Analysis and Recognition of Animals in Zoo Using Transform based techniques

Dr. Panyam Narahari Sastry[a], Karanam Deepak[b]

[a] Professor, Department of Electronics and Communication Engineering (ECE), CBIT, Hyderabad, Telangana, INDIA
[b] Assistant Professor, Department of Electrical & Electronics Engineering, G. Pullaiah College of Engineering and Technology, Pasupula Village, Nandikotkur Rd, near Venkayapalle, Kurnool, Andhra Pradesh 518002.

Abstract: An object recognition system identifies an object which is under test by comparing different features of the test and training database images. This task is difficult for computers, however for human's object recognition is effortless and instantaneous. The various applications for object recognition are in the fields of Medicine, Communications, Military Intelligence, Bioinformatics and many others. It is the ability to perceive an object's physical properties such as shape, colour and texture and apply semantic attributes to the object, which includes the understanding of its use, previous experience with the object and how it relates to others. Algorithmic description of this task for implementation on machines has been very difficult. Humans recognize a multitude of objects in images with little effort, despite the fact that the image of the objects may vary somewhat in different viewpoints, in many different sizes and scales or even when they are translated or rotated. Many approaches to this task have been implemented over decades, but still, this is an open area of research. There are standard databases available for research in the area of object recognition. In this proposed work, the images of the different animals are downloaded from https://www.rocq.inria.fr/gamma/gamma/download/ANIMALS/index0.php and 3D Meshes Research Database. These images are to be converted into binary form, by using thresholding method. In the next step, distinguishable features which may be Zone based, Transform based or Statistical in nature are to be extracted from these images. Using these features, animals (in the present work) can be recognized by using various classifiers such as SVM, Neural Networks and NNC (Nearest Neighbourhood Classifier) namely 'Euclidean Distance'. The execution time of the simulation would also be compared for all the transforms implemented in the work. The results obtained would be compared with the existing results of similar work

Keywords: Nearest Neighbourhood Classifier, Euclidean Distance, Military Intelligence
_____

1. Introduction

An object recognition system finds objects in the real world from an image of the world, using object models which are known to the system earlier. This task is surprisingly difficult. Humans perform object recognition effortlessly and instantaneously. It is the ability to perceive an object's physical properties (such as shape and colour) and apply semantic attributes to the object, which includes the understanding of its use, previous experience with the object and how it relates to others. Algorithmic description of this task for implementation on machines has been very difficult. Humans recognize a multitude of objects in images with little effort, despite the fact that the image of the objects may vary somewhat in different viewpoints, in many different sizes and scales or even when they are translated or rotated. Objects can even be recognized when they are partially obstructed from view. This task is still a challenge for computer vision systems. Many approaches to the task have been implemented over multiple decades.

Object recognition is concerned with determining the identity of an object being observed in the image from a set of known labels. It is assumed that the object being observed has been detected or there is a single object in the image.

2. Methodology and Block Diagram

2.1 Introduction

In this chapter, the methodology adopted for the proposed method is discussed. The step by step algorithm is discussed in detail and the various operations on the images are also elaborated.

2.2 Block Diagram for Recognition of Animals

The image pertaining to animals from a standard database are downloaded. The downloaded colour images of the animals are of the size 600*600 pixels. There are totally 600*600=36000 pixels in each image of the animal. After the colour image is converted into grayscale image using MATLAB, the intensity values of different pixels range from 0 to 255. These images are binarized using thresholding concept with various values ranging as 0.50,

0.55, 0.60, 0.65, 0.70 and 0.75. This task is performed to find out, about which particular thresholds gives the maximum recognition accuracy. Hence all the pixels of the binary image will be either 0 or 1. To the binary image we apply various transforms like 2D-FFT, 2D-DCT and 2D-HAAR wavelet transform. Then we train the system by using these transform-based intensity features and test the system. The step-by-step algorithm is discussed in Figure 3. The block diagram for recognition of animals is shown in Figure 1.

Data Collection	→	**Select features**	→	**Select Transform**	→	**Train classifier**	→	**Evaluate Classifie**

Figure 1: Block Diagram for Recognition of Animals

Then the proposed method finds the transform having best recognition accuracy. This recognition accuracy is calculated using Euclidean distance concept. The recognition accuracy is defined as,

$$\text{Recognition Accuracy} = \frac{\text{No. of matched images}}{\text{Total no. of images}}$$

