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Monitoring of Barnacle Growth on the Underwater Hull of an FRP Boat using Image Processing

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Abstract

In this research, photos of barnacles were analysed using image processing. The images of barnacles were taken from the CITRA MOSTI boat made from fibre-glass reinforced plastic (FRP) for monitoring purpose. The photos were taken within a period of three (3) months. Results showed that the barnacles' growth in terms of their size and quantity might be due to the effect of saltwater. Results obtained through SCILAB programming were analysed and comprehensive data were tabulated. From images recorded on February 2013, it was observed that the barnacles had been growing aggressively achieving the highest pixel count of 3000 as compared to images captured in December that only amounted to 2600 pixels. The barnacles were growing at a rate of approximately 10% from the first image analysis. The highest recorded pixels were in the month of the March 2013, attaining about 3500 pixel counts. These changes in growth rate throughout the stipulated period may be due to numerous factors such as the fluctuating of seawater temperature and weather.

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1. Introduction

The oceans cover about two-thirds of the earth and have a great effect on the existence of all living beings. In the marine world, barnacles are considered as one of the major problems for marine vehicles such as boats, ships and sub-marines because they cling onto the underwater surfaces and removing them needs periodical blasting and

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cleansing processes. Barnacle is a small saltwater animal with a protective shell-like covering as shown in Fig.1. There are more than 1,000 different species. Barnacles on the hull of a ship increases the drag of the vessel, thus the increase in friction can reduce the vessel's travelling speed. It also increases the fuel consumption to offset the higher friction created. The ship must then be put in a dry dock to have the bottom scraped. To prevent barnacles from clinging to ships, the hulls are either treated with toxic paint containing tin or copper or are coated with plastic. Almost all ships in the world are facing problems related to the breeding of barnacles on the hull surface.



Fig. 1. Photo of Barnacles growth at hull boat¹

This problem is also known as marine fouling. Marine fouling is of major importance in shipping – impacting on ship performance, economy and the environment¹. Since monitoring barnacle growth is difficult, the use of computers for simulation and data analysis has become a popular choice throughout many engineering disciplines. There are various applications of image processing e.g. detection of surface defects in industrial quality control, detection of anatomical landmarks in surgery, counting cells in biotechnology and classification of regions in remote sensing. Images are generated by optical cameras, ultrasound, x-ray machines and other imaging devices. When processing an image with a computer, it must be digitized or created in a digital format². There are some basic methods to distinguish between objects and background and to describe regions in digital images.

SCILAB is a free software alternative to MATLAB, hailed very often as the language of technical and scientific computing³. MATLAB has found a permanent place not only in the curriculum of applied science and engineering studies, but also in research and development arena. SCILAB has similar functionalities as MATLAB and may be considered to be an effective alternative since it also provides a rich collection of tool boxes. In particular, the SCILAB Image Processing Design Toolbox (IPD) has various applications that are suitable for image processing. These include some basic methods to distinguish between objects and background and to describe the different regions in digital images.

In this research the photo of barnacles on the underwater hull surface were analysed using SCILAB. This surface is very important because it is in constant contact with the water and this is where the undesirable additional friction occurs. The photos of the barnacles were taken once a month.

2. SCILAB Image Processing Tool

SCILAB is a free software and user-friendly alternative to the commercial MATLAB package. SCILAB has as much functionality as compared to MATLAB. SCILAB has many collections of tool boxes suited for applications in science and technology fields. Image Processing Design Toolbox (IPD) is an image processing toolbox, which supports formats like BMP, PNG, JPEG, TIFF, and PBM⁴. It can do a variety of applications like image type conversion, spatial transformation functions, image analysis and statistical functions, image arithmetic functions, linear filtering, morphological operations, and colour space conversions⁵.

Colour images consist of each pixel of a colour image there is a vector of colour components, e. g. red – green – blue. In SCILAB, colour images are represented as 3D arrays. The first dimension corresponds to the rows, the second dimension corresponds to the columns and the third dimension corresponds to the colour channel. Grey value images, also called “grey scale” images or “intensity images”: A grey value image is a matrix of grey values. In SCILAB a grey value image is a 2D array.

