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Classifying Penaeid Prawns Species using Canny and Otsu

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Abstract: ***Image recognition is a challenging problem. The identification of prawn species can be done using Image Processing. Each species of the prawn has got its own distinctive patterns which enable the various researchers to accurately classify the prawns. Image segmentation is a key topic of research from many years. Image segmentation plays a very important role in computer vision .The purpose of image segmentation is to partition the image into an set of disjoint regions with the homogeneous and uniform attributes like intensity, tone, color and texture. Edge detection in images considerably reduces the amount of data and filters useless information, while considering the important properties of an image. In this paper the fundamental concepts of different edge detection techniques are to be studied and apply the best techniques in identifying the Penaeid Prawn species type. In this paper the segmentation algorithms are analyzed using Canny edge detection and Otsu thresholding and are tested with different species of Prawn images. The paper focuses mainly on the effectiveness and efficiency of the two techniques, used for testing their suitability for the type of Prawn images.***

Keywords- Image processing, image segmentation, Canny edge detection, Otsu thresholding

I. INTRODUCTION

The prawns of India belong to three major families, namely Pedaeidae, Sergestidae and Palaemonidae of the decapod groups. Prawns are among the most popular types of seafood. With the increase in demand for seafood, the marine aquaculture has become one of the growing industries in the world wide. Various types of prawns are found in both brakish water and fresh water. Freshwater prawn farming is an aquaculture business was mainly designed to raise and produce freshwater prawns for human consumption. The penaeid prawns include here are three categories namely Penaeus Monodon, Penaeus Indicus and Vannamei.

The images of different prawns are isolated from one another and from the background. The physical differences between the types of prawns are length; body mass, width, pleopod, pereiopod and tail. The automatic recognition of prawn species by their patterns is a very interesting field. Some areas of the aquaculture particularly fish family have been benefited by the automation and monitoring equipment. But these advances are not implemented in the prawn aquaculture. The need for computer based prawn species recognition systems that can automatically recognize species of prawns from digital images is expected to increase in the near future. In general it is not easy for a human being to inspect and recognize the bulky amount of prawn species and more over it is extremely cost effective. So automatic classification of the prawn species is necessary to overcome the errors caused by manual sorting of prawn species which is completely based on the human expertise. The goal is to develop commercially possible system that allows the farmers of the prawn to reduce the labour costs. For this, the usage of image analysis is proposed for automation.

Prawn species classification and recognition is an active research area in aquaculture. Many features may be different among the different species of the prawn. The classification is made by analyzing the features of the prawn. To extract the features of the prawn Image segmentation has to be done because segmentation is the first and foremost step of image processing applications in which the properties of objects in an image needs to be analyzed. The image segmentation is an important task for the extraction of useful information from the image such as the color, shape, texture and the structure. Image segmentation is the process of partitioning an image into different segments. The main goal of segmentation is to identify some objects of interest depicted in the image so that we can simplify or the change the representation of the image into more meaningful form to analyze in easy manner. Based on the image acquisition type the Images can be classified into different types. The most common type of images which we see are light intensity images, they represent the variation of light intensity. The common digital image processing tasks are Zooming, image segmentation, resizing, edge detection and color enhancement. Among these techniques, this paper focused on image segmentation of digital images. Image segmentation is the process of giving a label to each and every pixel of an image so that the pixels with same label share some features. In image segmentation the segments that cover the entire image or set of contours extracted from the image. In a particular region some pixels are same based on color, texture or intensity [1],[2] Image segmentation is usually done using edge detection techniques which are basically 2-D filters and detects the edges depending upon the level of intensity difference in pixels and the level of discontinuity. The effective image segmentation is very difficult and challenging task in the processing of an image [11],[12]. The Segmentation algorithms that are based on discontinuity approach partitions an image based on rapid changes in intensity and those on similarity approach are based on partitioning an image into regions that are similar based on the predefined criteria [3],[4],[5]. As a result of image segmentation more meaningful image is obtained which is easier to understand. Because images provide semantically poor information, image segmentation is essentially an application oriented problem that demands the involvement of the human experts or application specific solutions. The choice of the particular segmentation technique depends on the type of task to be performed and the nature of the images available.

II. Related Work

Prawn species recognition and classification is an active area in aquaculture. Some features may vary among different prawn species. Image acquisition process can be affected by noise and considered as a potential research in utilizing the existing technology for encouraging and pushing the aquaculture researches ahead. Although advancements have been made in the areas of developing real time data collection and on improving range solutions, existing systems are still limited in their ability to detect or classify prawns. There is a difficulty in identifying the different species of prawns. The classification is made by analyzing prawn with the various features as shown in Figure1. The various species of prawns with different morphological features look identical [12]. It has to be processed using the image processing. The image processing concept mainly deals with three aspects. The first is edge detection of the prawn, followed by feature extraction and then training. To do image processing with computers, the more suitable images are to be created for the people to identify and examine. Then the computer can identify the image. Edge is the basic feature of an image. It contains all the internal information of the image. There are so many edge detectors.

