Vaname (*Litopenaeus vannamei*) Shrimp Fry Counting Based on Image Processing Method

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Abstract. Manually counting for vaname shrimp fry has some weaknesses, such as subjectivity in counting, time payload, exhausted in counting and inadequate accuracy especially in calculate large quantities of shrimp fry. Considering that condition, therefore a fast and good accuracy method in shrimp fry counting is needed. The purposes of this study are to develop a method in vaname shrimp fry counting through image processing by using, also determine the value of parameters which is needed in creating a machine to count shrimp fry automatically based on CCD camera. Images taken using CCD camera with backlight system. Image processing processes are consist of image cutting, thresholding, dilation and labelling. Accuracy value of shrimp fry counting using image processing program is 98.49%. The average time of shrimp fry counting using image processing program is 1.70 second/image with standard deviation is 0.15 seconds.

1. Introduction

Vaname shrimp and tiger shrimp are the two main commodities for the export of Indonesian shrimp commodities. Currently, shrimp farmers prefer vaname shrimp than tiger prawns. Vaname shrimp is a commodity imported from South America to cope with the constraints of tiger shrimp cultivation that many attacked by White Spot Virus (WSV). Vaname shrimp have several advantages, such as: domesticated mothers (not dependent on nature), more resistant to virus attacks, and can be maintained with high density [1].

Production of vaname shrimp in Indonesia over the past five years has continued to increase. Increased production of shrimp can be seen in table 1.

Table 1. Vaname shrimp production (2010-2014)

Year	Production (ton)
2010	206578
2011	246420
2012	251763
2013	390278
2014	411729

Source : Directorate General of Aquaculture [3]

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The cultivation of vaname shrimp is broadly divided into two main activities, namely hatchery and cultivation. Hatchery activities conducted by hatcheries or known as hatchery or by household-scale pembenih. In the hatchery activities there is the process of calculating shrimp fry at the time will be sold to consumers. Until now the calculation process is still done manually. Calculation of fish or shrimp fry conducted manually has many weaknesses, among others: subjectivity calculation, slow time, fatigue in calculation, and inaccurate accuracy, especially to calculate the fry of fish or shrimp in large numbers [2]. Manual calculation of fry loss is a problem in itself, especially wasted time to do the activity.

Currently the utilization of machine vision technology has been widely used to replace the function of vision in humans. The use of camera CCD camera or digital camera in various fields proved able to replace the function of the sense of human vision. The advantages of such technology is able to do the job quickly and consistently. The technology is a great opportunity to develop because it is cheap, available and easy to make.

The development of image-based technology with camera as image capture is very possible developed in the process of calculating shrimp fry. Image processing technology is expected to help the calculation of shrimp fry quickly, accurately and cheaply. Shrimp fry can be counted using an image processing program from shrimp or photo shrimp. This study aims to develop the method of calculating vaname shrimp fry with image processing using C # (C-Sharp) programming language, and to determine the value of the parameters required in CCD-based shrimp fry counter machine design.

2. Materials and methods

2.1. *Vaname Shrimp (Litopenaeus vannamei)*

Vaname Shrimp (Litopenaeus *vannamei*) is a native shrimp of South America. The inauguration of vaname shrimp in Indonesia by the government (Ministry of Marine Affairs and Fisheries) was carried out in 2002 [1].

The shrimp fry used in this study have a length of 6 mm - 8.5 mm. Transparent glass tray is prepared as a place for shrimp fry when shooting the image. The water level in the tray is set as high as 0.5 cm so that the shrimp fry do not overlap each other. The glass tray is placed on top of a backlight system with LEDs as a light and the background is white. The CCD camera is placed perpendicular to the tray.

Image capture is done using CCD camera. Image captured images from CCD cameras are displayed on a computer monitor and stored in JPG format. The image that has been taken is inserted into the pre-made image processing program. Some processes are done at the image processing stage. The process used is image cutting, binary (thresholding) and dilation three times. The next process is enumeration of the image of shrimp fry by labeling method, which serves to calculate the number of shrimp fry.

2.2. *Experimental Setup*

The digital image is obtained by a digital image device system that performs an image exploration to form a matrix in which its elements express the value of the light intensity in a discrete set from the point. According to Prasetyo [4] Image origin is defined at coordinates (0,0). The image coordinate system can be represented by a two dimensional matrix f (x, y). Image processing is needed as a process of processing pixels in digital images to improve the quality of the image where the resulting image can display information clearly, and the second extracts the prominent feature information in an image, where humans get characteristic information from the image numerically. With other words the computer to interpret the existing information on the image through the amount of data that can be clearly distinguished [5].

