Ship Identification for Port Security using Faster Region Convolution Neural Network

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Abstract: Research on Ship identification has increasingly become very important in port security and marine traffic control. This is because of port's evolution process towards automation and in addressing the security challenges like the piracy. In this research we focus on the application of Faster Region convolution neural network (Faster R-CNN) method for identifying various classes of ship images.

1. Introduction

In recent years, there is significant research focus on marine vessel detection and identification with the view of improving security, marine traffic management, and pollution control, as well as improving efficiency in port operations. Depending on operational needs, various approaches have been used for ship detection and identification for surveillance of marine vessels. However, their capabilities have raised claims of inadequacy to meet operational needs. Ship identification approaches therefore, calls for accuracy improvement and ability to provide real time solutions.

Automatic Identification System (AIS) is a global standard for ship identification with ship specifications, position and a two-way information within the designated vicinity. It requires relevant data and tracking system particularly on compliant ships. For non-compliant ships, for instance, an invading ship known for piracy, terrorism or any other illegal activity may not be positively tracked or identified with the AIS. This limitation therefore is a baseline for recent research motivation for better approaches to ship identification for port security.

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 area. The successful identification of ship types using Faster R-CNN is useful in port security as well as maritime management.

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. Their 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 relation to Faster R-CNN, the ground truth of image source with a varied lighting coditions do not have adverse effect on performance.

Zhang et al attempted 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 effficient detection which proved suitable for better application on remote sesing 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.

It is still difficult to obtain successful classsification of ships especially in using space imagery. High resolution optical images can be classified well, however, little focus has been done on automatic systems for optical images due to weather effects on sensors [3]. Many researches have, therefore, continued to focus on addressing the problems of space images and with the combination of recent deep learning approaches may lead to better solutions.

A comprehensive Faster R-CNN method is an efficient accurate and consistent in performance method using RPNs in region proposal generation. It is nearly a cost-free method because it operate by sharing convolutional features with the detection networks [4]. In addition, the learned RPN improves the region proposal quality and hence the improved accuracy on object detection accuracy.

3. Our Approach

In our method, Faster R-CNN, is made up of deep convolutional network and Fast R-CNN for region proposal and dection respectively. The overall system involves a detection network from which Region Proposal Network (RPN) tells the Fast R-CNN module where to look [4].

4. Experiment

Our method is guided by [4], approach with the detection benchmark of PASCAL VOC 2007. Our dataset consists of 1300 trainval images of ship and 1300 test images over 4 categories; cargo ship, Tanker ship, fishing ship and military type ship images. Our method used Imagenet pretrained network with VGG-16 model that has 13 convolution layers and 3 fully-connected layers. We also determined the detection mean average precision which is an actual metric for in object detection. All images were obtained from shipspotting.com. Details and nature of camera used were not considered in our research. However, the images were re-scaled so that the shorter side was 600 pixels.

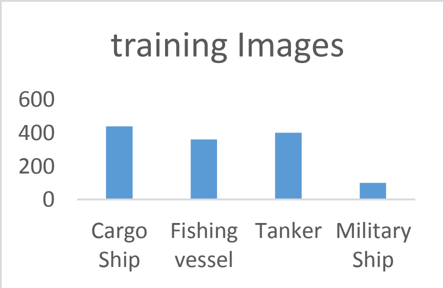

Figure 1: Images used in training based on 4 classes

The following are selected samples of object detection results on PASCAL VOC 2007 test set using Faster R-CNN system and VGG-16model. Our focus was to detect different types of ship as shown in *Figure 1*.

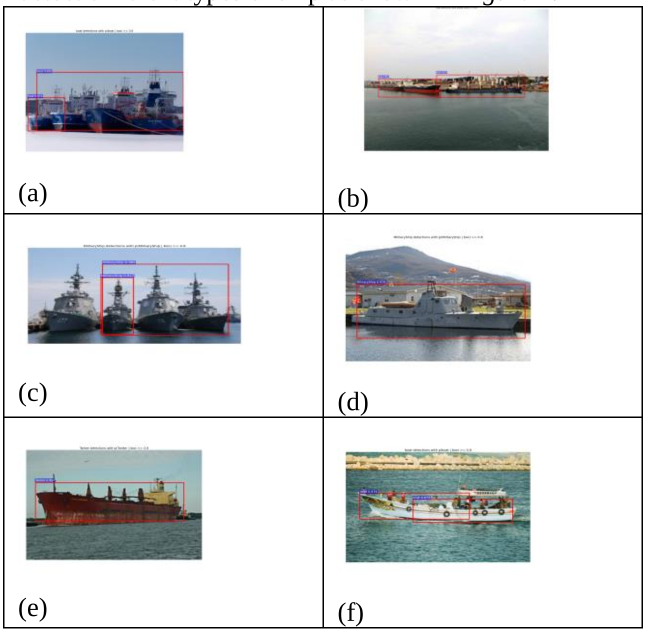

Figure 2: Selected samples of detected vessels using Faster R-CNN
{(a) Cargo vessels (b) Tankers (c) Military ships (d) Fishing vessel (e) Tanker (f) Fishing boat}

For each output result, the output box reflects a category mark and a softmax score in [0,1]. The threshold score was set to 0.8 to display the images. The average running time was less than 198ms per image.

5. Conclusion

Our research indicates that, the use of Faster Region Convolution Neural Network (Faster R-CNN) on identification of ship images is an efficient method. As a basis for future utilization of the method, we considered testing the method with 4 classes of ships which are common in marine environment. From the experiment results, it is clear that Faster RCNN is more effective method as compared to the general image classification approaches. However it requires sufficient amount of images in order to produce consistent results.

For better performance of the method in ship classification, large number of images are suitable with many classes for stratification. For better results, our research suggest future increase in classes of ships as well as increasing the number or training images. For improvement in accuracy, research intends to use high resolution radar/remote sensing images. This may solve the real time problems as the images will have real time geographic information details.

Our future plan is to increase the ship classes, involve remote sensing and assess the performance of our method with different models of object classifications.

References

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