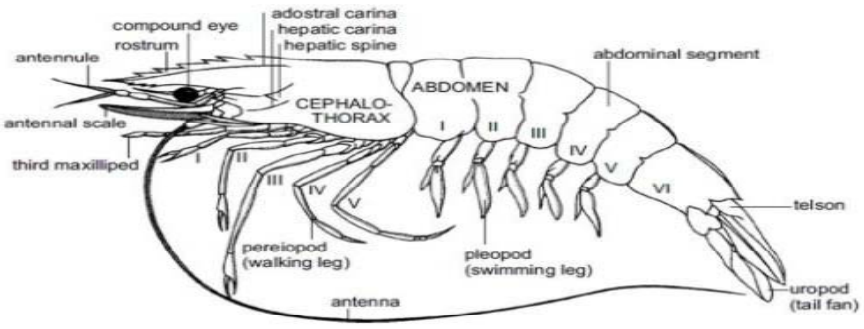

Figure 1. Morphological Features

The main problems are that edge detectors work differently. Some of them may take more time when compared to other. Some edge detectors finds more edges when compared to other. So the edge detection for image mainly depends on the noise, intensity, brightness, and blur. By working with different edge detectors for the same image the actual difference can be found. This paper pertains with study and comparison of various edge detection techniques for a single image and applying the best technique for identifying the species of prawn. The system has to recognize the isolated pattern of prawn which is consisting of its morphological features by which it is identified. As the system acquire an image consisting pattern of prawns then the image will be processed into several phases such as edge detection, feature extraction and then training for identifying the prawn with morphological feature extraction [1] before recognizing the pattern of the Prawn.

Edge detection is the problem of fundamental importance in image analysis. Edges characterize the object boundaries and are useful for segmentation, and identification of objects. Edges in an image are the locations of the pixel with the rapid changes in the gray levels. If there is a continuous image then the derivative of the image f(x, y) assumes a local maximum in the direction of the edge[8]. Therefore, one of the edge detection techniques is to measure the gradient of f in particular location. This is performed by using a gradient operator. Such operators are also called masks. It provides finite-difference approximations of the orthogonal gradient vector fx and fy Gradient Operator [11].

There are different ways to perform edge detection. They are Sobel, Prewitt, Robert and Canny. All these four edge detection techniques are implemented in MATLAB7.3 on prawn images [6]. The operator consists of the pair of 3x3 convolution kernels in Sobel Edge detector as shown in Table1. One kernel is simply the other rotated by 900. The two convolution masks Gx and Gy is used by this sobel operator which as shown in Table1. This can be joined together for finding the absolute magnitude and the orientation of the gradient. Gradient magnitude given by The sobel operator is used mostly for detecting vertical and horizontal edges [3][5]. The edges detected by this sobel operator may not be suitable for all the applications [7]. The Prewitt's edge detector uses the 3 X 3 convolution mask, which is slightly different from the Sobel edge detector. The convolution mask is used for smoothing the image The prewitt's edge detector is same as that of sobel operator and is also used for detecting horizontal and vertical edges in the image [3]. The Roberts cross operator has 2x2 convolution kernels. It does fast computing. One kernel is simply the other rotated by 900. These kernels are designed to respond maximally to edges running at 450 to the pixel grid. One kernel for each of the two perpendicular orientations. The Roberts Cross operator performs a simple and quick to compute, 2D spatial gradient measurement on an image. Pixels at each point in the output represent the expected absolute magnitude of the spatial gradient of the input image at that point. The Canny edge detector is also known to be an optimal edge detector [9], which satisfies all of the performance criteria. This edge detector has the advantage that maximum edges get detected by using this edge detector.

For visual comparison of edge detectors the images of Monodon, Indicus and vannamei are chosen which are the species of Paenaid prawns with noise are applied to the different edge detectors such as Sobel, Prewitt, Robert and Canny. The original images used for the analysis of edge detection are shown in Figure6. In the image recognition edge detection is the basic point,

so the differences between various edge detection techniques are to be known. In this paper various edge detection techniques are studied and analyzed.