3. Methodology

Photos of the barnacles were taken every month for a period of three months. Scientifically barnacle’s growth is not aggressive thus a monthly time gap is sufficient for data analysis. The location of the chosen area is marked on the hull of the boat. This identification process is performed by divers using a waterproof digital camera and captured images were then uploaded onto a laptop for specific image selection. Fig. 2 shows an image of the activity. An example of an enlarged photo is shown in Fig. 3.



Fig. 2. Divers preparing to capture images of barnacles on the underside of the boat



Fig. 3. Photo of Barnacles captured at the hull of the boat

It’s clear that the extent of the barnacle growth can be calculated if the clarity of the seawater is good. As a countermeasure of barnacle growth, a number of existing pharmacological products had previously been studied and tested for antifouling activity against barnacles. Also, a paint system with a controlled release rate of one of these products has been shown to be effective, enhancing the mortality of barnacles, thus disabling them from attaching to ship hulls.

4. Results and Discussion

Sample image analysis of barnacles for the three-month period that starts from December 2012 to March 2013 is illustrated in Fig. 4. From obtained results, it can be seen that the barnacle growth is increasing throughout the period. SCILAB performed four analyses on captured images; namely, blob analyses, edge detection, gradient analyses, and graph Histogram. For this research, the sample photos taken on December 2012, February and March 2013 at CITRA MOSTI stern hull part were used. The main purpose of blob analysis is to find the difference between the hull of the CITRA MOSTI and the barnacle growth from the photo. This analysis produced three different Red, Grey and Blue (RGB) images.

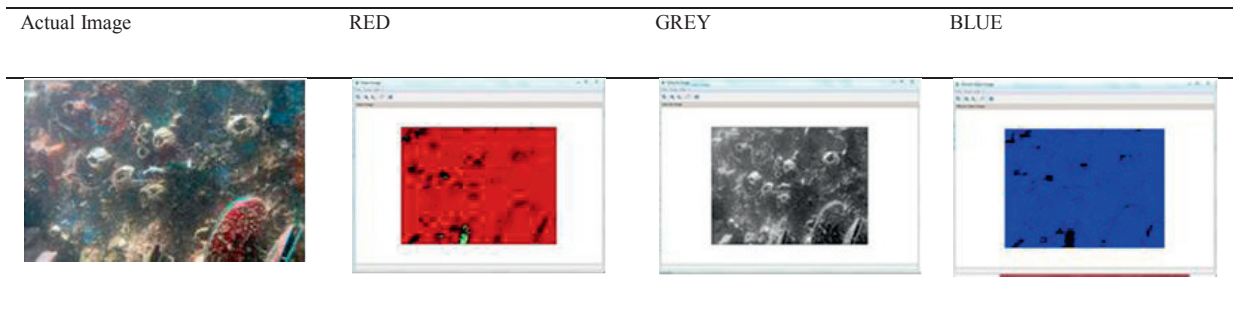


Fig. 4. Barnacles image blob analyses.

These barnacles change their colours according to the surface of the hull. When the images colour properties were compared, it can be seen that image has the best view due to the clarity of the seawater at the time. Even when the images were not as good, we can still see that the amount of barnacles continued to increase over time. The white colour shows that the new barnacles continue to grow and this can be depicted by histograms using SCILAB programming. When using blob analyses, it can be seen that all images can be represented by three basic colours RED, GREY and BLUE. From the above images, the differences of barnacle growth in the period of three months can be tracked. The barnacles started to grow in March (black colour depicts the barnacles). Red image is the intensity of the image, grey are the greyscale and the blue is the filtered image. Objects can be found in a logical image by searching the connected areas of true pixels. The pixels of each connected area are mapped to an integer number greater than zero. All pixels of the same area have the same number whereas pixels belonging to different areas have different numbers. All false pixels are mapped to zero. Edge detection analysis was also analysed in this study. The main purpose of edge detection analysis is to define the edge of the barnacle growth from the captured images. The expanding edge of the area of barnacle growth can be seen from the three captured images. From an image taken in December 2012 to March 2013, we can see the continuous growth of the barnacles using edge detection. From the Edge detection analysis it can be seen that the darker the image is, the greater the amount of barnacles present. The image captured in March showed that barnacles were starting to grow and started to fill-up the designated area.

