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A Combined Graph and Texture Based Approach for Recognition of Animal Contour Images of MPEG-7 Database

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Abstract

Animal image recognition, classification and retrieval from a database based on shape features are of research interest in image processing. This paper proposes a combined graph and texture based approach for recognition of animal contour images. The methodology uses texture features of the complete graph image obtained from the contour of an object. MPEG-7 database is used for testing. The recognition accuracy of 96% is achieved and is an improvement over the state-of-the-reported results. The work has potential applications in image retrieval from databases.

Keywords: *Animal Recognition, Graph and Texture Combined, Shape Classification, Animal Contour.*

1. Introduction

Image Processing forms a core research area in computer science and engineering disciplines. Object recognition and classification is a major field in Image Processing. The objects are recognized by their shapes, textures, colors, contours and many other attributes. Shape is one of the primary low level image features explored in content based image retrieval. Generally there are two types of shape representation methods, namely, the region based and contour based methods. The contour based methods explore only the shape boundary information. There are two types of contour shape modeling: conventional and structural. In the conventional approach, it treats the boundary as a whole, and a feature vector derived from the whole boundary is used to describe the shape. But in the structural approach, it breaks the shape boundary into segments, known as primitives, using certain criterion. The final representation is usually a string or a tree, and the measure of shape similarity is string matching or graph matching.

We have considered contour-based shape recognition, because attention is given to contour while recognition, in addition to other features. We have considered equidistant points on the contour in order to draw a complete graph and apply GLCM technique to obtain texture features. An artificial neural network with backpropagation learning is adopted for recognition of contours of animals taken from MPEG-7 shape database. The MPEG-7 shape database consists of 1400 silhouette images and is grouped into 70 classes with 20 objects per class. Some sample images of MPEG-7 database are given in Figure 1.

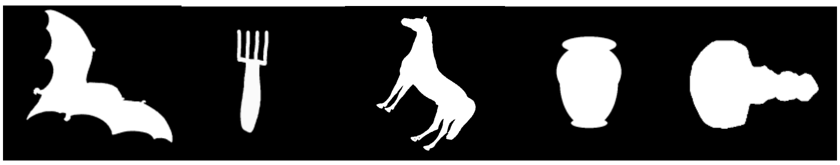

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Figure 1. Some Sample Images of MPEG-7 Database

It is a multimedia content description standard. It was standardized in ISO/IEC 15938. This description is associated with the content itself, to allow fast and efficient searching for material of interest to the user. MPEG-7 is also, formally, called Multimedia Content Description Interface. Most of approaches used in this field try to find the correspondence between contour points across one in the knowledge base and another under test. This type of approach is not only time-consuming but also missing correspondences.

The rest of the paper is organized as follows. Section 2 presents the survey carried out related to the proposed work. In Section 3, methodology adopted is explained in detail. The experiments have done on MPEG-7 database and results are discussed in Section 4. Finally, Section 5 gives conclusion of the work.

2. Literature Survey

In order to know state-of-the-art in contour based recognition, we have carried out a literature survey and following is the gist of the cited papers related to the work carried out.

Zhiyang *et. al.,* [2012] have defined a new 2D descriptor, which is invariant to geometric transformations, such as translation, rotation and scaling. Extensive experiments are performed on several public databases including MPEG7 CE-shape-1, Kimia and ETH-80 databases. The experimental results were found to be better and more suitable for the BOW (Bag-of-Words) framework than context based descriptors.

Junwei Wang *et. al.,* [2011] have worked on a novel descriptor for shape matching and recognizing 2D object silhouettes using the height function. It provides a good discriminative power, which is demonstrated by observed retrieval performances on several popular shape benchmarks that include MPEG-7 data set, Kimia's data set and ETH-80 data set. From the observed experimental results, this method was found to be effective under both geometric transformations and nonlinear deformations.

Dengsheng Zhang *et. al.,* [2003] have given the two shape descriptors and they have evaluated against other shape descriptors and also each other. More specially, they have used standard databases, large data sets and query sets, commonly used performance measurements and guided principles. The results revealed that Fourier descriptor (FD) outperforms Curvature Scale Space descriptor (CSSD) that CSSD could be replaced by either FD or Zernike moment descriptor (ZMD).

Mohammad Reza Daliri *et. al.,* [2010] have proposed a method for shape recognition based on the edit distance between pairs of shapes after transforming them into symbol strings and it is invariant to similarity transforms. This method is tested on a variety of shape databases including Kimia-99, Chicken Pieces, Natural Silhouettes, Gesture database, Marine database, MPEG-7 shape database and ETH-80 object database. Experimental results over a variety of shape databases have shown that the proposed approach is suitable for shape recognition.

Serge Belongie *et. al.,* [2002] have presented an approach for measuring similarity between shapes and exploit it for object recognition. In this approach, the measurement of similarity is preceded by (i) solving for correspondences between points on the two shapes, and (ii) using the correspondences to estimate an aligning transform. The dissimilarity between the two shapes is computed as a sum of matching errors between corresponding points. Results are presented for silhouettes, trademarks and handwritten digits.

