Shrimp Quality Classification with Color Based Features and Linear Discriminant Analysis

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Abstract—This paper was aimed to evaluate and classify the quality of shrimp using image processing. The quality was determined by classifying color-based features extracted from the image using decision tree classification and linear discriminant analysis. Color parameter of the images, such as the mean, entropy, energy, contrast, correlation and homogeneity of color range red (r), green (g), blue (b), hue (h), saturation (s), value (v), lightness (*L), redness (*a**), and yellowness (*b**)**

Keyword—shrimp quality, color, image analysis, decision tree classification, linear discriminant analysis

I. INTRODUCTION

The white-legged shrimp (*Litopenaus vannamei*) makes up about 90% of shrimp aquaculture in the western hemisphere[1]. The aquaculture of this vannamei shrimp is a future oriented aquaculture with a low volume high density concept. According to International Trade Center (2017), the global demand of shrimps grew by 7.45% each year[2]. A controlled cultivation with high efficiency, meaning a good waste management and productive distribution is suspected to be profitable and sustainable farming system. Increasing this shrimp production and distribution can cause the increase of shrimp quality importance.

In order to evaluate the quality of shrimps, the indicator must first be found. These indicators can be found by using a variety of methods including sensory methods, physical methods (texture), chemical and biochemical methods, and micro bacterial method[1]. The method most feasible to use in computer vision are the sensory methods and physical methods.

It has been researched that colors in sea foods are strongly related to their colors[6]. Similar, colors can be an important indicator in shrimp quality. Shrimp color change depends on several factors of which the microbiological and chemical process such as change in protein, lipid fractions, and enzymes. These factors can mean the study in shrimp colors to be related in its chemical and biochemical study of shrimp quality. The color changes usually emerges with spots, which is nutritionally harmless. The quality of aquatic foods has been reported before. However, few apply image processing as quality evaluation for shrimps.[3]

In related studies, fish image classification has been studied for decades. Commonly the method address how to extract features from fish images and how to train the classifiers. Previous study proposed the use of red laser and convolution neural network (CNN) as classifier and object detection[3]. Another study closer to shrimps proposed edge detection and boundary extraction as shrimp segmentation and discrete wavelet transformation to extract feature for classification. The classification itself is performed using feature vectors[4].

According to World Wide Funds for Nature (WWF) 2014[5], another quality indicator for shrimps are the size and thickness. The technology to measure size is possible with the help of multiple cameras or the help of known-size object in the image[3].

The technology to build a sea foods automatic sorting to evaluate and rank said sea food has been proposed by a previous study[3]. In this study, the machine is build with a conveyor to move the sea food, three camera to measure the size and feature extraction, a red laser as sensor to help feature extraction, and a sort part to sort it based on it’s classification.

The writer has also conducted experiment to create an algorithm to recognize one of the disease white-legged shrimps can contract, and that is the black gill disease. The experiment is focused on recognizing a black circle spot on a shrimp after removing noise and background.

The purpose of this study is to develop an algorithm to evaluate the quality of white-legged shrimp before distribution to divide it based on export quality, import quality, or damaged.

Following previous studies and the writer previous experiment, the proposed method is focused on extracting colors of shrimp after removing noises and background.

