VESSEL DETECTION FROM SPACE BORNE IMAGES

Abstract—

Vessel detection from remote sensing imagery is a crucial application for maritime security which includes traffic surveillance, protection against illegal fisheries, oil discharge control and sea pollution monitoring. This is currently manually being done through the use of an Automated Identification System (AIS), which uses Very High Frequency (VHF) radio frequencies. AIS is very effective at monitoring ships which are legally required to install a VHF transponder, but fail to detect those which are not, also in some cases people disconnect their transponder which is a quite common case. Satellite imagery can be used in these cases as it removes the human element out of the loop. Synthetic Aperture Radar (SAR) imagery uses radio waves to image the Earth's surface. A number of factors can make vessel detection and segmentation a challenging task. Some of these factors include flaws in image quality like uneven brightness, obstruction, and also the fact that there are many images which have similar shape, color and texture. The goal of this work is to build an algorithm to detect and segment ships in satellite images. The model as a backbone to detect and segment ships in the satellite images. This model is very effective and hence can be used to detect and segment ships in realtime applications.

1. INTRODUCTION

Vessel detection from satellite images is an important application for maritime applications like ship traffic surveillance, protection against illegal fisheries, oil discharge control and sea pollution monitoring. Machine Learning techniques are used to detect and segment vessels from satellite images. It is very effective and can be used for real time applications. This can be of great help to the maritime security and offshore operations in the surveillance, energy and military sector.

OBJECTIVE

Vessel detection is currently being manually done through AIS which uses very high frequency (VHF) radio frequencies. To remove the human element out of loop satellite images are used to detect vessels. The goal of the system is to build an algorithm to effectively detect and segment vessels from the satellite images. Using a public data set, a deep-learning network is uses custom Mask RCNN with Resnet-50 vessels from the satellite images. Using a public data set, a deep-learning network is trained to detect the images and segment them with better accuracy.

METHODOLOGY

To detect and segment vessels a large collection of satellite image data is required. The images are downloaded from the Airbus

Ship detection Challenge. In this section the methodology followed is discussed in detail

DATASET

In this work, a public dataset from Kaggle from the Airbus Ship Detection Challenge is obtained. The dataset contains more than 200 thousand 768 × 768 high resolution images taken from satellite out of which 193k images are used for training and 15.6k images are used for testing. The total size of the dataset is 29.25 Gb. Along with the images in the dataset, is a CSV file that lists all the images ids and their corresponding pixels coordinates. These coordinates represent segmentation bounding boxes of ships. Not having pixel coordinates for an image means that particular image doesn't have any ships

THE PROPOSED MODEL

The model has two tasks namely detection and segmentation. First phase of the model is to build an algorithm to detect if a satellite image has vessel or not and the second phase is to build an algorithm to segment or locate the vessel if it is detected. For detection of vessel in an image the training data is fed into ResNet50. After Classification, Segmentation is done using Mask RCNN algorithm to locate or segment the ship. ResNet-50: ResNet-50 is one of the transfer-learning techniques. Transfer

earning generally refers to a deeplearning process where a model trained on one problem is used in some way on a second related problem. Transfer learning has the benefit of decreasing the training time for a neural network model and can result in lower generalization error. Residual Net (ResNet) is one such widely used model for transfer learning because of its performance. It is a pre-trained model provided by the Keras and can be efficiently used based on requirements. ResNet is a powerful backbone model that is used very frequently in many computer vision tasks. ResNet uses skip connection to add the output from an earlier layer to a later layer. This helps it mitigate the vanishing gradient problem

Mask RCNN:

Mask RCNN is a deep neural network aimed to solve instance segmentation problem in machine learning or computer vision. In other words, it can separate different objects in an image or a video. Vessel detection from space borne images 9 You give it an image, it gives you the object bounding boxes, classes and masks. There are two stages in it. First, it generates proposals about the regions where there might be an object based on the input image. Second, it predicts the class of the object, refines the bounding box and generates a mask in pixel level of the object based on the first stage proposal. It is one of the most efficient networks to solve single instance segmentation problem.

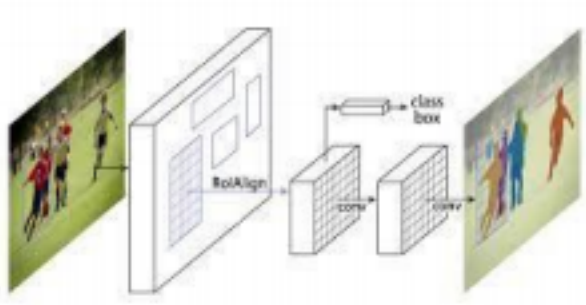


Fig:1 Mask RCNN framework for instance segmentation

Using Mask RCNN with ResNet50 as a

backbone, vessel can be detected and segmented in a satellite image with better efficiency.

