Project Title: Classification of animals using texture features and neural networks.

Theory:

Texture characterizes the spatial arrangement of pixel values in an image. Animals are characterized by the difference in pattern on their coats, thus making texure based methods useful for animal segmentation and classification. Different types of texture features include statistical moments, co-occurrence matrix features, spectral features, Gabor features.

Gray-level co-occurrence matrix :

The Gray-level co-occurrence matrix (GLCM) is a matrix G whose (i,j)th element denotes the number of times the gray-level combination i-j occurs within the neighbourhood defined as Q. Dividing G by the sum of its elements gives a matrix containing probabilities of co-occurrence of gray levels.

The features extracted from this matrix are

1) Maximum probability
2) Contrast
3) Correlation
4) Uniformity
5) Homogeneity
6) Entropy

These features characterize the smoothness/coarseness of the image. However, to obtain more information about the texture, other types of features are used.

Fourier Descriptors :

Fourier spectrum describes the directionality and periodicity of texture patterns. It forms a global description of texture which can be easily distinguished by the location of peaks in the spectrum. The DFT of image/region is converted to polar form (□, □) and descriptors are (□) and □(□) generated by summing along □ and □ respectively. Location of peaks of (□) denotes the periodicity of the pattern and peaks of (□) denote its orientation.

Texture based Segmentation :

Region merging techniques for segmentation are based on similarity in gray values. For texture based segmentation of animals in an image, similarity in texture can be used as a criteria for merging regions. The procedure is as follows:

1) The image is split into 16 x 16 sized blocks and texture features using any of the methods are calculated for each block.
2) K-means clustering is applied to these features. The number of clusters is decided by finding the k value for which distance between clusters is maximum, i.e. different clusters are dissimilar.
3) Examining the connected components for each cluster gives the segmented foreground pixels. Border pixels are excluded to distinguish between background and foreground. The extracted connected components are further used for classification.

Classification :

Segmentation detects the foreground (animals) in the image. These animals can be classified into different classes using ANN.

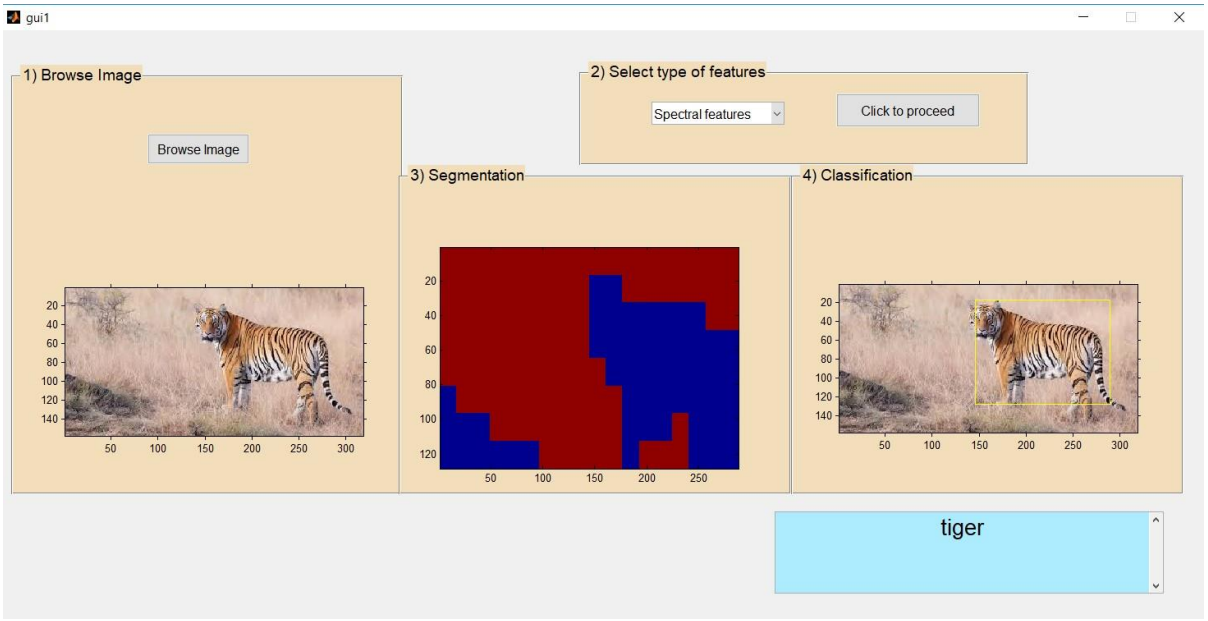
Artificial Neural Network classifier:

ANN is a set layers of neurons connected by different weights. The input layer takes the values of features and output layer takes the values of classes. The hidden layers are intermediate stages in reaching to the output values by combinations of input features. Training of neural network involves optimizing the weights so as to minimize error between output class and target class. This done by using gradient descent algorithm.

The procedure of animal classification is as follows :

1) Calculate texture features for the extracted foreground.
2) Apply the test features to the classifier.
3) If the maximum class score is greater than a threshold, animal is classified as that class.

Result :



Confusion Matrix:

GLCM features

Output\Target	Tiger	Leopard	Bear	Lion
Tiger	0	0	0	0
Leopard	6	7	3	3
Bear	0	0	2	0
Lion	3	3	3	5

Accuracy = 42.42%

Fourier descriptor

Output\Target	Tiger	Leopard	Bear	Lion
Tiger	11	1	0	0
Leopard	1	13	0	0
Bear	0	0	17	1
Lion	0	0	2	11

Accuracy = 90.7%

Conclusion :

GLCM and Fourier descriptors both perform well for segmentation. However, the accuracy of classification for GLCM is low, as only coarseness of texture cannot distinguish between different patterns found on animal coats. Fourier descriptor performs well for classification as it can distinguish between periodicity and shape of texture patterns.