

# Detection of Ship using Image Processing and Neural Network

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## Abstract

*Indonesia is one of the countries in this world that has the most outstanding fishery potential. There are more than 3000 fish species under Indonesia's sea, yet the people are still not able to relish them completely. Illegal fishing by foreign ships in Indonesia's territorial sea is one of the reasons why this happens. In order to minimize this kind of loss, those ships should be detected automatically by implementing image processing and artificial intelligence techniques. The study proposed techniques for automatic detection of ships at sea on digital images. These techniques are global image thresholding and artificial neural network backpropagation. The result of this research is proposed of technique able to detect ship with 85% accuracy level. This method may be improved by adding more training data varieties.*

**Keywords:** ship detection, image processing, artificial neural network, global image thresholding

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## 1. Introduction

Indonesia is one of the countries in this world that has the outstanding fishery potential as 70% of its area is water as large as 5,8 million Km<sup>2</sup> [1]. With this, Indonesia has more than 3000 fish species. However, the public has not fully enjoyed. One of the reasons is the illegal fishing performed by foreign ships in Indonesia's territorial sea. Theft mode of fish that often happens is the multiplication of permits by some ships and the transfer of goods from small ships owned by fishermen to large ships in the middle of the sea.

In order to abate more illegal fishing within Indonesia's territorial sea, the Indonesian air force carries out surveillance using reconnaissance aircraft equipped with aerial photography capabilities for recording. From these recordings, ships detection is performed, notably those exercising illegal fishing. As technologies develop nowadays, digital image processing techniques and artificial intelligence can be used for analysis of the object on digital image such as for motorcycle detection [2-4], renal tumor detection [5], traffic monitoring [6], virtual reality robot [7], motorcyclist's helmet wearing detection [8], blood typing [9], cotton pests detection [10], rice variety identification [11] and analysis of road damage [12]. Meanwhile, the studies on ship detection have been complied by percolating several methods, such as Support Vector Machine (SVM) [13-14], visual saliency and histogram [15], Discrete Wavelet Transform (DWT) [16], combination statistical methods, mathematical morphology and other signal-processing techniques [17], and sea surface analysis [18].

The study conducted by Morillas et al. describes the process of ship detection in four steps: distinguishing ships and non-ships, feature extraction (color and texture), SVM training and classification, and reconstruction [13]. Fang and Jing-hong proposed unsupervised method to detect and extract ships from optical remote sensing images [15]. The used method is visual saliency and Histogram of Oriented Gradients (HOG). The salient targets are extracted and marked with segmentation and the radon transform is applied to confirm the target of the ship with symmetry profiles. Then, the real ship is distinguished by using HOG. Other studies explain that the process of ship detection consists of four measures: extracting ship target by determining the highest frequency of DWT, improving target and expunging background by using fuzzy set, reconstructing target by ignoring low frequency coefficient and inverse DWT at high frequency coefficient, and lastly, extracting target by applying adaptive threshold segmentation of the final target-highlighted image [16]. This paper proposed that the ship

detection is performed by employing global image thresholding and backpropagation neural network. The ship detection process using 20x20 pixel detector starts from the top right corner to the lower right corner of the image to be detected. Detection algorithm in the detector implements backpropagation artificial neural network that has previously been trained. This method may be improved to systems that are capable of automatically detecting ship in real-time, especially those conducting illegal fishing.

## 2. Research Method

Methods described in this study are generally categorized into three stages as shown in Figure 1. Those stages are data preprocessing, data training, and ship detection.