Image thresholding is applied as a method to separate objects and backgrounds. Thresholding is a simple and effective technique for image segmentation. Image segmentation is the process of separating images into several homogeneous parts and extracting them into several objects to be observed [7]. Ahmad [6] also explains that the process of thresholding is to convert the pixels of an object to a color image into pixels of maximum intensity (255) in binary imagery and to change background pixels on

the color image into pixels of minimum intensity (0) on a binary image, or vice versa (an object with an intensity value of 0 and a background with an intensity value of 255 on the resulting binary image).

Morphological operations in image processing is needed to change the shape of the object structure contained in the image. Morphological operations are usually applied to binary imagery. According to Tambe et al. [8] there are four basic operations of morphological processing ie dilation, erosion, opening and closing. The dilation operation is to adjust the object in an image where the expansion is based on the structuring element. The erosion operation is shrinking the object in an image where the amount of depreciation is based on the structuring element [9]. According to Raid et al. [10] opening is an erosion operation followed by a dilation operation using the same structuring element and closing is a dilation operation followed by erosion operation using the same structuring element.

3. Result and discussion

3.1. Setup of image capture devices

The camera height or distance of the shoot affects the length and width of the image capture. The camera height should be adjusted so that the resulting image capture represents the entire desired image area. The camera image capture format in this study is 720 x 576 pixels or with 5 : 4 image ratios. The camera height (T) relationship to the length (P) and width (L) of the image follows the following equation:

$$P = 1.0282 \times T + 2.0537 \quad (1)$$

$$L = 0.7464 \times T + 1.4907 \quad (2)$$

The above equation is obtained from the measurement test of the distance of the shooting distance to the length and width of the image. The minimum distance of shooting used in the experiment is 10 cm. Figure 1 below shows a graph of the relationship between the distance of the shoot by the length and width of the image. Backlight system also has other advantages that there is no reflected light from the water because the light is given from below. The backlight system was finally selected in this study. Image acquisition system in this study can be seen in figure 2.

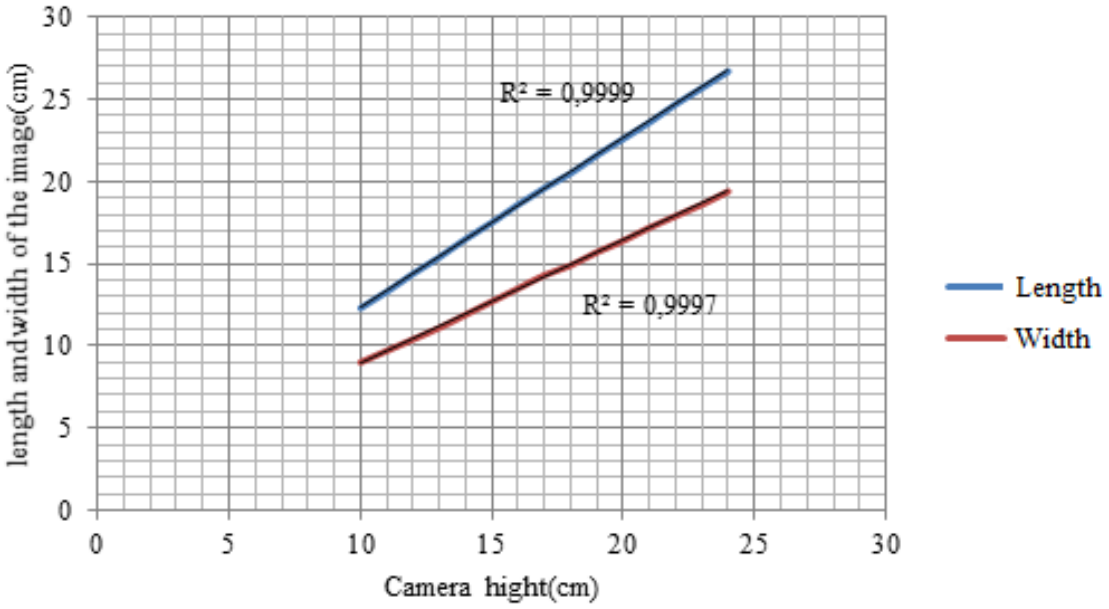


Figure 1. The relationship between the distance of the shoot by the length and width of the image

The image acquisition system in figure 2 used the LED as a light sources. White color selected to facilitate the separation of objects against the background in the thresholding process. Glass tray containing shrimp fry placed on a transparent plate made of acrylic and the camera placed perpendicular to it.