Tae-Kyun Kim *et. al.,* [2004] have carried out a work on face description for facial image retrieval from a large data base and for MPEG-7 (Moving Picture Experts Group) standardization. The novel descriptor obtained by decomposing a face image into several components and then combining the component features. The decomposition combined with LDA (Linear Discriminant Analysis) provides discriminative facial descriptions. The experimental results obtained on the MPEG-7 data set shown an impressive accuracy of algorithm as compared with other methods including conventional PCA (Principal Component Analysis), ICA (Independent Component Analysis), LDA methods and the previous MPEG-7 proposals.

Manjary P.Gangan *et. al.,* [2012] have introduced an automatic image annotation method using MPEG-7 features on fruit images. This method is just a prototype for implementation of automatic image annotation using a fruit image database. The feature vectors are provided for training the KNN-classifier. A comparison of annotation results are made by taking different number of MPEG-7 feature descriptors.

Manimala Singha *et. al.,* [2012] have done work on the content based image retrieval using features like texture and color called WBCHIR (Wavelet Based Color Histogram Image Retrieval). The texture and color features are extracted through wavelet transformation and color histogram. The experimental results revealed that the proposed method outperformed the other retrieval methods in terms of average precision. The whole indexing time for the 1000 image database is 5 to 6 minutes.

Pranali Prakash Lokhande *et. al.,* [2012] have proposed an efficient image retrieval technique, which uses dynamic dominant color, texture and shape features of an image. This method is based on GLCM (Gray Level Co-occurrence Matrix). They have considered edge orientation over all pixels as texture, but edge orientation only on region contours gives shape information.

Kalpana Saini *et. al.,* [2010] have carried out a work on ultra sound image segmentation in the area of ultrasound. This method discussed the ultrasound image segmentation methods, in broad sense, focusing on techniques developed for medical. They have presented basic methods of image segmentation and forming of ultrasound images.

Mamatha Hosalli Ramappa *et. al.,* [2012] have proposed skew detection, correction and segmentation of handwritten Kannada document. In this method they have used bounding box technique for the skew detection and correction and Hough transform and contour detection for segmentation of document into lines and words respectively. This method was tested on totally unconstrained handwritten Kannada scripts. Finally they have got 91% of line segmentation rate and 70% of word segmentation.

Sangita Bhataacharjee *et. at.,* [2014] have done work on review on histopathological slide analysis using digital microscopy. This method was presented a systematic survey of the algorithms used in automated cancer diagnosis based on histopathology. The various computational processes were involved like pre-processing, feature extraction, post-processing and diseases detection.

Zhao Lei *et. al.,* [2014] have carried out a work on research on the wood cell contour extraction method based on image texture and gray-scale information. This work mainly carried out with the wood slice microscopic cell images as the research objects. They have used the traditional snake, gray-scale information and green’s formula for transformation. Finally they have proved that presented method performs better in adaptability and robustness.

Wang Shu-zhong *et. al.,* [2013] have proposed an improved normalization method for ear feature extraction. In this method they have applied the improved morphological filtering method to preprocessing the ear image and the angle normalization method by geometrical parameters. Advantages of this method were scaling invariance, translation invariance and rotation invariance. They have got the results were reasonable and good for later feature extraction.

Xu Chuanyun *et. al.,* [2014] have done a work on cell contour irregularity feature extraction methods based on linear geometric heat flow curve evaluation. In this work they have introduced the heat flow curve of linear geometric evaluation method of cell contour, and then gave two irregular metric indexes: the total area ratio of non overlapping area and the average area ratio of non overlapping area ratio. Finally classification ability of these metrics was relatively better than the existing irregularity measurements methods.

From the literature survey, it is observed that Fourier descriptor (FD), curvature scale space descriptor (CSSD), Zernike moment descriptor (ZMD) and texture descriptors are used for shape recognition. The standard databases like MPEG-7, ETH-80 and Kimia-99 are deployed for testing the methods. Here the idea of contour converted is to graphs and extracting texture features from its image is conceived. We are proposing a combined graph and texture based approach for recognition of animal contour images of MPEG-7 database.

3. Methodology

We have used contour of an object and extracted equidistant contour points. The contour points are joined by lines with a color contrast to the background so as to get a complete graph. The texture features are obtained by treating the complete graph as an object image. Hence, the problem statement is “A combined graph and texture based approach for recognition of animal contour images of MPEG-7 database”.

3.1. Model for the Proposed Work

The proposed method consists of five steps, namely, boundary extraction from input image, complete graph generation, texture features extraction, feature reduction and classification. These steps are as shown in Figure 2. We have considered images from the MPEG-7 database for input. This database consists of 1400 silhouette images, which are grouped into 70 classes with 20 objects per class. In Figure 1, we have shown some images of MPEG-7 database. Gray scale is a range of monochromatic shades from black to white. The gray scale image contains only shades of gray and no color. While digital images are saved as gray scale (or black and white) images and color images contain gray scale information. The reason is that each pixel has a luminance value, regardless of its color. Luminance is measured on a scale from black to white.

