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Penaeid Prawn Species Classification Based on Shape and Texture Feature Extraction Using Support Vector Machine

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Abstract

The proposed work is to develop a tool to identify the Penaeid Prawn Species automatically without the human intervention. The Prawn species are identified by human experts by examining its features. These methods are time consuming and are subjected to errors. In this work the shape and texture features are extracted from the prawn images. The features extracted from the prawn images are then classified using support Vector Machines. Support Vector Machines(SVM) have the capability of high approximation and quicker convergence. The experiment was conducted on two species of Prawns which consisted of 200 samples of each. The system was able to recognize two species of prawns with an accuracy of 95%.

Keywords: SVM, Feature extraction, Penaeid, Prawn, Species.

Introduction

Prawns are among the most popular types of seafood. There are so many prawn species which are distributed world-wide. Freshwater prawn farming is an aquaculture and agriculture business mainly raised to produce freshwater prawns for the consumption of humans as well as decorative intent. The different types of penaeid prawns are Penaeus monodon, Penaeus Indicus, Vannamei etc. The various species belonging to Penaeus are found both in steamy and moderate latitudes. Practically some of the species are marine and some spend their life in both fresh water and brackish water. Among the twenty eight species of the genus, eight species are represented in Indian waters are P. Japonicus, P. Indicus, P. latisulcatus, P. canaliculature, P.monodon, P. semisulcatus, P. merguiensis and P.Vannamei. The Indian prawns belong to three major families, namely Sergestidae, Penaeidae, and Palaemonidae. With the increase in demand for seafood, the marine aquaculture is one of the growing industries in the world[1]. Different types of prawns are available in brakish water and fresh water. The penaeid prawn species include Penaeus Monodon, and Vannamei in our work. At present the sorting of prawns by species is done by hand and it is a labour intensive slow work and a more assessment is required. Sorting into single species the man handling capacity is very high because the sorters take very long time to decide. When they try to sort in a quicker manner mistakes increases. 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[2] Therefore when we have to sort different species the obvious thing is need for automation. So there is a requirement for automation to reduce the labour. 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. In order to classify the prawn species SVM classifier is used.

Related Work

BZion et al developed a technique to sort the fish that grows in a pond according to species and size. An image processing algorithm based on the method of moment invariants used for the discrimination between the images of three fish species[3]. Frank et al describes a system to recognize species of fish by using computer vision and neural network based on features extracted like heights and widths at different areas of the fish[4]. Ling PP et al have introduced the machine vision system for the removal of the shrimp heads. Different features of the shrimp are examined for the identification of the optimum location for the removal of heads. It includes features like carapace length to total length ratio, carapace width to carapace length ratio and the difference between the shrimp head and tail[5]. Harbitz developed an image analysis technique which is used to estimate the length of carapace of shrimp automatically[6]. Muttasem at el have proposed a fish recognition system by neural Networks which employs back propagation training algorithm for sorting fish species[7].

Materials and Methods:

The Research work was done using the following computer hardware specifications:

1. CPU Intel Core, 2.3 GHZ
2. Hard disk with 600 GB.
3. Memory DDR3 4GB
4. MATLAB 2011 for the development of the application.

At First the system starts with the user by taking a prawn images with a digital Camera. Then the images of prawn are entered into the computer for identification.

The system compares each prawn image with all the prawn images available in the database of the system. Then the system displays the results of recognition of the type of species as shown in the fig1.

