Ship Detection in Satellite Images

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***Abstract*—This paper presents a ship detection system from satellite images using a U-Net model. The system is trained on the Airbus Ship Detection Dataset, which contains satellite images of different sizes and of resolutions 768 x 768. The images are preprocessed using run-length decoding to create masks out of the csv file, removing images lower than 50 kb, and image augmentation. The U-Net model is trained using a combination of the Dice coefficient and Combo loss functions. Early stopping is used to prevent overfitting. The system achieves an accuracy of 99% on the test set, demonstrating its effectiveness in detecting ships in satellite images.**

I. Introduction

Ship detection from satellite images is a challenging task due to the large variability in ship sizes, shapes, and colors, as well as the presence of noise and occlusions. However, recent advances in deep learning, particularly U-Net models, have led to significant improvements in ship detection accuracy.U-Net models are a type of deep learning model that are well-suited for segmentation tasks. U-Net models have a U-shaped architecture, with an encoder and decoder. The encoder extracts features from the input image, and the decoder reconstructs the image from the extracted features. The Airbus Ship Detection Dataset is a publicly available dataset that contains satellite images of different sizes and of resolution 768 x 768. The images are labeled with ship masks. The dataset is divided into two sets: a training set and a test set.

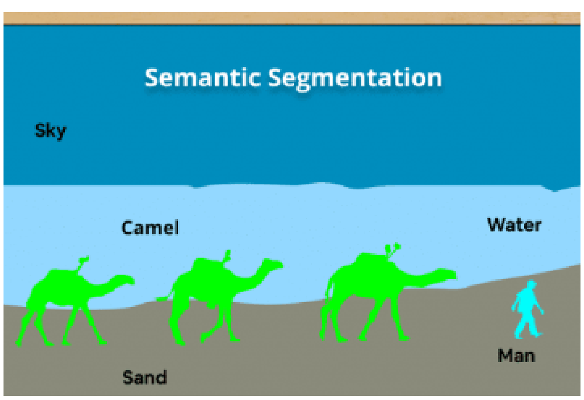

Fig. 1. Semantic Segmentation

II. Methodology

A. Data Collection

This project uses the Airbus Ship Detection Dataset available on Kaggle. It contains 192556 training images and 89556 test images in the dataset are in RGB format and have a size of 768 x 768 pixels. The ship masks are binary images, with 1 representing the ship pixels and 0 representing the background pixels.

The dataset contains a diverse range of ship sizes, shapes, and colors. The ships are also located in different geographical regions and weather conditions. This makes the dataset a good representation of the real world, and it can be used to train machine learning models for ship detection in a variety of scenarios.

B. Data preparation

The Airbus Ship Detection Dataset is preprocessed using the following steps:

1) Run-length decoding: The ship masks in the dataset are encoded using run-length encoding. To create a mask from the encoded string, run-length decoding is used to expand the string into a binary image.
2) Remove images lower than 50 kb: Some of the images in the dataset are very small and have a file size less than 50 kb. These images are removed from the dataset because they are likely to be noisy and difficult to detect ships in.
3) Image augmentation: Image augmentation is used to increase the size and diversity of the training dataset. The data augmentation techniques used are: Rotation, Horizontal Flip and Vertical Flip.

C. Creating model

The U-Net model used in this project consists of the following layers:

1) Encoder: The encoder consists of a series of convolutional and Maxpooling layers. The encoder extracts features from the input image.
2) Decoder: The decoder consists of a series of convolutional and upsampling layers. The decoder reconstructs the image from the extracted features.