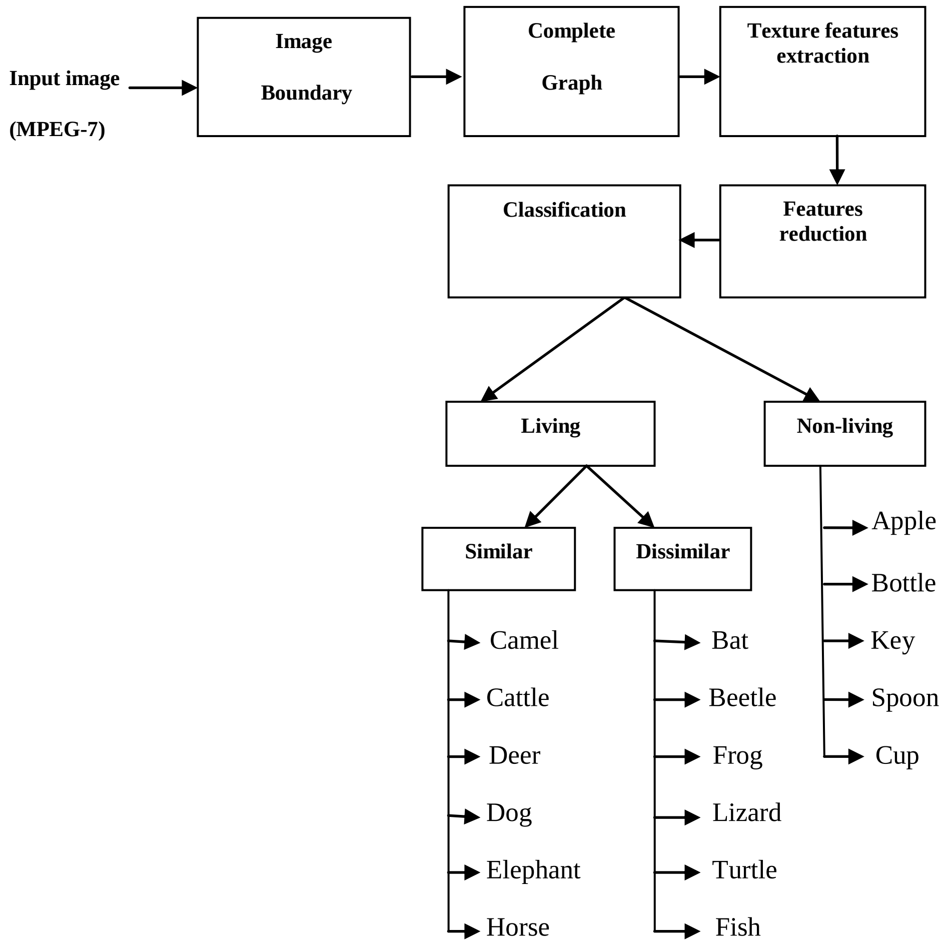


Figure 2. Block Diagram of the Proposed Methodology

3.1.1. Image boundary: The boundary of an image is traced to find whether the boundary is continuous. If it is discontinuous then it is necessary to preprocess to make it continuous to extract the contours of the images. The boundary traced image is shown in Figure 3.

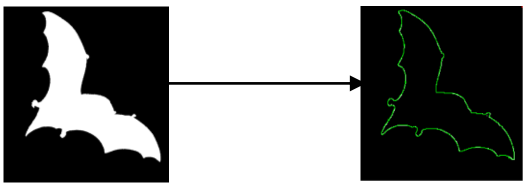


Figure 3. Result of Boundary Traced Image

We have used the *bwtraceboundary ( )* function to find the boundary of an image. This function has three parameters like *bw*, *P* and *fstep*. The *bwtraceboundary ( )* function traces the outline of an object in binary image *bw*. Nonzero pixels belong to an object and zero pixels constitute the background. *P* is a two-element vector specifying the row and column coordinates of the point on the object boundary from where tracing has to begin. And the *fstep* is a string specifying the initial search direction for the next object pixel connected to *P* and use strings such as 'N' for north, 'NE' for northeast, to specify the direction.

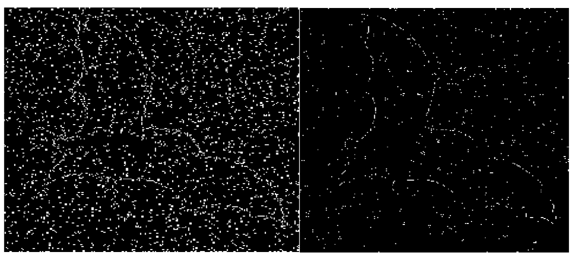
Image boundary tracing is the preprocessing technique performed on the input images in order to extract information about their general shapes. Once the contour of a given object is extracted, the different properties are obtained and used as features. Therefore, accuracy of the contour information produces good features, which inturn increase the accuracy of classification process. The contours of images are extracted using some operators like canny, Sobel, Roberts and Prewitt. Canny method performs best among Sobel, Roberts and Prewitt methods under normal and noisy conditions. Canny method produces single pixel thick, continuous edges as shown in Figure 4(a).

(a)Result of Canny (b) Result of Prewitt (c) Result of Roberts (d) Result of Sobel

Figure 4. Results of Various Edge Detection Methods

From the Figure 4, it is clear that Canny works the best among all the four edge detectors. The main advantages of this method are elimination of multiple responses to a single edge and better detection especially in noise conditions. We have added salt and pepper noise to the image and when it is passed through the detectors; the results are shown in Figure 5. By looking at each image we conclude that canny method performs better detection in noise conditions.

