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Bird Species Identification System

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***Abstract*—** Birds are amazing creatures, and having wonderful lives right along with humans. Birds are one of the indicators of climatic changes. They help in maintaining the environment and food chain by eating pest and this result in ecological balance. Naturally, each and every bird differs from one another by their characteristics and also with the body features like shape, size, color, beak, feathers and silhouette etc. The images of birds are very much helpful in finding the species rather than audio based classification. Humans are more comfortable to recognize the birds through image classification than any other ways of classification. The dataset of birds are collected and it is one of the important parts in image classification. Image classification is the process of taking an input and outputting the probability that the input is a particular class .By using Machine learning technique called Random Forest, the input image is converted into grey scale format to generate autograph by using tensor flow. As a result of this, the features of the given bird image is extracted and name of the bird is identified along with its origin.

***Keywords*—**Machine Learning, Random Forest

I. INTRODUCTION

Birds play a major role in different levels of tropic webs, from mid-level consumers to top predators. As like other organisms, birds also helps in maintaining the sustainable population levels of their prey and predator species and, after death, provide food for scavengers and decomposers. Many birds are pollinators or seed dispersers in plant reproduction through their services. Birds also provide bottleneck for their many host-specific parasites, including lice that eat only feathers of birds, flies adapted for living on birds, and mites that hitchhike on birds from plant to plant and even between countries through migration. Some birds are considered keystone species. A keystone **species** is sometimes considered as a dominant predator whose removal allows its prey population to explode and often decreases overall diversity of its prey or other species which depends on them. For example, woodpeckers create cavities that are then used by many other species like eastern screech owls, wrens, and bluebirds need pre-existing cavities for their nests, and they often use woodpecker holes. After the extinction of the dodo, it was discovered that tambalacoque whose fruits had been a primary food item of the dodo was unable to reproduce without its seeds passing through the dodos' digestive tracts, which process scarified the seed coat and enabled germination. This tree is often called as dodo tree because this tree serves as the primary food of dodo bird. To avoid these kinds of extinction of birds and bird dependent species it is important to protect the birds which are available as of now. To protect them, one should know about the species and the origin of the bird. Many systems to find bird species were proposed and still many researchers working on that to find an efficient way.

The identification of bird species can be done through different ways like image, audio or video. An audio processing technique makes it possible to identify by capturing the audio signal of birds, because each and every bird has unique voice signals. But, due to the mixed sounds in environment such as insects, other birds, objects from real world, etc. processing of such information becomes more complicated. So, Image based classification of birds is mostly preferred .The marks that distinguish one bird from another are also useful in image based classification , such as breast spots, wing bars which are described as thin lines along the wings, eye rings, crowns, eyebrows. The shape of the beak is also an important feature as a bird can recognized uniquely. The characteristics of bird such as shape and posture are the two important features used to identify birds. Mostly experts can identify a bird from its silhouette because this characteristic is unique and it is difficult to change. A bird can also be identified and differentiated from other using its tail. The tail can be recognized in different ways such as notched, long, pointed, and rounded. Sometimes legs are also used for recognizing an image in the format as long, or short. Many parameters are available for recognizing the bird, by considering a single parameter will not yield an accurate result. So, multiple parameters are to be considered in order to get appropriate and better output. Supervised learning algorithm is used for developing the system. Supervised learning algorithm is one where you have input variables (x) and an output variable (Y)

$$Y = f(X)$$

Supervised learning is mostly used for classification algorithms and regression techniques to develop predictive models. K-nearest neighbor algorithms or KNN, belongs to a type of machine learning models which are frequently called 'lazy algorithms'. These algorithms receive this name because they do not learn how to discriminate the dataset with an optimized function, but memorize the dataset instead. It also refers to the kind of algorithms called nonparametric. These algorithms are characterized by memorizing the training dataset, and lazy learning is a specific case of these algorithms, they are associated with zero computational cost during the learning. If the image has a lot of features, the decision tree Algorithm usually tend to overfit, overcomplicating the model and the learning process. To solve this issue each feature is selected randomly and making decision trees for each batch of features. This algorithm is called random forest. The "forest" it builds, is an ensemble of decision trees, usually trained with the "bagging" method. The proposed system uses these two algorithms to produce an efficient bird species identification system. The importance of the proposed algorithm is that the system can handle high dimensional spaces as well as large number of training examples and is robust to noisy training data and is effective in case of large number of training examples.

II. RELATED WORK

This section provides an introduction of the existing methods in detecting the forgeries and elaborates the challenges.