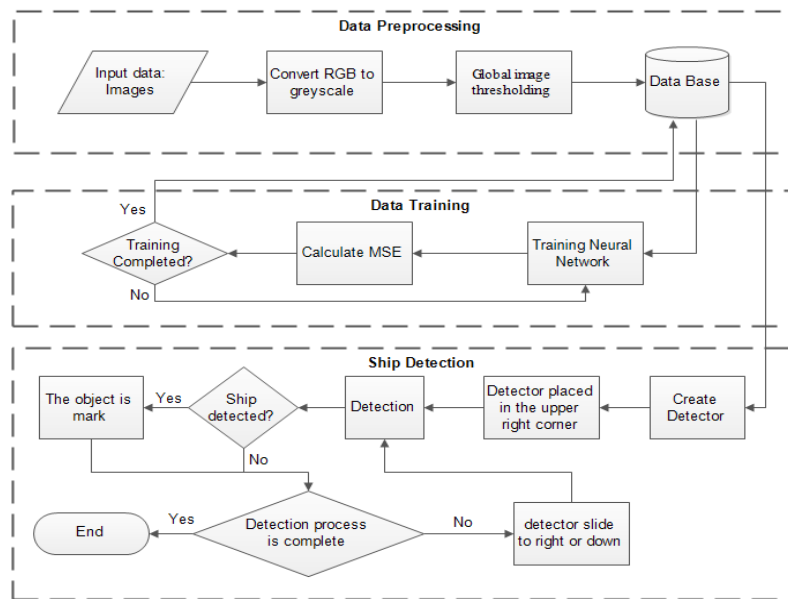


Figure 1. Proposed technique for this research

### 2.1. Data Preprocessing

Data preprocessing is performed to prepare the data before it goes through the training. In this stage, several ships image data are inputted, not including 20x20 pixels ships. These image data are then converted from RGB (Red, Green, Blue) to greyscale and go through the global image thresholding so that the images alter to binary of 0 and 1. The results of this process are recorded in a database to prepare for the data training process.

### 2.2. Data Training

Data training is conducted for data developing purpose that is classified into two: ship and non-ship image. Training algorithm adopted in this study is the backpropagation neural network. In this stage, there are 400 inputs of the pixel value of binary images. Algorithm backpropagation training consists of three phases: feed forward, backpropagation, and weight change. In this process, MSE (Mean Square Error) measurement is performed at each epoch to cease training process by comparing error limit determined before. The result of this process includes network weight and is recorded in a database used in detection process.

### 2.3. Ship Detection

Ship detection is the main process on this research used to detect ships on a 250x250 pixels digital imagery. This stage begins by creating 20x20 pixels detector to check the image to be detected. There will be backpropagation neural network algorithm and processed network weight from earlier network training process. After detector is formed, scanning stage start from

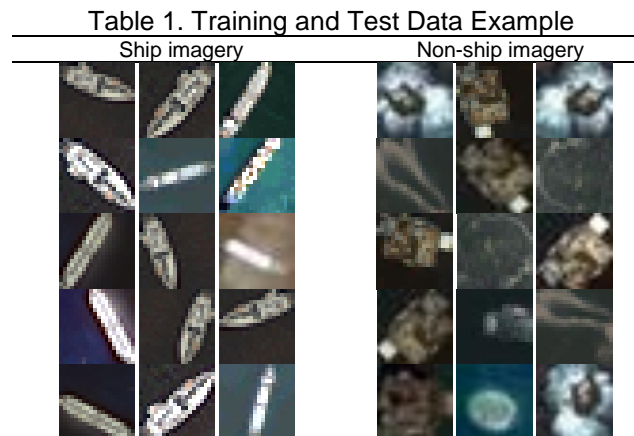
right bottom corner until left bottom corner of the image. The scanning movement should be horizontal and vertical until all pixels are tested. If a ship is detected, the detector will mark it with lines forming a rectangle covering the detected object.

### 3. Results and Discussion

In this research, four types of test used which are algorithm training test, algorithm performance test, ship detection test with variation value  $\alpha$  and ship imagery detection test with different number of ships and background.

#### 3.1. Algorithm Training Test

Performance of backpropagation algorithm is extremely affected by the trainer. In this research network architecture composed by 400 neuron inputs, one hidden layer formed by 40 neurons, and one neuron on the output layer. Input from this training test was composed by 326 data from 65 ships imagery and 261 non-ship imagery. Each imagery is 20x20 pixels that has been through preprocessing process that is a process from real imagery to RGB imagery then thresholding global imagery process from RGB to binary. Imagery examples used for training is in Table 1.



Input variable used in the training is using 10.000 epoch maximum, 0,001 error limits, and learning rate value ( $\alpha$ ) varied with range of 0,1 to 0,9. Artificial neural network algorithm training tested nine times with different learning rate value to understand the effect from value  $\alpha$  toward maximal epoch and the system's ability for ship detecting with the same error variable of 0,001. Result of this test shown in Figure 2. From Figure 2, it can be seen that bigger training rate value will produce smaller maximal epoch or less time needed for training. The cause of the learning rate value is too small resulted in the learning process takes a long time to reach convergent, but if the learning rate value is too large, then the learning process becomes unstable. This instability will actually take a long time learning process.

