Detecting Shrimp with Legs using Fourier Descriptors

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***Abstract*— This research proposes the method of detection Raw White Shrimp's leg (Penaeus vannamei) by finding distinctive structural characteristic (Contour) using Fourier Descriptor in order to increase the effectiveness of detection. As a result, the distictive characteristic was sought at the area of shimp's inside feature that was able to detect shimp with legs and with no leg clearly. Eleven values of coeficient was used to explain the boundary of shrimp's inside feature. Subsequently, coefficient of vector obtained from shrimp with no leg was calculated to find Euclidean vector norm for analysis and thresholding. This method provided DSR (Detection Success Rate) higher than 90% from all 130 images used for testing. That might be incorrect due to the manner of shrimp's legs that close to its feature leading to inspection fault.**

Keywords- Fourier Descriptor; Shrimp; Inspection; Shape Analysis

I. INTRODUCTION (HEADING 1)

Shrimp industry is considered to be the important industry for Thailand's economy. The shrimps will be exported for distributing in international market in the form of frozen shrimp and processing shrimp. Seven of the 10 world's largest shrimp producers in 2003 were Asian countries. These seven producers - China, India, Indonesia, Thailand, Vietnam, Malaysia and The Philippines –had a combined output of 6.96 billion pounds which represented two-thirds of world production [5].

Since the inspection process of frozen shrimp industry's QC inspection is operated by visual inspection of trained experts, such inspector must be qualified specialists. In addition, there are several subjects for inspection, for example, the inspection of dehydration at the shrimp's skin due to freezing, shrimp's color change, black spot, and shrimp amount counting per package. Such inspection is operated to classify good shrimps out of defected shrimps for determining the shrimp grade of such manufacturing. As a result, there is a possibility of having poor quality shrimp or product that is not inspected. The most important fault of QC in this manner is inspection process performed after checking shrimp. As a result, in the event of finding any error with percentage lower than acceptable percentage, such manufacturing will be returned giving bad effect to export industry and reliability.

The main cause is that inspector is unable to use his/her sense to evaluate product continuously and regularly due to tiredness and influence of usualness and monotony on working. Consequently, the analysis's result may be incorrect. Although repeated inspection may provide experience to inspector, it can be seen clearly that the influence of usualness will reduce the speed of analysis.

As a result, from the reason above, shrimp's QC inspections and product's quality assurance becomes very important. One of QC inspection process is the inspection of appearance condition. This inspection stage is generally uses visual inspection requiring large amount of specialists for this process. However, although it is the inspection performed by expert, there is possibility of error due to the limitation of operation performed by human. Tiredness due to visual inspection of inspecting defect on shrimp's feature contributes boredom in operating repeated works. As a result, automatic QC system becomes one method to solve the problem of product QC as well as reduce the cost of employing personnel for shrimp's QC inspection.

The objectives of this research are:

1) To develop the use of Machine Vision for shrimp's QC inspection for Thailand's export;

2) To test the effectiveness of shrimp classification from developed system.

II. PREPROCESSING AND FEATURE EXTRACTION

LCdr. Nikorn Chaichuay [1] presented a method to recognize a ship on a river by extract 36 Fourier descriptor coefficients representing global boundary features of the ship. *Tyler Karrels* [4] extracted and assign information contained in images is using Fourier descriptors to recognize shapes of leaf. *L. Xu* [7] segmented the image of skin cancer by intensity thresholding. *Øivind Due Trier* [9] presented an overview of feature extraction methods for recognition of segmentation characters. Different feature extraction methods are designed for different representation of the characters, such as solid binary, character contour.

A. Noise Filter

Blurring of the image is to remove noise. Therefore the image is first smoothed by applying a Gaussian filter. The kernel of a Gaussian filter with a standard deviation of σ = 1.4 is shown in Equation (1).

$$B = \frac{1}{159} \cdot \begin{bmatrix} 2 & 4 & 5 & 4 & 2 \\ 4 & 9 & 12 & 9 & 4 \\ 5 & 12 & 15 & 12 & 5 \\ 4 & 9 & 12 & 9 & 4 \\ 2 & 4 & 5 & 4 & 2 \end{bmatrix} \quad (1)$$

B. Segmentation and Edge Detection: Canny

In [6], [8], Canny is a good Detection and have a good localization. That is edge detection near true edge. For the one - dimentional case.

Firstly, two-dimensional Gaussian Filter is used as shown in equation (2)

$$G(i,j) = e^{-\left(\frac{i^2+j^2}{2\sigma^2}\right)} \quad (2)$$

Then the position of boundary is able to be found as shown in equation (3).

