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Detection Object on Sea Surface to Avoid Collision with Post-Processed in Background Subtraction Image

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***Abstract*— Data on shipping accident investigations from the National Transportation Safety Committee (NTSC) throughout 2010-2016 of fifty-four accident cases at sea, seventeen of which were accidents caused by collisions on ships in Indonesian waters, act to avoid a collision by detecting an object on the sea surface. Detection object is challenging because so many varieties object on the sea surface. Illumination variations with different seasons, periods, illumination intensity and direction affect the detection of objects directly. A rough sea is seen as a dynamic background of moving objects with size order and shape. All these factors make it difficult to object detection. Therefore, it is possible to conclude that background subtraction on sea surface problem remains open and a definitive robust solution is still missing. In this paper, we have applied a selection of background subtraction algorithms with post-processed to the problem. Experimental results with our dataset verify the high efficiency of our proposed method.**

***Keywords*— Background Subtraction, Post-Processed, Collision Avoidance, Sea Surface.**

I. Introduction

As the largest archipelagic country in the world, Indonesia has 17,499 islands from Sabang to Merauke. The total area of Indonesia is 7.81 million km2 consisting of 2.01 million km2 of land, 3.25 million km2 of ocean, and 2.55 million km2 of Exclusive Economic Zone (EEZ). There is a country with an area of water greater than the land area. Therefore Indonesia is called a Maritime State. The beauty of marine and marine products owned by Indonesia certainly has the best quality. Start a beautiful island with sea contents such as coral reefs and marine plants. The area of coral reefs in Indonesia reaches 50,875 square kilometers which accounts for 18% of the total area of the world's coral reefs and 65% of the total area in the coral triangle. Most of these coral reefs are located in eastern Indonesia [1] Indonesian marine waters contain marine and fisheries resources that are ready to be processed and utilized to the maximum extent possible, so that most Indonesian people in coastal areas who work as fishermen are inherited from their ancestors and depend on marine wealth for fishing using fish boat and boats. Besides that boats and ships are also used as a means of transportation which also acts as a supporter, driver, and driving force for regional growth which has large but undeveloped natural resource potential, in an effort to increase and equalize development and its results [2]

With so many activities carried out by the community using boats or regional boats in Indonesian waters, the risk of ship accidents often occurs. Data on shipping accident investigations from the National Transportation Safety Committee (NTSC) throughout 2010-2016 of fifty-four accident cases at sea, seventeen of which were accidents caused by collisions on ships in Indonesian waters. This is equivalent to twenty percent of accidents that have occurred, as many as 80% of collision accidents are caused by a human error from the crew or people in the sea transportation system, and only a few are caused by natural factors or machinery. Human errors that occur in maritime transportation accidents can be caused by a lack of understanding of the crew on the signs on the travel route, the negligence of port officers in supervising ships sailing. Or the negligence of the crew in maintaining the machines on the ship [3].

Sea surveillance has been attracted more and more to attentions of navy and researchers in recent years [4][5]. Several notable methods have presented in recent literatures about object detection in sea water surface. The method [7] proposed first analyzes whether the sea surface is homogeneous or not by using two new features. Then, a novel linear function combining pixel and region characteristics is employed to select ship candidates. Xin *et al*, Based on the morphological processing method and the template matching, a combined method for detecting sea surface targets is proposed. In this method, a possible target region can be obtained through morphological open-minus-original operation, and then targets can be located exactly with template matching method [8]. Bobkov *et al,* propose a method for navigation of autonomous underwater vehicle based on visual odometry with regard to the conditions of the local maneuvers. The method is based on the SLAMalgorithm for stereo images and recognition algorithm for re-visited places. The operation of the algorithm for places recognition is based on using of virtual network for coordinate binding, which is constructed at the time of vehicle motion [9][10]. Chen *et al*, propose vessel target detection algorithm to achieve the maritime visual surveillance, which aims to reduce the influence of clutter that exists in the background and improve the reliability of ship target detection using Gaussian Mixture Model. This approach can achieve good results whether the background is relatively fixed.

This paper proposed method Detection Object on Sea Surface to Avoid Collision with Post-Processed in Background Subtraction Image. Post-processing techniques that can be used to improve upon the foreground masks that result from foreground detection with the dynamic background.

II. Research Method

The object detection system process that is categorized as obstruction runs in several stages, as shown in Figure 1. When the system is running, the system will capture images in real-time while taking pictures. When the resulting image is at an appropriate angle, the image will be analyzed at the stage of preprocessing, object detection, and object filter to obtain object data that is categorized as an obstacle. The results of the analysis are then used as a reference for the direction of the ship's motion.

