H-039

Ship Classification Using Faster Region Convolution Neural Network (Faster R-CNN) for Automatic Identification of Marine vessels

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1. **Abstract**

In this paper, we consider the application of Faster R-CNN in ship identification for port safety and security. It arising due to global increase in maritime traffic, piracy, and persistent increase in unmonitored pollution related activities. Approaches using deep learning have been the most dependable means of classifying images with high precision and speed. We used Faster R-CNN to identify different types of marine vessels. For training and testing, 400 images are used. The overall mean average precision of the classification result is **0.8774** which outperforms the conventional image feature-based approaches.

***Key Words*: Region Proposal Network, average precision,**

1. Introduction

Understanding ship image-based port security systems is critical to modern maritime issues surrounding prediction of threats. Ports have been widening in size and complexity of maritime scenes caused by many vessel activities, waves, small vessel size, and Occlusions. Ships activity analysis and identification requires detailed understanding of ship location, movement, and capabilities. To obtain these attributes, feature based systems can be used to detect, recognize, and track vessels.

Many approaches that have been used previously have limitations in automatic classifications since most rely on two-way transmission of data. Most problems relate to limited use of Automatic Identification System (AIS) data which can only be utilized on compliant ship. It is therefore preferable to consider ways of better approaches which can address such limitations.

Our research uses the Faster R-CNN method for ship identification for port security, a method which has been found to have higher performance both in accuracy and runtime comparisons. Our aim is to obtain automatic classification of different types of ship in a port environment. In our method, we used 9 classes of ships for identification and it outperformed other state of the art methods with a higher accuracy. The overall mean average precision was better than the previous methods.

2. Related Researches

AlexNet deep convolution neural networks have been used to classify marine vessel images with different configurations [1]. This was done by measuring the top-1 and top-5 accuracy rates. It involved tuning specific range of vessels which depended on commodity hardware and size of images. This method used a dataset of 130,000 images of maritime vessels and labelled 35 classes. The method registered 80.39% and 95.43% accuracy rates for top-1 and top-5 accuracy rates respectively. In the case of Faster R-CNN, the ground truth of image source with a varied lighting conditions do not have adverse effect on performance.

An attempt was carried out to automatically detect ships based on S-CNN method with proposals designed from a combination of ship model and an improved saliency detection method [2]. "V" ship head and "‖" ship body models were used to localize the ship proposals from the line segments of test images. The proposals are fed to the trained CNN for efficient detection which proved suitable for better application on remote sensing images with different kinds of ships. This resulted in 91.1% and 97.9% recall performance for in-shore and off-shore ships respectively, while, 95.9% and 99.1 % precision rates respectively. In this regard, deep learning still is an appropriate method for detection, however S-CNN may not produce better results on classification due to problems affecting space images like weather as well as being slower in detection rate.

A comprehensive Faster R-CNN method is an efficient accurate and consistent in performance method using Region Proposal Networks (RPNs) in region proposal generation. It is nearly a cost-free method because it operates by sharing convolutional features with the detection networks [3]. In addition, the learned RPN improves the region proposal quality and hence the improved accuracy on object detection accuracy.

3. Proposed Approach

Based on the analysis of recent researches, there is an evidence on improvement in accuracy and reliability on application of deep learning approaches on image classification.

In our study, we analysed the performance of deep learning approaches over past years as shown in Fig. 1. The data used for this analysis was based selected reults of old models and those using deep convets models from the year 2006 upto the year 2015. Faster R-CNN is therefore suitable for ship classification particularly because of it is attributed to high accuracy [3].