If, $$\frac{\sigma^2 G(i,j)}{\sigma n^2} \otimes g(x,y) = 0 \quad (3)$$

It is the boundary

By, $$n = \frac{\nabla(G(i,j) \otimes g(x,y))}{|\nabla(G(i,j) \otimes g(x,y))|} \quad (4)$$

When n is perpendicular with the pixel that is boundary

C. Morphological Image Processing

- Dilation[2]

Suppose *A* and *B* are sets of pixels. Then the dilation of *A* by *B*, denoted $A \oplus B$, is defined as

$$A \oplus B = \bigcup_{x \in B} A_x \quad (5)$$

This is for every point $x \in B$, we translate A by those coordinates. Then we take the union of all these translations. An equivalent definition is that

$$A \oplus B = \{(x,y)+(u,v) : (x,y) \in A, (u,v) \in B\}. \quad (6)$$

From this last definition, we see that dilation is commutative: that

$$A \oplus B = B \oplus A \quad (7)$$

- Erosion

Give sets *A* and *B*, the erosion of *A* by *B*, written *A*, *A* $\odot$ *B*, as shown in equation (8)

$$A \Theta B = \{z \mid (B)_z \subseteq A\} \quad (8)$$

That is the erosion of *A* by *B* consists of all points z=(x, y) for which B_Z is in *A*. To perform and erosion, we can move *B* over *A*, and fine all the places it will fit, and for each such place mark down the corresponding (0,0) point of *B*. The set of all such points will form the erosion.

- Opening

Give *A* and a structuring element *B*, the opening of *A* by *B*, denoted *A* º *B*, is defined as:

$$A \circ B = (A \odot B) \oplus B \quad (9)$$

That is, *A* º *B* is the union of all translations of *B* which fit side *A*.

- Closing

Analogous to opening we can define closing, which may be considered as a dilation followed by an erosion, and is denoted A • B:

$$A \circ B = (A \oplus B) \odot B \quad (10)$$

D. Feature Extraction

[1],[12]That is using analysis for pulling interested images data to be the form of vector for applying as theinput of Classifier. In this research, we use Fourier Descriptor because images of shrimp's feature inthis research has curve such curve manners seem to be slightly ,However .skeleton ferent ondifSpatial Domain. As a result, when the image groups are able to be classified, it is interesting to analyze boundary's data (Contour on Spectral Domain by using Fourier Transformation Theory for providing the value of Fourier Descriptor.

ngFor findiFourier Descriptor value, it is begun from finding the boundary of object's image. Subsequently, the pixel of image on boundary will be ordered. Such finding is calculated from

$$u(n) = x_1(n) + jx_2(n) \quad (11)$$

in the form of Complex Number as shown in equation (11) because obtained boundary is discrete data. The pixel needed for sampling is determined asN and coefficient, as well as N value, is able to be calculated in a(k) Frequency

Domain of u(n) by using Discrete Fourier Transform Theory. DFT value is able to be calculated by equation (12),

$$a(k) = \sum_{n=0}^{N-1} u(n) e^{-2\pi jkn/N} \tag{12}$$

by k=0,1,…,N-1 called Coefficient a(k) as the Fourier Descriptor finding. For the finding of a(k) size or the finding ofComplex norm size, that is able to be called as Magnitude value, it is able to be calculated by using equation (13).

$$|z| = |x + jy| = \sqrt{x^2 + y^2} \tag{13}$$

E. Euclidean Vector Norm

The length of a vector $u \in \Re^2$ is obtained from the Pythagorean theorem by computing the length of the hypotenuse of a right triangle as shown in Figure 1, For vector X_{nx1}, the Euclidean norm of x is defined to be[10]

$$\| X \| = \left(\sum_{i=1}^{n} x_i^2 \right)^{1/2} = \sqrt{X^T X} \quad \text{whenever} \quad X \in \Re^{nx1} \tag{14}$$

$$\| X \| = \left(\sum_{i=1}^{n} | x_i |^2 \right)^{1/2} = \sqrt{X^* X} \quad \text{whenever} \quad X \in \mathbb{C}^{nx1} \tag{15}$$

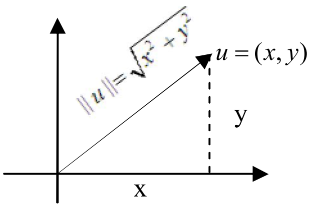

Figure 1: Euclidean vector norm for 2 dimentional

This measure of length,

$$\| u \| = \sqrt{x^2 + y^2} \tag{16}$$

III. PREPARE METHODOLOGY AND EXPERMENTS

In the experiment using color image (RGB) of shrimp tooken by digital camera in the same environment with the size of 365x270 pixels, the image was laid on a transparent acrylic sheet overlaying white paper sheet as shown in Figure 2.