3.2. Thresholding Determination.

The thresholding process is used to separate the object (shrimp fry) with the background. The thresholding process converts the background pixels to black (R,G,B : 0,0,0) and the shrimp fry pixels to white (R,G,B : 255, 255, 255). The greyscale value is used as the thresholding limit in this study.

Determination of thresholding limit is done by adjusting (tuning) the greyscale value until the image obtained where the object and the background look real different. The *ImageJ* app is used for tuning greyscale values. The value of greyscale 70 is chosen as the thresholding limit of the tuning result because it is able to separate the object and the background well. Figure 3 shows the tuning process of thresholding boundary determination.

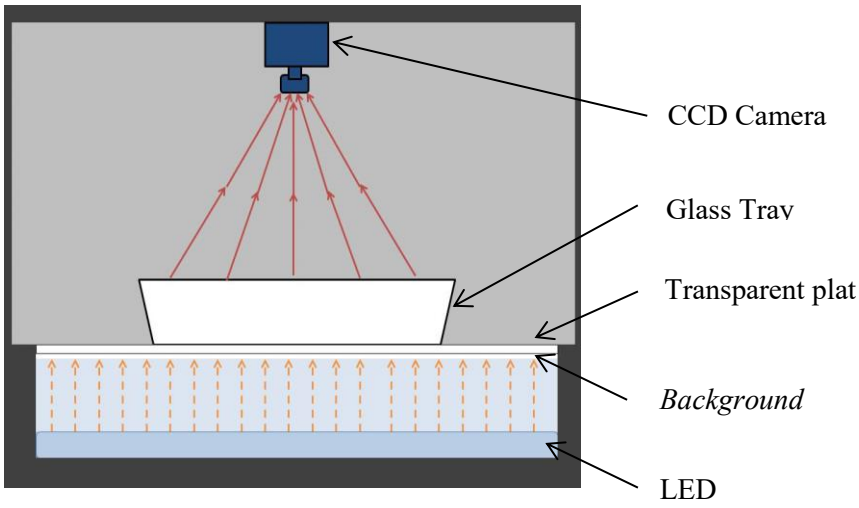


Figure 2. Image acquisition design

Pixels on images that have a greyscale value above 70 are considered as backgrounds and changed to black. Pixels that have a greyscale value below 70 are considered as objects and changed to white. The result of thresholding shows that the greyscale 70 delimiter value can separate object and background well.

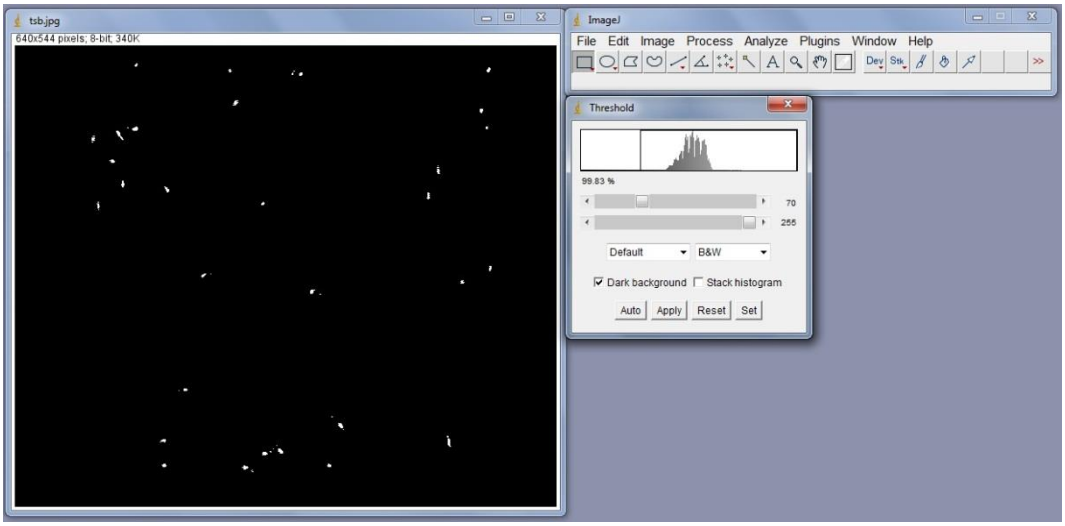


Figure 3. Interface of tuning process for thresholding delimiter value in Image-J application

3.3. Result of Image Processing.

Processing of shrimp fry image begins with thresholding the original image (figure 4) where the background is changed to black and the object is changed to white. The next stage is to perform a dilation operation on the binary image. Dilation operation is the process of adjusting the object, which in this study aims to combine the pixels of a separate object (shrimp fry). Dilation process is done three times for each image. The result of the dilation process of the threshold image is shown in figure 5.