This Euclidean distance is calculated in between test image and all the database images. The Figure 2 is the collection of different animals extracted from '3D Meshes Research Database'.
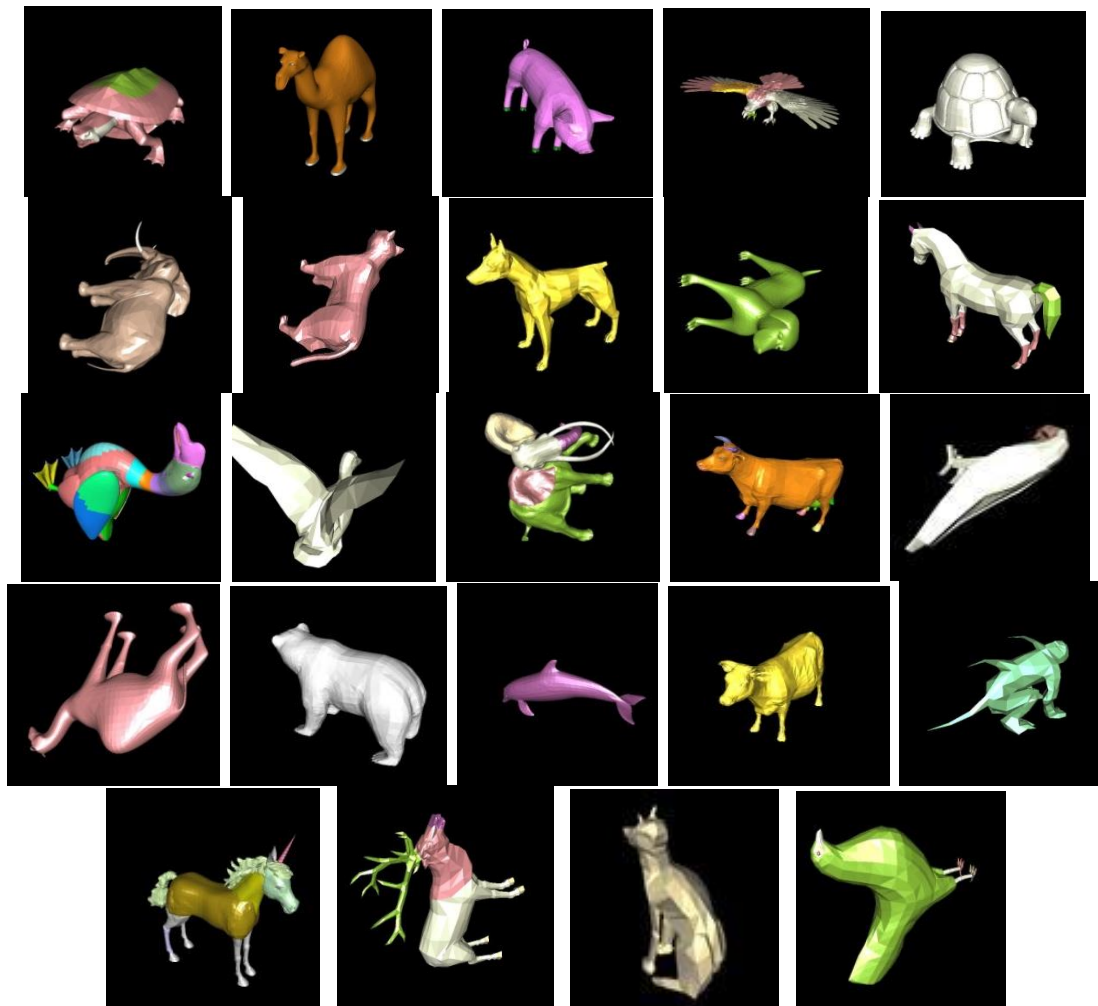

Figure 2: Animals Database

2.3 Step by Step Algorithm for Animal Recognition using Euclidean Distance

In this work 100 images for database and 25 images for testing purpose. The 100 X 1 column matrix are available for both training and testing images. The step-by-step algorithm for animal recognition is discussed below.

Step 1: Load test image and data base image of size 600*600 pixels.

Step 2: Read all the images.

Step 3: Convert the image into grayscale image.

Step 4: These grayscale images are converted into binary type using different threshold values 0.50, 0.55, 0.60, 0.65, 0.70 and 0.75.

Step 5: Reshape these 100 images into a column matrix of size 100 X 1.

Step 6: Repeat the above procedure for all the training/database and test images.

Step 7: Finding the Euclidean distance between column vector of test image and each of training image column

vector.

Step 8: Select the database image which has minimum distance from the test image.

Step 9: Display the test image and its corresponding matched data base image.

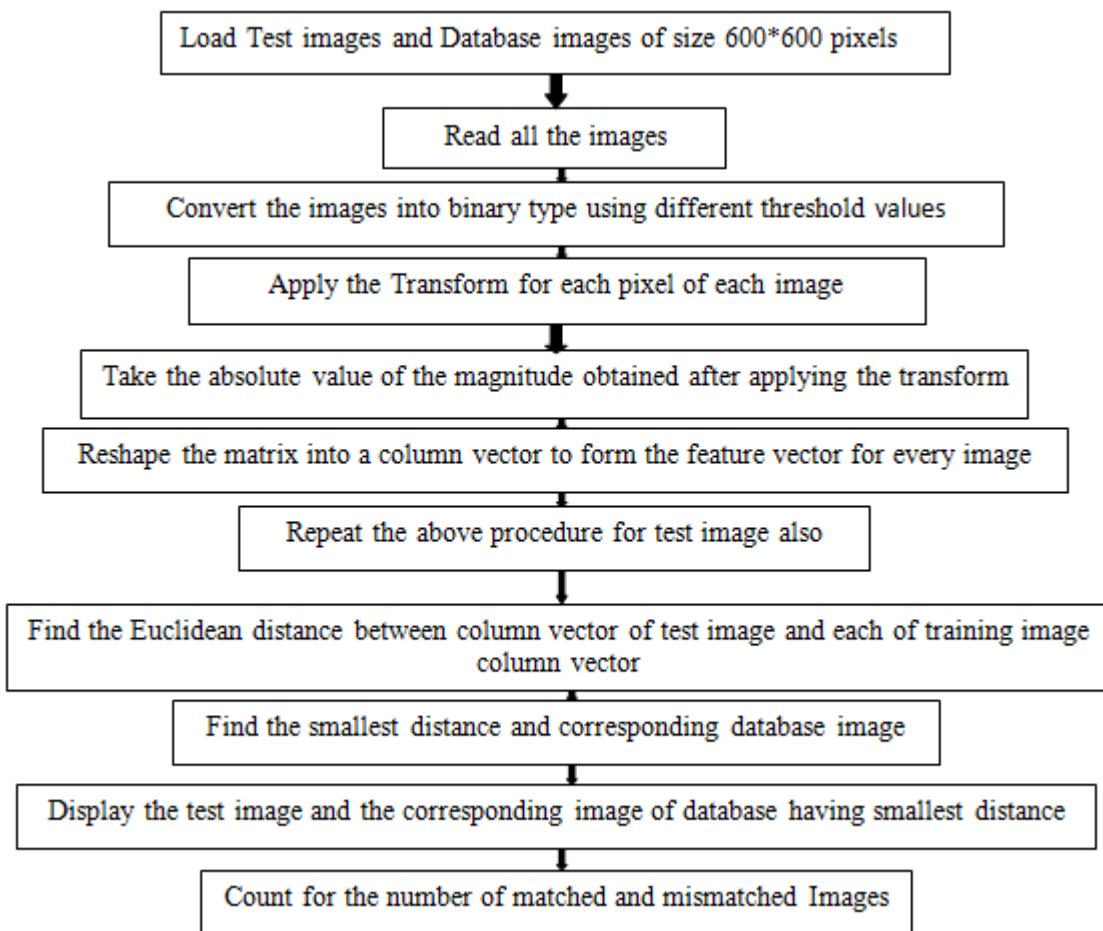The Figure 3 shows Step by step algorithm for implementing Animal Recognition using Euclidean distance.

