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Classification of Birds Species Using Artificial Neural Network

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Abstract – In this paper classification of birds species using Artificial Neural Network is proposed by carefully selecting a combination of features from shape, color and texture feature. A detailed and up to date study of bird species would help us to transform entire landscape, control pests and pollinate plants. In this paper experiment is performed on a datasets of 56 birds and by selecting the most appropriate features a good accuracy was recorded. The main motive of the paper is to optimize the features required for bird classification when the dataset contains birds at various view-point s and configurations.

Key Words: Optimized features, Artificial Neural Network, Confusion Matrix

I. INTRODUCTION

Bird detection and classification using Pattern Recognition is a widely concentrating field in research. Birds play an essential role in shaping the ecosystem of the world by directly influencing food production, human health, revenue generation and culture. The importance of bird is quite apparent in controlling pests, pollinating plants, spreading seeds and transforming landscapes. Even the sea birds help in maintaining the coral reef alive and fertilizing the marine ecosystems. For the past 5 centuries more than 190 bird species have become extinct and the rate of extinction seems to be increasing. Some bird species are critically endangered, vulnerable and near threatened. Some of the most common critically endangered species includes sparrow, parrot, owl etc. The reason for their diminishing population can be attributed to many reasons such as emissions from microwave towers, loss of habitat, rapid urbanization, high level of pollution and illegal bird killing. Due to high intrinsic value of birds humans have an ethical obligation to conserve and protect them. The motivation of the project is to build an automatic bird detection and recognition system that can be deployed in cameras, which will be helpful for biologists, researchers , wild life photographers, monitoring and security purposes. In this work intra-species bird classification using artificial neural network is proposed based on four bird classes that include some critically endangered species and finding out the optimum features required for its classification especially when birds are present at various angles and configurations.

II. PREVIOUS WORK

There are number of works related to bird classification. A deep learning based technique for bird recognition using the concept of image processing was proposed in [1]. Image recognition system using Pytorch Model was proposed in [2]. An inception neural network model to improve bird classification accuracy was proposed in [3]. Shape feature based bird classification using KNN and SVM classifier was proposed in [4]. Automatic Bird Recognition system by their vocalization using Support Vector Machine was proposed in [5]. White-tailed Eagle and Lesser Black-backed Gull bird species was classified using CNN in [6]. Bird detection and scaring system to protect ripening fruit was proposed in [7]. 27 bird species was detected using a mobile app named Internet of Birds (IoB) and classified using CNN and SVM was proposed in [8]. An automatic bird sound detection using deep learning was in [9]. Bird acoustic detection using CNN and RNN was proposed in [10]. An animal recognition system based on Bilateral Convolutional Network (BCNet) so as to be exploited in mobile devices was proposed in [11]. Recognition of animal species based on combination of features using ANN was proposed in [12].

III. PROPOSED METHOD

Bird recognition is one of the research areas in which few useful technologies have been suggested. Classification of bird species using artificial neural network is done by taking the most relevant features that is independent of view-point. Fig.1 illustrates the process flow diagram of the suggested method.

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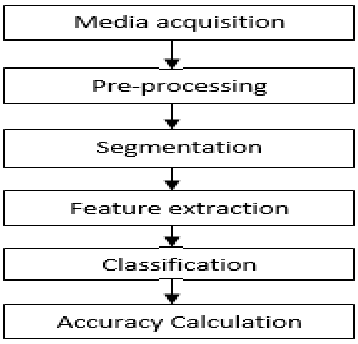

Fig-1: Process Flow Diagram of Proposed Method

1.1 MEDIA ACQUISITION

A customized dataset is created for both training and testing images by downloading images from the internet. To introduce sufficient alteration, the images are shown from different viewpoints.

1.2 PRE-PROCESSING

It includes steps to make image suitable for feature extraction to reduce the computational load by resizing the images to standard dimensions of horizontal 256 and vertical 256 pixels.