Fig:2 Instance Segmentation

4. DESIGN

INTRODUCTION

Software design sits at the technical kernel of the software engineering process and is applied regardless of the development paradigm and area of application. Design is the first step in the development phase for any engineered product or system. The designer's goal is to produce a model or representation of an entity that will later be built. Beginning, once system requirement has been specified and analyzed, system design is the first of the three technical activities -design, code and test that is required to build and verify software. The importance can be stated with a single word "Quality". Design is the place where quality is fostered in software development. Design provides us with representations of software that can assess for quality. Design is the only way that we can accurately translate a customer's view into a finished software product or system. Software design serves as a foundation for all the software engineering steps that follow. Without a strong design we risk building an unstable system – one that will be difficult to test, one whose quality cannot be assessed until the last stage. During design, progressive refinement of data structure, program structure, and procedural details are developed reviewed and documented. System design can be viewed from either technical or project management perspective. From the technical point of view, design is comprised of four activities – architectural design, data structure design, interface design and procedural design.

Architecture

(a) Classification part:

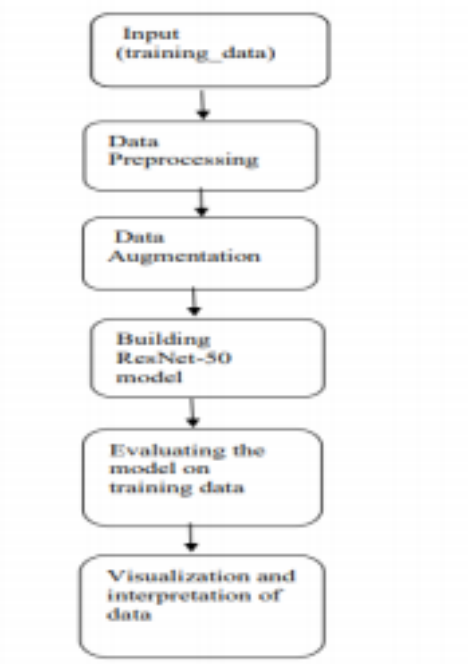
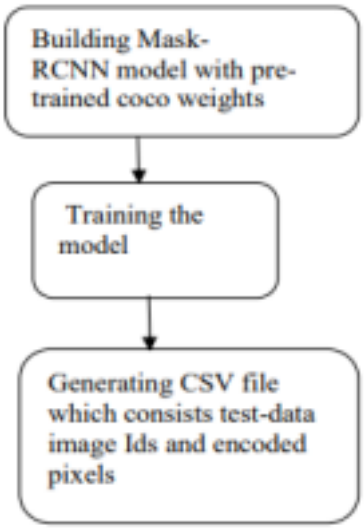


Fig 3. Classification architecture

(b) Segmentation part:

Dataset

The dataset taken from Kaggle has train_v2 folder which is training data and has 193k high-resolution images and test_v2 folder which is testing data and has 15.6k 768 *768 high-resolution images. The train_ship_segmentations_v2.csv file has image id and its encoded pixel coordinates.



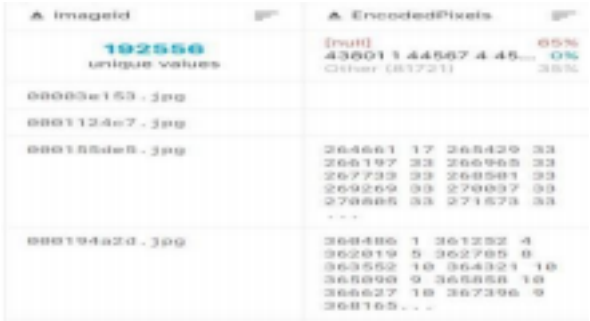


Fig 4.Segmentaton architecture

Fig: 5 Dataset screenshot

Output Screenshots

Fig: 6 Upload image

This window consists of one buttons, upload image. Clicking on upload image button will prompt user to select the input image.