Figure.3: Step by step algorithm for implementing Animal Recognition using Euclidean distance

2.4 Mathematical equations for Euclidean Distance

The Euclidean distance between test image column vector and each of the column vectors of Training/database image is computed Euclidean distance can be found out mathematically between 2 vectors Equation No. 2.1 and 2.2 as follows,

$$A_i = \left[A_1, A_2, \ldots\ldots, A_n\right] \tag{2.1}$$

$$B_i = \left[B_1, B_2, \ldots\ldots, B_n\right] \tag{2.2}$$

Where n = number of animals

The Euclidean distance (D) equation is given by

$$D = \sqrt{(A_1 - B_1)^2 + (A_2 - B_2)^2 + \cdots (A_n - B_n)^2} \qquad (2.3)$$

Equation No. 2.3 describes the calculation of Euclidean for vectors represented by Equation No. 2.1 and 2.2. Hence Euclidean distance between test image vector and each of the data base images are computed and put in a row matrix as D_j in equation 2.4.

$$D_j = [D_1, D_2, D_3, \ldots \ldots \ldots \ldots D_n] \qquad (2.4)$$

Where $1 < n < 100$,

A_i is the A matrix B_i is the B matrix   D is the Euclidean Distance

D_j is the D matrix which contains the values of Euclidean distances between the test image vector and each of the training image vector.

The various transforms used in the proposed method are,

1.   2D- FFT (2D-Fast Fourier Transform)
2.   2D-DCT (2D-Discrete Cosine Transform)
3.   2D-DWT (2D-HAAR Discrete Wavelet Transform)

2D-FFT (2D-Fast Fourier Transform)

The 2D Fourier transform is useful for processing 2D signals and other 2D data such as images. The Fourier Transform is an important image processing tool. 2D-FFT can be used to perform image "classification". It can't be used to recognize different faces or objects, but it can be used to classify the type of image. 2D-FFT is used in pre-processing for image recognition. The Fourier transform is a representation of an image as a sum of complex exponentials of varying magnitudes, frequencies, and phases. The 2D-Fourier transform plays a critical role in a broad range of image processing applications, including enhancement, analysis, restoration, and compression.

Mathematical equations for 2D-FFT

In the proposed method 2D-FFT is made invariant to size, rotations and shift. The 2D-FFT for a 1-dimension vector x is mathematically shown in equation number 2.5 and the inverse FFT (IFFT) is represented by equation number 2.6.

$$X(k) = \sum_{n=0}^{N-1} x(n) e^{-\left(\frac{2\pi i}{N}\right) K(n)} \qquad (2.5)$$

Where   k=0,1,2……N-1

X=fft(x)   (1-D Fourier transform)

$$x(n) = \left(\frac{1}{N}\right) \sum_{k=0}^{N-1} X(k) e^{\left(\frac{2\pi i}{N}\right) K(n)} \qquad (2.6)$$

Where   n=0,1,2…………..N-1

x=ifft(X)   (1-D Inverse Fourier transform)

Mathematically the function X=fft(x) and x=ifft(X) are the functions used to implement the transform and inverse transform pair given for the vectors of length N. in MATLAB X=fft(x) returns the Discrete Fourier Transform (DFT) of vector X, computed with a Fast Fourier Transform (1D-FFT) algorithm. If X is a matrix, fft returns the Fourier transform of each column of the matrix.

The 2D-FFT and 2D-IFFT for images are represented by equations 2.7 and 2.8 respectively.

$$F(u,v) = \{1/(MN)\} \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} f(x,y) e^{-i2\pi\left\{\left(\frac{ux}{M}\right) + \left(\frac{vy}{N}\right)\right\}} \qquad (2.7)$$

$$F(x,y) = \sum_{u=0}^{M-1} \sum_{v=0}^{N-1} F(u,v) e^{i2\pi\left\{\left(\frac{ux}{M}\right) + \left(\frac{vy}{N}\right)\right\}} \qquad (2.8)$$

Where,

u=0, 1, 2, …………..M-1 and v=0, 1, 2, ……N-1

x=0, 1, 2, ………….M-1 and y=0,1 ,2, ……N-1

In MATLAB, Y=fft2(x) returns the two-dimensional discrete Fourier transform (2D-DFT) of x computed with 2D-FFT algorithm. The Fourier coefficients derived according to equation (2.7) are not rotation as shift invariant. The following operations are defined to derive a set of Fourier co-efficient that have the rotation and invariant properties.

A set of invariant descriptors Z(n) (equation 2.9) are computed for each

Z(n)=(real(y)^2+imag(y)^2)   (2.9)

Where,

Z(n) = set of invariant descriptors

The dependence of Z(n) on the size of the characters is eliminated in the descriptors by computing a new set of descriptors S(n) (equation 2.10) as

S(n)=Z(n)/Z (1)   (2.10)

Where,

S(n)= set of descriptors

n=1, 2, ……(N-1)

The Fourier co-efficient and the invariant descriptors S(n), n=1, 2, ….. (N-1) were derived for all characters.

2.6 2D- DCT (2D-Discrete Cosine Transform)

A Discrete Cosine Transform (2D-DCT) expresses a finite sequence of data points in terms of a sum of Cosine functions oscillating at different frequencies. 2D-DCTs are important to numerous applications in science and engineering, from lossy compression of audio (e.g. MP3) and images (e.g. JPEG) (where small high-frequency components can be discarded). The equation 2.11 shows the discrete cosine transform mathematical equation (2D-DCT). The 2D-DCT is used in JPEG (Joint Photographic Experts Group), image compression, MJPEG (Motion-JPEG), MPEG (Moving Picture Experts Group) , DV (Digital Video).

