SHIP DETECTION AND RECOGNITION IN SAR IMAGES

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ABSTRACT

Object detection area has been seeing rapid radical changes. Its application in image based sensor’s outputs make most challenging task. The objective of object detection technique is to determine objects and classify objects. You Only Look Once or YOLO is one of the popular algorithms in object detection used by the researchers around the globe. Presently in this work, YOLO has been applied for airplane detection. YOLO algorithm presently gave very good results, when generalizing from natural images to optical remote sensing domains.
Although the Faster-R-CNN achieves good detection results, its accuracy is not high enough. To meet high detection accuracy and high-speed performance requirements of real-time operation, Redmon et al. [17] proposed another CNN-based unified target detection method. The proposed method, YOLO, predicts the bounding box and object class probability directly from the complete image in a single estimate. Since the entire detection pipeline is a single network, end-to-end optimization of the detection performance is straightforward.
You Only Look Once or YOLO is one of the popular algorithms in object detection used by the researchers around the globe. According to the researchers at Facebook AI Research, the unified architecture of YOLO is extremely fast in manner. The base YOLO model processes images in real-time at 45 frames per second, while the smaller version of the network, Fast YOLO processes an astounding 155 frames per second while still achieving double the mAP of other real-time detectors. This algorithm outperforms the other detection methods, including DPM and R-CNN, when generalizing from natural images to other domains like artwork.

Fast R-CNN, Faster R-CNN, Histogram of Oriented Gradients (HOG), Region-based Convolutional Neural Networks (R-CNN), Region-based Fully Convolutional Network (R-FCN), Single Shot Detector (SSD), Spatial Pyramid Pooling (SPP-net), YOLO (You Only Look Once).

Index Terms— Object detection, Deep Learning, *You Only Look Once or (YOLO)*

1. INTRODUCTION

Object detection applied in different fields is a computer-based technology belongs to computer vision and image processing area. Object detection deals with detecting occurrences of semantic objects of a specific type objects like; humans, buildings, or cars in natural images and videos [1]. Various research domains related to object detection include face detection, vehicle detection, pedestrian detection, animals and other objects. Object detection has applications in many areas of computer vision, medical science, remote sensing, image retrieval and video surveillance.
Object detection has been extensively used in computer vision tasks such as image marking[2], motion recognition[3], face detection, face recognition, video segmentation. Object detection has been extensively used in tracking moving objects. For example tracking football, tracking cricket bat movement, or moving person tracking in a video.
Now a days high resolution Synthetic Aperture Radar (SAR) is regarded as one of the most suitable sensors for object detection and environment monitoring in the field of space technology. It offers wide coverage and ability to scan regardless of weather or time of day. The SAR images are characterized as having high resolution capability, not being dependent on the weather condition and independent of flight altitude. SAR always provides quality images at any condition because of their self-illumination ability. SAR images have a lot of applications in remote sensing and mapping of different surfaces of any planets including the earth. Other important applications of SAR imagery include oceanography, topography, glaciology, geology, forestry, biomass, volcano and earthquake monitoring. It is also useful in monitoring maritime activities like oil spills and ship detection.
Ship detection is an important topic in the field of remote sensing. At present, many object detection methods have been developed in the pattern recognition community. However, many of the proposed systems have computationally intensive problems for high accuracy performance. We have implemented latest version of YOLO(i.e. YOLOv5)

2. OBJECT DETREDCTION METHODS

Every object class has special features and these helps in detecting the objects – for example all rectangles are bound with straight lines. Object class detection uses special features of an object. For example, when looking for rectangles, objects, which are at a particular distance from camera, are sought. Similarly, when looking for circles, objects that are having center point are sought. A type of similar approach can be used for face detection where eyes, nose, and lips can be identified and features like skin color and distance between eyes can be identified.