1.3 SEGMENTATION

After resizing the images to standard dimensions, the color image is converted to grayscale image for binary thresholding and for color thresholding, the image is splitted into three separate color channels Red, Green, Blue, and thresholding for the individual channel is done. The Otsu's Binarization technique is used for thresholding and the threshold level is maintained at 0.94. The threshold level is estimated on the basis of trial and error method by observing the histograms for the individual channels.

1.4 FEATURE EXTRACTION

After the completion of segmentation steps, the individual features like shape, color and texture are extracted.

Shape Features: The most relevant shape features for bird classification includes **Area**, **Centroid**, **MajorAxisLength**, **MinorAxisLength**, **Perimeter** and **FilledArea** are collected.

Color Features: The image is splitted into three color channels. The H(Hue), S(Saturation), V(Value) rather than R(Red), G(Green), B(Blue) channel for feature extraction due to the robustness of HSV over RGB in getting the luminance information. **Mean** and **Standard Deviation** for those individual color channels are collected.

Texture Features: Texture indicates the variations of gray-level over the image. Hence it is computed from gray-level co-occurrence matrices (GLCM) along four directions, 0 degree, 45 degrees, 90 degrees and 135 degrees. The GLCM based features includes **Energy (GE)**, **Correlation (GN)**, **Homogeneity (GH)** and **Contrast (GC)** respectively.

IV. CLASSIFICATION

The classification is done with help of **Multilayer Perceptron (MLP). MLPs** are generally applied to problems related to supervised learning. It consists of a training phase and a testing phase. In train phase a model is created to learn the dependencies between input and output. It involves adjusting the weights and biases iteratively for error minimization, until convergence is achieved. Then it is tested with the help of unknown test samples. The test samples have variations relative to the training samples. 50% of images in the dataset are treated as training samples whereas the rest 50% of dataset is treated as unknown testing samples to predict the classification percentage. It is reported in experimentation section below.

V. EXPERIMENTATION AND RESULTS

Experiments are performed on a customized dataset of 56 images, in order to test the classification performance. The dataset is divided into 4 classes i.e Crow, Parrot, Sparrow, Eagle. The dataset contains some critically endangered species like Parrot and Sparrow. The training and testing dataset is divided equally in the ratio 50:50 as shown in Fig. 2 and Fig. 3 respectively with one image of each class.

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

Figure-2: Training Samples: Crow class 1(a); Parrot class 3(b); Sparrow class 4(c); Eagle class 2(d)

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

Figure-3: Testing Samples: Crow class 1(a); Parrot class 3(b); Sparrow class 4(c); Eagle class 2(d)

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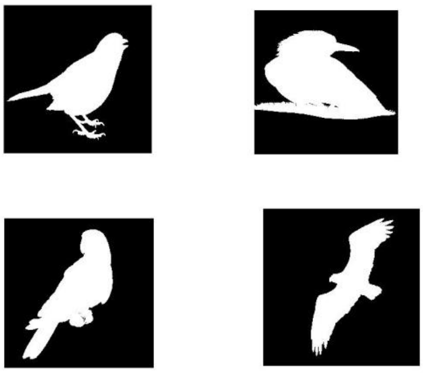
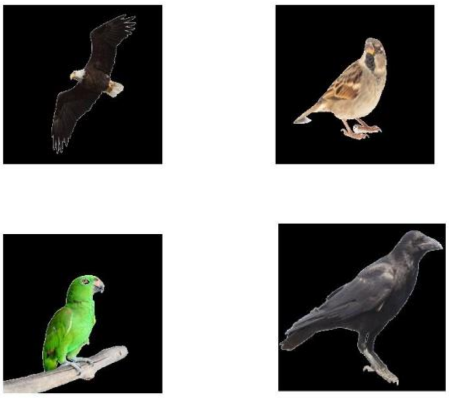
The images from the customized dataset are pre-processed by scaling down to standard 256 horizontal pixels and 256 vertical pixels to minimize the computational burden.The Black and White and Color segmented images is obtained using Otsu Thresholding whose threshold level is maintained as **0.94** for black and white segmentation and for color segmentation, the image is splitted into 3 separate color channels and threshold value for individual channel is maintained as **0.94** (Red), **0.94** (Green) and **0.94** (Blue) respectively as shown in Fig. 4 and Fig. 5 respectively with one image of each class.



