ISSN:0975-9646

G.T. Shrivakshan et al, / (IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 2 (6) , 2011, 2562-2567.

Detecting the Age of the Fish through Image Processing using its Morphological Features

G.T.Shrivakshan[1] , Dr.C. Chandrasekar [2]

[1] Department of Computer Science,
Swami Vivekananda Arts & Science college,
Villupuram, TamilNadu, India.

[2]Associate Professor, Department of Computer Science
Periyar University
Salem, TamilNadu, India

***Abstract*- This paper deals with detecting the age of the fish through its morphological features using image processing. The age of the fish is calculated with growth rate in body length. The length of the fish is being calculated using edged detection technology. In this paper it uses the edged detection algorithm, Sobel Filter and Gabor Filter. Gabor filter for texture, pattern extraction and geometrical shape feature extraction to find the fishes distinctive dark lines that mark the body and tail. The feature based scaling by which the length of the fish is calculated through which the age of the fish can be computed.**

Key words:
Image processing, Feature extraction, Edge detection, sobel filter.

I. INTRODUCTION

Beneath the sea there are unexplored area on earth, the underwater world has unlimited attraction to marine scientist. In this research, it tries to resolve the complexity in finding the age of fish through its morphological features. It uses the image processing [6][7] concept to extract the fish image. With the image of the fish it passes through several analysis to find the age of the fish, for which it uses edge detection technology followed by sober filter to compute the length of the fish and another method using Gober filter for texture, pattern extraction and geometrical shape feature extraction to find the fishes distinctive dark lines that mark the body and tail. In this paper the sample fish coilia ectenes taihuensis, the lake of China which is being taken for study. To compute the Length of the fish it uses the weight formula which is as follows.

$$W=6.430x10^{-6}xL^{2.8603}(r=0.9980) \qquad (1)$$

W=Weight
L=Length

The von Bertalanffy growth formulae [1][2] of the fish were determined to be:

$$L_t=349.3384(1-\exp(-0.354(t-0.0319))) \qquad (2)$$

$$W_{t=}121.0399[121.0399(1-\exp(-0.3549t-0.0319))]^3 \qquad (3)$$

W_t=Body Weight at age t
L_t=Body length at age t.

The growth rate of the body length decreased gradually with increasing age. The acceleration of growth rate was positive from age 1 to 3.1 years, thereafter was negative. From this we can identify the age of the fish by its length feature correspondingly its weight also. To detect the length of the fish, in this paper it uses the edge detection technology, calculate the tip of the head to the pectoral fin and followed by the distance between the pectoral fin to dorsal fin then dorsal fin to tail which gives the length of the fish through which it can calculate the age of the fish. The paper describes the techniques to extract the morphological features of the fish through the video image processing [8][9], the fish features are obtained. A new technique called oblique projection segmentation has been developed that extracts particular features of the fish.

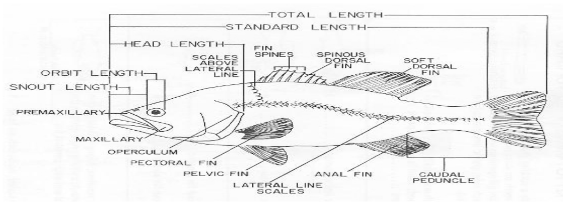

Fig 1: Depicting the length of the fish through its morphological features (fins)