Based on latest trend, methods for object detection were generally coming under domain of machine learning based approaches or more latest one called deep learning based approaches. In machine learning approaches, pre-processing step takes place to first define or extract features. Once features are extracted, later applying a technique like; as support vector machine (SVM) for classification. Latest upcoming deep learning techniques are capable to learn from data for point-to-point object detection while extracting features during training, and are typically based on convolutional neural networks (CNN). Machine learning based object detection approaches are like; Viola–Jones object detection framework based on Haar features, Scale-invariant feature transform (SIFT), Histogram of oriented gradients (HOG) features[5]. Secondly upcoming deep learning based object detections approaches are like; Region Proposals (R-CNN[6], Fast R-CNN[7], Faster R-CNN[8], cascade R-CNN[9]), Single Shot MultiBox Detector (SSD) [10]. You Only Look Once (YOLO) [11][12][13][4], Single-Shot Refinement Neural Network for Object Detection (RefineDet) [14], Retina-Net [15][9], Deformable convolutional networks [16][17].

3. DATA DETAILS

Data set used in this study were SAR images of ship with 300 images for training, 300 images for validation and later 300 images for testing sample data. Target class identified was only ship. Thus total no of target class is one.

4. METHODOLOGY

In this study YOLOv5 object detection algorithms is implemented which is released recently on 9 June 2020. YOLOv5 released only four days back of releasing of YOLOv4 by an unofficial author Glenn Jocher. There are lots of controversies about the selection of the name "YOLOv5" and other stuff. Glenn introduced PyTorch based version of YOLOv5 with exceptional improvements. Hence he has not released any official paper.

We construct a YOLOv5-based end-to-end training convolutional neural network to detect ships. First, YOLO uses a single neural network to directly predict the bounding box and class probability. The SAR image is divided into an S x S grid of cells. Each grid cell predicts only one object. If the center of an object falls into a grid cell, that grid cell is responsible for detecting that object. Every grid cells predicts the B bounding boxes and the confidence score of that bounding boxes, and class probabilities. The bounding box prediction has 5 components: (x, y, w, h, confidence). The (x, y) coordinates represent the center of the box relative to the grid cell location. These coordinates are normalized to fall between 0 and 1. The (w, h) box dimensions are the width and the height of the bounding box also normalized to 0 and 1 relative to the image size.

Complete flow chart of detection algorithm is illustrated in below figure 1.