(a) Noisy image (b) Result of Canny (c) Result of Prewitt



(d) Result of Roberts (e) Result of Sobel

Figure 5. Results of Noisy Images Passed through the Various Detectors

Sobel, Prewitt and Sobel edge detectors are fast in processing but are less precise and the canny edge detector is bit slower in processing but is precise as compared to its competitors. The speed of canny is slow because of its deep processing which is shown in Figure 6.

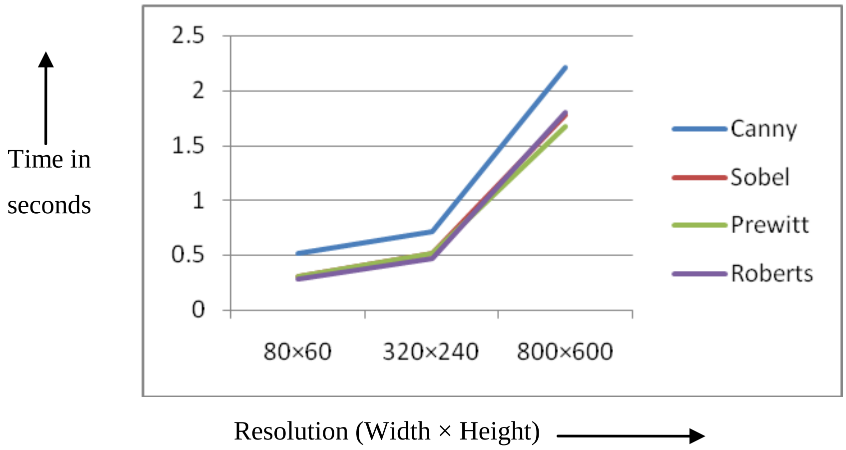


Figure 6. Speed Comparison

Form the above experiments we conclude that canny edge detection method is feasible and hence we have used same for the contour extraction as shown in the Figure 7.

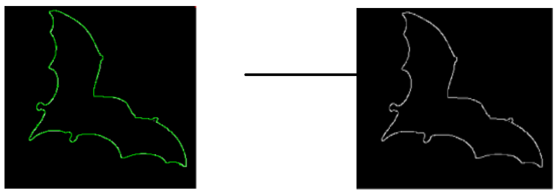
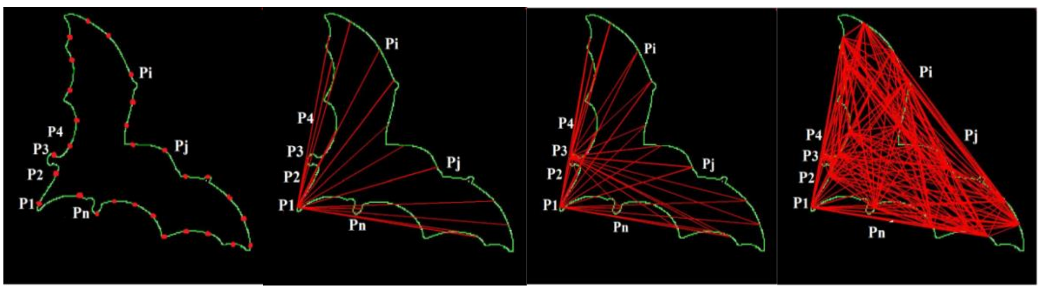


Figure 7. Result of Contour Extracted using 'Canny' Operator

3.1.2. Complete graph: A complete graph is a simple undirected graph in which every pair of distinct vertices is connected by a unique edge. By using the contours, we have selected the equidistance points on the contours to obtain a complete graph.



(a) (b) (c) (d)

Figure 8. Construction of Complete Graphs

A complete graph image of 'n' vertices is obtained as shown in Figure 8. The vertices are connected as defined in expression (1).

P_i connected to P_j, for $j = (i+1)$ to n and $(i \neq j)$ (1)

where P_i and P_j are the two points on the contour of a given image as shown in Figure 8(a) to 8(d).

We have obtained the mesh structures depending upon the images based on their contour shapes. In the proposed method, we have experimented for pixel distances of 10, 20, 30, 40, 50, 60, 70 and 80 and the corresponding graphs are shown in Figure 9(a) to

Figure 9(h) respectively. We found that pixel distance of 50 has given better performance. While plotting a complete graph, we have selected the contour points on trial and error basis. While plotting a complete graph, we have selected the contour points on trial and error basis.

