Color-Based Bird Image Classification using Support Vector Machine

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***Abstract*—The classification and identification of the bird species from the visual image is complex compared by using audio song. The knowledge of the features species type is very important as to ensure it is classified to the correct species. Color-based feature extraction is one of the procedure in extracting the color properties from the bird which to represent the species of the bird. However, it is a challenging task due to the environment problems which is from the background with natural habitat of the bird images. It is also difficult when the bird images come into view of different angles and sizes. Therefore, this paper proposed a solution to consumer electronic which field-portability, cost-effectiveness and easy-to-use interface that experimented on the segmented bird images as to ensure the accurate results of classification is produced. This paper investigated on nine color-based features of mean, standard deviation and skewness of each plane of red, green and blue (RGB) from the bird images. All these features are experimented on 100 images for each species of snowy owl and toucan. The bird classification using Support Vector Machine algorithm is identified as a promising method in bird classification which produced 97.14% accuracy rate for training data and 98.33% for testing data.**

Keywords—Feature extraction; Color-based features; Color analysis; Bird classification; Support Vector Machine

I. INTRODUCTION

The research on bird classification was started over 20 years ago by using audio song which to recognize and identify the types of bird species. The increasing growth of bird studies which can be applied in various applications. The use of various platform of bird studies applications such as mobile application is to provide better services to consumers such as for experts, teaching and learning of bird species and tourism sector. These applications are seen as a necessary as field-portability, cost-effectiveness and easy-to-use interface to the potential consumers. In recent times, the bird classification studies initiate by using visual bird images in image processing which to recognize the bird species type. There are many advantages of this bird classification such as for environmental protection and endangered animal rescue [1]. The manual identification and classification of bird species is usually done by ornithologists which is the expert on the bird domain. The well-known setback to the ornithologists is its requires a longer time to identify the correct species. They have to study on the bird existence in nature, biology species, songs, distribution and ecological impact [1] before been able to identify the species type. This is a challenging tasks to the expert. Besides, the main problem in image processing domain when to identify the bird species, the study need to acquire the main object that is bird within the image since the images include the unwanted objects such as background, trees and other objects.

Therefore, the bird classification and identification studies which to predict the bird species can be described and represented from the visual bird images and bioacoustical of the bird [2] [3] [4]. There are numerous works and techniques which proposed and utilized the bioacoustic sound, songs and signals to identify the correct species type of the bird. However, there are several researches on the bird

However, it is very challenging and difficult works due to the environment factors such as illumination, and background problems with natural habitat of the bird images. The other variations of visual features such as shape, color and texture which to annotate, identify and classify the bird species

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accurately [3]. It is complex problem when involved with the geometric factors such as the difference and the difficulty of the rotation, angle and size.

Feature extraction is one of the components required when to process the image properties which the aim is to classify the bird species. There are three common visual features in extracting the features and patterns which are to describe and represent the object: color-based, texture-based and shape-based methods [5]. The color feature extraction refers to the describing and computing the color properties of the image to represent the color features which to classify the color properties of the image. Texture feature extraction is applied when computed on the characteristic of images which to describe the texture of the image. Besides, this feature has advantages when to differentiate between object with similar color and shape [6].

Therefore, this paper investigated and experimented on the color-based feature extraction for bird species classification. This research is experimented on the nine extracted features of mean, standard deviation and skewness of each plane of red, green and blue (RGB) of bird images.

This paper is organized into various sections. Section I identifies the motivation of the existing research. On the other hand, Section II describes the datasets that are investigated in the experiments. The details about the techniques and methods applied are explained in Section III. Then, Section IV presented the experimental results and discussion of the applied methods during the experiment. Finally, the paper is summarized in the Section V.

II. Bird Species Datasets

The image datasets for this experiment comprise of bird images which are taken and downloaded from the Datasets for Computer Vision Research [7]. This database contains six bird species which are egret, mandarin duck, snowy owl, puffin, toucan and wood duck. This paper is focused and experimented on two species which are snowy owl and toucan. The two bird species experimented are randomly selected from the database. The total of 200 images which consist of 100 images of snowy owl bird species and 100 images of bird species of toucan are utilized as the test images.

All the datasets are pre-processed prior to color feature extraction as the original images included the unrelated background and objects which will affect the results of color feature extraction of bird images. The detail explanation on the bird image segmentation in Section 3.1. Fig. 1 and Fig. 2 below illustrates some example of snowy and toucan bird species from the Datasets for Computer Vision Research.

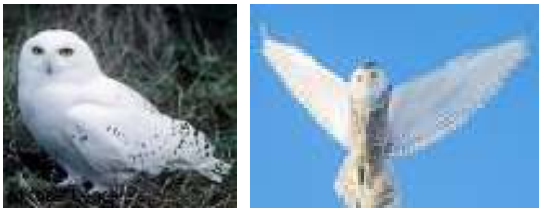

Fig. 1. Example of Snowy Owl Bird Species

Fig. 2. Example of Toucan Bird Species

III. Methodology

The aim of this paper is to investigate and experiment on the nine color-based features which are mean, standard deviation and skewness for all planes of red, green and blue (RGB) of bird images. The purpose is to extract all the nine color-based features which to classify the bird species using Support Vector Machine algorithm. The phases involved are (1) bird image segmentation (2) color-based feature extraction (3) color-based classification.