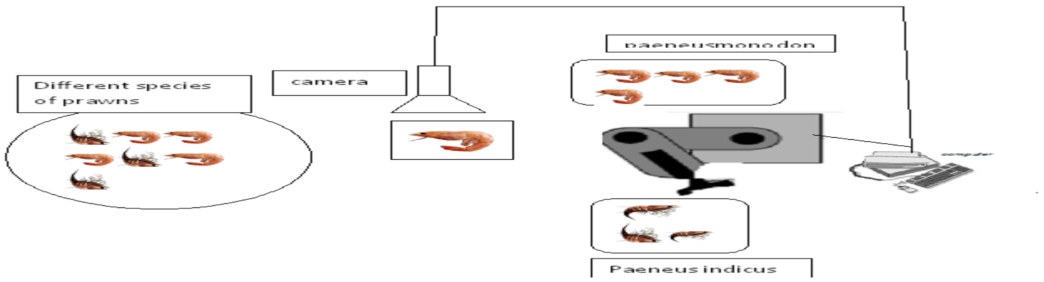

Figure 1: Automatic Classification

Methodology

The objective of this system is the classification of the Penaeid Prawn Species based on the patterns in the image. The classifier used in this work is Support Vector Machine.

Image Acquisition

This module takes the Penaeid prawn images from the top view angle. The first stage of any system is image acquisition stage. Various Penaeid Prawn samples of penaeus Monodon and Vennamei are collected from ponds, hatcheries, harbors and Ports. Prawn images are captured using a camera. More than 20cms distance is maintained between camera and the Prawns shown in fig2. Two species of Penaeid Prawns are considered for the work.

Figure 2: Image Acquisition

Image Preprocessing

The Image preprocessing consists of the following :

1. Image resize
2. Conversion of color images to Gray scale images.
3. Noise Removal and
4. Normalization

Image Resize: The prawn image which is given as input is resized to 256 x 256 pixels. This is done to maintain consistency and to reduce the time of processing . The original image and resized image are shown in fig.3

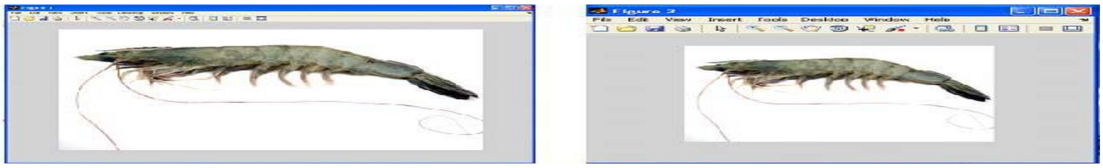

Figure 3: a) Original image b)Image Resized

Gray Scale Conversion: After resizing the image the prawn image is converted into gray scale image as shown in Fig.4.. The value range of gray scale level is 0-255. RGB to Gray converts RGB values to grayscale values by a weighted sum of the *R*, *G*, and *B* components using 0.2989 * R + 0.5870 * G + 0.1140 * B.

Figure 4: a) Original Images b) Gray Scale Images

Noise Removal : The image usually contains unwanted parts, dust and noise. So noise has to be removed from the images. In addition the system also fill open area if an in the object. Image enhancement is done using this process. For this image Dilation process is used.

Normalization: Normalization is done on all images to maintain the pixel intensity uniform.

Feature Extraction

At first set of features has to be extracted. For each prawn features are to be found which can be differentiated. Feature extraction refers to the dimensionality reduction of that object. In this work shape and texture features are considered. The prawn images are represented by a set of numerical features. The main goal of feature extraction is to characterize the images to be recognized by the measurements whose values are likely similar for those that belongs to the same class and different for those in different class. The classifier uses these data to classify the species. Shape and Texture features are extracted for every database image and also query image.

A) Shape Feature Extraction

Shape feature is used to describe content of an image. In order to extract the shape features of an image, Edge detection is used. In this work for the prawn images Canny Edge Detection algorithm is used for detecting the edges[8]. The shape feature database was constructed for the image data set. The canny algorithm is described as:

Step1: Smoothing the image with a two dimensional Gaussian. The computation is shown in the following equation.

$g(m,n)=G\sigma(m,n)*f(m,n)$

Where $G\sigma = \frac{1}{\sqrt{2\pi\sigma^2}} \exp\left[-\frac{m^2+n^2}{2\sigma^2}\right]$

Step 2: Computation of Gradient: The gradient of the image showing changes in the intensity is taken. It indicates the presence of the edges in two directions. That is the gradient in the x direction and gradient in y direction.

