International Journal of Future Generation Communication and Networking

Vol. 13, No. 3s, (2020), pp. 711–716

Machine Learning Based Ship Detection Technique

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Abstract

Ship Detection has a wide range of applications in the commercial/military area, and maritime security is an increasing and important need for every country across the globe. It helps to prevent and investigate different unlawful actions as well as environmental hazards present at sea. This paper presents a novel Ship Detection technique from high-resolution satellite images with the help of Convolutional Neural Networks(CNN). The proposed system uses Machine Learning techniques for image processing. CNN has been used extensively to get good accuracy and has been most successful in the past. The described approach provides reasonable performance and therefore is potentially suitable for near-real-time (NRT) applications.

Keywords— Optical Satellite Images, SAR Images, Tensorflow, Python, Artificial Neural Network, Convolutional Neural Networks(CNN), Ship Detection.

I. INTRODUCTION

The effective use and control of maritime routes in the commercial/military area is an increasing and important need for states. As a result of the rapid development in the shipbuilding industry, the number of ships and their size increases day by day. Ship detection has been playing an important role for a long time and can promote national defense construction, port management, cargo transportation, and maritime rescue. Although many ship detection methods have been proposed before, this task still poses a great challenge due to the existence of uncertainties such as light, disruptors, the density of the ship and so on.

Due to the recent decline in the number of fish reserves in the world, ship detection has become a more effective and efficient method of monitoring fishermen to identify illegal fishing activities. Remote monitoring of the regions of interest in terms of detection and tracking of foreign/enemy elements threatening the security of the area in the seas makes a major contribution to the early warning of military intelligence, crime, and anti-terrorism units.

It is also useful for detecting lost ships, boats, airplanes, debris, containers, etc. Nowadays, ship detection has attracted great interest in the wide applications of maritime safety, e.g., illegal smuggling, traffic surveillance, fishery management, and so forth.

The identified problem of the development of ship detection techniques deals with Big image data processing and pattern recognition methods. The images used are high-resolution optical satellite images. The machine learning technique used for image processing is CNN with the help of Tensorflow.

ISSN: 2233-7857 IJFGCN

This paper also describes and reviews different types of methods used for ship detection in the sea.

Inspired by successful object detection trends in the computer vision community, a CNN-based ship detection framework is presented. Part II describes the review and comparative analysis of different papers referred to. The main precondition of any deep learning project is available training data. In part III section C, the dataset and source of the dataset for the training are described. The conclusion is discussed in the last part.

II. RELATED WORK

TABLE I

Sr. No.	Title	Publication	Algorithm/Techniques	Findings
1.	Multiclass Vessel Detection From High Resolution Optical Satellite Images Based On Deep Neural Networks[1]	IEEE	Deep Convolutional Neural networks (DCNN) and principle component analysis (PCA)	CNN model "MobileNet" is used to classify image patches of 300x300 pixels whether they contain ship/ship parts or not. Next, resulting in image subsets are processed with complex object detection model "Faster R-CNN ResNet-101" to extract locations, classes, and north oriented minimum-maximum bounding boxes of the ships. And finally, with the help of PCA, vessel heading is estimated.
2.	Ship Detection and Classification on Optical Remote Sensing Images Using Deep Learning[2]	ITM Web Of Conferences	CNN model	CNN was trained to detect actual ships from all candidates. Finally, using the CNN model, all the actual ships were classified into different ships.
3.	Towards Automated Vessel Detection And Type Recognition From VHR Optical Satellite Images[3]	IEEE	CNN-based vessel detection work flow	This paper presents the test results of vessel detection from VHR optical satellite images based on deep convolutional neural networks. Two different CNN architectures: MobileNet for fast preselection of potential vessel

ISSN: 2233-7857 IJFGCN

				containing regions of the satellite image and Faster R-CNN Inception-ResNet for final object detection are used.
4.	Automatic Ship Detection of Remote Sensing Images from Google Earth in Complex Scenes Based on Multi-Scale Rotation Dense Feature Pyramid Networks[4]	Article	R-DPFN Framework	This paper proposes a multi-scale rotation region detection method that can handle different complex scenes, detect intensive objects and reduce redundant detection region. A framework called Rotation Dense Feature Pyramid Networks (R-DFPN) is used.
5.	Ship Detection From Optical Satellite Images With Deep Learning[5]	IEEE	Deep Learning Algorithm, TensorFlow Object Detection	Tensorflow Object Detection Application Programming Interface (API) is trained by optical satellite images with ships and used as object detection API.
6.	Convolutional neural networks for ship type recognition[6]	SPIE	Convolutional neural networks (CNNs)	The paper reported results from the application of a convolutional neural network algorithm to several ship recognition tasks using images chipped from satellite imagery.

Table.1. Comparative Analysis

III. FUTURE DIRECTION

A. Scope

The Project aims at providing a fast near real-time framework and smooth detection of ships in the waters with the help of satellite images. If Ship Detection is Extensively used then this will help various Security agencies in avoiding and averting possible National Security threats. This project can be used by different agencies of government. For example :

- Coast Guards
- Indian Navy
- Merchant Navy
- Cruises

ISSN: 2233-7857 IJFGCN

- Private Industries and Start ups
- Academics and Research

The Detection of illegal ships is the need of the hour. The increasing number of terrorist attacks and illegal activities around the world is mostly related to the intrusion of terrorists and aliens through seaways. If this can be stopped at the very first level, a lot can be avoided.