2.6.1 Mathematical equation for 2D-DCT

The mathematical equation for Two-dimensional Discrete Cosine Transform (2D-DCT) is given by equation 2.11 which is as follows:

$$C(u,v) = \alpha(u)\alpha(v) \sum_{x=0}^{N-1} \sum_{y=0}^{N-1} f(x,y) \cos\left[\frac{\pi(2x+1)u}{2N}\right] \cos\left[\frac{\pi(2y+1)v}{2N}\right] \qquad (2.11)$$

Where,

$$u, v = 0,1,2,3, \ldots \ldots \ldots, N-1$$

$$\alpha(u), \alpha(v) = \begin{cases} \sqrt{\frac{1}{N}} \ for \ u,v = 0 \\ \sqrt{\frac{2}{N}} \ for \ u,v \neq 0 \end{cases}$$

$u -$ represents the rows

$v -$ represents the columns

$N -$ Real number

2.7 2D- HAAR (2D-HAAR Discrete Wavelet Transform)

The 2D-HAAR transform is the simplest of the wavelet transforms. Modern cameras are capable of producing images with resolutions in the range of tens of megapixels. These images need to be compressed before storage and transfer.

The 2D-HAAR transform can be used for image compression. 2D-HAAR like features are digital image features used in object recognition. The basic idea is to transfer the image into a matrix in which each element of the matrix represents a pixel in the image. For example, a 256×256 matrix is saved for a 256×256 image.

In discrete form, 2D-HAAR wavelets are related to a mathematical operation called the Haar transform. The 2D-HAAR transform serves as a prototype for all other wavelet transforms. The 2D-HAAR transform can be used for compressing audio signals and for removing noise. One distinctive feature that the 2D-HAAR transform enjoys is that it lends itself easily to simple hand calculations.

Mathematical equation for 2D-Haar Discrete Wavelet Transform

The mathematical equation for HAAR Discrete Wavelet Transform is given by equation 2.12 which is as follows:

$$B_n = H_n A_n H_n^T \qquad\qquad (2.12)$$

Where,

$A_n = \text{n} * \text{n matrix}$

$B_n = \text{p} * \text{q matrix}$

$H_n = \text{n} - \text{point Haar Transform}$

$H_n^T = \text{Transpose n} - \text{point Haar Transform}$

Implementation of 2D-FFT / 2D-DCT / 2D-Haar Discrete Wavelet Transform

All the experiments were carried out on a PC machine with P4 3GHz CPU and 512MB RAM memory under MATLAB 13a platform. The images of various animals are obtained from a standard database '3D Meshes Research Database'.

Four samples of each class of animals with 25 different classes are used to train the database in the proposed system. A separate sample of each class is used to test the recognition accuracy of the proposed system. Hence the training sample set contained 100 samples (25*4=100) of animals, whereas the testing sample set contained 25 images of different animals.

3. Results And Discussion

3.1 Introduction

In the present proposed research work, there are 100 trained images and 25 test images. Experimental results for 2D-FFT (Fast Fourier Transform), 2D-DCT (Discrete Cosine Transform) and 2D-HAAR (Discrete HAAR wavelet) transforms are discussed in detail and finding recognition accuracy for various threshold ranges from 0.50, 0.55, 0.60, 0.65, 0.70 and 0.75 are also elaborated.

3.2 Simulation Results for 2D-FFT

The results obtained with the proposed system using 2D-FFT are shown in Figure 4 and 5. This system has 2 sets of images. The left-hand side image of each set is the input image whereas the image on the right-hand side is the image identified in the database. All these images indicate that the test image has been correctly recognized after training the computer with only 4 samples of each class of animals.

The images of animals correctly identified using 2D-FFT are shown in Figure 4 and the images of animals wrongly identified using 2D-FFT are shown in Figure 5.
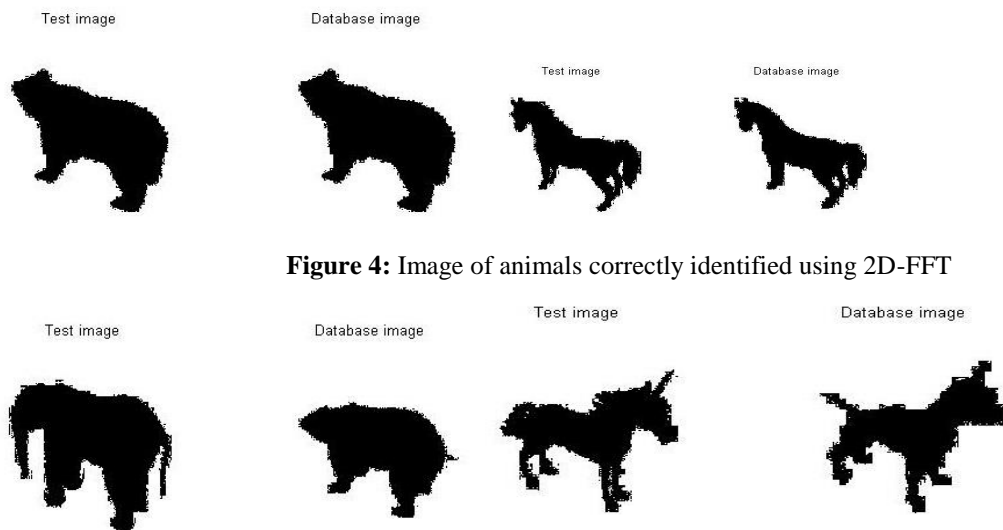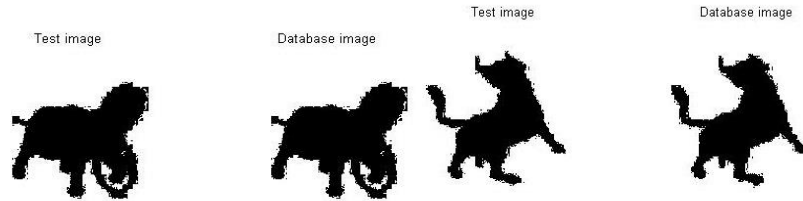
Figure 4: Image of animals correctly identified using 2D-FFT

Figure 5: Images of animals wrongly identified using 2D-FFT

3.3 Simulation Results for 2D-DCT

The results obtained with the proposed system using 2D-DCT are shown in Figure 6 and 7. This system has 2 sets of images. The left-hand side image of each set is the input image whereas the image on the right-hand side is the image identified in the database. All these images indicate that the test image has been correctly recognized after training the computer with only 4 samples of each class of animals.