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

Figure-4: Black and White Segmented images



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

Figure-5: Color Segmented images

Then the individual features are extracted and stored in feature vectors. For each image of bird the shape feature is represented by 7 dimensions of vector.

FS = {Area, Centroid, MajorAxisLength, MinorAxisLength, Perimeter, FilledArea}

For each image the color feature is represented by 2 dimensions of vector in three distinct channels hue, saturation and value leading to a total of 6 color features

FC = {Mean, Standard Deviation}

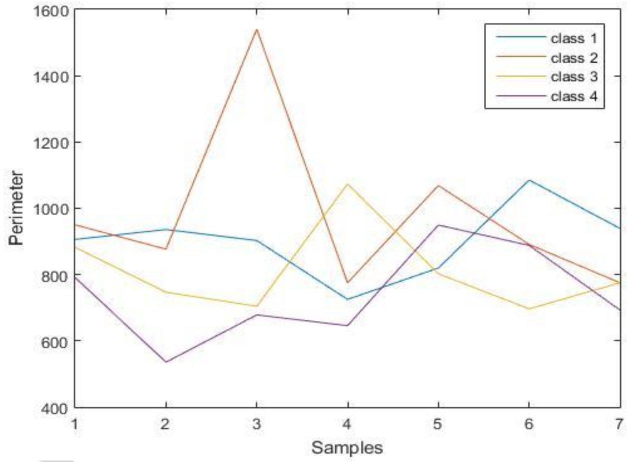
For each image 4 GLCM based features which represent texture are calculated along 4 different directions visualizing 0 degree, 45 degrees, 90 degrees and 135 degrees, leading to a total of 16 texture feature.

FT = {Energy, Correlation, Homogeneity, Contrast}

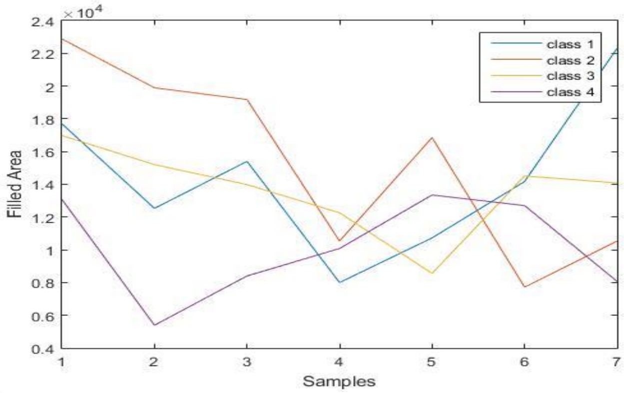
For each image the optimized features are obtained by combining shape, color and texture features and represented by 29 dimensions of vector.

FO = {FS, FC, FT}

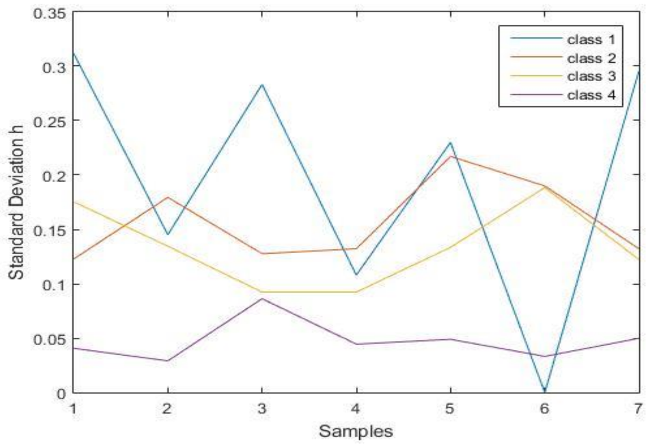
The variations of the some features like shape, color and texture are illustrated in Fig. 6 below. These features indicate variability between different classes. This apparent variation of shape, color and texture features between different classes is exploited in classification.



