2019, Kaggle, Dataset

[6] Sam Lin, 2019, mask-r-cnn-ship-detection-minimum-viable-model-1 url (https://www.kaggle.com/samlin001)

[7] Planet's Open California dataset, url (https://www.planet.com/)

[8] Daniel Moraite, Keras for search ships in satellite image, 2019, GitHub repository, url (https://github.com/DanielMoraite)