Figure 6: Images of animals correctly identified using 2D-DCT

The images of animals correctly identified using 2D-DCT are shown in Figure 6 and the images of animals wrongly identified using 2D-DCT are shown in Figure 7.
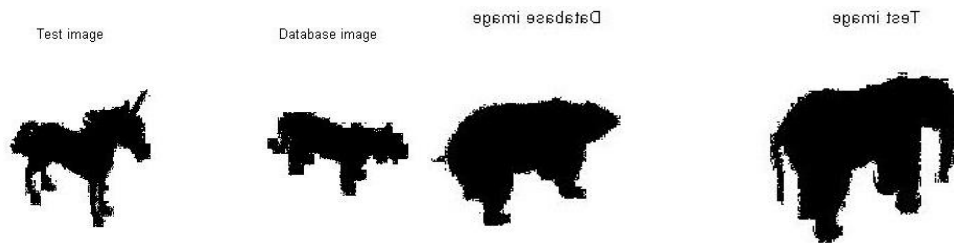

Figure 7: Images of animals wrongly identified using 2D-DCT

3.4 Simulation Results for 2D-Haar wavelet Transform

The results obtained with the proposed system using 2D-HAAR are shown in Figure 8 and 9. This system has 2 sets of images. The left-hand side image of each set is the input image whereas the image on the right-hand side is the image identified in the database. All these images indicate that the test image has been correctly recognized after training the computer with only 4 samples of each class of animals.

The images of animals correctly identified using 2D-HAAR wavelet transform are shown in Figure 8 and the images of animals wrongly identified using 2D-HAAR wavelet transform are shown in Figure 9.
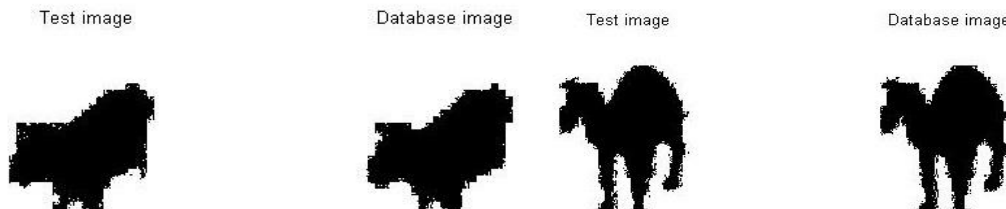

Figure 8: Images of animals correctly identified using 2D-HAAR

Figure 9: Images of animals wrongly identified using 2D-HAAR

The Table 1 shows the recognition accuracy with various values of threshold ranging from 0.50, 0.55, 0.60, 0.65, 0.70 and 0.75. It is found that at threshold of 0.50 maximum recognition accuracy is achieved for the proposed transform-based approach. The various transforms used in the research work are 2D-FFT, 2D-DCT, 2D-Wavelet transform (HAAR transform). In this table it is observed that as the threshold value increase the recognition accuracy decreases for all the three transforms.

Table 1: Recognition Accuracy at different Thresholds

THRESHOLD	*TRANSFORM*	*RECOGNITION ACCURACY*
0.50	FFT	80%
0.50	DCT	80%
0.50	Haar	84%
0.55	FFT	72%
0.55	DCT	72%
0.55	Haar	84%
0.60	FFT	68%
0.60	DCT	68%
0.60	Haar	76%
0.65	FFT	60%
0.65	DCT	64%
0.65	Haar	76%
0.70	FFT	64%
0.70	DCT	64%
0.70	Haar	68%
0.75	FFT	64%
0.75	DCT	64%
0.75	Haar	68%

The Figure 10 shows the recognition accuracy with various values of threshold ranging from 0.50, 0.55, 0.60, 0.65, 0.70 and 0.75. It is found that at threshold of 0.50 maximum recognition accuracy is achieved for the proposed transform-based approach. The various transforms used in the research work are 2D-FFT, 2D-DCT, 2D-Discrete Wavelet transform (HAAR transform). In this figure it is observed that as the threshold value increase the recognition accuracy decreases for all the three transforms. In this Figure 10, X-axis shows the different values of threshold ranging from 0.50, 0.55, 0.60, 0.65, 0.70 and 0.75 and Y-axis shows the recognition accuracy.
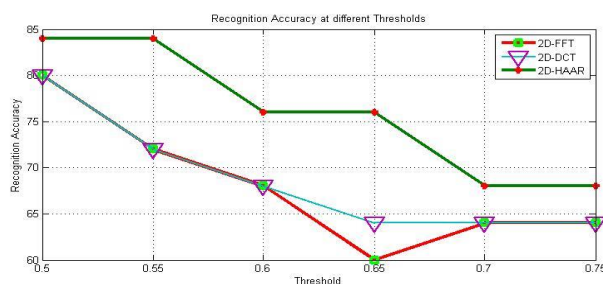
Figure 10: Recognition accuracy at different thresholds

The Figure 11 shows the recognition accuracy for different transforms at threshold 0.75. Here X-Axis shows the transforms such as 2D-FFT, 2D-DCT, and 2D-HAAR wavelet and Y-Axis shows the recognition accuracy. When the threshold value is 0.75, 2D-Fast Fourier Transform, 2D-Discrete cosine transforms and 2D-HAAR discrete wavelet transform gave the recognition accuracy of 64%, 64% and 68% respectively. From this graph concluded that 2D-HAAR discrete wavelet transform has the more recognition accuracy. In this bar graph red colour shows the 2D-Fast Fourier Transform, Blue colour shows the 2D-Discrete Cosine Transform and Green colour shows the 2D-HAAR Wavelet.
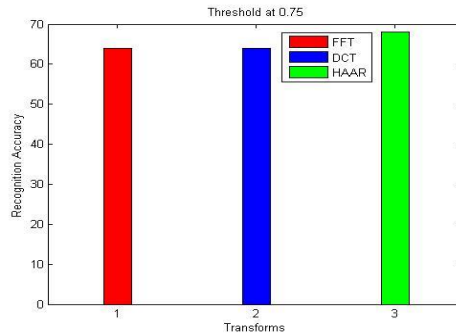
Figure 11: Threshold at 0.75