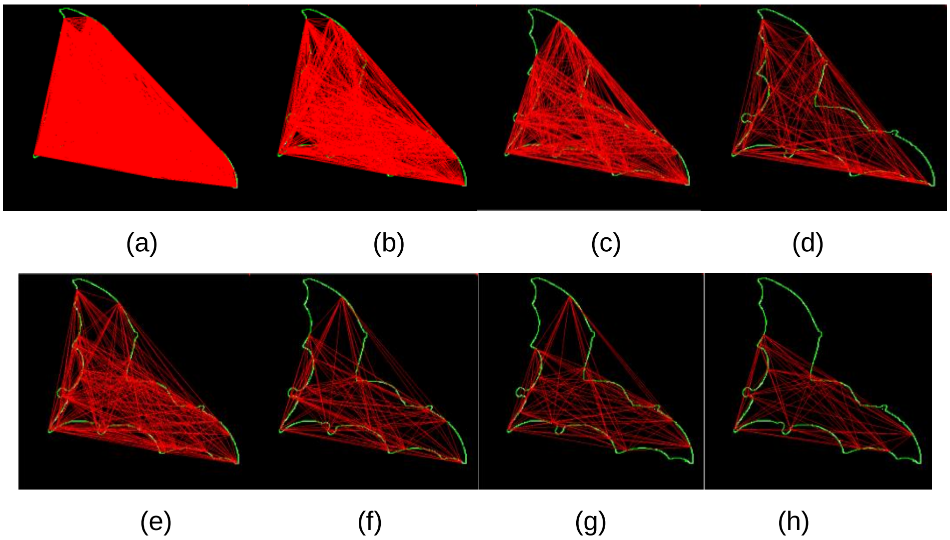


Figure 9. Results of Complete Graph Images with Various Equidistance Pixels

Incrementing the equidistance by 10 pixels and obtaining complete graphs, we have found that results are better for 50 pixels. In this case, we have got the better performance when compared to all equidistance such as 10, 20, 30, 40, 60, 70 and 80.

Therefore, we have taken equidistant points having 50 pixels distance. Using the plot ( ) function of MATLAB, connections are made for all equidistance points of a contour of an image. The plot ( ) function has parameters such as color and line width, which are set to extract the texture features.

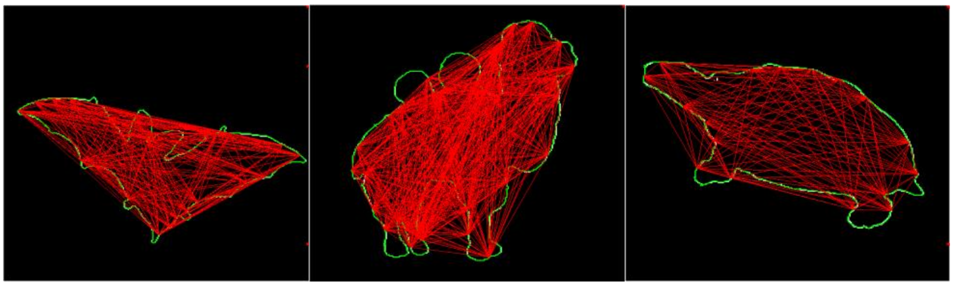


Figure 10. Results of Complete Graph Images of Different Animal Images with Equidistance 50

3.1.3.Texture features extraction: By observing the images shown in the above Figure 10, these images exhibit certain textures for images. Texture gives us information about the spatial arrangement of the colors or intensities in an image. Hence, we have extracted texture features from the complete graph images using the gray-level co-occurrence matrix (GLCM) method. Table 1 gives the texture features extracted from images.

Table 1. Average Values of All Texture Features of the Animal Category

	Cluster (F1)	Cluster shade (F2)	Dissimilarity (F3)	Sum Square (F4)	Auto Correlation (F5)	Entropy (F6)	Correlation1 (F7)	Sum average (F8)
Bat	0.2934	0.2409	0.2528	0.4951	0.4883	0.6801	0.8946	12.8256
Beetle	0.2574	0.2106	0.2939	0.5350	0.5268	0.5932	0.8265	13.7145
Camel	0.2899	0.2389	0.2881	0.5037	0.4957	0.6798	0.8763	13.0179
Cattle	0.2592	0.2114	0.2383	0.5386	0.5324	0.5597	0.8564	13.7956
Deer	0.2701	0.2214	0.2823	0.5317	0.524	0.6043	0.8484	13.6421
Elephant	0.2659	0.2193	0.4009	0.5234	0.5115	0.6736	0.8023	13.4573
Frog	0.2718	0.2233	0.3482	0.5232	0.5131	0.6537	0.8338	13.4523
Horse	0.2789	0.2293	0.2861	0.5201	0.5121	0.6353	0.85968	13.3820
Lizard	0.2766	0.2278	0.3161	0.5195	0.5105	0.6493	0.8447	13.3698
Turtle	0.2887	0.2371	0.2788	0.4988	0.4911	0.6817	0.8796	12.9090

Table 1. Average Values of All Texture Features of the Animal Category (Continued)

	Correlation2 (F9)	Energy (F10)	Maximum Probability (F11)	Sum entropy (F12)	Difference Variance (F13)	Difference Entropy (F14)	Homogeneity 1 (F15)
Bat	0.8946	0.6152	0.7552	0.6551	0.1769	0.1527	0.9683
Beetle	0.8265	0.6909	0.8157	0.5640	0.2057	0.1719	0.9632
Camel	0.8763	0.6255	0.7664	0.6513	0.2017	0.1711	0.9639
Cattle	0.8564	0.7067	0.8255	0.5360	0.1668	0.1465	0.9702
Deer	0.8484	0.6832	0.8114	0.5764	0.1976	0.1678	0.9647
Elephant	0.8023	0.6497	0.7897	0.6339	0.2806	0.2182	0.9498
Frog	0.8338	0.6568	0.7931	0.6192	0.2437	0.1957	0.9564
Horse	0.8596	0.6588	0.7925	0.6069	0.2002	0.1683	0.9642
Lizard	0.8447	0.6534	0.7895	0.61800	0.2213	0.1816	0.9604
Turtle	0.8796	0.6191	0.7592	0.6540	0.1952	0.1643	0.9651