A. Bird Image Segmentation

The bird image segmentation is an essential stage as it is needed for pre-processing step before can be applied to the other applications. Other applications that can be applied such as various color, texture, shape extraction and bird classification. In the phase of pre-processing, bird image segmentation is a preliminary study before used further for the other applications and analysis which needed prior to perform the bird species analysis such as extraction and classification. The results of this phase can also be used for other applications. This phase is important since this research focused to identify the species type without to include any objects such as unwanted objects within the images.

This bird image segmentation procedure refers to the segmentation and extraction the bird region within the image which eliminate the unwanted regions. Nevertheless, this procedure is difficult when the environmental factors of background with natural habitat which included in that image. There are many setbacks when to extract the bird region accurately. For example, variations of visual features such as shape, color and texture which to annotate and segment the bird images accurately [3]. The computational calculations [1] are also higher when involved with human and experts. The manual identification and classification requires ornithologists that are experts in this domain to identify the accurate bird species which need longer time to process. They also need to

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study on the bird biological existence [3] before identifying the bird species type. This is a challenging tasks to the experts.

As to make sure to produce the accurate the results of classification. This stage experimented on the variety of bird species images that had been taken in the area of Malacca city. The steps involved are explained as follows.

1) Sobel Edge Detection: The purpose of this step is to detect the edges of the bird images. Fig. 3 shows the process of Sobel edge detection method.

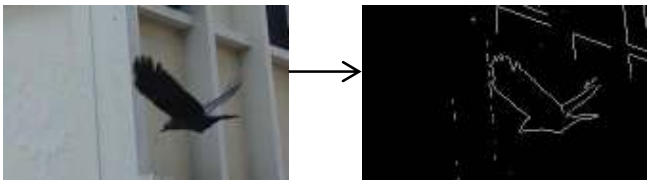

Fig. 3. Sobel Edge Detection

2) Mathematical Morphology: In this stage, this study applied dilated gradient. Then, fill in the bird region. After the results of fill in is produced, this study cleared border within the image. Finally, applied erosion to get back the original size of the bird images. The mathematical morphology involved shown in Fig. 4 below.

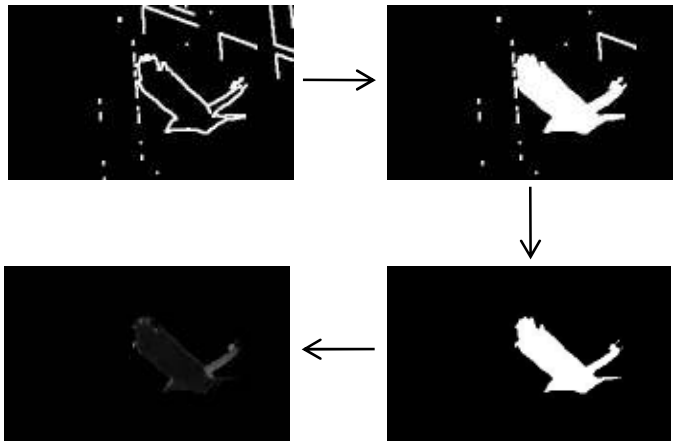

Fig. 4. Mathematical Morphology Process

B. Color-Based Feature Extraction

For this phase, there are three color-based features are extracted from the bird color images. The aim of this experiment is to extract the nine color features of mean, standard deviation and skewness for red, green and blue (RGB) planes of the bird images [15][16].

1) Mean: To calculate the amount of color average in the bird color image. The formula of mean can be computed as Equation (1).

$$E_i = \sum_{j=1}^{N} \frac{1}{N} P_{ij} \quad (1)$$

where:

N = number of pixels in the image

P_{ij} = the value of the j[th] image pixel at the i[th] color component

2) Standard Deviation: It is obtained from the square root of the color distribution variance. It is computed as Equation (2) below.

$$\sigma_i = \sqrt{\left(\frac{1}{N}\left(P_{ij} - E_i\right)^2\right)} \quad (2)$$

where:

E_i = mean value for the i[th] color component of the image

3) Skewness: To measures of asymmetric distribution of colors in an image. It can be calculated as Equation □ 3□ .

$$s_i = \sqrt[3]{\left(\frac{1}{N}\sum_{j=1}^{N}\left(P_{ij} - E_i\right)^3\right)} \quad (3)$$

where:

N = number of pixels in the image

P_{ij} = the value of the jth image pixel at the ith color component

E_i mean value for the i[th] color component of the image

The total of nine color-based features are computed for all planes of RGB which are red, green and blue components.