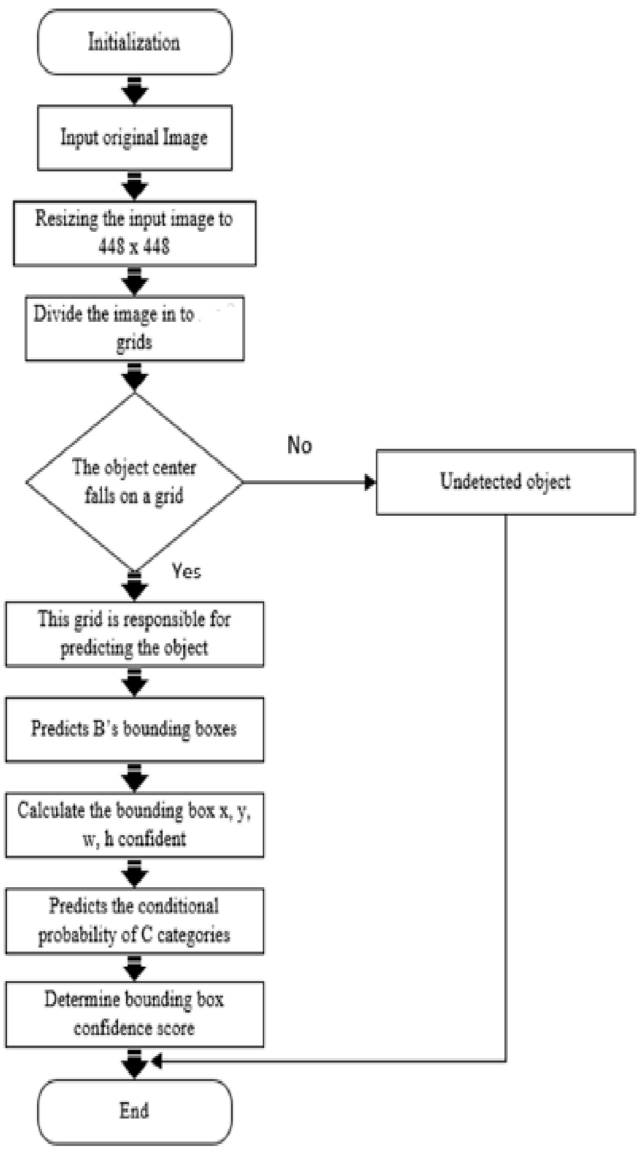

Figure 1 YOLOv5 Detection Flow Chart

5. RESULTS AND DISCUSSION

In this work, we implement a novel and fast object detection approach on google colab GPU that fully utilizes the complementarity of the optical images to robustly identify the ship.

Fig 2(a)

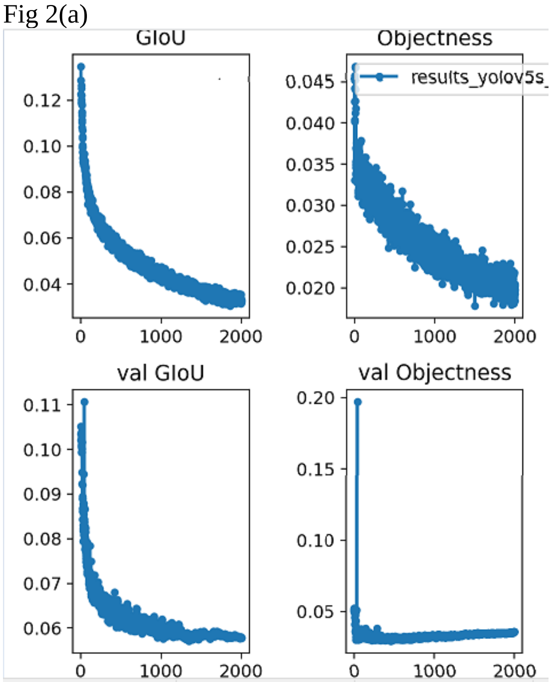

Fig 2(b)

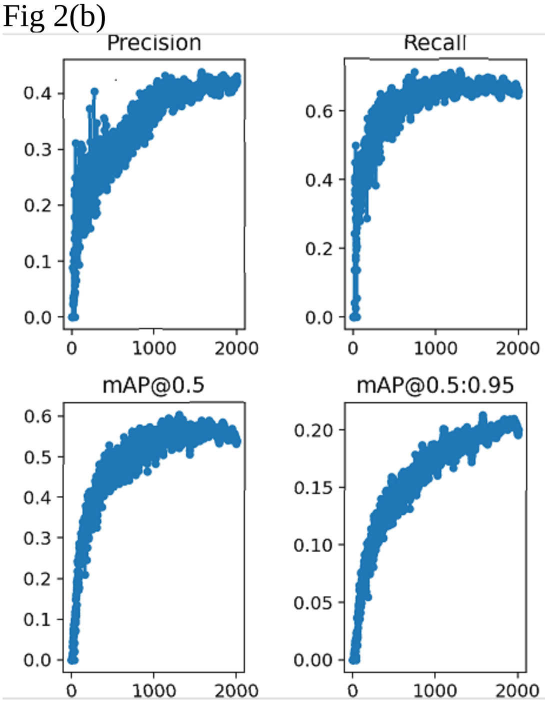

Figure 2 (a & b) Illustration of various performance evaluating parameters

We train our model for 2000 iteration and various observations are plotted in Figure 2. It is clearly found that our precision, recall, Map are improving with respect to epochs. It's about 1500 iteration when these things gone in a little bit saturation. Hence no need of further trainings is required after 2000 iterations.