The Figure 12 shows the recognition accuracy for different transforms at threshold 0.70. Here X-Axis shows the transforms such as 2D-FFT, 2D-DCT, and 2D-HAAR wavelet and Y-Axis shows the recognition accuracy. When the threshold value is 0.70, 2D-Fast Fourier Transform, 2D-Discrete cosine transforms and 2D-HAAR discrete wavelet transform gave the recognition accuracy of 64%, 64% and 68% respectively. From this graph concluded that 2D-HAAR discrete wavelet transform has the more recognition accuracy. In this bar graph red colour shows the 2D-Fast Fourier Transform, Blue colour shows the 2D-Discrete Cosine Transform and Green colour shows the 2D-HAAR Wavelet.
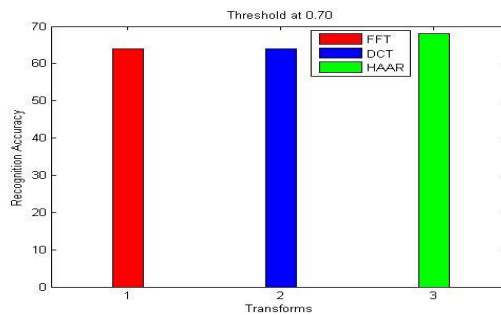
Figure 12: Threshold at 0.70

The Figure 13 shows the recognition accuracy for different transforms at threshold 0.65. Here X-Axis shows the transforms such as 2D-FFT, 2D-DCT, and 2D-HAAR wavelet and Y-Axis shows the recognition accuracy. When the threshold value is 0.65, 2D-Fast Fourier Transform, 2D-Discrete cosine transform and 2D-HAAR discrete wavelet transform gave the recognition accuracy of 60%, 64% and 76% respectively. From this graph concluded that 2D-HAAR discrete wavelet transform has the more recognition accuracy. In this bar graph red colour shows the 2D-Fast Fourier Transform, Blue colour shows the 2D-Discrete Cosine Transform and Green colour shows the 2D-HAAR Wavelet.
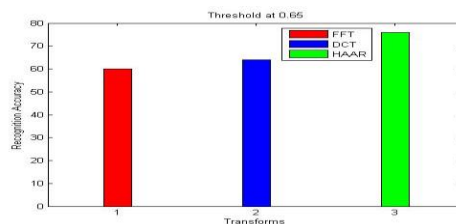
Figure 13: Threshold at 0.65

The Figure 14 shows the recognition accuracy for different transforms at threshold 0.60. Here X-Axis shows the transforms such as 2D-FFT, 2D-DCT, and 2D-Haar wavelet and Y-Axis shows the recognition accuracy. When the threshold value is 0.60, 2D-Fast Fourier Transform, 2D-Discrete cosine transform and 2D-Haar discrete wavelet transform gave the recognition accuracy of 68%, 68% and 76% respectively. From this graph concluded that 2D-Haar discrete wavelet transform has the more recognition accuracy. In this bar graph Red colour shows the 2D-Fast Fourier Transform, Blue colour shows the 2D-Discrete Cosine Transform and Green colour shows the 2D-HAAR Wavelet.
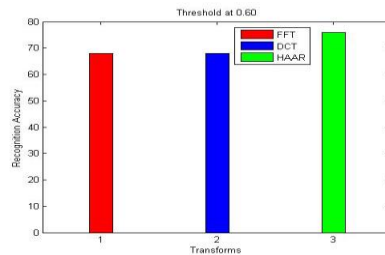

Figure 14: Threshold at 0.60

The Figure 15 shows the recognition accuracy for different transforms at threshold 0.55. Here X-Axis shows the transforms such as 2D-FFT, 2D-DCT, and 2D-HAAR wavelet and Y-Axis shows the recognition accuracy. When the threshold value is 0.55, 2D-Fast Fourier Transform, 2D-Discrete cosine transform and 2D-HAAR discrete wavelet transform gave the recognition accuracy of 72%, 72% and 84% respectively. From this graph concluded that 2D-HAAR discrete wavelet transform has the more recognition accuracy. In this bar graph Red colour shows the 2D-Fast Fourier Transform, Blue colour shows the 2D-Discrete Cosine Transform and Green colour shows the 2D-HAAR Wavelet.

Figure 15: Threshold at 0.55

The Figure 16 shows the recognition accuracy for different transforms at threshold 0.50. Here X-Axis shows the transforms such as 2D-FFT, 2D-DCT, and 2D-HAAR wavelet and Y-Axis shows the recognition accuracy. When the threshold value is 0.50, 2D-Fast Fourier Transform, 2D-Discrete cosine transform and 2D-HAAR discrete wavelet transform gave the recognition accuracy of 80%, 80% and 84% respectively. From this graph concluded that 2D-HAAR discrete wavelet transform has the more recognition accuracy. In this bar graph Red colour shows the 2D-Fast Fourier Transform, Blue colour shows the 2D-Discrete Cosine Transform and Green colour shows the 2D-HAAR Wavelet.
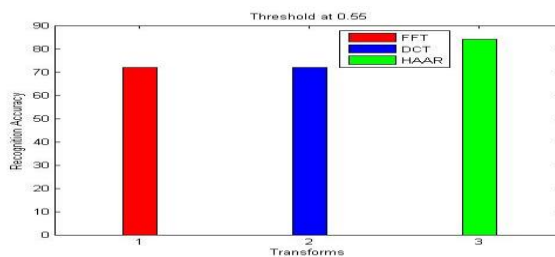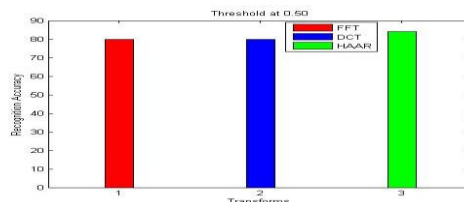

Figure 16: Threshold at 0.50

The 2D-FFT transform gave the highest recognition accuracy at a threshold of 0.50 which is 80% and the lowest recognition accuracy at threshold 0.65 which is 60%. This 2D-Fast Fourier Transform is used in pre-processing for image recognition. In this table threshold increases Recognition Accuracy is decreases. This is shown in Table 2.