Gradient g(m,n) is calculated by using

$M(m,n) = \sqrt{g^2m(m,n) + g^2n(m,n)}$ and

$\theta = \tan^{-1}\left[\frac{gn(m,n)}{gm(m,n)}\right]$

Step3: Non-Maximal suppression: The edges will occur at some points where the gradient is maximum.

Step 4: Threshold of edge: uses high threshold and low threshold.

Threshold M is

$$Mt(m,n) = \begin{cases} M(m,n) \\ 0 \end{cases} if\ M(m,n)T\ otherwise\ 0$$

Step5: Using Interpolation for finding the pixels where the norms of gradient are local maximum.

The results obtained after applying the canny edge detection algorithm are shown in the fig. 5 and the features are being stored in feature database to feed as input to the SVM classifier.

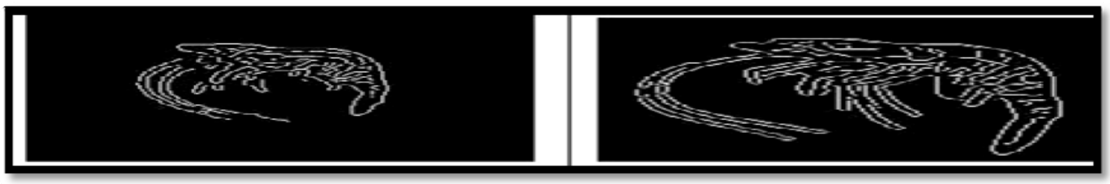

Figure 5: Canny Edge Detection

B) Texture Feature Extraction

Texture is very important feature that can be extracted from natural images. In this work Gabor filter is used to extract texture features from the prawn images [9] . The Gabor filters are defined as a group of wavelets, where each wavelet captures energy at a specific frequency and also in specific direction. The 2-D Gabor function can be specified by the frequency of the sinusoid W and the standard deviation σ_{x} and σ_{y}, of the Gaussian envelope as:

$$g(x,y)= \frac{1}{2\pi\sigma_x\sigma_y} \exp(-\frac{1}{2}(\frac{x^2}{\sigma_x^2}+\frac{y^2}{\sigma_y^2})+2\pi jWx) \quad (1)$$

$$g_{mn}(, ,y) = a^{-m}.\ g(\tilde{x},\tilde{y}) \quad (2)$$

Where m, n are integers which specifies the scale and orientation. And

$$\tilde{x} = a^{-m}(\ x\cos\theta + y\sin\theta\ ) \quad (3)$$

$$\tilde{y} = a^{-m}(-x\sin\theta + y\cos\theta\ ) \quad (4)$$

Where a >1 and $\theta = 2\pi/N$.

Gabor filters when applied on the image with different orientation at different scale, .

$$\mu_{mn} = \frac{E(m,n)}{P\ X\ Q} \quad (5)$$

$$\sigma_{mn} = \frac{\sqrt{\Sigma_x\Sigma_y(|G_{mn}(x,y)|-\mu_{mn})^2}}{P\ X\ Q} \quad (6)$$

The main purpose of is to find out the images or regions with same texture. Therefore the mean μ_{mn} and standard deviation σ_{mn} are used to represent the homogenous texture feature of the region. A feature vector F is created using μ_{mn} and σ_{mn} as the feature components. When Gabor filter is applied on prawn images the results are shown in fig. 6.