(a)



(b)



(c)

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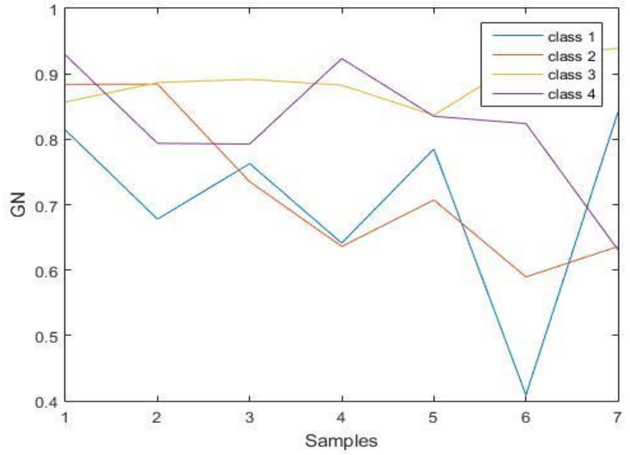
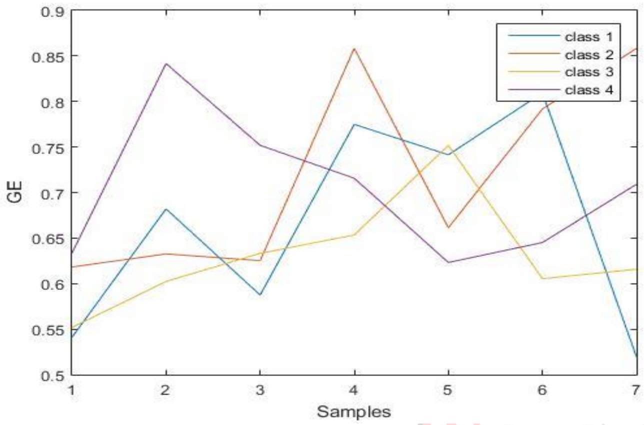
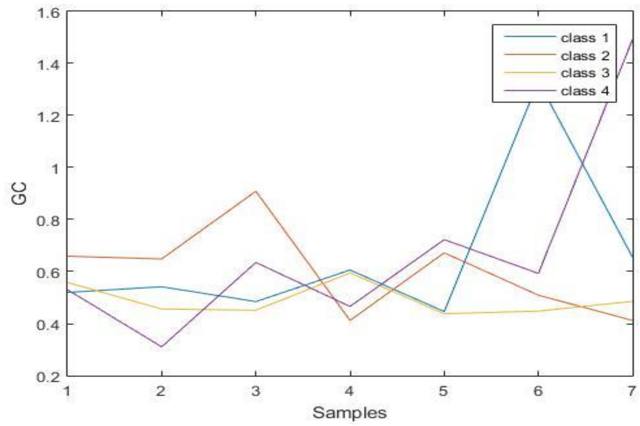


(d)



(e)



(f)

Figure-6: Feature variation plots: Shape features (a,b); Color features (c); Texture features (d,e,f)

After the completion of feature extraction the individual feature and combined feature vectors are fed into **MLP** for classification. It uses the number of features used for classification in input nodes, 18 nodes in hidden layer and 4 output nodes for four different bird species. The optimal size of the hidden layer usually lies between the size of input and output layers. The activation function used for the hidden layer is **Tan-sigmoid** activation function

$$y = \frac{1-e^{-x}}{1+e^{-x}}$$

VI. ACCURACY CALCULATION

The performance of the classification model is calculated from confusion matrix. It is a table used to predict the classification performance of testing data for which the actual values are previously known. The terminologies used in confusion matrix are **True Positive (TP)**, **True Negative (TN)**, **False positive (FP)** and **False Negative (FN)**. **True Positives** are the cases in which the classifier predicted yes and they are actually yes. **True Negatives** are the cases in which the classifier predicted no and they are actually no. **False Positives** are the cases in which the classifier predicted yes and they are actually no. **False Negatives** are the cases in which the classifier predicted no and they are actually yes. The **Classification Accuracy** means how often the classifier is correct and is given by the mathematical expression **(TP+TN)/total**.

