Ship Detection and Segmentation using Satellite Imagery

A Mini Project Report Submitted by

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UNDER THE GUIDANCE OF

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CERTIFICATE

Certified that the mini project work entitled

"Ship Detection and Segmentation using Satellite Imagery"

is a bonafide work carried out by

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in partial fulfilment of the requirements for the award of

Bachelor of Engineering Degree in Artificial Intelligence and Machine Learning Engineering

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It is certified that all corrections/suggestions indicated for Internal Assessment have been incorporated in the report deposited in the departmental library.

The mini project report has been approved as it satisfies the academic requirements in respect of the mini project work prescribed for the Bachelor of Engineering Degree.

13/12/2022

Signature of Guide

Signature of HOD

Evaluation

	Name of the Examiners	Signature with Date
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2.	Rakshitha	13/12/22

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INTRODUCTION

Automatic detection of objects of interests is a task that has been a challenge in the computer vision community for decades. A lot of work has been done over the past 10 years [2] to automatically extract objects from satellite imagery but with limited operational results. Often these solutions work with a limited dataset but are not able to generalize on unseen data. With the advent of deep learning algorithms which make use of convolutional neural networks (CNN's), there has been a lot of advancement in this field often producing state of the art results.

Shipping traffic has grown rapidly over the last couple of decades. To handle illegal shipping and infractions at seas, maritime bodies usually monitor shipping traffic manually by going through each image. However, this work is a time- consuming task and requires qualified people. Automating this task is of significant importance to many. The advances in computer vision along with the availability of high-resolution data at a higher frequency will lead to the automation of these tasks.

OVERVIEW

The ship-detection task in satellite imagery presents significant obstacles to even the most state of the art segmentation models due to lack of labelled dataset or approaches which are not able to generalize to unseen images. The most common methods for semantic segmentation involve complex two-stage networks or networks which make use of a multi-scale scene parsing module. In this paper, we propose a modified version of the popular U-Net architecure called Squeeze and Excitation U- Net and train it with a loss that helps in directly optimizing the intersection over union (IoU) score. Our method gives comparable performance to other methods while having the additional benefit of being computationally efficient.

PROBLEM STATEMENT

Build an algorithm to automatically identify whether a remotely sensed target is a ship or not. The algorithm had to be extremely accurate because lives and billions of dollars in energy infrastructure is at stake.


ship 0.997
ship 0.989
ship 0.997
ship 0.991
ship 0.996
ship 0.997
ship 0.999
ship 0.997

SYSTEM ANALYSIS

Relevance of Platform

Visual Studio Code is a lightweight but powerful source code editor which runs on your desktop and is available for Windows, macOS and Linux. It comes with built-in support for JavaScript, TypeScript and Node.js and has a rich ecosystem of extensions for other languages and runtimes (such as C++, C#, Java, Python, PHP, Go, .NET).

Relevance of Programming Language

Python is an interpreted, object-oriented, high-level programming language with dynamic semantics. Its high-level built in data structures, combined with dynamic typing and dynamic binding, make it very attractive for Rapid Application Development, as well as for use as a scripting or glue language to connect existing components together. Python's simple, easy to learn syntax emphasizes readability and therefore reduces the cost of program maintenance. Python supports modules and packages, which encourages program modularity and code reuse. The Python interpreter and the extensive standard library are available in source or binary form without charge for all major platforms, and can be freely distributed..

FUNCTIONAL REQUIREMENTS

Software Requirements:

- Software: 1. Visual Studio Code
  2. Python
  3. Scikit-learn
  4. Numpy
  5. Pandas
  6. Matplotlib

Hardware Requirements

- Operating system: Windows 7 and above.
- RAM: 8GB and above.
- Processor: Intel® Core(TM)2 duo CPU T6500.
- Processor speed: 2.67 GHz.
- CPU: 64-bit operating system

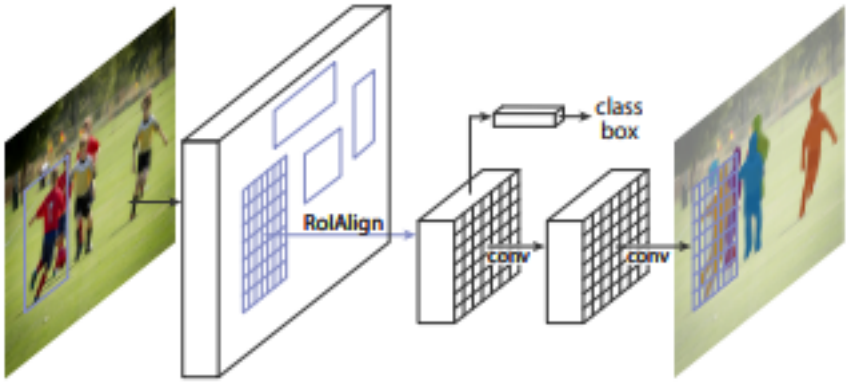
NON-FUNCTIONAL REQUIREMENTS:

In systems engineering and requirements engineering, a non-functional requirement (NFR) is a requirement that specifies criteria that can be used to judge the operation of a system, rather than specific behaviours. Non-functional requirements are conditions under which the system must be able to function and the quality the system must have. It defines how a system is supposed to be.

- Performance
  - With ideal condition detection and segmentation response should be fast and error free.
  - Performance shall not decrease with time or by usage.
- Flexibility:
  - This model will be easy to learn and use.
  - Is able to analyze and give the outputs as quickly as possible.
- Response Time:
  - The results should load and display quickly without consuming much buffer time.
- Understandability:
  - All users can learn to operate the model because of its simplicity.