II. METHOD

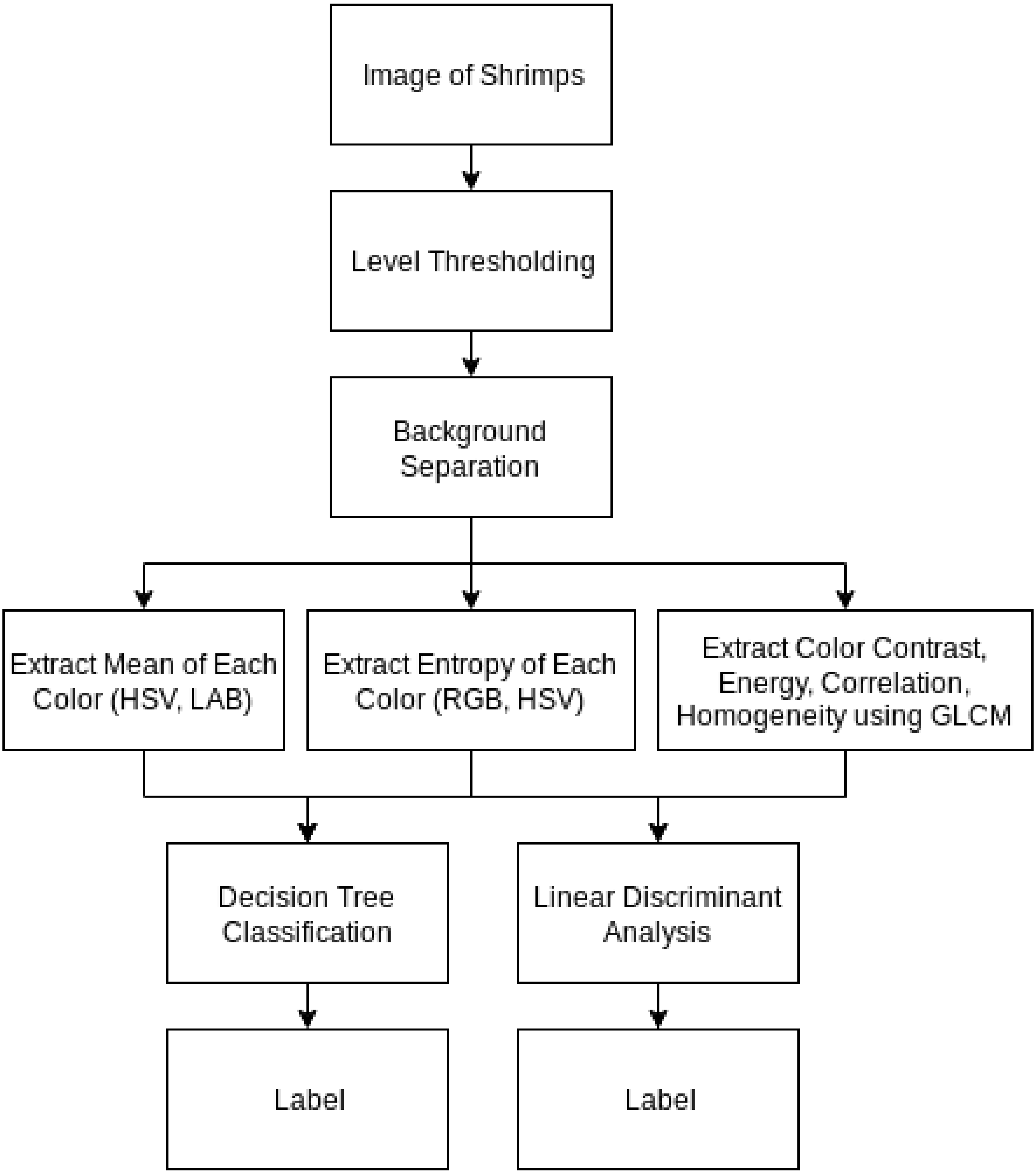

FIGURE 1. Method Flow of The Experiment

Material: The experiment is conducted with the programming language python. GNU Image Manipulation Program is used to manually manipulate the image before the image is inserted to the program. Several side view image of a shrimp is needed with varying quality is needed.

Preparation: First, separate the shrimp from the background. The shrimp is separated from the background and the background is changed into the color complete white or black. This process is done to make extracting color features from the shrimp as accurate as possible without having to use object detection. To achieve this, manual image manipulation using GNU Image Manipulation Program is done.

Multi Level Thresholding: The purpose of this algorithm is used to make sure only some value of the image is kept. The main purpose is to help filter shade of white in the case the background color that is changed in the preparation is not complete white. This method split the grayscale values based on how many level parameter.

Background Separation: Following the mask obtained from the previous step, the image is then separated from the background and the background is converted into the color black (RGB #000000) to make filtering easier when it's time to extract the color values.

Extract the Color Mean: The image color range is converted into HSV and $L^*a^*b^*$, and from each dimension, the mean is calculated, ignored the color black that is masked from the previous step.

Extract Entropy: This step extracts the entropy of the color range, following a previous study[7]. The formula is described as:

$$-\sum_{i,j=0}^{n-1} p_{ij} \log_b p_{ij}$$

where b is the base of log and is set to 2.

Extract Energy: The energy of a color is the sum of squared elements in the GLCM (gray-level co-occurence matrix). Also known as uniformity or the angular second moment.

$$\sum_{i,j=0}^{n-1} (p_{ij})^2$$

Extract Contrast: Measures the local variations in the gray-level co-occurrence matrix

$$\sum_{i,j=0}^{n-1} p_{ij}(i-j)^2$$

Extract Correlation: Measures the joint probability occurrence of the specified pixel pairs.

$$\sum_{i,j=0}^{n-1} p_{ij} \frac{(i-\mu)(j-\mu)}{\mu^2}$$

Extract Homogeneity: Measures the closeness of the distribution of elements in the GLCM to the GLCM diagonal.

$$\sum_{i,j=0}^{n-1} \frac{p_{ij}}{1+(i-j)^2}$$

where n is the number of gray levels (256), p_{ij} is the element of i,j of the normalized symmetrical GLCM and μ is GLCM mean, calculated as:

$$\mu = \sum_{i,j=0}^{n-1} i\, p_{ij}$$

Decision Tree Classification and Linear Discriminant Analysis: After the features are extracted and saved to the form of a table with the feature value as a column and each image as a row, these two classification method are used to train and test classification method.

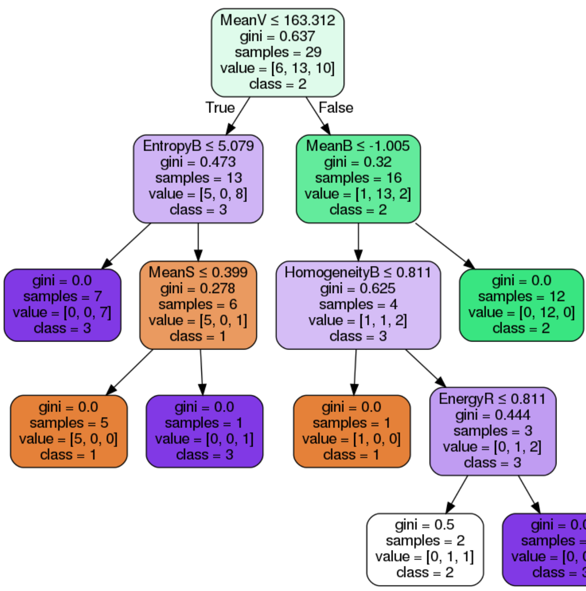

FIGURE 2. Decision Tree resulted from model training

FIGURE 3. Original Image

FIGURE 5. Multi Level Threshold Result

FIGURE 4. Manually Manipulated Image

FIGURE 6. Background Separation

III. RESULT

In this study, its possible to classify shrimps by image processing, despite the low number of image, which is 40 images, the result show high accuracy both with Decision Tree which reach 76% and Linear Discriminant Analysis which reach 84% which is split into 3 label of shrimp: good quality, low quality, and unhealthy.

IV. DISCUSSION

There are many things that can be improved. One way the writer can think of is to automatically segment the shrimp from the background, likely using edge detection and boundary finding. Another is feature improvement is better than the other, as from the current features only a few are actually used by the classifiers.

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