The accuracy obtained by using optimized features (combined features) is 88.5% as illustrated in Fig. 7.

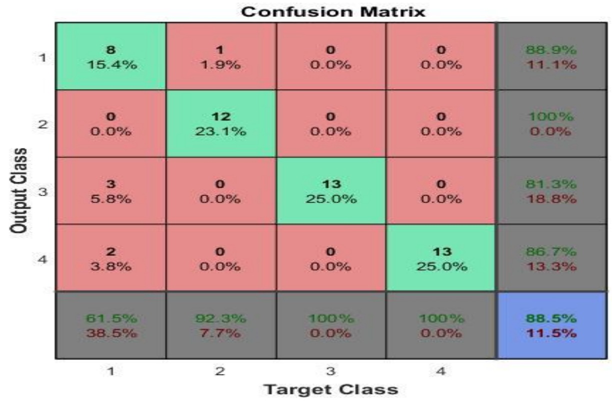


Figure-7: Confusion Matrix for combined features (Optimized features)

VII. ANALYSIS

A summary of the classification accuracies taking various features like **Shape (1), Color(2), Texture(3), Shape and Color(4), Shape and Texture(5), Color and Texture(6)** and the **Optimized Features(7)** is illustrated in Fig. 8. for four different bird species.

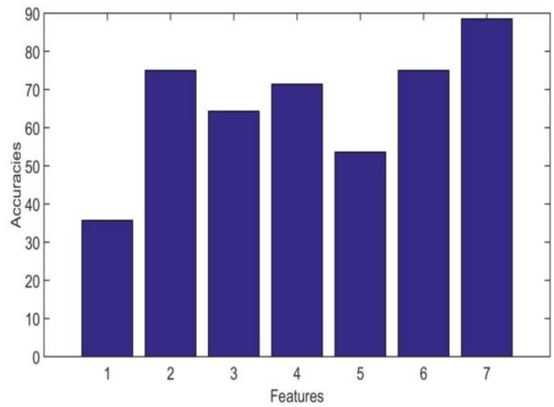


Figure-8: Summary of classification accuracies

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It is observed that the classification accuracy taking shape features alone is 35.4%, taking color features alone is 75% and taking texture features alone is 62.5%. Whereas on combining shape and color feature the accuracy obtained is 71.5%, on combining shape and texture the accuracy obtained is 52.5%, and on combining color and texture the accuracy obtained is 75% .It clearly shows that the classification accuracy has significantly increased when the features are combined or optimized which is evident from 88.5% accuracy in this case. The reason for obtaining high accuracy using combined features is due to the fact that the dataset contained images of birds that are taken at different orientation, angles and poses which resembles real life scenario.

VIII. CONCLUSION AND FUTURE SCOPES

This paper proposes a technique for classification of bird species using Artificial Neural Network by optimizing the features that obtained a good accuracy of 88.5%. The dataset used is quite robust, since it contained some bird species that are listed as critically endangered species. The proposal used a combination of shape, color and texture features on a dataset that contained 56 bird samples. A comparison of classification accuracies by combining various features is also performed, which may be useful in developing an automatic bird recognition system for accurately detecting bird species that can be exploited in cameras for bird researchers and monitoring purposes. The main contribution of the work is to identify the most appropriate features, for better classification of birds on a dataset that contains images that are present at various view-points and configurations. The most appropriate features include **Area**, **Centroid**, **Major Axis Length**, **Minor Axis length**, **Perimeter**, **Filled Area**, **Mean**, **Standard Deviation**, **Energy**, **Contrast**, **Correlation** and **Homogeneity** respectively. Future work will include classification of bird species using the optimized features by various classifiers like K-**Nearest Neighbor** and **Support Vector Machine**.

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