Table 2: Threshold (Vs) Recognition Accuracy in 2D-FFT Transform

THRESHOLD	RECOGNITION ACCURACY
0.50	80%
0.55	72%
0.60	68%
0.65	60%
0.70	64%
0.75	64%

At threshold 0.5 2D-FFT got the recognition accuracy is 80% which is the highest accuracy. The lowest recognition accuracy in 2D-FFT is at threshold 0.65 is 60%. The Bar Graph for Threshold (Vs) Recognition Accuracy in 2D-Fast Fourier Transform (2D-FFT) at different threshold levels are shown in Figure 17.
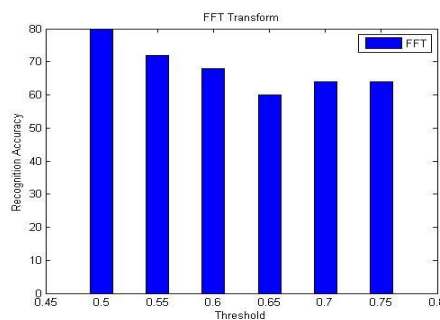

Figure 17: Bar Graph for Threshold (Vs) Recognition Accuracy in 2D-FFT Transform

The 2D-DCT transform gave the highest recognition accuracy at threshold of 0.50 which is 80% and the lowest recognition accuracy at different thresholds 0.65, 0.70 and 0.75 which is 64%. This 2D-Discrete Cosine Transform (2D-DCT) is used in JPEG image compression. In this table as threshold increases Recognition Accuracy is decreases. This is shown in Table 3.

Table 3: Threshold (Vs) Recognition Accuracy in 2D-DCT Transform

THRESHOLD	RECOGNITION ACCURACY
0.50	80%
0.55	72%
0.60	68%
0.65	64%
0.70	64%
0.75	64%

At threshold 0.50 2D-DCT got the recognition accuracy 80% and this is the highest accuracy. The lowest recognition accuracy in 2D- DCT is at different thresholds are 0.65, 0.70 and 0.75 is 64%. The bar graph for Threshold (Vs) Recognition Accuracy in 2D-Discrete Cosine Transform (2D-DCT) at different threshold levels are shown in Figure 18.
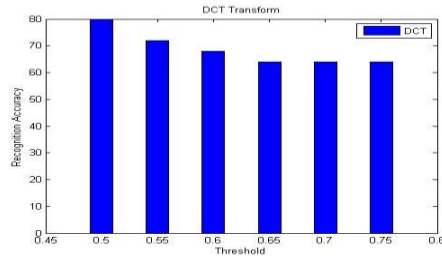
Figure 18: Bar Graph for Threshold (Vs) Recognition Accuracy in 2D-DCT Transform

The 2D-HAAR transform (2D-Haar Discrete Wavelet Transform) gave the highest recognition accuracy at threshold of 0.50 which is 84% and the lowest recognition accuracy at threshold 0.70 and 0.75 which is 68%. The Threshold (Vs) Recognition Accuracy in 2D-HAAR Wavelet Transform (2D-HAAR) is shown in Table 4

Table 4: Threshold (Vs) Recognition Accuracy in 2D-HAAR Wavelet

THRESHOLD	RECOGNITION ACCURACY
0.50	84%
0.55	84%
0.60	76%
0.65	76%
0.70	68%
0.75	68%

At threshold 0.50 2D-HAAR got the recognition accuracy is 84% and which is the highest accuracy. The lowest recognition accuracy in 2D-HAAR is at thresholds 0.70 and 0.75 is 68%. The Bar Graph for Threshold (Vs) Recognition Accuracy in 2D-HAAR Discrete Wavelet Transform (2D-HAAR) at different threshold levels are shown in Figure 19.
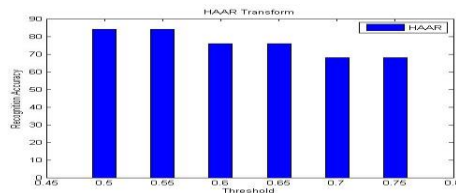

Figure 19: Bar Graph for Threshold (Vs) Recognition Accuracy in 2D-HAAR Wavelet Transform

3.6 Comparison between Existing Method and Proposed Method:

The comparison results between the existing method and proposed method are tabulated in Table 5. The published method used k-NN classifier with training sample size of 70 images. It is reported that the recognition accuracy obtained is 66.7% for 30 test images using Gabor Feature Vector. When SVM (Support Vector Machine) classifier was applied for the same testing and training database images, the recognition accuracy reported is 62%.

In the proposed method the total numbers of samples were 100 and the test samples were 25. The recognition accuracy obtained using k-NN classifier and using 2D-HAAR wavelet transform, the recognition accuracy of 84% is obtained.

The recognition accuracy is high in wavelet (2D-HAAR) transform since in the high pass bands, spatial resolution is high in frequency resolution is low compared to 2D-DCT which has high frequency resolution and low spatial resolution.

The wavelet (2D-HAAR) transform gave a higher recognition accuracy compared to 2D-FFT, since the 2D-HAAR transform captures both frequency and location information. Whereas, 2D-FFT is localized in frequency but not in space

Table 5: Comparison between Existing Method [3] and Proposed Method

	Existing Methods		Proposed Method
Algorithm	Euclidean Distance (k-NN Classifier)	SVM Classifier	Euclidean Distance (k-NN Classifier)
Number of trained samples	70	70	100
Number of tested samples	30	30	25
Recognition Accuracy	66.7%	62%	84%
Work	Animal Recognition	Animal Recognition	Animal Recognition
Technique	Gabor Feature Vector	Gabor Feature Vector	Image Processing Technique (2D-HAAR wavelet transform)

4.Conclusions

In this work, a total of 100 images of animals were considered as training samples and 25 images as testing set samples, which were downloaded from a standard database namely '3D Meshes Research Database'. The recognition accuracy of all these images are analyzed by using 2D-FFT, 2D-DCT and 2D-HAAR transforms. These images were binarized using thresholding concept with various values of threshold namely 0.50, 0.55, 0.60, 0.65, 0.70, 0.75 to find that value of threshold, which can give maximum recognition accuracy. The maximum recognition accuracy is obtained for a threshold 0.50 for all the transforms. The best recognition accuracy is obtained with 2D-HAAR transform compared to 2D-DCT and 2D-FFT.