MASK R-CNN

Mask R-CNN was proposed by Kaiming He et al. in 2017. It is very similar to Faster R-CNN except there is another layer to predict segmented. The stage of region proposal generation is same in both the architecture the second stage which works in parallel predict class, generate bounding box as well as outputs a binary mask for each RoI.



It comprises of –

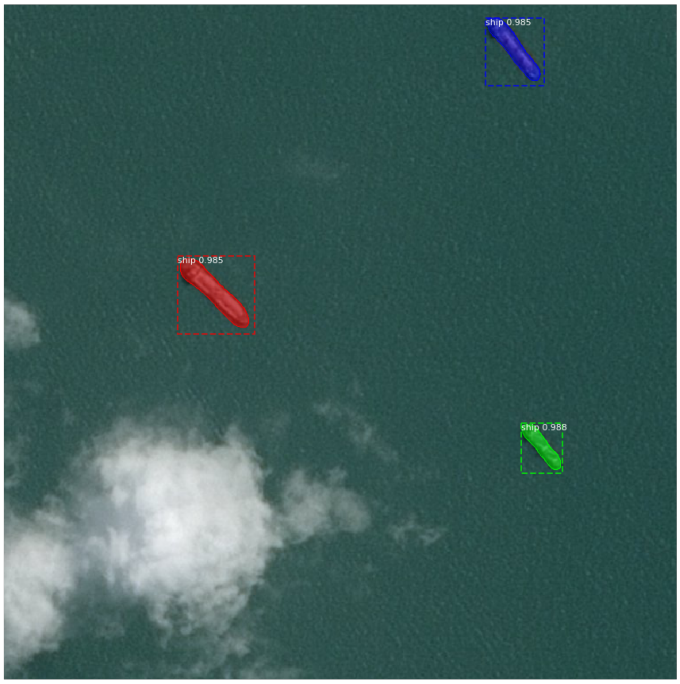
Backbone Network

Region Proposal Network

Mask Representation

RoI Align

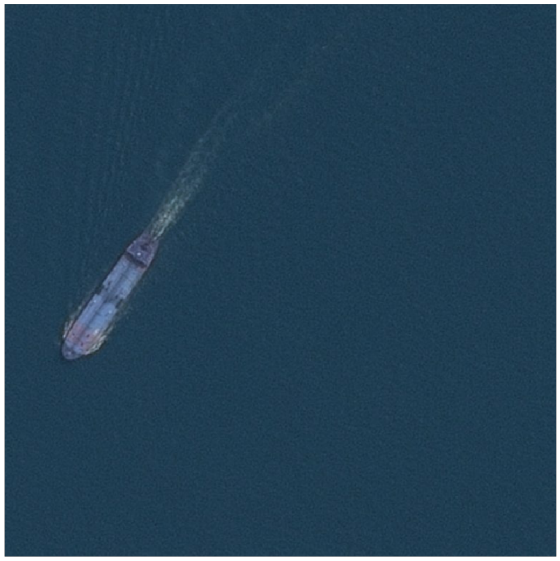
RESULTS



In some cases, the model failed when it detected a small island or coastal rocks as ship. In other words the model is generating false positives.

While at other times the model failed to detect a ship as shown in the image

below. In other words the model is generating false negatives.



CONCLUSION

Although this project is far from complete but it is remarkable to see the success of deep learning in such varied real world problems. If we are able to detect and segment ships in an image, it would be of great help to the logistics and transportation team in northern countries like Sweden, Norway and Canada. It could bring a whole new dimension of transport for container ships and vessels by tracking ships from satellite images in real time.

RELATED WORK

Deep learning has attracted a lot of attention, especially when applied to computer vision related tasks. Since AlexNet [4] was used to win the ImageNet challenge, CNN's have been applied to a variety of tasks. Fully-Convolutional Network [5] (FCN) was one of the first architectures for segmentation based on CNN's. Since then a number of architectures have evolved based on a similar structure. U-Net [17] which is a

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Fig. 1: Example images from the dataset

FCN having an encoder-decoder architecture along with skip- connections which was designed to perform in the absence of a large amount of data. In this paper, we make use of a modified version of U-Net by re-calibrating the learned feature maps using squeeze and excitation module [6].

When it comes to satellite images, Iglovikov et. al. [3] made use of a U-Net with a pretrained encoder (WideResnet-38) and recent improvements like activated batch normalization [15] which allows for memory savings and exponential linear unit [16] (ELU).

Rakhlin et. al. [12] made use of U-net with an m46 encoder which they designed for saving memory. They trained their network using stochastic weight averaging (SWA) [13] which helps in finding much broader optima than gradient descent.

In our work we propose to use U-Net architecture with Resnet-34 [9] as the backbone and add spatial and channel squeeze and excitation (SE) blocks to our network for seg- menting ships in satellite images. For optimizing our model we compare the performance of our model by using various loss functions.

REFERENCES

1. [1] M. Berman, A. Rannen Ep Triki, and M. Blaschko. The lovasz-softmax loss: A tractable surrogate for the optimiza- tion of the intersection- over-union measure in neural networks, 2018.
2. [2] J.K.E.Tunaley,Algorithmsforshipdetectionandtrackingusingsatellite imagery, 2004.
3. [3] V. Iglovikov, S. Mushinskiy, and V. Osin. Satellite imagery feature de- tection using deep convolutional neural network: A kaggle competition, 2017.
4. [4] Alex Krizhevsky, Ilya Sutskever, and Geoffrey E. Hinton. ImageNet Classification with Deep Convolutional Neural Networks, 2012.
5. [5] JonathanLong,EvanShelhamerandTrevorDarrell.FullyConvolutional Networks for Semantic Segmentation, 2015.
6. [6] Abhijit Guha Roy, Nassir Navab, Christian Wachinger, Recalibrating Fully Convolutional Networks with Spatial and Channel 'Squeeze & Excitation' Blocks, 2018.