Figure 2: Comparison between images of shrimp with no legs (Left) and legs (Right)

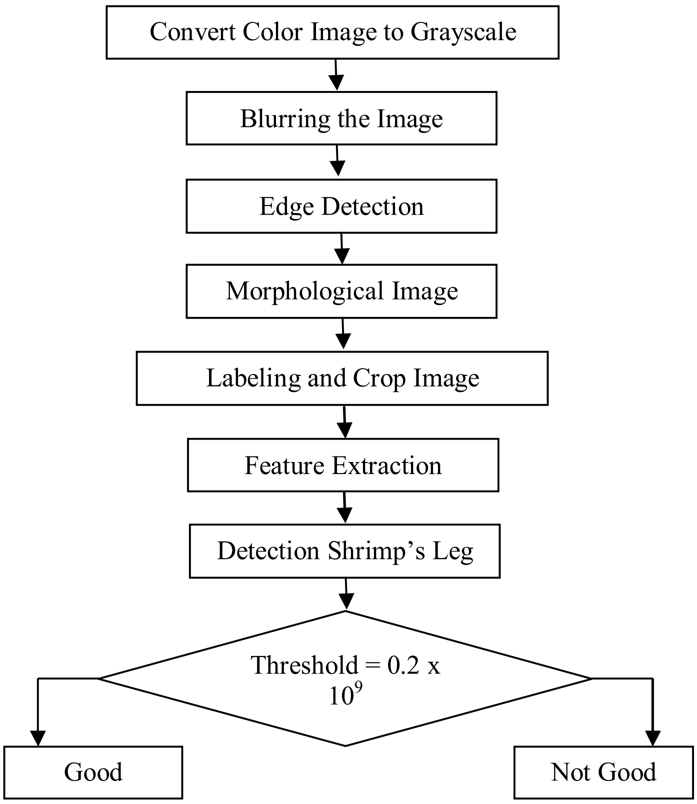

Figure 3: Flowchart shows a process of segmentation

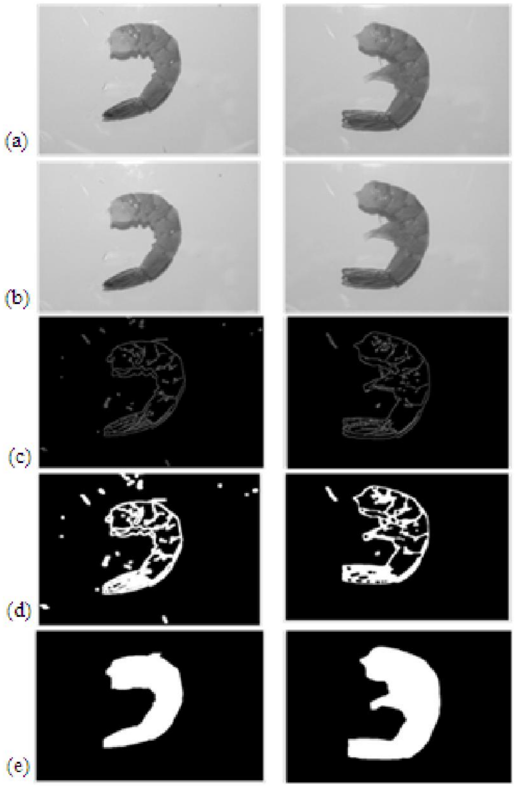

Figure 4: Figure exhibiting calculation process of segmentation, RGB Image (a), Convert to Gray Scale (b), Finding Edge Detection (c), Edge Dilation (d), Fill Region (e)

Figure 5: The images of shrimps after cropped whole shape

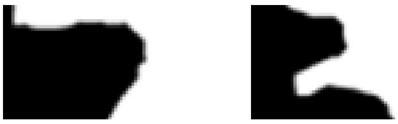

Figure 6: The images were cropped the area of shrimp's inside by fix point (246x201 pixels)

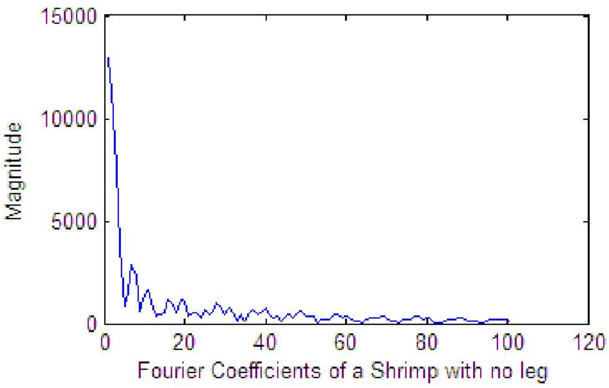

Figure 7: values of 10 Graph exhibitingFourier Coefficients (no leg)