The best recognition accuracy with 0.50 threshold is 84% when 2D-HAAR transform was applied to the test and training images. The recognition accuracy with 0.50 threshold using 2D-FFT is obtained as 80%. Again when 2D-DCT was applied to these test and training images at 0.50 threshold, the recognition accuracy is found to be 80%.

The recognition accuracy is high in wavelet (2D-HAAR) transform since in the high pass bands, spatial resolution is high in frequency resolution is low compared to 2D-DCT which has high frequency resolution and low spatial resolution.

The wavelet (2D-HAAR) transform gave a higher recognition accuracy compared to 2D-FFT, since the 2D-HAAR transform captures both frequency and location information. Whereas, 2D-FFT is localized in frequency but not in space.

The time of computation of the algorithm using MATLAB tool is 31 seconds using 2D-FFT method and 34 seconds for 2D-DCT method. However, 2D-HAAR Transform method took only 22 seconds for execution. Hence HAAR transfer method is the fastest in execution of the algorithm

References

1. Mark Brown et al, "A generalizable framework for saliency-based line segment detection", Pattern Recognition, 48 (2015), 3993–4011.
2. A.D. Reddy et al, "Quantifying soil carbon loss and uncertainty from a peatland wildfire using multi-temporal LiDAR", Remote Sensing of Environment, 170 (2015), 306–316.
3. Manohar N, Subrahmanya S, Bharathi R K, Sharath Kumar Y H, Hemantha Kumar G "Recognition and Classification of Animals based on Texture Features through Parallel Computing" 978-1-5090-1025-7/16/$31.00 ©2016 IEEE.
4. Anandakumar M. Ramiya et al, "Segmentation based building detection approach from LiDAR point cloud",The Egyptian Journal of Remote Sensing and Space Sciences (2016).
5. Shreyamsh Kamate et al, "Application of Object Detection and Tracking Techniques for Unmanned Aerial Vehicles" Procedia Computer Science, 61 (2015) 436 – 441.

6. https://www.rocq.inria.fr/gamma/gamma/download/ANIMALS/index0.php

7. Fabio POLLASTRONE et al, "Fully digital intensity modulated LIDAR", F. Pollastrone et al. / Defence Technology (2016).

8. Jianhua Yan et al., "Automatic Construction of 3-D Building Model from Airborne LIDAR Data Through 2-D Snake Algorithm", IEEE Transactions On Geoscience And Remote Sensing, Vol. 53, No. 1, January 2015.

9. Y H Sharath Kumar, Manohar N, Chethan H K(2014). Animal Classification System: A block based Approach. ICICT 2014.

10. Mikolajczyk, Krystian, and Cordelia Schmid. "A performance evaluation of local descriptors." Pattern Analysis and Machine Intelligence, IEEE Transactions on 27.10 (2005): 1615-1630.

11. Felzenszwalb, P. F., Girshick, R. B., McAllester, D., & Ramanan, D. (2010). Object detection with discriminatively trained part-based models. Pattern Analysis and Machine Intelligence, IEEE Transactions on, 32(9), 1627-1645.

12. Berg, Alexander C., Tamara L. Berg, and Jitendra Malik. "Shape matching and object recognition using low distortion correspondences."Computer Vision and Pattern Recognition, 2005. CVPR 2005. IEEE Computer Society Conference on. Vol. 1. IEEE, 2005.

13. Krijger, Hans, Greg Foster, and Shaun Bangay. "Designing a Framework for Animal Identification." (2008).

14. Haralick, Robert M., Karthikeyan Shanmugam, and Its' Hak Dinstein. "Textural features for image classification." Systems, Man and Cybernetics, IEEE Transactions on 6 (1973): 610-621.

15. Yuan, Xiao-Tong, Xiaobai Liu, and Shuicheng Yan. "Visual classification with multitask joint sparse representation." Image Processing, IEEE Transactions on 21.10 (2012): 4349-4360.

16. Tilo Burghardt. "Real time face detection and tracking of animals" (2006).. In: conference proceedings of Neural Network Applications in Electrical Engineering.

17. Yu, Xiaoyuan, et al. "Automated identification of animal species in camera trap images." EURASIP Journal on Image and Video Processing 2013.1 (2013): 1-10.

18. Zeppelzauer, Matthias. "Automated detection of elephants in wildlife video."EURASIP journal on image and video processing 2013.1 (2013): 1-23.

19. Narayanaswami, Ranga, et al. "Investigation of kinematic features for dismount detection and tracking." SPIE Defense, Security, and Sensing. International Society for Optics and Photonics, 2012.

20. Afkham, Heydar Maboudi, et al. "Joint visual vocabulary for animal classification." Pattern Recognition, 2008. ICPR 2008. 19th International Conference on. IEEE, 2008.

21. Ma, Lia, Yunhong Wang, and Tieniu Tan. "Iris recognition based on multichannel Gabor filtering." Proc. Fifth Asian Conf. Computer Vision. Vol. 1. 2002.

AUTHORS PROFILE

Dr. P. Narahari Sastry is working in CBIT **since 2003**, and is involved in Teaching and Research. He has recognized as Supervisor for JNTU Hyderabad, Osmania University Hyderabad and K.L. University Vijayawada. He has guided three **(03) PhD students** and also guiding eight (**8**) **Research scholars** from Osmania University Hyderabad presently. He has published **6 SCI Journals** in the last **5 years** and 2 of them are published in the reputed journals which are "Electrical **and Computer Engineering**" and **IEEE Communication letters**. Also he has applied and published his work in Indian Journal of patents, Chennai, India. He was the **PI** for an **AICTE project** titled "Design and Development of Palm Leaf Character Recognition System" granted under RPS scheme, which was successfully completed during the period**2013-16.**

Karanam Deepak, pursuing the Ph.D degree in Electrical Engineering from National Institute of Technology ,Patna, India. He Received the B.Tech degree in Electrical and Electronics Engineering from Prakasam Engineering College, Kandukuru, Prakasam (DT),A.P,India,in 2013.He has completed M.Tech in Power Electronics and Drives from VNR Engineering College,Ponnuru,Guntur (DT),A.P, India . Currently working as a Assistant Professor in G. Pullaiah College of Engineering and Technology since Three years. And his areas of interest are Power Systems, Electrical machines, Electrical Circuits and VLSI design