The Sobel method finds the edges using the Sobel approximation to the derivative. Sobel method is good for detecting vertical and horizontal edges. The difficulty it had with certain prawn features such as rostrum, pereiopod and pleopod, mouth, antennules and tails are noticed. The Prewitt edge detector finds edges using Prewitt approximation to the derivative. It returns the edges at those points where the gradient of I is maximum. The Prewitt edge detector has the drawback of being very sensitive to the noise. The size of the filter for an image cannot be adopted. Roberts cross operator is unable to detect all the edges of the prawn, it suffers from miss mapping some of the lines. The Canny method finds all the edges by seeing for local maxima of the gradient of I. By using the derivative of a Gaussian filter the gradient is calculated. The performance of the canny is very good and depends on the adjustable parameters, which is standard deviation and the method also uses thresholds for detecting strong and weak edges, and considers the weak edges in the output only if they are connected to strong edges. also controls the Gaussian filter size. Canny is also able to detect the maximum number of edges, circular edges and edges at the corner. Canny yielded the best results.

In this paper the segmentation algorithms are analyzed using Canny edge detection and Otsu thresholding and are tested with different species of Prawn images. The paper focuses mainly on the effectiveness and efficiency of the two techniques, used for testing their suitability for the type of Prawn images.

III. SEGMENTATION ALGORITHMS

The basic step is to segment an image in image analysis. There are so many segmentation algorithms. For the intensity images the popular segmentation methods are Edge detection methods, thresholding based, Region based and connectivity preserving relaxation methods. The edge based methods they center around the contour detection. Threshold methods take decisions based on the local information of pixels and they are effective if the intensity levels of the objects fall outside the range of the levels in the background. In the region based methods the image is partitioned into the regions connected by grouping neighboring pixels of same intensity levels. Segmentation based on the discontinuity of the edges or segmentation based on Region which segments an image into regions based on the likeness according to a criteria predefined, in this paper mainly the two methods are discussed and evaluated, they are edge based detection technique and threshold based segmentation. Canny edge detection is selected for edge based segmentation and Otsu thresholding segmentation represent the other method.

Segmentation by Edge detection techniques

The Segmentation Methods based which are based on discontinuity search for quick changes in the intensity value are called edge based methods[1],[7]. Edge detection techniques are used for finding discontinuities in intensity values. The edge is the boundary in between two regions with different grey level features. Edge based segmentation methods detect the discontinuities and produce the binary images containing edges and also their background as the output of them. Important features can be extracted from the edges.[3] Edge detection is used for object recognition and so many other applications. Edges can be detected in different ways such as Sobel, Roberts, Prewitt and Canny operators. The Canny edge detection is presented here.

Canny Edge Detector

The Canny edge detector [12] is determined as the best edge detectors, Canny's edge detector ensures good noise immunity and at the same time detects true edge points with minimum error. Canny method has optimized the edge detection with respect to certain criteria. The first two of these criteria discusses the issue of detection. If an edge is given whether the edge detector will find the edge or not. The third criteria address issue of the localization meaning that how exactly the position of an edge is identified.

The steps of the Canny algorithm are as follows:

1. Smoothing of an image: Blurring of the image to eliminate noise by using the Gaussian filter.
2. Finding the gradients: The edges should be marked where the gradients of image has large magnitudes.
3. Non-maximum suppression: Only local maxims should be marked as edges. finds the local maxima in the direction of the gradient, and suppresses all others, minimizing false edges.
4. Double thresholding: Potential edges are determined by thresholding, Instead of using a single threshold value for the entire image, the hysteresis thresholding is used by Canny algorithm which has some adaptivity to the local content of the image. There are two threshold levels, th, high and tl, low where th > tl. Pixel values above the th value without delay are classified as edges.
5. Edge tracking by hysteresis: Final the edges are determined by suppressing all edges which are not connected to a definite edge.

Threshold Segmention Technique

The thresholding methods are generally used to segment an images into various classes, which consist of dark object and bright background or a bright object and dark background[4],[6],[10]. The image segmentation depends upon the threshold value t which changes according to the feature values of an image. The gray scale or color images are segmented based on depending the gray values which convert the color or gray scale images into the binary images by taking into account each pixel[8]. The input to the thresholding method is a color image or gray scale image. The output is the binary image representing the image segmentation. Thresholding creates the binary images from grey level ones by transforming all pixels below some threshold to zero and all the pixels above to one. Thresholding is the transforming an input image to output image g as shown in the formula.

$$g(i,j) = \begin{cases} 1 & \text{if } f(i,j) \geq t \\ 0 & \text{if } f(i,< j) < t \end{cases}$$

where t is the threshold, g(i, j) = 1 for image elements as the objects, and g(i, j) = 0 for image elements as the background, in this way the chosen threshold is dependable on the grey level value, this is called global thresholding technique. The thresholding technique is mainly divided into three categories:

Local Thresholding : In the local thresholding method the parameters of threshold is considered over a small area[9].

