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Texture Feature Extraction for the Classsification of Penaeid Prawn Species using Gabor Filter

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Abstract

Prawn Species Recognition is very essential as Prawn culture is expanding in particular because of high price and demand. Aquatic experts use manual methods for identifying various Penaeid Prawn Species. A Gabor wavelet classification method is used for the Prawn species recognition. Using Gabor wavelet the texture features mean and variance are extracted and classification is done based on Nearest Neighbour algorithm using Euclidean distance. The species recognition based on unique texture feature extraction is quick, simple and reliable and further will speed up the discovery of many Species yet to be named. The proposed approach identifies the species of the prawns without any expert. Three different species of Penaeid prawns each of 100 image samples were collected from various parts of Indian coasts and are experimented to prove that Gabor filter is comparatively better with good recognition rate. This technique is robust against rotations to some extent. The experimental results are reported to show that by using simple statistical features like mean, variance and Euclidean Distance as a measure, 93% of recognition rate has been achieved. As an improvement it would be remarkable to extract more statistical features from prawn images that does not increase the feature vector but affects the execution time.

Keywords: Feature Extraction, Gabor, Penaeid Prawn, Recognition, Species, Statistical Features

1. Introduction

The requirement of prawn species recognition system using computer vision and image processing techniques is increasing rapidly. The accurate recognition of prawn species is essential for the aquaculture based industries and it has numerous additional applications. Even though it is sufficiently more efficient and accurate algorithms are available, processing speeds still fail to meet new requirements of manufacturers[1]. In the recent years, Prawn species recognition has got more attention from researchers from different areas such as computer vision, biometrics, pattern recognition, image processing and neural networks. The different types of penaeid prawns species are *Penaeus indicus*, *Penaeus monodon* and *Penaeus vennamei*. Many features may vary among the different species of the prawn. The classification is made by analyzing the features of the prawn. The existing systems are away from the perception of the human system. To classify prawn species texture features are extracted. Texture is defined as a repetitive pattern in which the elements are kept based on a placement rule. The feature vector contains a set of numerical values derived based on rule that describes the texture. Rather than a point texture occurs over a region or an area. In this work Gabor Wavelet Classification method is introduced for the extraction of texture features in the recognition of various species of prawn. The processing of Penaeid prawn images by using Gabor filter technique is selected based on its biological relevance and also technical properties. The Gabor kernels are multi-scale and multi-orientated. The prawn images transformed by Gabor filter displays

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localized features.

2. Image Acquisition

The image acquisition is the action of retrieving an image from source and it is the first and the fore most step in the workflow sequence[4]. The images of various prawn species like *Penaeus indicus, Penaeus monodon and Penaeus vennamei* were taken from SONY 50X camera, keeping 20 centimeters distance in between prawn and camera. All the images were captured from the top view with white background. In this research work 100 image samples of each species of prawn of different sizes were taken even though more samples are collected and some of them are taken as test samples. These prawn samples are collected from various ponds, harbors, ports and aqua labs. Among the images acquired some samples are shown in Figure 1. After the acquisition of the images they must be preprocessed by using the Digital Image processing techniques. The main use of image preprocessing is to enhance the quality of the image being processed[9]. As it is very difficult to interpret the images of prawn species the image quality is to be improved and make the results more effective.

Figure 1. Images Acquired.

2.1 Image Preprocessing

In the preprocessing stage, gray scale conversion, image resize, noise removal and Normalization are done.

2.1.1 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 .

2.1.2 Gray Scale Conversion

After resizing the image the prawn image is converted into gray scale image. 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. The original and gray scale images are shown in Figure 2.

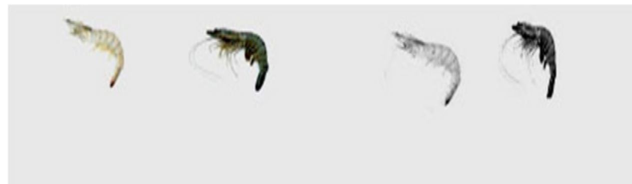

Figure 2. Original and Gray scale Images.

2.1.3 Noise Removal

The image usually contains unwanted parts, dust and noise. So noise has to be removed from the images.

2.1.4 Normalization

This is done on prawn images to maintain uniform pixel intensity.

3. 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. Texture features are extracted using Gabor filter. Texture features like mean and standard deviation are extracted[5].

3.1 Gabor Filter

Gabor filters are said to be group of wavelets where each wavelet captures energy at a particular frequency and in a specific direction[2]. The tunable property of orientation and scales of the Gabor filter makes it useful for the analysis of the texture features of the prawn image.

The two-dimensional Gabor Wavelets *g(x,y)* and The Fourier transform *G(u, v)* can be defined as follows[6-8]

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

W is the frequency of the sinusoidal plane along x-axis.

σ_x, σ_y are the space constants of the Gaussian envelope with respect to x and y axis respectively.

Let g(x, y) through generating function.