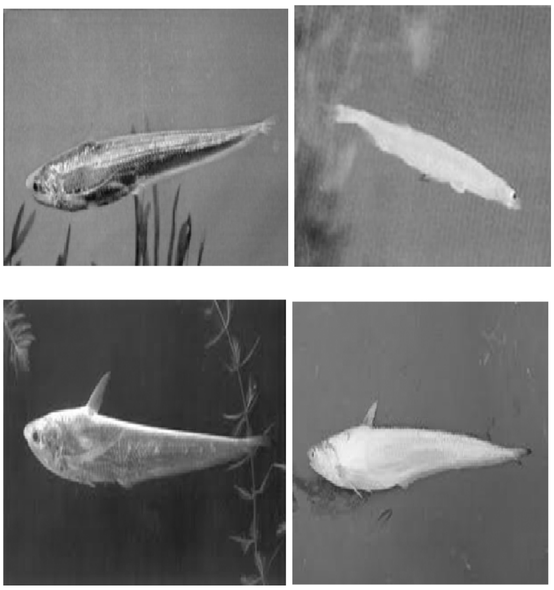

Fig 2: Different images of coilia ectenes taihuensis fish

II. METHODOLOGY

A. Image processing algorithm:

Edge detection algorithm

There are many ways to perform the edge detection. However, the most may be grouped into two categories, gradient and Laplacian. The gradient method detects the edges by looking for the maximum and minimum in the first derivative of the image. The Laplacian method searches for zero crossings in the second derivative of the image to find edges. This edges of an image detected using the gradient method (Roberts, Prewitt, Sobel) and the Laplacian method (Marrs-Hildreth). It can then compare the feature extraction using the Sobel edge detection using the Laplacian. It seems that although it does do better for some features (i.e.the fins), it still suffers from mismapping some of the lines. A morph constructed using individually selected points would still work better. It should also be noted that this method suffers the same drawbacks as mismapping. The difficulties are due to large contrast between images and the inability to handle large translation features. Another method of detecting edges is using wavelets. Specifically a two-dimensional Harr wavelet transform [3] of the image produces essentially edge maps of the vertical, horizontal and diagonal edges in an image. Although the Haar filter is nearly equivalent to the gradient and Laplacian edge detection methods, it does offer the ability to easily extend our edge detection to multiscales as demonstrated. Generally the threshold value [10] has to be randomly chosen but to overcome this limitation in this paper, it formulates a new method for finding the initial threshold value [10]. In this algorithm instead of choosing a random value as threshold which may not lead to the right prediction, in this paper it proposes a new way of taking the threshold value as one of the edge pixel which has the high intensity that is more advantages in edge detection technology.

B. Algorithm for finding the threshold value in the Wavelet Transformation:

1. An initial threshold (T) is chosen, this can be done by taking one of the edge pixels which has high intensity.
2. The image is segmented[5] into object and background pixels as described above, creating two sets:
   a) G_1 = {f(m,n):f(m,n)>T} (object pixels)
   b) G_2 = {f(m,n):f(m,n)≤ T} (background pixels) (note, f(m,n) is the value of the pixel located in the m^{th} column, n^{th} row)
3. The average of each set is computed.
   a) m_1 = average value of G_1
   b) m_2 = average value of G_2
4. A new threshold is created that is the average of m_1 and m_2
   a) T' = $(m_1 + m_2)/2$
5. Go back to step two, now using the new threshold computed in step four, keep repeating until the new threshold matches the one before it (i.e. until convergence has been reached).

This iterative algorithm is a special one-dimensional case of the enhanced k-means clustering algorithm, which has been proven to converge at a *local* minimum—meaning that a different initial threshold *may* give a different final result. In this wavelet algorithm it imposes multi-threading concept which is the modification concept that is done in the existing algorithm to identify the coilia ectenes taihuensis fish in this work. The Wavelet transformation is being applied in the sample coilia ectenes taihuensis fish.