C. Color-Based Classification

For this color-based classification phase, this study applied on Support Vector Machine algorithm to identify and classify the bird species type of color bird images [17]. In this phase, it is divided into two groups which are training and testing data with ratio of 70: 30.

The aim of SVM method is to find the optimal separating hyperplane between classes by focusing on the training cases that are placed at the edge of the class descriptors [18]. These training cases are normally called support vectors. Training cases other than support vectors are discarded. Support vector machine is a type of general linear classification and it is help to minimize error in classification. SVM is a kernel-based methodology used as a influential tool in recognition and automatic classification systems. Their larger generalization properties and accuracy offer benefit over other types of classifiers.

A typical output representing hyperplane and margins for an SVM trained model with samples from two classes. Support vectors are represented as samples on the margin,

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separated by a hyperplane. A kernel refers to a similarity function provided to a machine learning algorithm which takes two inputs and informs us about the degree of similarity in the two classes.

IV. Results and Discussions

The experimented methods are evaluated on 200 bird images of snowy owl and toucan species type. This paper utilized on all nine color-based features of mean, standard deviation and skewness for red, green and blue (RGB) planes of the bird images. The examples results of nine color-based features of mean, standard deviation and skewness of RGB planes for snowy owl and toucan are illustrated as in TABLE I.

The purpose of performance evaluation of color-based features is to evaluate the accuracy result of the training and testing datasets of the bird classification studies. Performance evaluation of color-based features are computed using quantitative evaluation of accuracy. The accuracy results of training and testing data are evaluated by comparing the experimented results with the ground truth data. For example, it is evaluated as true as both the ground truth data and experimented result are toucan bird species. If the experimented results are not produced the same results with the ground truth data, then it is evaluated as false. The examples results of bird classification for both species are tabulated in TABLE II.

TABLE I. The Results Of Color Feature Extraction For All Three Planes

Original Image	Color Features		
	Mean	**Standard Deviation**	**Skewness**
	Red: 84.0269003 Green: 84.13616918 Blue: 85.19859819	Red: 100.7173799 Green: 101.3551547 Blue: 103.5061422	Red: 0.47546145 Green: 0.490632866 Blue: 0.515585288
	Red: 20.92034314 Green: 15.62471318 Blue: 8.242536968	Red: 56.58303636 Green: 43.06265431 Blue: 29.02926582	Red: 2.804721574 Green: 3.067761922 Blue: 4.34891242

A. Color-Based Classification

The experimented datasets of the training and testing are then evaluated by using the evaluation classification model that is accuracy testing. The purpose is to measure the classifier performance when extracting all the nine color-based features. The result of accuracy for training datasets is 97.14% while the accuracy result of testing datasets is 98.33% which produced higher than training data. It shows that performance of classifier is stable when we applied on testing data.

V. Conclusion

The experimented nine color features are extracted on 100 images for both species of snowy owl and toucan. The bird classification using Support Vector Machine algorithm is identified as a promising method in bird classification.

For future development, further research may focus on improving the accuracy rate of mouth segmentation and temporal features extraction of the mouth segmented images.

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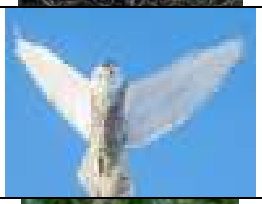
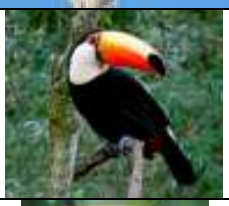
TABLE II. COMPARISON OF THE SAMPLE RESULTS OF BIRD CLASSIFICATION AND GROUND TRUTH

Data Set	Original Image	Color-Based Features			Ground Truth	Bird Classification	Results
		Mean	Standard Deviation	Skewness			
Snowy Owl		Red: 23.07058122 Green: 19.22913065 Blue: 14.18275211	Red: 62.00009668 Green: 51.06849124 Blue: 42.1139027	Red: 2.989422154 Green: 3.213000545 Blue: 4.057095127	Snowy Owl	Snowy Owl	True
Snowy Owl		Red: 59.13770014 Green: 61.49865789 Blue: 63.52823351	Red: 89.90863725 Green: 92.32010635 Blue: 94.88887918	Red: 1.008201249 Green: 0.934351008 Blue: 0.900747751	Snowy Owl	Snowy Owl	True
Toucan		Red: 20.87957581 Green: 15.48214317 Blue: 13.53248805	Red: 63.38636134 Green: 51.28935431 Blue: 46.75384174	Red: 2.993497786 Green: 3.562311381 Blue: 3.78711012	Toucan	Snowy Owl	False
Toucan		Red: 41.65429012 Green: 37.46080247 Blue: 31.86476852	Red: 73.73443047 Green: 63.73713243 Blue: 52.52791045	Red: 2.051647217 Green: 2.193208722 Blue: 2.284873238	Toucan	Toucan	True

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