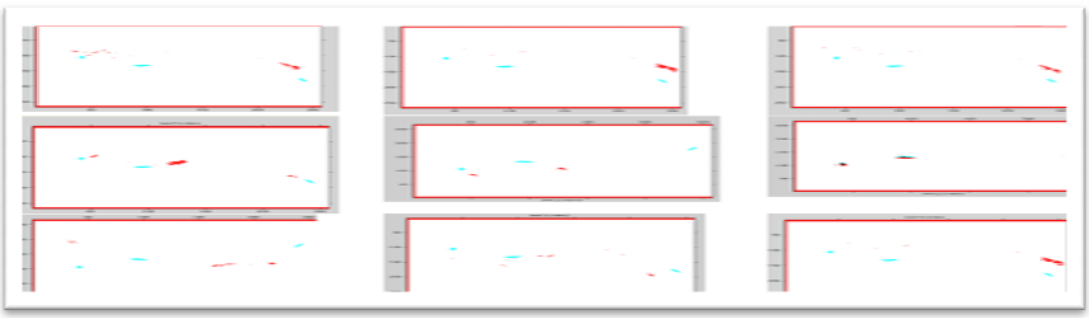

Figure 6: Gabor Filtered Images For Texture Features

Support Vector Machine:

Support vector machines are supervised learning models which are associated with the learning algorithms which analyze the data and can recognize the patterns which can be used for classification. It is a Robust technique for data classification. The idea behind SVM is to separate the given data in an optimal manner. Given a set of training samples each marked as belonging to one of two classes, Support Vector Machine maps the features non-linearly into n dimensional feature space when provided with a feature set represented in the space. It does the Binary classification.

In SVM inputs being given are in the form of the scalar products. An attribute in SVM is called as a predictor variable and the feature is a transformed attribute[10]. The features matrix define the hyper plane. Hyper plane is being constructed by the SVM to separate vector clusters with a class of features on one side of the plane and with different features on the other side. The margin represents the distance between hyper plane and support vectors. SVM analysis tries to positions the margin in such a way that space between it and support vectors are maximized. Fig.7 shows the overview of the SVM process.

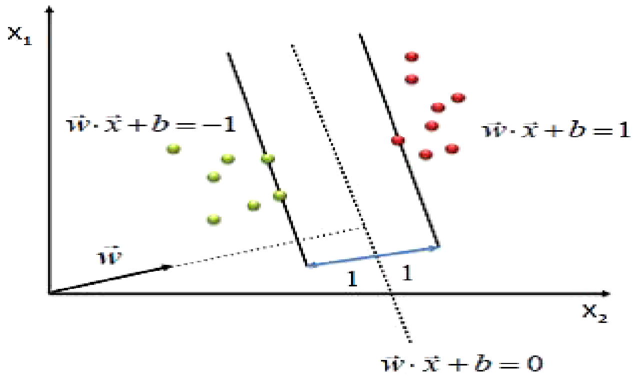

Figure 7: Support Vector Machine

Design of SVM

1.Hyperplane as the decision surface[11] is shown as

$$\sum_{i=1}^{N} \alpha_i d_i K(x, x_i) = 0 \quad (1)$$

Where $K(x,x_i) = \varphi^T(x)\varphi_1(x)$ Represents the inner product of two matrices in the feature space by input matrix a and inputs a_i.

Where W= $\sum_{i=1}^{N} \alpha_i d_i \varphi(x_i)$ (2)

$$\varphi(x) = [\varphi_0(x), \varphi_1(x), \ldots, \varphi_{m_1}(x)]^T \quad (3)$$

$\varphi_0(x)$=1 for all x.

The function of the kernel is selected as polynomial learning machine

$$K(x, x_i) = (1 + x^T x_i)^2 \quad (4)$$

The lagrange multipliers { } for I =1…N that maximize the objective function P( ) denoted by ---- is determined.

$$Q(\alpha)\sum_{i=1}^{N} = \alpha_i - \frac{1}{2}\sum_{i=1}^{N}\sum_{j=1}^{N} \alpha_i \alpha_j d_i d_j K(x_i, x_j) \quad (5)$$