Figure 4. Original image

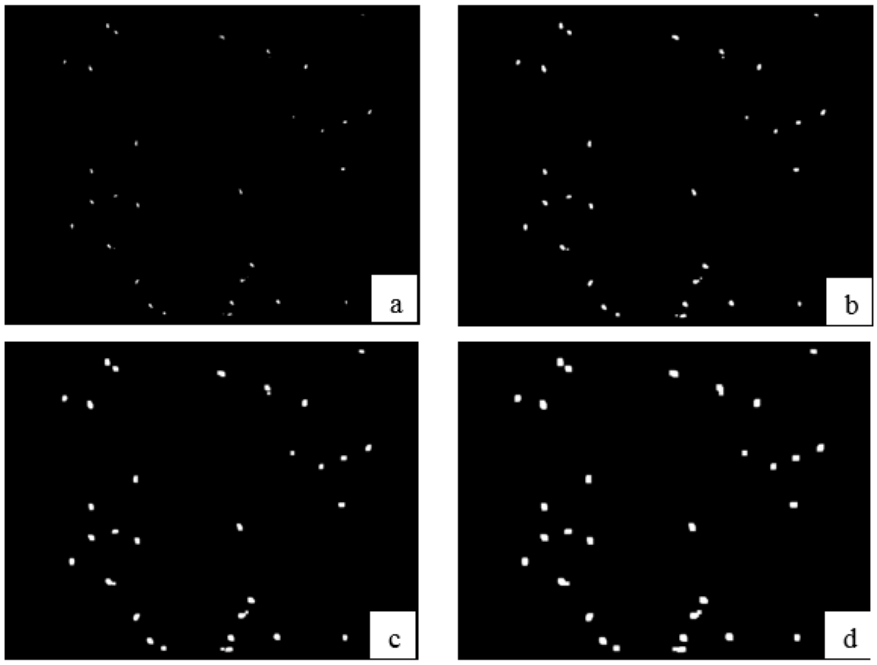


Figure 5. (a) The thresholding result (b) results once a dilation (c) the result of two dilations (d) the result of three dilations

The operation is dilationed three times after the thresholding process is able to unify separate object pixels, so counting errors can be minimized. The merging process of separate object pixels (one shrimp fry) can be seen in figure 6. Testing the program conducted to determine the level of accuracy and time consume of shrimp fry calculation. Testing the program is done by processing the image of shrimp fry that have been taken earlier into the image processing program. The processed image has a variety of shrimp fry. In the container used, the number of fry is limited to 66. The number of fry above 66 is ineffective, as more and more shrimp fry are overlapped. The average accuracy of program testing to calculate shrimp fry in images with different number of fry is shown in table 2.

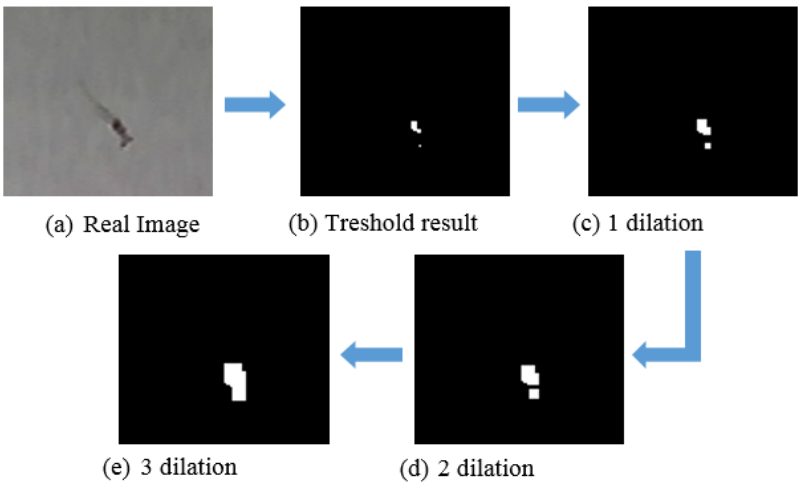


Figure 6. Pixel merging process of one separate shrimp fry

Table 2. Average accuracy of shrimp fry counter program

No	Number of Shrimp fry	Average accuracy (%)
1	5	100.00
2	10	100.00
3	15	100.00
4	20	100.00
5	25	100.00
6	30	100.00
7	35	100.00
8	40	99.00
9	46	97.39
10	56	96.07
11	61	96.72
12	66	92.73
	Average	98.49