Adaptive Thresholding or Dynamic Thresholding : If T is depending on the spatial co-ordinates then the thresholding is called as adaptive thresholding or dynamic thresholding. In this type different threshold is used for different regions in the image. The threshold changes dynamically over image. If the value of the pixel is below the threshold value then it is set to the background value else it set as a foreground value.

Global Thresholding : If the intensity distribution and background pixel are different then gobal thresholding must be used on the entire image. If T depends on the grey level value of the image and T is exclusively related to the properties of pixel in image, then this method is called global thresholding. Otsu method is called as a Global thresholding method.

a)Otsu Thresholding :

A measure of region homogeneity is variance that is the regions with high homogeneity will have the low variance. Otsu's thresholding technique selects the threshold by minimizing within-class variance of two groups of pixels separated by the thresholding operator[12]. Otsu threshold technique is used in many applications from image analysis to computer vision. It does not depend on modeling the probability density functions; on the other hand, it assumes a bimodal distribution of gray-

level values that if the image approximately fits the condition it will do a nice job. Otsu is based on the threshold for partitioning the pixels of an image into two classes C0 and C1 at grey level t, where : C0 = {1, 1, 2,…, t} and C1 = {t + 1, t +2,….l - 1}, and let q0 and q1and represent the estimate of class probabilities defined as follows:

$$q_0(t) = \sum_{i=0} p(i) \text{ , and } q_1(t) = \sum_{i=t+1} p(i)$$

and sigmas are the individual class variances defined by:

$$\sigma_0^2(t) = \sum_{i=0}^{t} [i - \mu_0(t)]^2 \frac{p(i)}{q_0(i)}, \text{ and}$$

$$\sigma_1^2(t) = \sum_{i=t+1}^{l-1} [i - \mu_1(t)]^2 \frac{p(i)}{q_1(t)}$$

Where the class means are defined by:

$$\mu_0(t) = \sum_{i=0}^{t} \frac{ip(i)}{q_0(t)} \text{ , and } \mu_1(t) = \sum_{i=t+1}^{l-1} \frac{ip(i)}{q_1(t)}$$

Here, P represents the histogram of the image. The problem of minimizing within the class variance can be expressed as maximizing between class variance which can be shown as a difference of total variance and within class variance:

$$\sigma_b^2(t) = \sigma^2 - \sigma_w^2(t) = q_0(t)[1 - q_{0(t)}]$$
$$[\mu_1(t) - \mu_0(t)]^2$$

This expression can be maximized and the solution is the t that maximizing $\sigma_b^2(t)$.
The steps of the algorithm are as follows:
1.Calculate the histogram and the probabilities of the each intensity level.
2.Set up initial $q_i(0)$ and $\mu_i(0)$.
3.Step through all possible thresholds to maximum intensity. Update q_i and μ_i.
4.Calculate $\sigma_b^2(t)$
5.The preferred threshold corresponds to the maximum. $\sigma_b^2(t)$

IV. EXPERPENTAL SETUP

The paper mainly presents two techniques of image segmentation one is Canny edge detection and the other is Otsu thresholding, they are tested with a various species of prawn images and their corresponding segmentation using the two methods, as examples of our experiments. The original images of three species of the prawn namely Penaeus Vannamei, Penaeus Monodon and Penaeus Indicus as shown in Figure 2.

Vannamei Monodon Indicus

Figure 2. Prawn species

a) Testing Procedure

The edge detection segmentation was implemented using MATLAB and tested for the species of prawn images.

b) Simulation Results

The canny edge detection and otsu thresholding is implemented. The performance results applied by the two Techniques can and ostu thresholding are shown in the Figure 3 and Figure 4.

Vannamei Monodon Indicus

Figure 3. Canny Edge Detection

Vannamei Monodon Indicus

Figure 4. Otsu segmented images

V. CONCLUSION

In image based analysis the segmentation is partitioning of the digital image into multiple regions which is a set of pixels, based on some criteria. The problem of the segmentation with various approaches is studied clearly for the identification of the prawn species. Different types of approaches are suited to various types of images and the quality output of a particular algorithm is not easy to measure because there may be so many correct segmentations for a single image. In this paper the effectiveness of the algorithms are evaluated for three different species of penaeid prawn images like Vannamei, Monodon and Indicus as shown in the figure .The Segmented Images are good that are obtained by both the types of the algorithms. The results given by the canny are quite good. The result gives us an idea about the efficiency of the algorithms is responsible based on the type of images and their applications. In this paper for the prawn images the effectiveness of the algorithms that are proposed are evaluated as seen in Fig.2. Both the algorithms give nice segmented images, but for the objects that are notable from background in the images Otsu is more suitable. Canny segmentation is more suitable than Otsu to the Prawn images because all the edges are clearly identified from the background so that we can extract the edge features as shown in Figure 3.

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