A. Audio-Based Techniques

Audio based recognition is the common technique used for species identification. Elias Sprengel, Martin Jaggi, Yannic Kilcher, and Thomas Hofmann proposed an efficient audio based identification of bird species using signal processing. The first step in signal processing is the separation of birds sound and the environmental noise. To divide the sound file into a birds sound signal and a noise part, first compute the spectrogram of the whole file. The signal is passed through a short-time Fourier transform (STFT).Then split both spectrograms into chunks of equal size. Every time the neural network with a training example is shifted in time by a random amount. In case of the spectrogram this means that the signal is cut into two parts and place the second part in front of the first. Pitch shifts (vertical shifts) also helped in reducing the classification error. Then the signal is processed by adding some files of the same class and then it is augmented. The main disadvantage of this approach is that it might disregard less audible background species because in the first step we divide the signal and noise and focus only on signal. This is unsuccessful for the following approaches: Bi-directional LSTM Recurrent Neural Networks, Regularization, Non-Square-Filters and Deeper networks.

B. Colour-Based Techniques

Andreia Marini, Jacques Facon and Alessandro L. Koerich proposed a color based approach, which is one of the important feature in the image based classification. This is a segmentation based approach which uses RGB and HSV for segmentation. The segmentation is based on the position of the birds in the images and the things which are other than birds is considered as strips in the image. These strips are considered as image background which are removed. Next, a search procedure is carried out in the remaining part of the image in which the colors that matches with the strips are considered as background , otherwise it is labeled as "bird". Then to calculate segmentation rate they counted the number of True Positives (TP), True Negatives(TN),False Positives(FP),and False Negatives(FN).These four measures are applied in the Segmentation Rate formula

$$\text{Segmentation Rate} = \frac{TP + TN}{TP + FP + TN + FN}$$

This approach does not provide a good scalability for large number of input species.

C. DNA Barcoding Technique

Paul D. N. Hebert, Mark Y. Stoeckle, Tyler S. Zemlak1 Charles M. Francis concluded, that short DNA sequences from a region of genome provides a DNA barcode identification of species. In this method the tissues or any parts of the birds are collected and DNA is extracted from the collected samples. After the extraction of DNA, appropriate DNA barcodes must be selected . These DNA barcodes are then linked to named specimens which provide a new master key for identifying the species. Mitochondrial DNA (mtDNA) has been widely employed in phylogenetic studies of birds because it evolves more rapidly than the nuclear DNA, resulting in the accumulation of differences between closely related species. If a short region of mtDNA that consistently differentiated the species could be found and accepted as a standard, a library of DNA sequences linked to vouchered specimens would make this sequence an identifier for species, a ''DNA barcode'' (Hebert et al. 2003a).The problem with this approach is that there is no universal barcode region and it is difficult to resolve recently diverged species.

D. Video-Based Technique

Juha Niemi and Juha T. Tanttu proposed a video based bird identification system. Radar is a feasible choice for the detection of birds the identification is restricted to the flying birds only. World Geodetic System 1984 (WGS84) is an Earth-centered reference system and geodetic datum. The video head steering is based on height, latitude and longitude coordinates (WGS84) provided by the radar. All calculations are performed by WGS84 system itself, so no coordinate conversion from one system to another is needed. There are three parameters provided by the radar system. They are (i) the distance in 3D of a target,(ii) the velocity of a target and (ii) the trajectory of a target. The

distance of a detected bird is used to estimate the size of the bird in meters and the velocity of a target bird is used for the final classification. This system also includes the camera with the telephoto lens and a motorized video head. The camera is controlled by the Application Programmable Interface (API) which is in the camera .The system has three servers: the radar server, the video head steering server and the camera control server. One of the problems with the video based recognition is that the time taken to analyze the masses of data collected by video systems.

III. METHODOLOGY

The proposed system uses Random Forest algorithm for bird species identification. The dataset used in the system is Caltech-UCSD Birds 200[CUB 200-2011].Due to the diversity and simplicity of Random Forest algorithm, the project is implemented using it. The Random Forest classifier uses decision trees to predict the output class. RF is a supervised learning that creates decision trees on data samples and then gets the output from each of them and at last selects the best one out of it through the means of voting. Through averaging the result it reduces the risk of overfitting. Numerical Python (NumPy) library is used as it consists of array objects and its routines. Various array operations can be done in NumPy. Scientific computing can be done using NumPy.

Fig 1 Caltech dataset

A. Pre-processing

Image preprocessing is done to obtain an enhanced image and to get the clear view of the image. It is used to improve the image data for further processing and analysing task. The image size is reduced to 80X80 resolution to speed up the training process. The libraries are imported and then the dataset is imported from Caltech database. The dataset is split into training and test data and the training data is used for feature scaling.