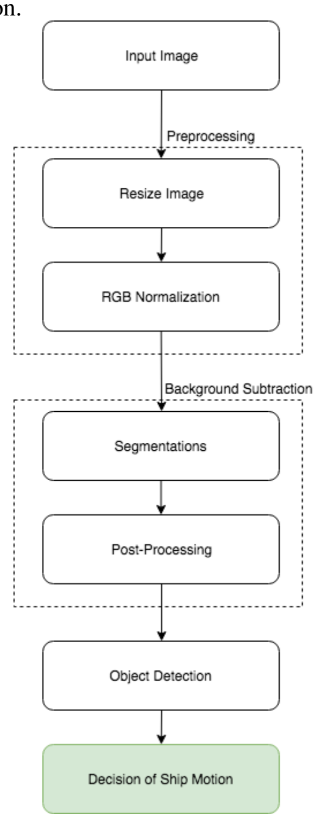


Fig. 1 Research approach for Detection Object on Sea Surface

A. Resize Image

Resize image is a process to limit certain parts of an image into a segment that is used as input to the next process. Part of the restricted image is the location of the real environment in front of the user as far as 2 meters which is visible in the image, meaning that the side and top of the image will be ignored. Suppose the stereo camera is calibrated, and the origin HD images with size W x H are rectified. Given the left and right rectified images, we first resize them to a relative small size, then the method of [6], which approximates the sea as an exactly planar, is applied to estimate the sea surface.

.An image height of 600 pixels, a value of 600 pixels is obtained for the upper limit of the segment to represent a distance of 2 meters..

B. RGB Normalization

RGB normalization is used to convert each component of normal RGB values into normalized RGB values. The normalization process is carried out on 40 training data images using Equation (1). The RGB values that have been normalized are then analyzed to get the mean, median, and min-max values which are then used as input to the segmentation process. The steps in the convert image stage are as follows:

1. Get the value of R, G, B pixels x, y
2. Recalculate the value of R, G, B by dividing the value of R, G, B with the total number R, G, B according to Equation (1).

C. Segmentations

The segmentation process is used to distinguish between foreground and background. In this study the segmentation method used is thresholding, with the threshold value used is the value of the upper and lower limits of R (red), upper and lower limits of G (Green), and the upper and lower limits of B (Blue) that have been normalized in the previous process. It's important for threshold selection of binary

image. There are two methods for threshold selection, adaptive threshold and global threshold [11]. Global threshold is suit for image with even gray background and the double peak feature [12].The steps in the segmentation stage are as follows:

1. Determine the start value x, start y, the x limit and the y limit of the image according to the cropping image stage
2. Calculate the RGB normalization value in x, y pixels
3. Check for each RGB normalization value
4. If the RGB normalization value is included in the range threshold then change the color of the x, y pixels with white, and if it is not included in the range threshold then change the color of the x, y pixels in black
5. Save the segmentation results in the array

D. Post-Processing

We consider a number of post-processing techniques that can be used to improve upon the foreground masks that result from foreground detection [15]. Conditional updating enhances the detection of foreground objects since the background model will not become polluted with foreground pixel information. Furthermore, it removes the problem of ghosts since valid foreground objects will not be incorporated into the background model. we performed conditional updating using the foreground mask produced at the end of our post-processing chain where all remaining blobs are highly likely to be from actual foreground objects.

E. Object Detection

Object detection is a process to identify objects contained in the segmentation results. An object is a collection of foreground pixels that are close together in a range of elements of 8 neighboring. The detection process is carried out using the Connected Component Analysis method, where each object that has been identified has a different label value. This value will be used for the filtering process at a later stage. The steps in the object detection stage are as follows: 1. Determine the central pixel based on the pixel value in the segmentation process 2. Get the pixel value of the array 3. Check the label and pixel value of the array 4. If the label and pixel value of the center are 0, then change the pixel color to a certain color and label the pixel 5. Check the neighbors from the central pixel with 8-connectivity. 6. Check the neighboring pixels found 7. If the neighbor's label and pixel value is 0, then change the pixel color to color according to the center pixel and label the pixel 8. Change the neighbor pixel to the central pixel 9. Re-start the checking process at number 5 until all pixels are labeled 10. Calculate and save the number of pixels per label.

F. Decision of Ship Motion

Head on selection situation from the International regulations for avoiding collisions at sea is the guideline used in this paper [16]. There are three of ship direction : 1) Forward, at or toward the front of a ship or further ahead of a location. 2) Starboard, the right side of the ship, when facing forward. 3) Port, the left side of the ship, when facing forward (Figure 2).