Table 1. Average Values of All Texture Features of the Animal Category (Continued)

	Information measure of correlation1 (F16)	Information measure of correlation2 (F17)	Homogeneity2 (F18)	Sum variance (F19)	Contrast (F20)	Inverse difference moment normalized (F21)	Inverse difference normalized (F22)
Bat	0.7243	0.7319	0.9646	0.1807	0.1760	0.9843	0.9831
Beetle	0.6229	0.6408	0.9588	0.1977	0.2057	0.9817	0.9804
Camel	0.6853	0.7121	0.9596	0.1837	0.2017	0.9821	0.9807
Cattle	0.6711	0.6525	0.9666	0.2002	0.1668	0.9852	0.9841
Deer	0.6484	0.6617	0.9604	0.1962	0.1976	0.9825	0.9811
Elephant	0.5687	0.6423	0.9438	0.1907	0.2806	0.9751	0.9732
Frog	0.6164	0.6616	0.95124	0.1914	0.2437	0.9784	0.9767
Horse	0.6662	0.6829	0.9599	0.191	0.2002	0.9822	0.9809
Lizard	0.6414	0.6743	0.9557	0.1903	0.2213	0.9804	0.9789
Turtle	0.6985	0.7179	0.9609	0.1819	0.1952	0.9827	0.9814

A total of 22 features are used. The classification of images is carried out with individual features and classification accuracies obtained are given in Figure 11.

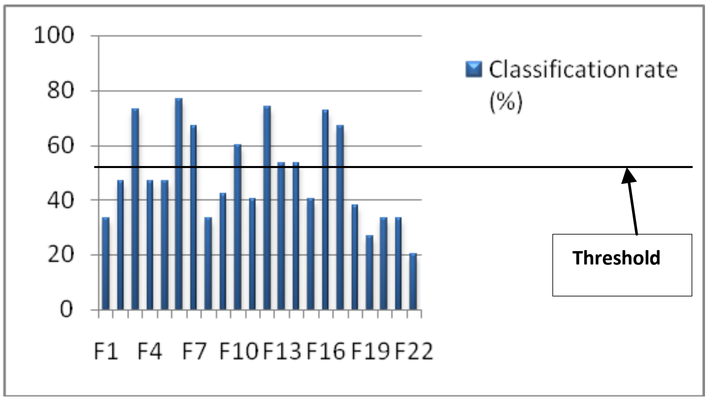


Figure 11. Classification Rates for Individual Texture Features

3.1.4. Texture features reduction: The 22 texture features are reduced based on their classification for each of the individual features. Figure 10 gives the classification for each of the texture features. The 22 features are reduced to 9 features that contribute significantly to the classification. We have fixed a threshold of 50% classification rate for individual features. The textures are reduced to nine texture features after the feature reduction, which is given in Table 2.

Table 2. Classification Rates for Reduced Nine Individual Texture Features

	Texture features	Classification rate (%)
F1	Correlation1	66.66
F2	Difference Entropy	53.38
F3	Dissimilarity	73.00
F4	Difference Variance	53.33
F5	Energy	60
F6	Entropy	76.63
F7	Information measure of correlation1	72.30
F8	Sum Entropy	73.70
F9	Information measure of correlation2	66.66

3.1.5. Classification: The Artificial Neural Network (ANN) with backpropagation learning is used for classification in this work. The different parameters of ANN are used. In the identification process, the output of neural network is represented by a vector of twelve values. Each binary value is associated with an animal type. For example, the vector [1 0 0 0 0 0 0 0 0 0 0 0] represent the bat.

Parameters of ANN are input layers, hidden, output layer learning constant and the like. In this work, we have 5 number of input neurons for input layer, 22 for hidden layer. TRINGDA is used as transfer function. As there are 12 varieties of classifications, output layer is 12 layers. Learning constant is 0.01 with acceptable error (MSE) as 0.00001 considering 1000 number of epochs. Termination conditions are set based on minimum mean square error (MSE).

4. Experimental Results

We have conducted several experiments on MPEG-7 shape data set and compared the results with the state-of-the-art approaches for shape classification. We have shown that the proposed method has given better results on MPEG-7 data set.

4.1. Living and non-living groups

In the proposed method, the classification of MPEG-7 database objects into two types, namely, living and non-living groups is achieved. The living category contains objects like animals, birds and children and the non-living category contains items like vehicles, fruits and many different devices, which are shown in the Figure 12 and Figure 13 respectively.

4.2 Similar and Dissimilar Animals

In the MPEG-7 shape database, the living group is further divided into two sub groups such as similar and dissimilar. In the proposed method, we have considered the images of animals, namely, bat, beetle, camel, cattle, deer, dog, elephant, fish, frog, horse, lizard and turtle. The animals are divided into two groups based on the physical appearance as similar and dissimilar, which are shown in Figure 14 and Figure 15 respectively.