B. Detection and Working

Convolutional Neural Networks

CNN is a kind of deep learning networks and it combines three architectural ideas to ensure some degree of shift, scale and distortion invariance: local receptive fields, shared weights, and spatial or temporal sub-sampling. With local receptive fields, neurons can extract elementary visual features such as oriented edges, end-points, and corners. These features are then combined by the subsequent layers to detect higher-order features. Units in a layer are organized in planes within which all the units share the same set of weights. The set of outputs of the units in such a plane is called a feature map. Units in a feature map are all constrained to perform the same operation on different parts of the image. A complete convolutional layer is composed of several feature maps (with different weight vectors) so that multiple features can be extracted from each location. An implementation of a feature map is equivalent to a convolution, followed by an additive bias and squashing function, hence the name convolutional neuron networks.

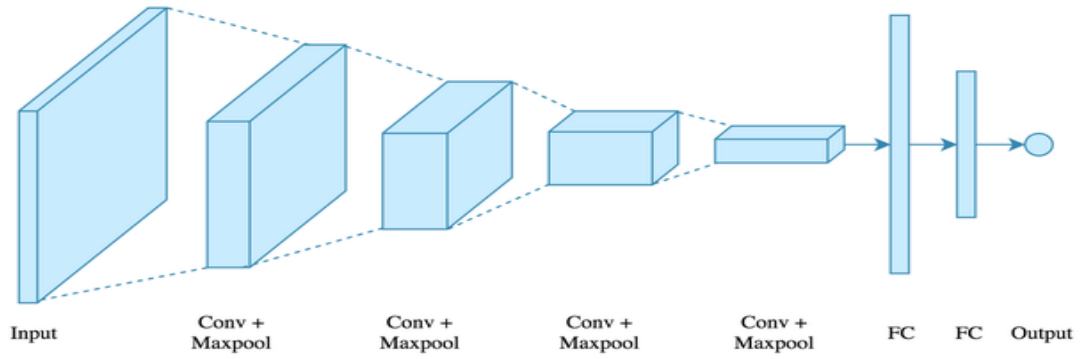

Fig.1. Working of CNN.[9]

CNN for Ship Detection

Convolutional neural network (CNN) in machine learning is a deep feed artificial neural network which has been successfully applied to the analysis of images. It is a multi-layer network architecture developed from the classic neural network process. CNN usually consists of an input layer, convolution layer, pooling layer, full connection layer, and output layer. From the labeled training dataset consisting of image chips extracted from Planet satellite imagery. It contains hundreds of 80x80 pixel RGB image chips labeled with either a ‘ship’ or ‘no ship’ classification. Machine Learning model is trained against this data to classify any given input image into either one of these classes.

C. Dataset

ISSN: 2233-7857 IJFGCN

The kaggle shipsnet dataset[8] has 4000 images with the class label. There are two classes, 1000 images with ‘ship’ class label and other 3000 with ‘no ship’ class label. This dataset will be extensively used for training and testing of the algorithm. The dataset consists of image chips extracted from Planet satellite imagery collected over the San Francisco Bay and San Pedro Bay areas of California.

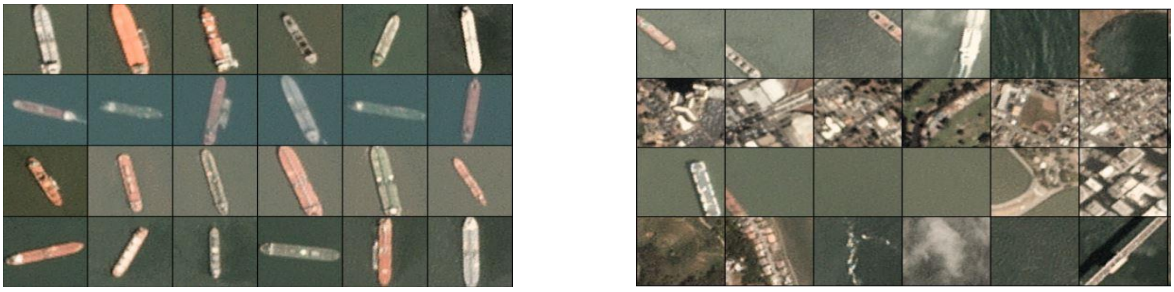

Fig.2. Examples of images from the training data set.[8]

IV. CONCLUSIONS

In this paper, we explore a novel method for ship detection from optical satellite images. Ship detection and classification is a widely studied topic both in civilian and military applications. First, an ML model is trained to identify a ship or no ship. In the next step, the trained model is tested on a new set of images. The use of GPU for detection and especially for the training process makes a significant impact on the processing performance. In the end, we can ultimately identify the true ships by the trained CNN model.

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ISSN: 2233-7857 IJFGCN