The results of the test program showed a fairly high average accuracy of 98.49%. Lower accuracy occurs in higher number of shrimp fry. The calculation result is less than the actual amount caused by two conditions. The first condition is the presence of shrimp fry (more than one) that are interconnected or overlap , as shown in figure 7. The shrimp fry are mutually counted as one by the program. The second condition is that shrimp fry are detected as background because the black spots on the head are not visible, so it has a greyscale value above the threshold limit. This condition can be seen in figure 8. The calculation result is more than the actual amount caused by pixels from one shrimp fry that is still separated (over segmentation) even though it has been through dilation process. This condition causes one shrimp fry can be counted as more than one fry, as shown in figure 9.

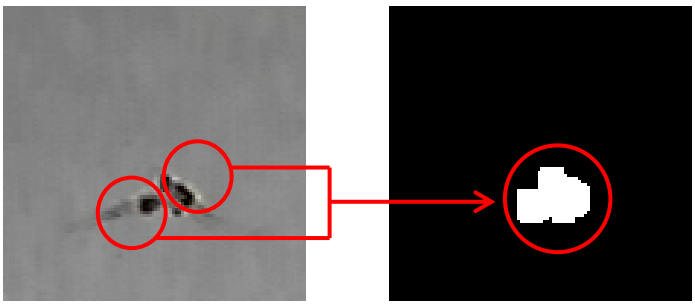


Figure 7. Two tangled shrimp fry are counted as one

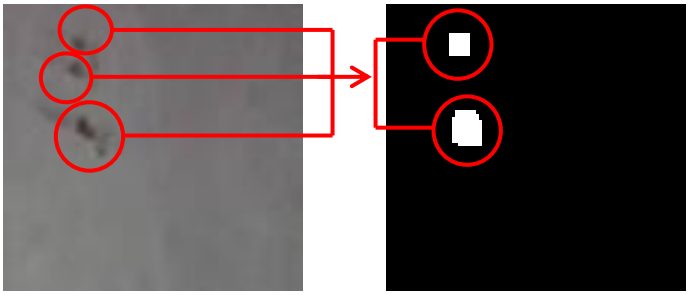


Figure 8. One shrimp fry missing as detected as background

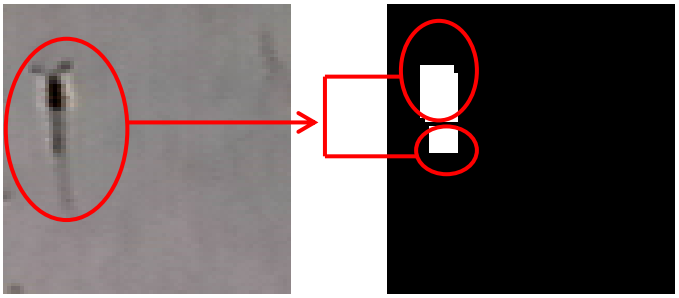


Figure 9. One shrimp fry count is counted as two

Table 3 shows the average calculation time using a program for twelve different densities, where the water level in the tray is 0.5 cm. Image processing time (calculation time) uses an average program of 1.70 seconds with standard deviation of 0.15 seconds. The amount of 61 shrimp is the optimal number of shrimp where the count errors are still below 5%. The calculation time without loading time to bring the fries to the tray and reload back to the original container per shrimp at 61 shrimp is 0.027 seconds, while the conventional counting time (manual) per shrimp is 1.04 seconds.

Table 3 Calculation time using shrimp fry counter program

No	Number of Shrimp Fries	Density (Shrimp/cm^3)	Calculation process (second)
1	5	0.07	1.66
2	10	0.15	1.75
3	15	0.22	1.70
4	20	0.30	1.62
5	25	0.37	1.54
6	30	0.45	1.60
7	35	0.52	1.82
8	40	0.60	1.76
9	46	0.69	1.76
10	56	0.84	1.70
11	61	0.92	1.72
12	66	0.99	1.74
Average			1.70

4. Conclusions

Thresholding operation to process the image of shrimp fry using greyscale value 70. Calculation of shrimp fry using image processing program that has been built has 98.49% accuracy. Average shrimp fry counting time using image processing program of 1.70 is seconds with standard deviation of 0.152 seconds. The counting time without loading time to bring the fries to the tray and reload back to the original container per shrimp fry in an image with 61 fry is 0.027 seconds. The weakness of the image processing program that has been built that is not able to separate the shrimp fry are mutually intersect, have not been able to detect the shrimp fry that are not visible black spots and there are still images of shrimp fry over segmentation.

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