#### 3.2. System Performance Test

System performance test to measure system performance especially algorithm used in this research. Algorithm used is backpropagation artificial neural network algorithm feed forward phase. Input from this testing process that is network weight produced from previous training process and data to be tested, which is 20x20 pixels imagery. Result from the test determine an imagery is ship or not. Data tested in total of 40 data consist of 20 ships imagery and 20 non-ships imagery. Data examples tested shown in Table 1 and resulted in Table 2. From the results of the research shows that the proposed technique is able to recognize the object of the ship with the average data accuracy rate 85%. Other methods used to solve similar cases on simple sea level have been performed with several techniques such as a combination of statistical methods, mathematical morphology and other signal processing yielding 80.645% accuracy,

sea level analysis yielding 84.946% accuracy, and visual calibration and histogram yielding accuracy of 95.699 % [15].

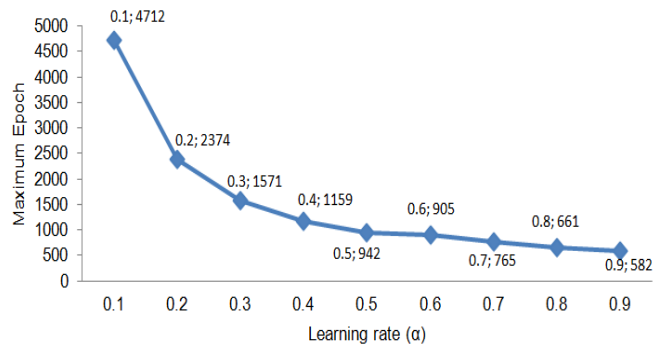


Figure 2. Alpha value graphic towards maximum epoch network training

Table 2. System Performance Test Result

	Correct Detection (%)	Wrong Detection (%)
Ship	75	25
Non Ship	95	5
Average	85	15

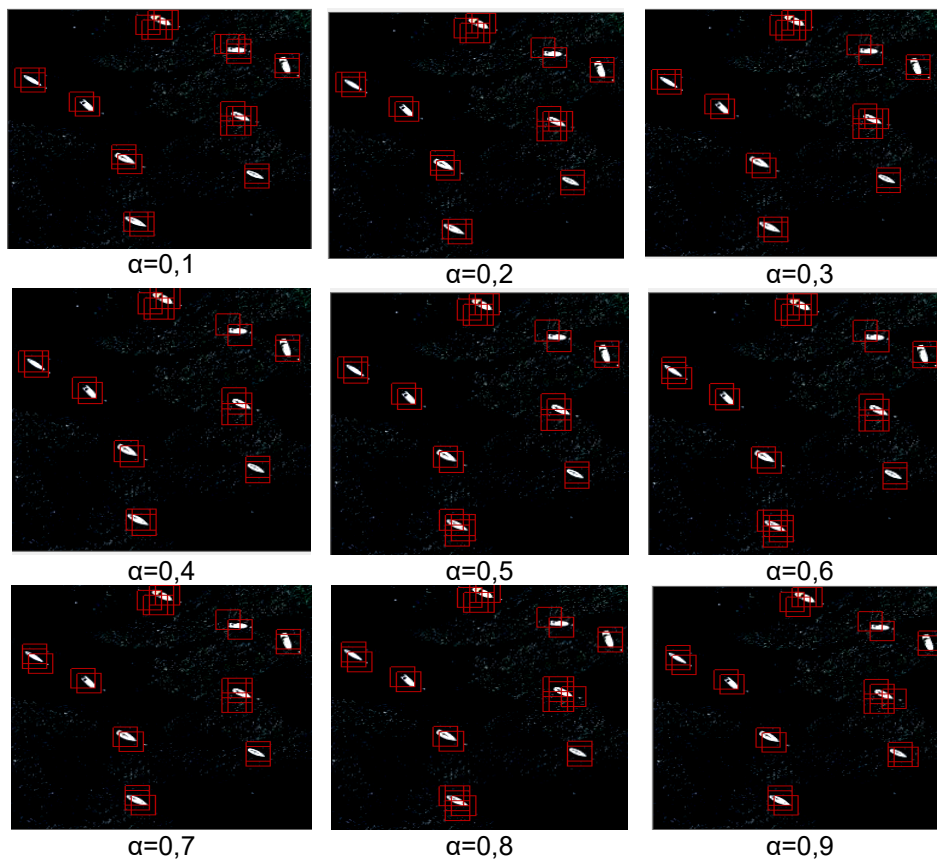


Figure 3. The result of comparison test of ships detection with various value of learning rate

### 3.3. Ships Detection Test with Various Value of Learning Rate

In this case, the ship detection test is applied on digital image with the quality of 250x250 pixels and also the network weight on this practice with the value of  $\alpha$  starts from 0.1 up to 0.9 with 0,1 of increase. The result of this test is shown in Figure 3. From the practice, it can be seen that all the  $\alpha$  values is able to detect the ships on the digital image. The effect of giving different values of  $\alpha$  is that there are ships detected with different amounts of detection. The reason is the value of different learning rates on the network learning process will result in different network weight values, so that the number of ship object detection will be different as well.