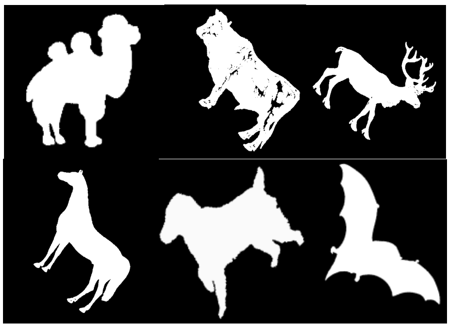


Figure 12. Some Sample Images of Living Category of MPEG-7 Database

Figure 13. Some Sample Images of Non-Living Category of MPEG-7 Database

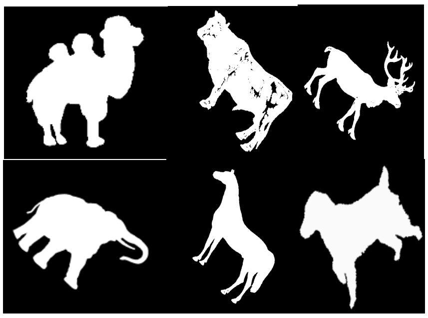


Figure 14. Similar Group Images of Animal Category from MPEG-7 Database

Figure 15. Dissimilar Group Images of Animal Category from MPEG-7 Database

The similar and dissimilar animal groups contain six animals each, namely, camel, cattle, deer, elephant, horse and dog in similar and bat, beetle, frog, lizard, turtle and fish in dissimilar.

In the MPEG-7 database, each animal set has 20 different samples. For these samples, we have extracted 22 texture features and found the classification rate as 46% for similar group. We have considered 9 texture features, after the reduction step, and it is found that the classification rate is improved to 60%.

Further, these nine features are reduced to six and then to four to arrive at minimum feature set and it is found that the classification rates are 53% and 51% respectively, which is shown in Figure 16. The classification rate for the dissimilar group is found as 75%, 96%, 85% and 82% for 22, 9, 6 and 4 texture features respectively, which is shown in Figure 17.

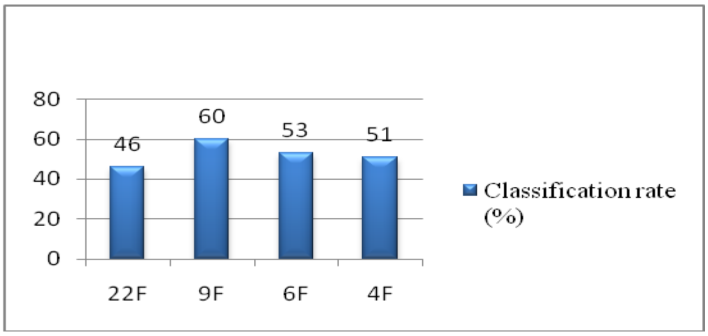


Figure 16. Classification Rate for Similar Group by Considering Each Feature Set

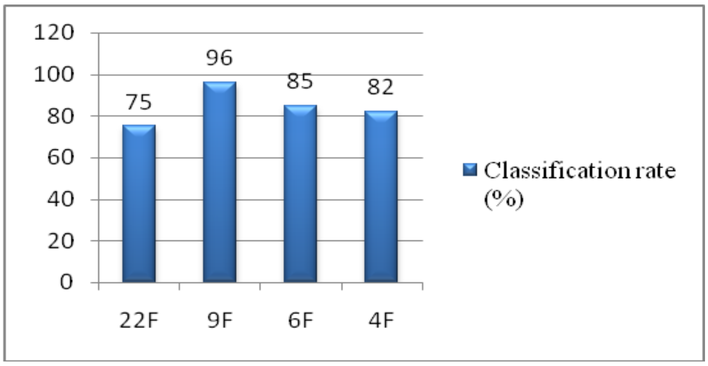


Figure 17.Classification Rate for Dissimilar Group by Considering Each Feature Set

4.3. Combinations of Similar and Dissimilar Groups

We have also experimented on combination of similar and dissimilar group of animals by considering the 9 features. The classification rate is found to be 40%, which is low compared to the both the similar and dissimilar groups. The comparison of the classification rates across all groups, such as similar, dissimilar and combination of both is shown in Figure 18.

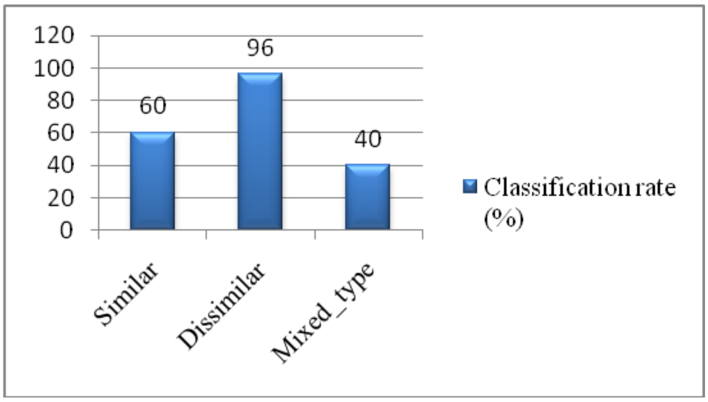


Figure 18.Comparison of Classification Rates for Similar, Dissimilar and Mixed Type Animals

4.4. Evaluation of Accuracy

Using the similar and dissimilar groups, we have demonstrated an experiment on animal set by considering ratios of similar and dissimilar groups which are taken together. The performance evaluation on 80:20 ratios of similar and dissimilar group is found to be 53% and in the same way 60:40 is 50%, 40:60 is 65% and 20:80 is 89% as shown in the Figure19.

