SHIP PART SURFACE EVALUATION USING IMAGE PROCESSING TOOLBOX IN MATLAB

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ABSTRACT

Corrosion will continue present on the hull as the material (metal) experiences the process of chemical degradation by influence from its environment which is seawater. Meanwhile, marine growth also will keep growing because the ship is continuously in contact with seawater. These problems also happen with a boat made of fibre-glass reinforced plastic (FRP). Furthermore, these types of defects will cause early failure to the hull part and also shortened the service life of the ship. Currently, both defects are detected by human inspection or the non-destructive testing (NDT) method. In this research, we purpose to use the Image Processing Toolbox in MATLAB to identify types of Image Processing methods that are suitable to use for the image, defining percentage, and area of defects. The defects are quantified using the developing MATLAB Graphical User Interface (GUI).

Keywords: Image Processing, Marine growth, MATLAB

INTRODUCTION

Hull is the most external part and important structure of the ship. Corrosion forms and marine growth such as shell, weed, and slime clings to the structure because of hulls that are constantly in contact with seawater. Due to marine growth on the ship hull, it will increase the drag force of the vessel and hull resistance thus reduce the speed of the ships. Moreover, it also raises fuel consumption due to the frictional force created. To handle occurring corrosion and breeding of marine growth, the external part of the ships needs to paint with anti-fouling and anti-corrosion paints. Currently, detection and analysing defects are manually done by human inspection or visual inspection on the surface of the ship hull and mark the areas to be treated or repaired. This is one of the non-destructing testing (NDT) methods. The defect could be any size and shape on the ship hull. So, it needs a very expert and experienced person to inspect the defects. Furthermore, this method is widely used in the industry, but it will cause high cost, time, and equipment to be used. In this research, we introduce low-cost techniques to quantify the defects which are corrosion spots and marine growth on the ship hull using image processing. The image processing toolbox is one of the application tools in MATLAB software. There many methods in this application tool that can use to filter the image. "These include some basic methods to distinguish between objects and background and to describe the different regions in digital images", (Ismail, Salleh, Yusop, & Fakhruradzi, 2013). In this research, the defect image used is the same as the experimental by Muhammad Ikram as a reference, also the results are used to compare with our results. The image was taken with different depths and days. Then, the image will be filtered before the area and percentage were calculated in MATLAB Graphical User Interface (GUI) that will develop by the end of this research. Error measurement metrics will be used to measure the quality performance between the two images.

LITERATURE REVIEW

Image processing methods were used in different types of metal defect detection and classification. "Defects like a hole, scratch, coil break, and rust could be detected with up to 90% accuracy" (Naladala, Raju, Aishwarya, & Koolagudi, 2018a). There many methods that can be used in image processing. Several methods were tried by various related research that has been done below;

(Li, Zhang, Zhuang, & Wang, 2018), "mainly focuses on the detection of surface defects in spoons that used in restaurants". For identification and detect surface defects of the spoon they used image acquisition methods and image processing software. They also used edge detection algorithms and methods of texture features for more accurate in the detection of defect features.

(Mohamad, 2018), proposed aims to develop an image enhancement method for the radiographic image by focus on low-quality images to enhance using the image processing process for improved visualization. They applied, noise removal and contrast adjustment to the image. Continue with edge detection and thresholding with a morphological structuring element.

(Naladala et al. 2018), proposed to use image processing to find out the corrosion and evaluation of the period before the ship parts need to be replaced. They used pre-corrosion and post-corrosion image and compared.

(Diaz, Jr, Jose, & Bandala, 2017), applied thresholding, edge detection, and segmentation to find out the rust on the image. Same with (Choudhary, Anand, & C, 2015), detected rust area from metal(iron) using image processing for more accurate and fast results.

(Ismail et al., 2013), analyzed photos of barnacles that were taken from the boat that made from fiber-glass reinforced plastic (FRP). The photos were taken in 3 months before evaluated using image processing through SCILAB programming.

From the above literature from various articles, it may be concluded that almost the article was carried out in corrosion identification using image processing software in MATLAB but, very little research was done for the detection of corrosion and marine growth on the surface of the ship hull. Therefore, in this paper, our aim to evaluate the defect on the hull using a convenient algorithm in image processing software in MATLAB.