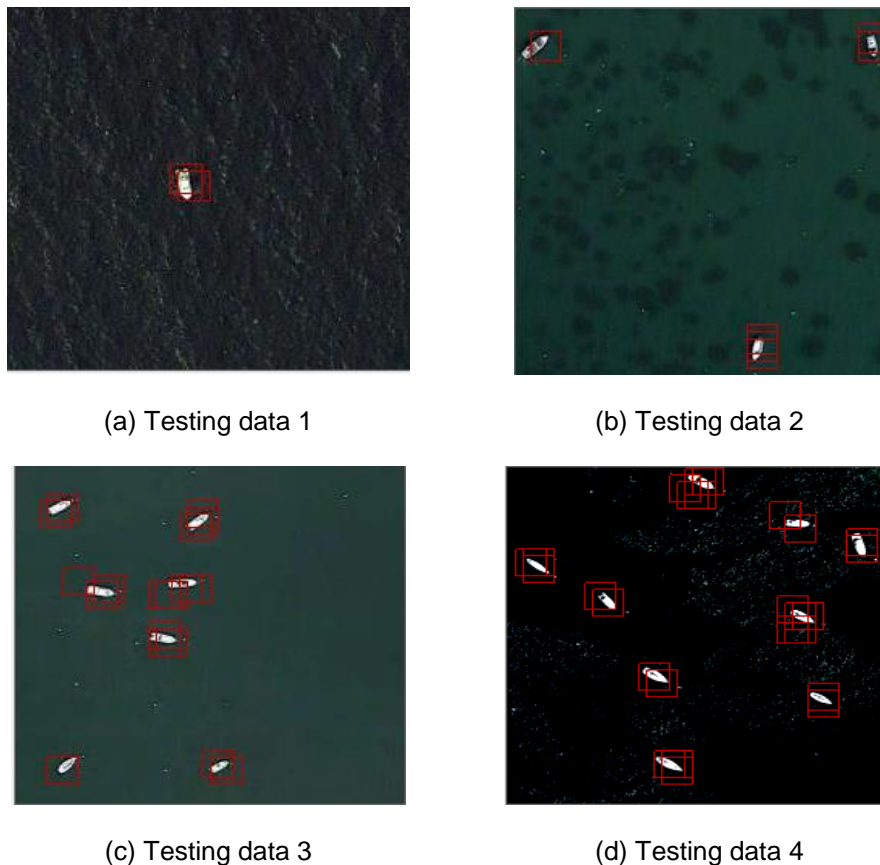


Figure 4. The test of ships detection with various object amount and background

### 3.4. Ships Detection Test

It aims to acknowledge the algorithm ability to detect the ships in the background and various ships amount. The image detected is displayed on 250x250 pixels taken from the digital image. The result of this test is described in Figure 4. This test uses the variable boundary epoch of 10.000; error limit of 0.001 and value of  $\alpha$  is 0.2.

From the test, it can be seen that the system is able to detect ships on all types of tests. In spite of that, there have been ships detected several times on the digital image. This is caused by the previous system which had been made without the algorithm used to accommodate in merging some detection on one ship. The other factor is very few data used in the practice because of the performance of artificial neural network algorithms is strongly influenced by training [19]. To increase the system performance, it is required to add various practice data and algorithm which can accommodate the merging of some detector which detect on the ship image detected several times.

#### 4. Conclusion

Image processing technique that is global image thresholding and backpropagation artificial neural network algorithms is able to detect ships on digital image with the accuracy value of 85%. This technique can be improved by adding various practice data. On the ship detection on image display of 250x250 pixels with different amount of ships and background, this technique detects all ship objects, but there are some ships objects detected more than once. This problem can be refined by making algorithm which can merge some detectors which detect only one ship object, with the result there will be no detector stacking on one ship object.

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