The image is converted into pixel arrays and then passed to the random forest classifier. Pillow is the library in Python that supports many different image file formats.

from PIL import image

line is used to import images to the code. The pillow library provides many image functions to work with the images.

Import numpy as np

line is used to perform numerical operations on arrays of the image.

B. Training

In training each tree learns from a random sample. The random forest algorithm constructs n subsets from the given training dataset. The split points are chosen from the attribute value with the lower cost. This proposed system uses Gini index as the cost function. The Gini index can be calculated by subtracting the sum of the squared probabilities of the each class from one.

$$Gini = 1 - \sum_{i=1}^{n} (p_i)^2$$

The best split points can be found by evaluating the cost of each value. The bootstrap is a powerful method used for estimating a quantity from the samples of data. The random forest uses bagging method for decision tree construction and prediction of the classes. Bagging works by combining the result of all the subsets and averaging their predictions to obtain the output class of the input. In bootstrapping single sample may be used for more than one time. The training time is less compared to other machine learning algorithms. It also gives high accuracy.

C. Classification

The predictions are made by taking average of all the subsets of the tree formed by the training dataset. In our proposed system the n value is given as 10 which means the ten different trees are formed and every time the prediction is obtained by passing the test samples through all subsets and averaging the result. The prediction accuracy is high compared to other machine learning techniques.

IV. RESULTS AND OUTPUTS

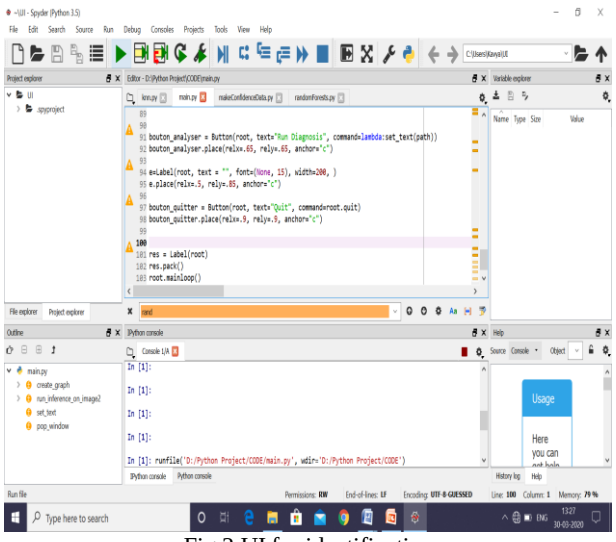

Fig 2 UI for identification

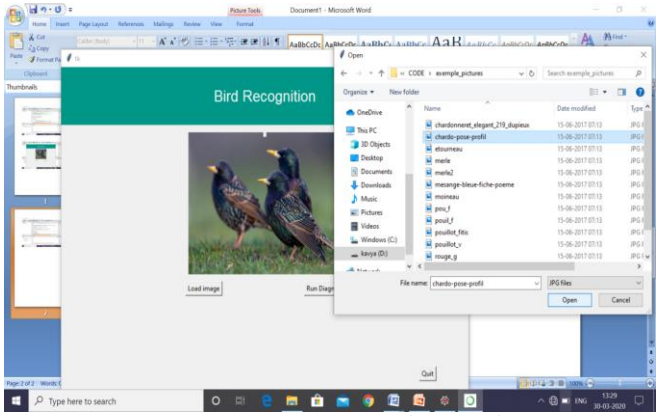

Fig 3 choosing image from the folder

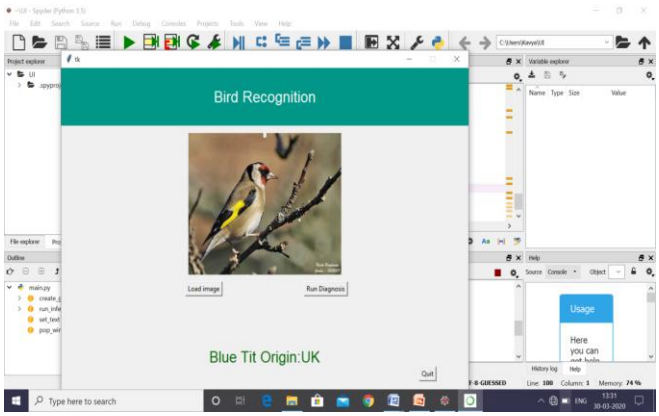

Fig 4 Displaying the bird species

V. CONCLUSION AND FUTURE SCOPE

Bird species identification is a tedious task. The main purpose of this system is to identify the species of the bird using the input image. This system builds model that is extremely helpful in bird species identification. This system is extremely useful for bird watchers and in the field of ornithology. In the future, mobile app can be developed that uses cloud based image processing to identify bird species from digital images uploaded by the user on a smart phone.

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