RESEARCH METHODOLOGY

The steps followed in the methodology to detect and quantify the defects which are corrosion spots and marine growth on the ship hull using image processing are as shown in Figure 1.

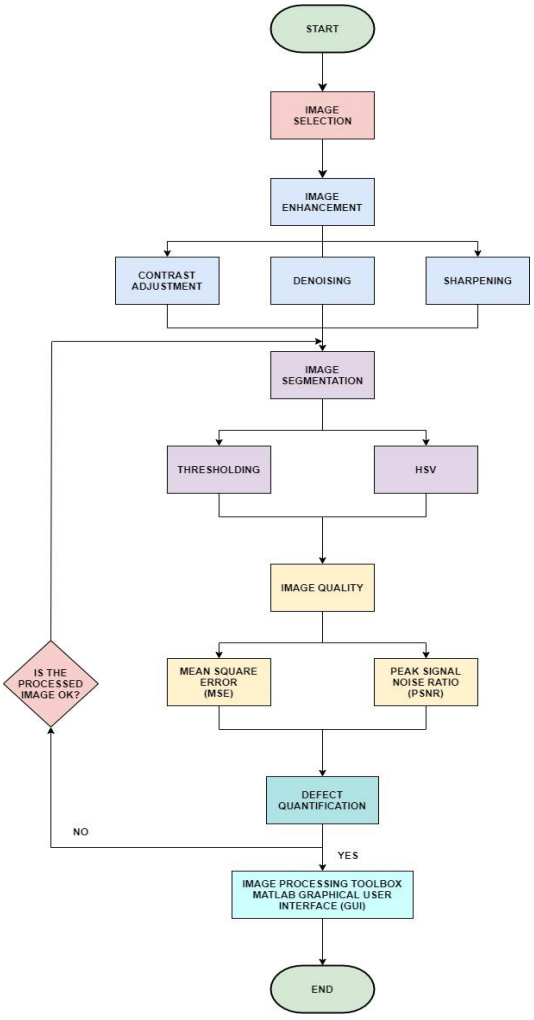


Figure 2. Methodology Flowchart

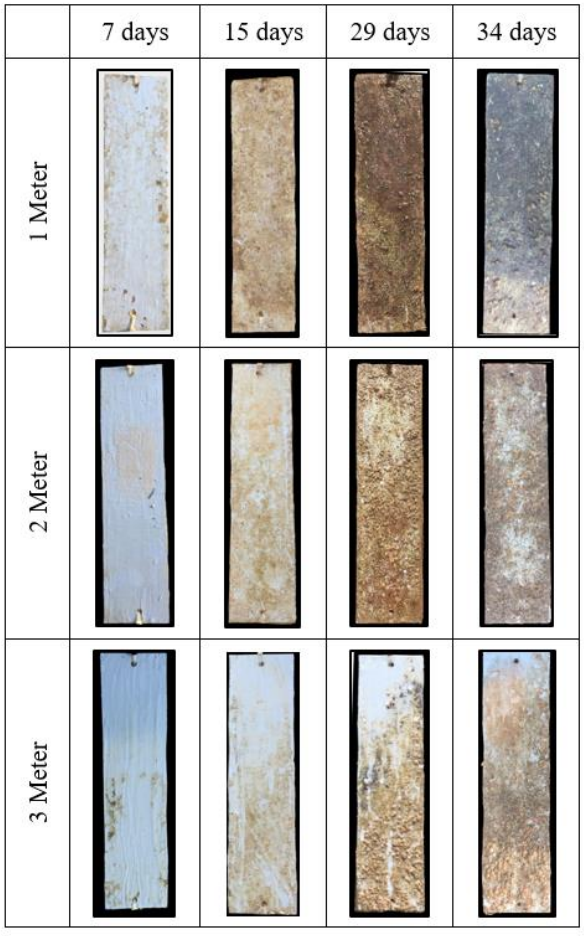


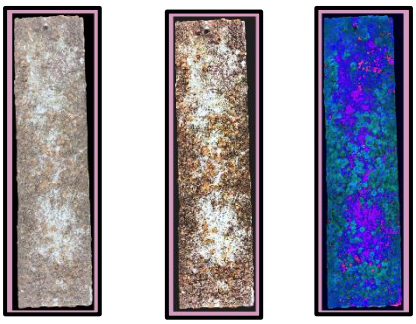
Figure 1. Experimental image that used as reference