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

Where m and n are integers specifying the scale and orientation of the wavelets, respectively with, m=0, 1, 2……, M-1, n=0, 1, 2,…N-1, M and N are the total number of scales and orientations, respectively. And

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

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

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

The non-orthogonality of the Gabor wavelets implies that there is redundant information in the filtered images, and the following procedure is used to reduce the redundancy. Let lf and uf denote the lower and upper center frequencies of interest. Let O and S be defined as the number of Orientations and scales. This is designed to make sure half-peak magnitude support of filter responses touch each other in the frequency spectrum. The parameters of the filter σ_u and σ_y .

$$a = (uf / lf)^{-1/s-1} \quad (5)$$

$$\sigma_u = \frac{(a-1)uf}{(a+1)\sqrt{2\ln 2}} \quad (6)$$

$$\sigma y = \tan(\frac{\Pi}{2k})[uf - 2\ln(\frac{\sigma_u}{uf})][2\ln 2 - \frac{(2\ln 2)^2 \sigma_u{}^2}{uf^2}]^{-1/2} \quad (7)$$

For any image I(x, y) the Gabor wavelet transformation is given as

$$w_{mn} = \int I(x_1, y_1) g^*{}_{mn}(x - x_1, y - y_1) dx_1 dy_1 \quad (8)$$

The * is complex conjugate. Gabor wavelet transformation for the prawn images is computed at 5 orientation and 4 scales. In the implementation process, the following constants are commonly used $f_1 = 0.05$ and $f_h = 0.4$. The Gabor wavelet transformation is denoted by W_{mn} of the prawn. The Gabor filter when applied to prawn image is shown in Figure 3.

A Gabor feature matrix can be formed. For each element *Wmn*, from the feature vector, the features of prawn image like mean and variance are computed so called μ_{mn} and σ_{mn}. The best results are achieved if 4 scales and 5 orientations are used. The resultant feature vector is given as

$f = [\mu_{00}\,\sigma_{00}, \mu_{01}\,\sigma_{01}, \mu_{4.5}\,\sigma_{4.5,}]$ (9)

for every image of prawn 40 element feature vector.

In this research work a nearest neighbor classification with Euclidean distance is used[3]. If two prawn images are considered p and q, $f^{(p)}$ and $f^{(q)}$ are the features vectors. Then distance between two patterns of prawn in the feature space is given as:

$$d_{pq} = \sqrt{\sum_n \sum_m [(\frac{\mu_{mn}{}^p - \mu_{mn}{}^q}{\alpha(\mu_m)})^2 + (\frac{\sigma_{mn}{}^p - \sigma_{mn}{}^q}{\alpha(\sigma_{mn})})^2]} \quad (10)$$

where $\alpha(\mu_{mn})$ and $\alpha(\sigma_{mn})$ are the standard deviations over the entire database.

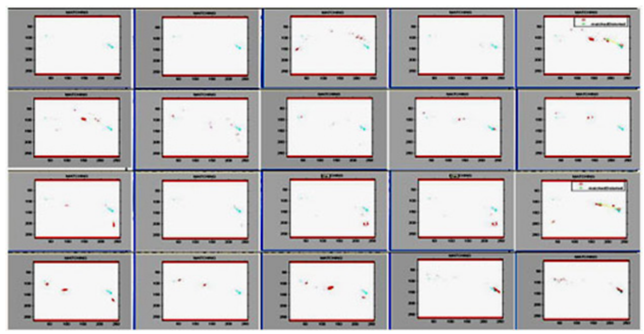

Figure 3. Gabor Filtered Images.

4. Results and Discussions

The Research work is being carried out experimentally using the prawn database covering the three species of prawns from the natural ones to digital images for the Research work. The database contains 300 images of three categories namely *P. monodon, P. indicus and P. vennamei.* 100 images of each category prawn species are considered. The proposed system is implemented in MATLAB 7.11 by extracted Gabor texture features. To define the ideal parameters of Gabor filter bank some parameters are changed and the database was reduced to 90 prawn images of different categories. 45 images are used for testing. The number of orientations and scales have been changed as shown in the Table 1. The recognition rate increases from 84% to 93%. If 4 scales and 5 orientations are exceeded there is no change in the recognition.

Table 1. Recognition rate

Sl. No.	Parameters	Misclassifications	Recognition rate(%)
1	S=2, K=4	7	84
2	S=3, K=4	5	88.8
3	S=5, K=6	3	93.3
4	S=6, K=7	3	93.3

Sometimes the size of the database also effects the rate of the recognition. The distances are compared, and the minimum distance corresponds to the same species of the prawn. For the values k=4 and S=6 the results obtained are shown in Table 2. From Table 2, it is very clear that, as the database size increases the recognition rate decreases.

Table 2. Recognition over database size

No. of images in dataset	Misclassifications	Recognition rate(%)
40	3	92.5
60	7	88.33
90	13	85.5

5. Conclusion

In this work a technique of Gabor Filter for extracting texture features is applied to the novel problem of Penaeid Prawn Species Classification. Gabor filter technique yields robustness against orientations and rotations. The recognition rate of 93% has been achieved by using very simple statistical features of texture such as mean and variances and a classification is done based on a metric such as Euclidean distance. Gabor filter has achieved a good classification accuracy. As a future work, more statistical features can be extracted from the filtered images so that execution time reduces and it would better classification accuracy. The database size can also be increased for better classification. Recognition rate must also be improved as the database size increases. This 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.

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