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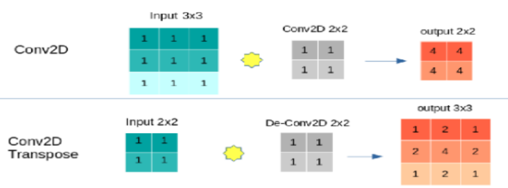

Fig. 2. Convolution and Transpose Convolution

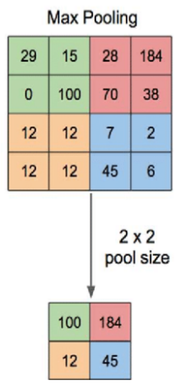

Fig. 3. Maxpooling

D. Training the model

The U-Net model is trained using the following techniques:

1) Gaussian noise: Gaussian noise is added to the input images to make the model more robust to noise.
2) Batch normalization: Batch normalization is used to accelerate the training process and improve the generalization ability of the model.
3) Early stopping: Early stopping is a technique that stops the training process if the validation loss does not improve for a certain number of epochs.

The following loss functions are used to train the U-Net model:

1) Dice coefficient: The Dice coefficient is a measure of the similarity between two sets. The Dice coefficient is used to measure the similarity between the predicted ship masks and the ground truth ship masks.

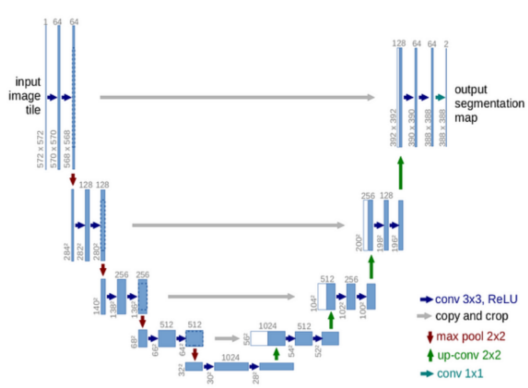

Fig. 4. U-Net architecture

2) Combo loss: The Combo loss is a combination of the Dice coefficient and the binary cross-entropy loss function. The Combo loss is used to train the U-Net model to produce accurate ship masks.

E. Evaluate the model

Using some combinations of metrics, find the objective performance of the model. Observe and ensure the error and accuracy percentage improving iteration by iteration while training the data.

F. Testing of model

Test the model by sending the testdata to the model and check the predicted output for each testcase in testdata and save the outputs in a list. And the accuracy of model is found by comparing each predicted output with corresponding actual output.

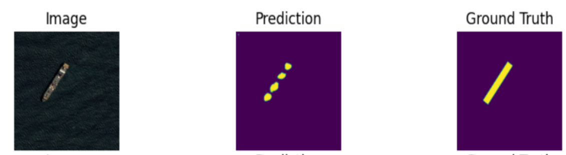

Fig. 5. Prediction done by trained model

III. Results

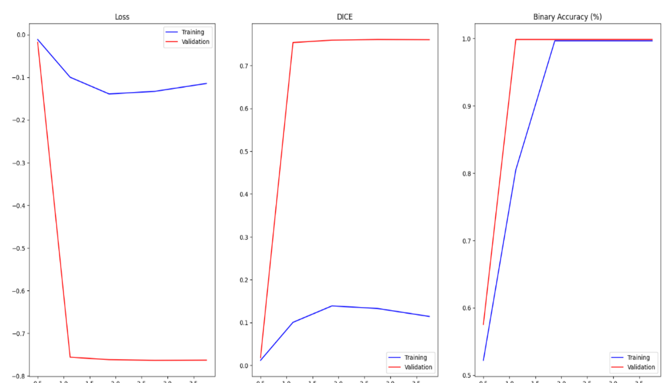

Fig. 6. Result Plots of various Metrics

IV. Conclusion

This paper presented a ship detection system from satellite images using a U-Net model. The system was trained on the Airbus Ship Detection Dataset and achieved an accuracy of 99% on the test set. This shows that the system is able to effectively detect ships in satellite images. The system is able to detect ships in a variety of sizes, shapes, and colors, even in the presence of noise and occlusions. This makes it a valuable tool for maritime surveillance, traffic monitoring, and environmental monitoring. The system can be further improved by using a larger and more diverse dataset, exploring different U-Net architectures, and using other techniques such as data augmentation.