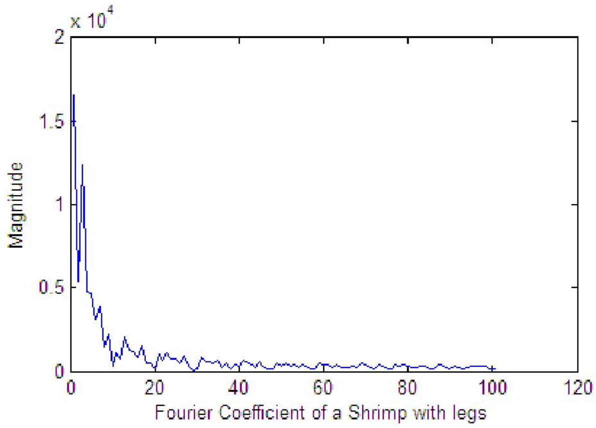

Figure8: legs of 10 Graph exhibiting Fourier Coefficients (with legs)

From graph exhibiting magnitude of Complex Number on axis y and Fourier Coefficients on axis x, it was found that the comparison between Figure 7 and Figure 8 shows that shrimp with legs in graph 8 has higher frequency than Figure 7. Consequently, it shown that shrimp's image with large difference of boundary, that was different from graph 7, had lower frequency. This shown that the boundary has more curve manner. In consideration on graph obtained from plotting graph between Magnitude and Fourier Coefficients, as shown in Figure 7 and Figure 8, by selecting 10 values of Fourier Coefficients, magnitude obtained from coefficient value at 10 that close to the center. As a result, when comparing the feature of shrimps, the difference between such two types of shrimp was not clear.

TABLE I. OURIERF ABSOLUTE VALUES OF 10 EXHIBITING OEFFICIENTSC TABLE TYPE STYLES

No.	Fourier Coefficient	
	Shrimp with no leg	*Shrimp with legs*
FD1	12979	19629
FD2	11367.12	7507.57
FD3	7606.27	11371.61
FD4	3786.76	2764.99
FD5	837.86	3902.12
FD6	1552.66	4747.56
FD7	2827.74	2758.55
FD8	2305.20	4049.96
FD9	635.51	2190.70
FD10	1394.55	2211.58

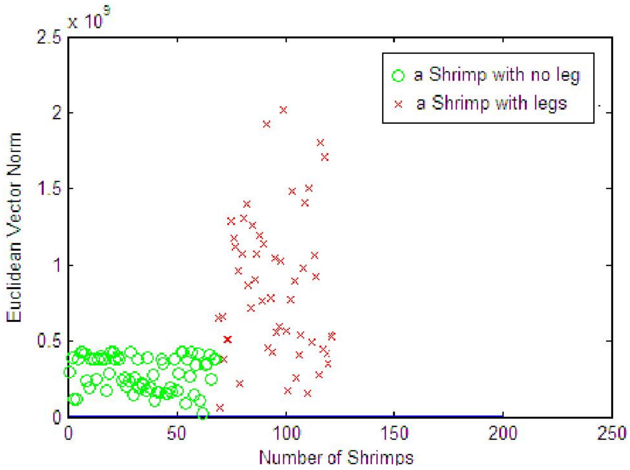

Figure 9: Graph exhibiting Vector Norm Calculation

After calculating Vector Norm, we have to select 1 value for thresholding in order to classify shrimp with legs out of shrimp with no leg.

IV. RESULT AND DISCUSSION

From Fourier Transform Theory [2], it is found that Fourier Descriptors have the symmetry around (L-1)/2 positions. As a result, the first half of Fourier Descriptors was applied. Graph with low frequency explained total characteristics and high frequency explained the detailed characteristics of object. This has shown that such image had angel and edge. In this research, there were 10 values of Fourier coefficients that were used as Features and applied for finding the Euclidean vector norm value and thresholding's value. From the experiment, it was found that the best thresholding's value was 0.2×10^9 that was able to classify shrimp with legs and shrimp with no leg. This evaluation value had higher efficiency at 90.77% which was compared by humans. The percent error was higher than 10%. Such error might be caused by image cropping of shrimp's inside feature that was the determination of fixed boundary. As a result, the error was occurred because the nature of shrimp is variance shape. As a result, the specified boundary may not cut the part of inside feature to meet with the demand.

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