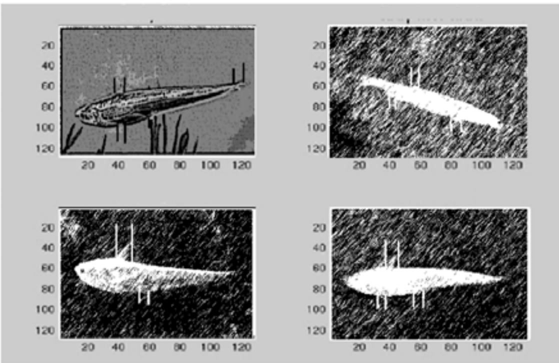

Fig 3: Vertical Sobel Filter

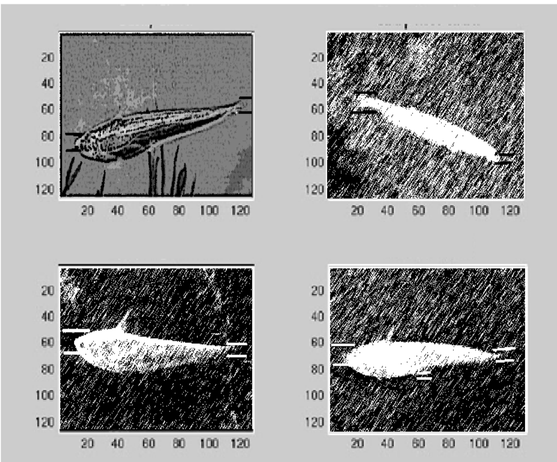

Fig 4: Horizontal Sobel Filter

In the fig 1 & 2, it is clearly able to distinguish the various morphological features of the fins especially the head, pectoral fin, dorsal fin and tail fin. The length of the fish can be computed using the various horizontal and vertical Sobel filters. In this paper it also adopts another methodology for finding the length of the fish using image scaling. This section describes the vision processing algorithm . The algorithm combines a series of existing filters commonly found in the vision literature, with a new segmentation filter called Pattern Extraction (see Fig. 5).

C. Image Grading

To reduce computation, the input original color images are converted to grayscale and the pixel values are limited in the interval (0,1). Due to underwater light limitations, images are underexposed and blurry. The poor contrast forces grey values to concentrate into a small range. To remedy this, intensities are adjusted linearly to maximize the range, and histogram equalization method is used to stretch contrast so that all grey-levels have similar likelihoods, (see Fig. 6).

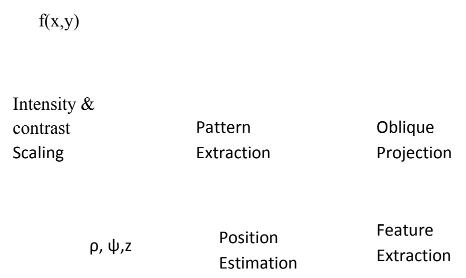

Fig 5: Image Processing System

D. Pattern Extraction by Gabor filter

Pattern Extraction is the problem of breaking an image into components within which the texture is constant. In this case, the target fish's tail and body consist of obvious and regular orientation stripes. To extract these features, a single oriented Gabor filter of spatial-frequency is proposed. The method is not only effective in extracting the patterns, but is efficient since only a single texture extraction filter is required. The Gabor filter is orientation selective. Its kernels are Fourier basis elements that are multiplied by Gaussians, meaning they respond strongly at image points where there are components that locally have a particular spatial frequency and orientation. If $s(x,y)$ is a complex sinusoidal known as the carrier, and $w_r(x,y)$ is a 2-D Gaussian-shaped function known as the envelope, the Gabor filter is a complex function $g(x,y)$:

$$g(x,y) = s(x,y) \times \omega_r(x,y) \quad (4)$$

The sinusoidal is defined in terms of the spatial frequencies (u_0, v_0) and the carrier phase P as follows.

$$s(x,y)= exp(j2\pi(u_0x + u_0y)+P) \quad (5)$$

The Gaussian envelope is defined in Eq. 3, where K scales the envelope magnitude, (a,b) scale the envelope axis, θ defines the envelope rotation angle, and (x_0,y_0) defines the peak location of the envelope.

$$\omega_r (x,y)=K\, exp\, (pi(a^2(x-x_0)^2r + b^2(y-y_0)^2r)) \quad (6)$$

Note that the subscript r represents a rotation operation such that:

$$(x-x_0) = +(x-x_0)cos\theta + (y-y_0)sin\theta$$

$$(y-y_0) = -(x-x_0)sin\theta + (y-y_0)cos\theta \quad (7)$$

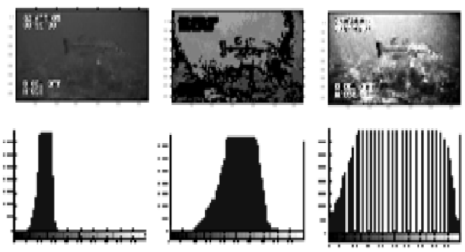

Fig 6: Images and related bars (a) original images, (b) intensity gradient image, and (c) the contrast sealed image.