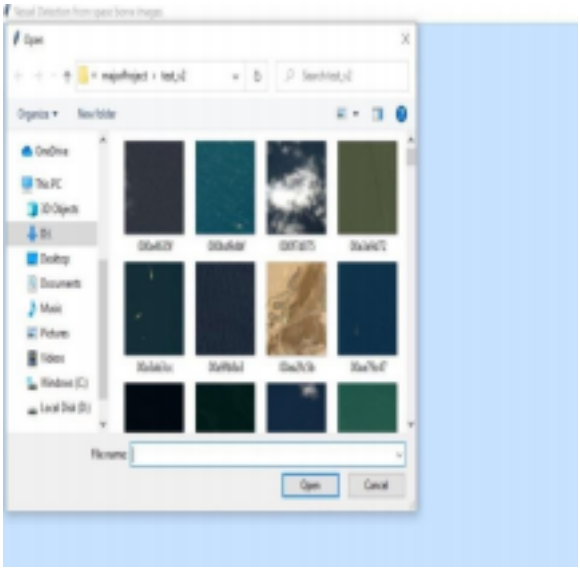


Fig :7 Prompt to select input image

Here, user will select the input image and upload the image

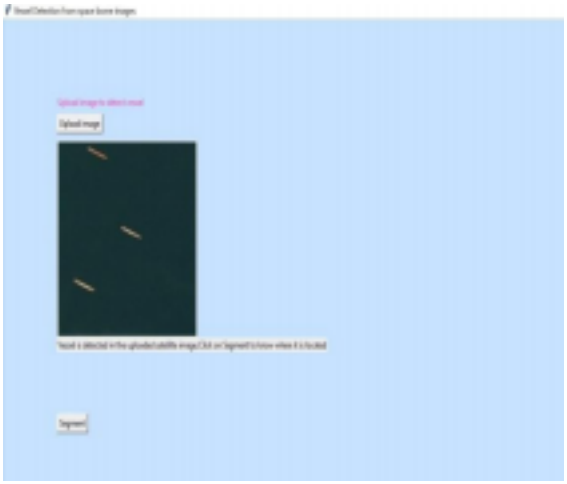


Fig 8. Vessel detected Case

This window displays the image which the user selected as the input image. If the image contains vessel it will detect the vessel is detected from the uploaded satellite image. It also has a button named 'Segment', by clicking on which it will show where it is located.

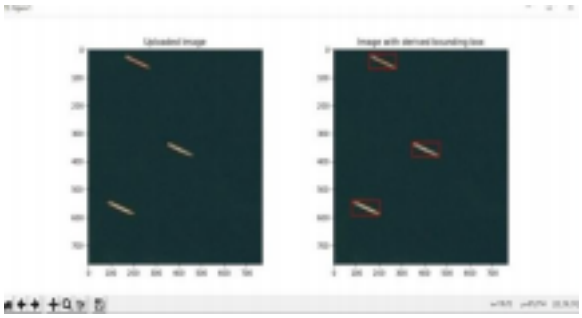


Fig:9 Vessel Segmentation

In this window displays the image with derived bounding box.

Fig: 10 No vessel detected case.

This window shows when we upload the image if

their no vessel it will show the vessel is not detected from the uploaded satellite image.

CONCLUSION

Thousands of vessels are constantly sailing in sea, oceans etc. These vessels are used for Global Positioning System (GPS) applications, vessel detection, communications and forecasting weather etc. Vessel detection from satellite (space borne) images is an important application for maritime applications like ship traffic surveillance, protection against illegal fisheries, oil discharge control and sea pollution monitoring. This is currently manually being done through the use of an Automated Identification System (AIS), which uses Very High Frequency (VHF) radio frequencies. AIS are very effective at monitoring ships which are legally required to install a VHF transponder, but fail to detect those which are not. Satellite imagery can be used in these cases as it removes the human element out of the loop. This project uses satellite images to detect vessels and segment them. Resnet-50, a residual neural network along with Mask- RCNN, a deep neural network that is aimed to solve instance segmentation problem is used for effectively detecting and segmenting ships. Resnet -50 is the transfer-learning network which is very efficient than basic neural networks and therefore this project detects if a vessel is there in the image with better accuracy and if the vessel is detected, it also segments the vessel and encloses it with a bounding-box. This application can be of great help to the maritime security and offshore operations in the surveillance, energy and military sector. It could bring a whole new dimension of transport for container ships and vessels by tracking ships from satellite images in real time. It can also be extended to navy for safetymonitoring, ship-tracking etc. The further enhancements of this application are:

(i) Increasing the training data with wide variety of satellite images with islands that resemble the shape of vessel, images with many vessels, ports and whales for much accurate detection.