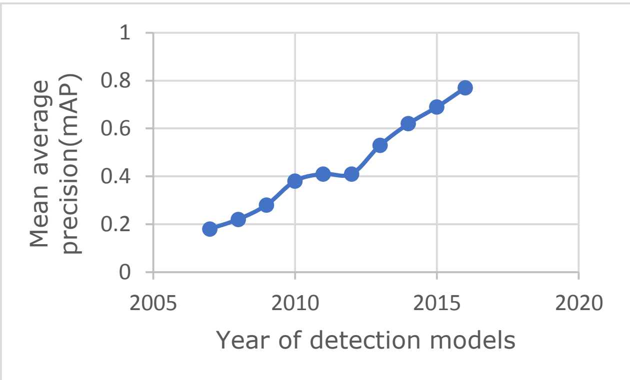

Fig. 1 Recent development of object recognition using deep learning

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4. Experiment results

First, we investigated the effect of the number of training images. As a preliminary experiment, 4 ship types are classified by Faster R-CNN. The number of training images changed from100 to 400 at every 50 images. The result of mean average precision is shown in Fig. 2. From Fig.2, it is turned out that the average precision performance of our method tends to improve with increase in number of images, and saturate around 400 images..

We, therfore, chose 400 images as appropriate for training and testing in 9 classes of target ship images. All images used were obtained from *shipspotting.com* and were pre-processed by resizing to 500 pixels. The Mean Average precision value over all class predictions was used as metric messure of performance. Details on average precisions scores for each class of ship images and the overal performance are shown in Table 1. The sample of the output classification results are shown in Fig. 3.

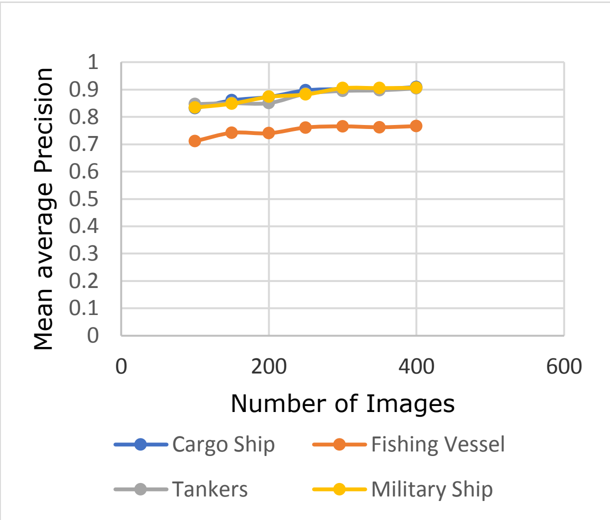

Fig. 2 Change in mAP with number of training images used

Table 1 shows the experimental results for the 9 classes with their respective IMO standard names.

Table 1 Experiment results Using Faster R-CNN

Class (IMO Standard Names)	Train	Test	AP
Container Ship	400	400	0.9091
Fishing Vessel	400	400	0.7659
Tanker	400	400	0.9420
Submarine	400	400	0.8896
Tug	400	400	0.8165
Vehicle Carrier	400	400	0.9091
Rescue Ship	400	400	0.8862
Ferry	400	400	0.9091
Destroyer Ship	400	400	0.9069
Mean AP			0.8774

Fig. 3 Samples of result output

There was minimal variation of AP values on individual classes except for fishing vessel. This could have been caused by nature of images used for fishing vessels as most of them are had huge transformations due to modifiation by users hence the complexity. Samples of the results output are shown in Fig 3. Tanker whis is usually phisically big in size scored highly in AP value. This may suggest that the physical appearance can be a factor for considerations in ship classification.

It is evident that our approach achieved an average mean precision value of 0.8774 which outperforms other approaches that have been used in marine vessel classifications. For Fishing vessels with the least mAP, it is suggested that better classification may be improved by varying pixel in all images.

5. Conclusion

In this research, we proposed to use Faster R-CNN to ship classification. The result shows high precision which is 0.8774 in average. This may be considered a better classification system for ships which do not need two way communication as in AIS. Thus, it is suitable for automatic classification of ships. However, It can be improved by utilizing the infra-red camera images to address issues of image quality caused by of weather effects and night times. The result obtained is nevertheless useful outcome which can be applied in marine technology for port security management..

References

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