The constraints are as follows:

$$\sum_{i=1}^{N} \alpha_i d_i = 0 \text{ for i=1,2..N.} \qquad (6)$$

The linear weight vector W0 with respect to Optimum values of the lagrange multipliers are determined using the formula:

$$W_0 \sum_{i=1}^{N} \alpha_0,_i \, d_i \psi(x_i) \text{ where } W_0 \text{ represents the bias } b_0 \qquad (7)$$

Experiments and Results

The features like shape and texture extracted from the images are given as input to SVM classifier. The Research work is being carried out experimentally using the prawn database covering the two species of prawns from the natural scenes to digital images for the Research work. The database is carried in two categories namely ***Penaeus Monodon and Penaeus Vennamei***. 200 images of each category prawns are considered. The proposed system is implemented in MATLAB 7.11 by implementing the SVM Model. To design Front End a GUI environment is used as shown in fig.8. To perform the classification correctly large database is required. 200 samples of each species were collected and 140 images are used for training and the remaining 60 samples are used for testing phase.

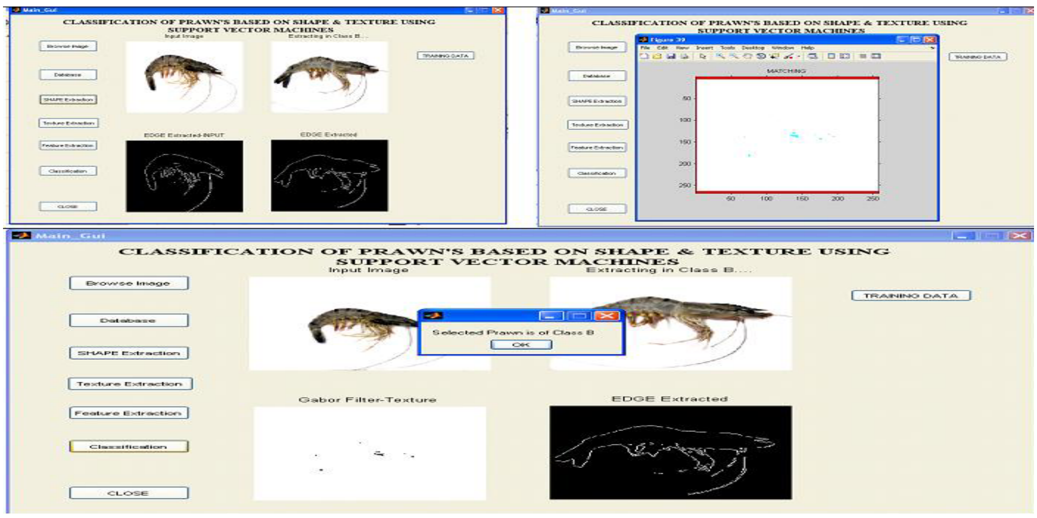

Figure 8: Classification of Prawn species

Results

The table.1 below shows the number of input images for both the training and testing phase and how many images have been classified and recognized correctly by using support Vector machines. 60 samples of. Monodon were tested 94% were classified correctly. In the case of vennamei 96% efficiency was there.

Table 1: Performance of The Proposed System

Prawn Species type	No of Prawn Samples tested	Efficiency
Penaeus Vennamei	60	96%
Penaeus Monodon	60	94%
Total Accuracy		**95%**

Conclusion

The system developed has been successfully applied to two species of prawns. The Performance of SVM when it is tested on the unseen data previously is very good. The proposed approach of using SVM classifier in the classification of Penaeid Prawn species gives a classification accuracy of 95% during training and 92% accuracy during test phase. The accuracy can be still improved by extracting more features and also increase the training database. The automatic classification system like this is inexpensive when compared to taxonomic categorizers. The advantage of the system is to reduce prawn samples analysis time, if done manually may take more time to analyze. This system would be reduced to very less time with computer based categorization using support vector machines. SVM works very well when the classification is with respect to two species of prawns, i.e when the problem is of binary classification. Classification must be generalized which allows categorization of more species of prawn which will helpful to the farmers of Aquaculture and agriculture.

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