Each complex Gabor consists of two functions in quadrature (out of phase by 90 degrees), conveniently located in the real and imaginary parts of a complex function. Now we have the complex Gabor function in space domain. The 2-D Fourier transform of this Gabor is as follows

$$T = exp\, (j\, (2\pi\, (u_0x + v_0y) + P$$
$$g(x, y) = K\, exp\, (-\pi\, (a^2(x-x_0)^2r + b^2(y-y_0)^2r))T \quad (8)$$

$$T1 = exp\, (-\pi\, (((u - u_0)^2r)/a^2) + ((v - v_0)^2r)/b^2)$$
$$T2 = J\, (-2\, \pi(x_0(u - u_0) + y(v - v_0) + p))\, exp\, T1$$
$$g\, (u,v) = k/ab\, exp\, T2 \quad (9)$$

The Gabor filter is used as a kernel to convolve with the input image $I(x,y)$, input image to produce:

$$imagabout(x,y) = l(x.y) \otimes imag(g(x,y))$$
$$regabout(x,y) = l(x,y) \otimes real(g(x,y)) \quad (10)$$

By applying the Gabor filter, the majority of the fish and its local background are removed except for the tail and body features. This establishes a good basis for the following feature projection segmentation which will be useful in finding length of the fish.

E. Oblique Projection Segmentation

In this step of the vision processing, the body and tail features are extracted from the remaining back-ground. After the image is processed by the Gabor Filter, a threshold is applied to force pixels to take on values of 0 or 1. In observing the resulting image (see Fig. 7 a), only the fish tail pattern, body center pattern, and some background patterns (i.e. under-water grass) remain. The fish patterns have limited overlap with the background. Projecting the threshold image into a vertical histogram Hv(y) i.e. summing the number of black pixels in each row of the image, results in two separate shapes. The first is the background curve with no defining shape. The second is a sharp and narrow spike protruding from a smooth and low curve. This second shape is a projection of the tail and body features, (Fig. 7 b). With this histogram, a search for the tail and body patterns is conducted to produce an interval of rows in which the fish is located. If A is a predetermined threshold that characterizes the tail width, the tail interval is defined as rows belonging to $[Y_{tailstart}, Y_{tailstop}]$ such that a scan from the top of the image produces:

$$Y_{tailstart} = max\, (y|H_v(y) > A) \quad (11)$$

$$y_{tailstop} = max\, (y|H_v(y) < A,\, y < y_{tailstart}) \quad (12)$$

The peak within this interval is determined by:

$$y_{max} = max\, (y|y \in [y_{tailstart},y_{tailstop}]) \quad (13)$$

If the slope of the histogram within intervals $[y_{max}- \delta, y_{max}]$ and $[y_{max}, y_{max}+\delta]$ have magnitudes less than m_{min}, it is determined that the fish tail feature is found. If the slope conditions are satisfied, rows outside the interval $[y_{tailstart},y_{tailstop}]$ are subtracted from the image, effectively eliminating background in the top and bottom portions of the image, (see Fig. 7c). In a similar fashion, the image is projected into a horizontal histogram $H_{h(x)}$, i.e. summing the number of black pixels in each column of the image. The tail pattern dominates the histogram with an obvious spike. The body pattern is also evident as a region of constant amplitude adjacent to the tail spike. In this case, a search for these two features is conducted to define an interval of columns in which the fish resides. Columns outside this interval are subtracted to remove background on the two sides of the fish,(see Fig. 7d). What remains is an image with only the tail and body features.

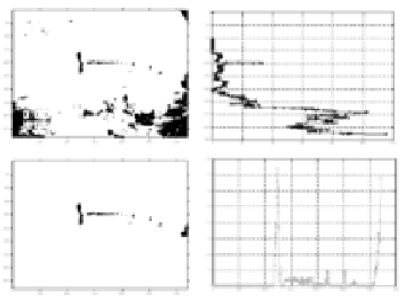

Fig 7: Oblique Projection Segmentation: (a) Image after Gabor filter and threshold. (b) The vertical projection curve, (c) the image after subtracting top and bottom background, and (d) the horizontal Oblique projection.

F. Feature Extraction

In this stage of the image processing, the remaining black pixels of the image are modeled with two lines, one representing the tail feature and one representing the body feature. These two lines are later used to describe the position and orientation of the fish. The leftmost and the right-most pixels $(U_1(i),V_1(i))$, $(U_2(i),V_2(i))$ are determined for each row in the tail interval. The central points $(U_0(i),V_0(i))$of the tail are defined as follows:

$$U_0(i) = (U_1(i) + U_2(i))/2 \qquad (14)$$

$$V_0(i) = (V_1(i) + V_2(i))/2 \qquad (15)$$

Fit a straight line to the tail. A similar process is used to find the body's central line through which the length of the fish is calculated.