I. Image Selection Process

The experimental defect images are cut to the dimension (400mm x 100mm). The sample is prepared from panels of Fiberglass that using hand lay-up techniques and 4% polyester is used as resin and was reinforced by using Chopped Strand Mat (CSM). After fiberglass panels are prepared, it is then coated with antifoulant. Afterward, the sample will do the immersion test at UniKL MIMET's slipway seawater, under various depths, 1 meter, 2 meters, and 3 meters at intervals of 7, 15, 29, and 34 days. The image from the experimental as shown in Figure 2 and all are selected to use in this research. Then, the image will be upload into the Image Processing toolbox MATLAB for the image enhancement process.

II. Image Enhancement Process

Image enhancement is the adjusting image process to improve the quality of the image. The objective is to produce a better display or further image analysis than the original images. Image enhancement will make images more useful for a specific application. The process is to eliminate the various noises that contain in the image when the selection process. Also, to give the defects image brightness and clarity compared to the original image. Contrast adjustment, denoising, and sharpening filter were used in this process.

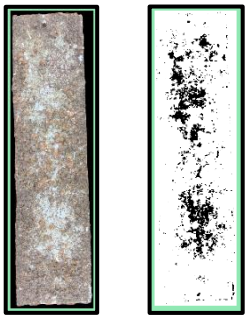


(a) (b) (c)

Figure 3. Image enhancement result of experimental image (29 days of immersion at 2 meters), (a) original image, (b) enhancement process, (c) HSV conversion.

III. Image segmentation process

After the enhancement process, the resulting image will be collected and the image segmentation process was applied. "Image Segmentation is the process of dividing an image into its constituent regions or objects",(Rubesh, 2020). The level to which an image is subdivided would depend on the problem. In this research, we used two techniques of segmentation which is thresholding and HSV color space. Thresholding is a technique of converting the image into binary. The advantage of this technique is the high adaptability without losing accuracy to shifts in pixel values. While, HSV (Hue, Saturation, Value) color space is the color space of HSV is also much similar to the RGB color space that human beings describe and color experience in.

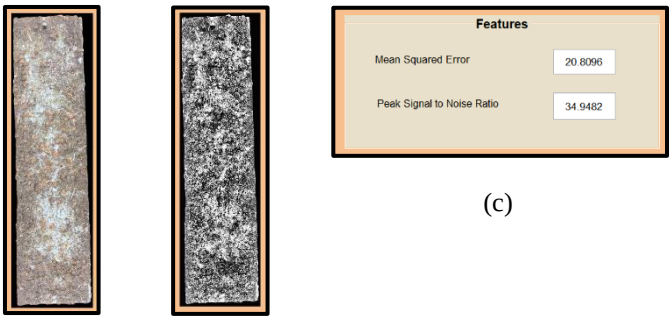


(a) (b)

Figure 4. Image segmentation result of experimental image (29 days of immersion at 2 meters), (a) original image, (b) segmentation process.

IV. Image Quality Process

"Image quality can be defined as the specification or image-level whether it is a high-quality image or not," (Mohamad, 2018). In simple words, this technique is to measure the perceived degradation of the image. Image quality can be evaluated by using the method of Mean Square Error (MSE) and Peak Noise Ratio Signal (PSNR). Both methods function to measure the presence of noise in the image. The interpretation of image quality can be concluded as the results are better when the MSE value is smaller. Meanwhile, the higher the PSNR value, the better result for the image quality.



(a) (b) (c)

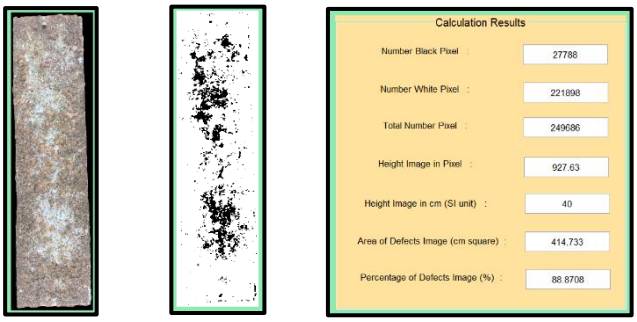
Figure 5. Image quality result of experimental image (29 days of immersion at 2 meters), (a) original image, (b) error measurement process, (c) result of MSE and PSNR.