In the similar way, we have experimented on animal groups by considering ratios of dissimilar and similar groups as we did in the previous work for the similar and dissimilar. For this the performance evaluation on 80:20 ratios of dissimilar and similar group is found to be 89% and in the same way 60:40 is 84%, 40:60 is 50% and 20:80 is 53% as shown in the Figure 20.

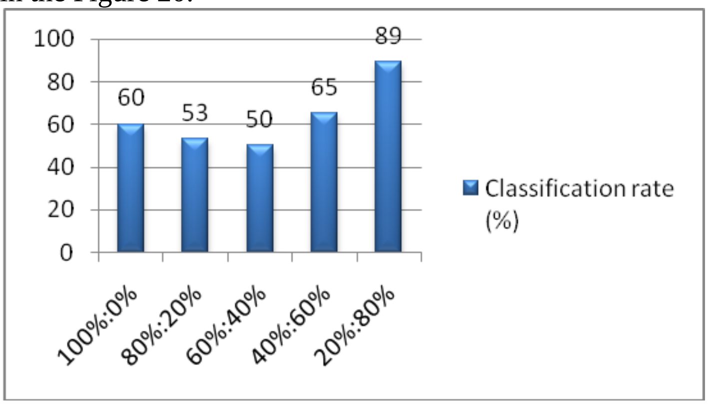


Figure 19. Comparison of Classification Rates for Ratios of Similar and Dissimilar Animals

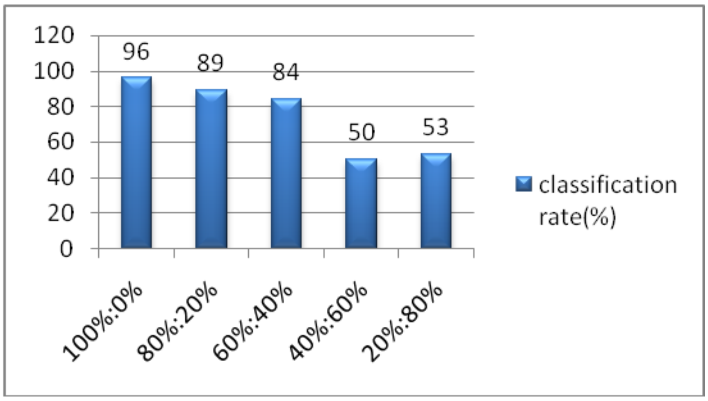


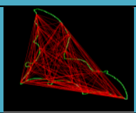
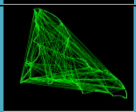
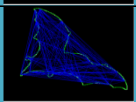
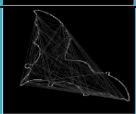
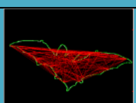
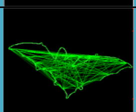
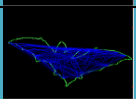
Figure 20. Comparison of Classification Rates by Considering Ratios of Dissimilar and Similar Animals

4.5. Color Experimentation

In the proposed method, we have experimented on MPEG-7 database by taking the colored lines while drawing the complete graphs for the contours. We have tried to study the effect of color on feature values.

In this experimentation, we have taken colored lines such as red, green and blue color images separately. The texture feature values of each type are shown in Table 3. From the feature values, we have concluded that the texture feature values of the images are independent of color, when converted to gray scale.

Table 3. Texture Feature Values for Different Color Images

	F1	F2	F3	F4	F5	F6	F7	F8	F9
	0.9148	0.1370	0.2147	1.5028	0.6101	0.6776	-0.7584	0.6564	0.7503
	0.9148	0.1370	0.2147	1.5028	0.6101	0.6776	-0.7584	0.6564	0.7503
	0.9148	0.1370	0.2147	1.5028	0.6101	0.6776	-0.7584	0.6564	0.7503
	0.9148	0.1370	0.2147	1.5028	0.6101	0.6776	-0.7584	0.6564	0.7503
	0.9450	0.0990	0.1417	0.9925	0.6116	0.6510	0.8273	0.6369	0.7751
	0.9450	0.0990	0.1417	0.9925	0.6116	0.6510	0.8273	0.6369	0.7751
	0.9450	0.0990	0.1417	0.9925	0.6116	0.6510	0.8273	0.6369	0.7751
	0.9450	0.0990	0.1417	0.9925	0.6116	0.6510	-0.8273	0.6369	0.7751

4.6. Comparison with other Approaches

The proposed approach is compared with the other different existing approaches and found that the proposed approach performs better than all the previous approaches. Compared to existing approach Elliptic FD given by (Nixon and Aguado) with 82% classification accuracy, the proposed approach has 96% classification accuracy.

5. Conclusion

The proposed method uses a different approach compared to those exist in the literature. Contour images of MPEG-7 database are converted to a complete graph with certain color. Every object yields unique mesh structure when converted to a graph. The texture features obtained from the graph image are used to define the shapes of the objects. Only nine texture features are used in the work, the proposed method has outperformed the state-of-the-art methods and has given 96% classification accuracy when texture features are used with artificial neural networks.

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