We also tested our model on validation data, and some samples of detection capability of YOLOv5 is shown in Figure 3.

Fig 3(a)

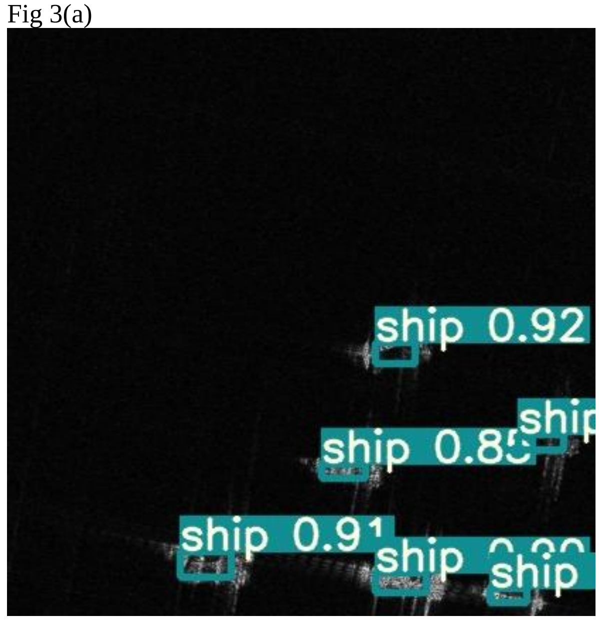

Fig 3(b)

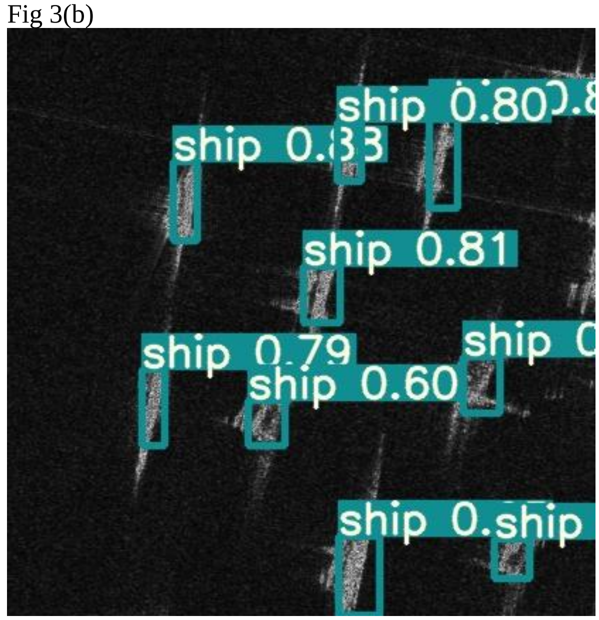

Figure 3 (a & b) Examples of ship detection in different test images

This shows that our model is capable of detecting various objects with much confidence. It also yields an acceptable accuracy and can be implemented in real time as it takes about 20ms/per image in detection of multiple objects associated with that image., which means it can be executed rapidly and implemented online and that its performance is competitive with current popular methods. Because of its prominent learning capability, it avoids the problems associated with the effects of environmental illumination changes. It should also be mentioned, that the trained YOLO v.5's CNN was able to detect an airplane in the image, even if its contours were obscured by another object, ground, or in pretty different conditions

6. CONCLUSION

We implemented YOLOv5, a unified model for object detection. Our model is simple to construct and can be trained. directly on full images. Unlike classifier-based approaches, YOLO is trained on a loss function that directly corresponds to detection performance and the entire model is trained jointly. The results of this study verify the correctness and effectiveness of the method in both accuracy and computational cost. Fast YOLO is the fastest general-purpose object detector in the literature and YOLO pushes the state-of-the-art in real-time object detection. YOLO also generalizes well to new domains making it ideal for applications that rely on fast, robust object detection.

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