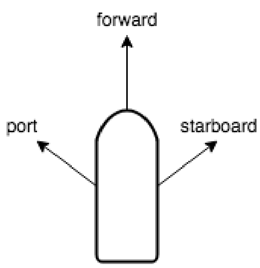


Fig. 2 List of Ship Direction

III. Result and Discussion

In this study testing the accuracy of detection with test data as many as 50 scenario images. The image for this test is not taken in real time but by taking several image samples by conditioning the object at a particular time and distance to resemble the image captured. The image is obtained by using a camera placed on the front of the ship that moves in the waters. The object used to determine the direction of movement of the ship is the sea coast, the spread of marine fish, ships, and mangrove trees. For the time used taking in morning and afternoon.

Fig. 3 Sample of Scenario Images

The test conducted in this study aims to determine the success rate of the image segmentation process carried out. Successful parameters are certainly needed so that the performance of the line segmentation method carried out in the implementation stage can be measured. The success parameter used is numerical and quantitative computing by calculating Sensitivity and False Negative Rate.

The following is the definition of each element used in calculating sensitivity and false negative

- FN, or False Negative, states that the Amount of Determination of ground truth that is not included / is not detected
- FP, or False Positive, states the detected Determination Number which is not included / not a member of the Ground Truth Determination Number
- TP, or True Positive, states the Amount of Determination that is detected that corresponds to the Amount of Direction Determined from Ground Truth
- TN, or True Negative, states the Number of Directions that do not include the Amount of Determination of ground truth and the area of ROI that has been detected

The TN value cannot be calculated, because in the reference image there is no negative amount of direction determination. In measuring accuracy using sensitivity used as a percentage of success, to get the value used equation 4.1.

$$Sensitivity\ \% = \frac{TP}{TP+FN} * 100 \qquad (4.1)$$

In addition to using Sensitivity, this study also uses the False Negative Rate (FNR) presentation shown in equation 4.2. Usually besides False Negative, False Positive calculation is also done so that the percentage of Overall Error can be obtained as well. However, in this study it cannot be done because the calculation of the percentage of False Positive requires the True Negative value.

$$False\ Negative\ Rate\ \% = \frac{FN}{TP+FN} * 100 \qquad (4.2)$$

(a) (b) (c)

Fig 4 Approach post-processed result (a) Original images (b) Segementation result (c) Post-processed.

Post-processed from segmentation result can remove directly noise around the image is described in Figure 4. That the binary process has less effect on the target boundary we can properly enlarge the target area after the open-minus-original operation.

TABLE I
APPROACH POST-PROCESSED EBALUATION RESULT

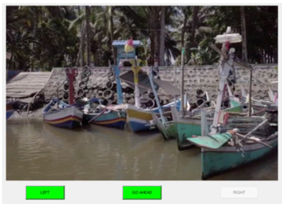
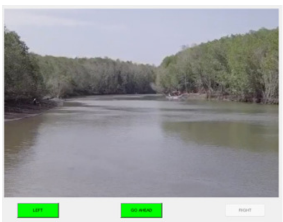
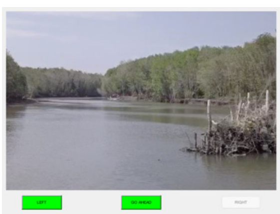
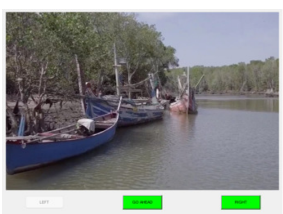
Scenario Images	TP	FN	Sensi tivity	FNR
	3	0	100%	0%
	2	1	67%	33%
	3	0	100%	0%
	3	0	100%	0%

Table 1 illustrates an example of calculating the accuracy of determining the direction of ship motion in sample images. By calculating Sensitivity to determine the accuracy of the results of determining the direction of motion of the ship. From the results of testing 50 images of sea surface objects produced an average value of sensitivity of 87.67% while false negative rate of 12.33%. The higher the sensitivity indicates that the accuracy is getting better, so that the false negative rate is lower, the accuracy is getting better.

IV. CONCLUSIONS

The system for detection of objects on sea surface is designed with several stages, namely the initial stage for angle detection and image preprocessing which includes the stages of preprocessing, background substraction, object detection and decision. The results of the preprocessing process can be used as input in the next stage, namely background substaction that combining segmentation and post-processing. The result of this stage is a value for object detection that is used by the system as a reference to provide ship direction directions

Determination of the direction of movement of the ship to avoid the leading object in front of the ship with 3 direction options, namely Forward, Starboard, or Port. From the test results to determine accuracy by calculating the average sensitivity value of 87.67% and with overall error 12.33%.

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