G. Results and Analysis

From the above algorithms the length of the Coilia ectenes taihuensis fish [5] is being computed which is tabulated in Table1

Table 1. True, back calculated and theoretical body length(mm) of Coilia ectenes taihuensis by age (years)

Age	1	2	3	4	5
The body length	102	179	230	272	284
Back calculated length	103	176	226	268	289
Theoretical body length	101	175	227	264	289

The graph depicting the age of the fish relative to its length:

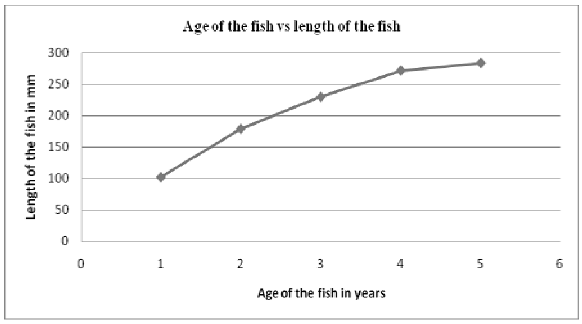

Fig 8: The figure gives the relation between the age and length of the fish

From the above explanation the age of the fish is predictable through the image processing algorithms.

CONCLUSION

This paper describes a system for finding age of the fish from its image. The core of the paper focuses on finding the length of the fish with its morphological features an efficient image processing algorithms are used to extract the length of the fish are edge detection algorithms mainly sober vertical filter and horizontal filter. Another algorithm for finding the length of the fish is gober filter which uses relative position of the fish. The algorithm uses a Gabor filter to extract texture, a new filter called Oblique projection segmentation to remove background, The length of the fish is calculated by the above two methods. From the length of the fish, the age of the fish can be calculated. The limitation is the while the uncertainty in fish size and feature lengths decreased the accuracy of relative range estimation. Despite the success in finding the length of the fish over several images, the algorithm has several limitations. It is assumed that only one fish be present in each frame.

REFERENCES

[1] Bertalanffy, L. von 1938. "A quantitative theory of organic growth (Inquiries on growth laws. II)". Human Biol. 10: pp.181-213.

[2] Bertalanffy, L. von 1960. *"Principles and theory of growth. In Fundamental aspects of normal and malignant growth"*. Pp 137-259. W. W. Nowinski ed. Elsevier, Amsterdam.

[3] David Stanhill and Yehoshua Y. Zeevi, "*Two-Dimensional Orthogonal Filter Banks and Wavelets with Linear Phase",* IEEE transactions on signal processing, vol. 46, no. 1, january 1998. Pp 183-190

[4] Pierre-Louis Bazin, Dzung L. Pham, "*Topology correction of segmented medical images using a fast marching algorithm"*, Computer Methods and Programs in Biomedicine, November 2007, volume 88, issue 2, pp182-190.

[5] QI-QUN CHENG and DA-RULU, "*PCR-RFLP "Analysis of cytochrome b gene does not support Coilia ectenes taihuensis being a subspecies of Coilia ectenes".* In Indian Academy of Sciences. Journal of Genetics, Vol. 84, No. 3, December 2005 pp.307-310

[6] Rafael C. Gonzalez, and Richard E. Woods, "*Digital image processing"*, Pearson-Prentice Hall, 2005.

[7] Raman Maini Dr. Himanshu Aggarwal , "*International Journal of Image Processing (IJIP)"*, Volume 3, Issue 1, 2002, pp1 to 12.

[8] Rife J, "*Automated robotic tracking of gelatinous animals in the deep ocean". PhD thesis, Stanford University, Stanford,California,*, December,2003.

[9] Ritendra datta, dhiraj joshi, jia li, and james z. Wang , "*Image Retrieval: Ideas, Influences, and Trends of the New Age*" The Pennsylvania State University ACM Computing Surveys, Vol. 40, issue 2, Article 5, Publication date: April 2008, pp 1-60.

[10] Terzija Nataša, Geisselhardt Walter, "*Robust digital image watermarking based on complex wavelet transform"*, Proceedings of the 9th WSEAS International Conference on Communications, July 14-16, 2005, Athens, Greece, pp1 to 6.