V. Defect quantification process

Once the defects are detected using image segmentation, the next step is to measure percentage and area and. In this research, we the value of area have been converted from pixel units to SI Unit (cm^2) by using the formula:

$$Percentage = \frac{number\ of\ defect\ pixel}{total\ number\ of\ pixel} \times 100\% \qquad Area = number\ of\ defect\ pixel \times factor^2$$

The number of defect pixels is identified as the defected part that has marine growth and the total number of pixels is measured by the total pixel of the experimental image. The factor is the number of a ratio where the length of the image in the SI unit is divided by the length of the image in pixels.



(a) (b) (c)

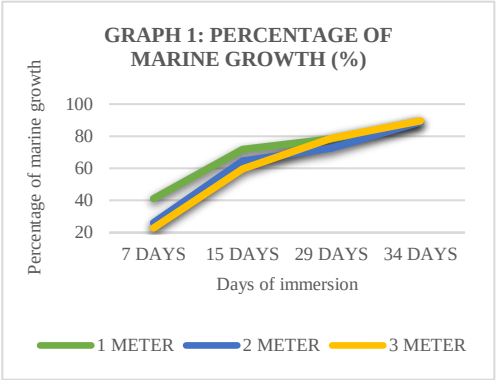
Figure 6. Defect quantification result of experimental image (29 days of immersion at 2 meters), (a) original image, (b) segmentation process, (c) result of defect quantification.

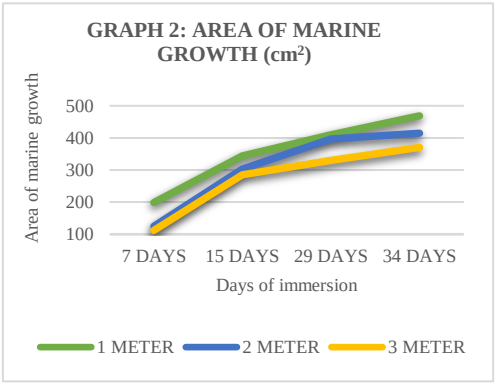
VI. Developing Image Processing MATLAB GUI

In this part, the techniques which are image enhancement, image segmentation, image quality, and defect quantification process were interpreted by using syntax or codding to achieve the final results. All the command labels and text are converted into a much simpler graphic icon. The syntax or codding does not need to type again in command windows. Meanwhile, the user can use the GUI to process the image of the defect and click on a graphic icon. All the callbacks used must be accurate and usable to build a completely functional GUI.

RESULTS AND DISCUSSION

Days	Area of Marine Growth (cm^2)	Percentage of Marine Growth (%)	Mean Square Error (MSE)	Peak Signal Noise To Ratio (PSNR)
7C1	198.70	41.11	9.36	38.42
15C1	343.55	71.78	6.7	39.87
29C1	409.56	78.28	16.54	35.94
34C1	468.77	88.97	18.27	35.51
7C2	124.88	26.07	8.96	38.61
15C2	303.51	64.63	3.05	43.28
29C2	397.09	72.52	39.31	32.19
34C2	414.73	88.87	20.81	34.95
7C3	112.01	22.84	9.71	38.26
15C3	284.76	59.65	2.57	44.03
29C3	329.48	78.85	15.92	36.11
34C3	370.50	89.59	13.75	36.75





The defects were observed by the value of percentage and area to detect marine growth. Based on graph 1 and graph 2, the trends are increasing according to different depths and days. Besides, this accuracy of results shows almost the same as the experimental result taken as reference. The results for MSE and PSNR follow the theory where the MSE value is smaller and the PSNR value is higher to produce a better result for the image quality.

CONCLUSION AND RECOMMENDATION

In this study, the defects on the experimental image were identified according to the methodology in image processing. The method used is image enhancement, image segmentation, and image quality. The image is being processed to improve the quality of the image based on contrast adjustment, noise removal, and sharpening. The processed image is then evaluated using error measurement metrics which are Mean Square Error (MSE) and Peak Signal Noise Ratio (PSNR). Also, the defects quantification measured by percentage and area and the value of area have been converted from pixel unit to SI Units. Finally, MATLAB Graphical User Interface (GUI), was developed and makes the user enables to load the selected image, choose an ideal method to improve the image, and will display the results through the interface.

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