Based on the graph intensity histogram analyses, the growth of the barnacles from December 2012, February 2013 and March 2013 can be depicted. Starting from December 2012 image right through to March 2013, the number of peaks continued to increase. That is, the barnacles were growing slowly but continuously through time. Fig. 5 shows that in December 2012, the graph only shows one peak with a pixel amount of 2600 pixels. In February 2013 image (Fig. 6), it can be seen that there are now 2 peaks in the graph attaining a maximum value of 3000 pixels. Graph in Fig. 7 shows an analysis made on an image captured in March 2013. It can be seen that the barnacles were starting to have a higher growth rate and the graph now has four peaks, doubled the number of peaks in graph generated from image captured in February and quadrupled that of December. It can also be estimated that the barnacles have grown to about 10% within 3 months since December, achieving a maximum growth rate in March 2013 at a value of 3500 pixels.

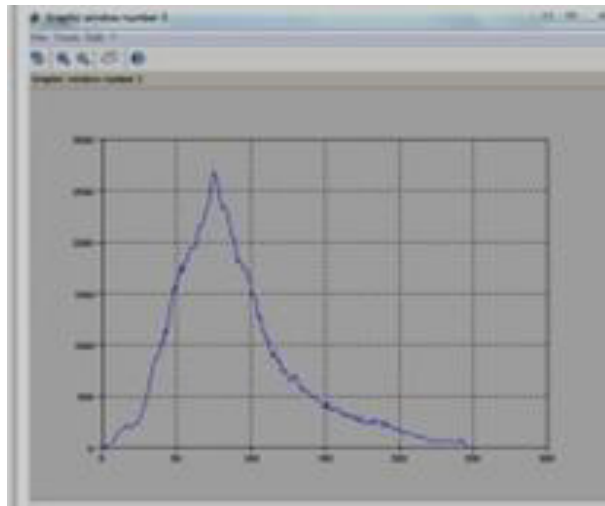


Fig. 5. Graph Intensity Histogram derived from December 2012 image

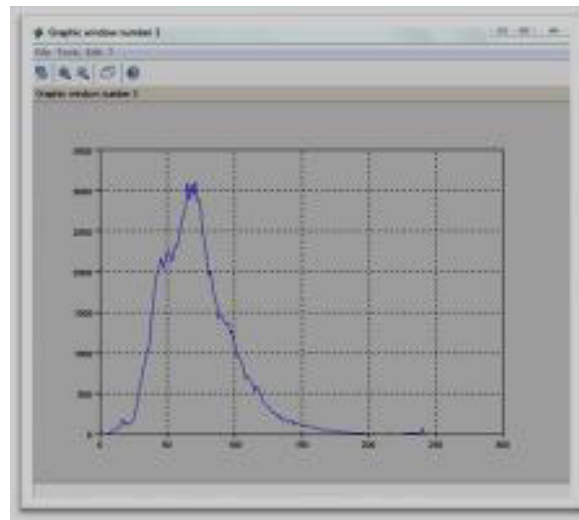


Fig. 6. Graph Intensity Histogram derived from February 2012 image

5. Conclusion

Based on three analyses that were performed, it can be concluded that the growth of barnacles were approximately 10% within the stipulated 3-month period. The growth of barnacles is difficult to control and its growth depends on factors such as weather and seawater conditions. An extended period of observation is needed in order to know more about the growth rate and growth pattern of barnacles. Image processing done through SCILAB can provide a promising insight in understanding the growth of barnacles.

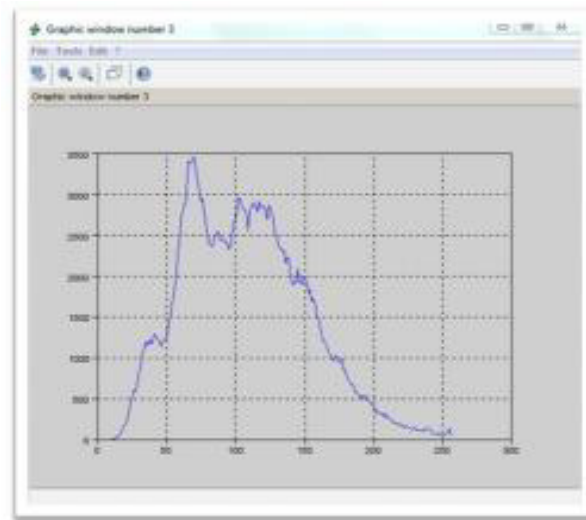


Fig. 7. Graph Intensity Histogram derived from March 2012 image

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