Image Classification using Deep Learning and Neural Networks

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Abstract—Image classification is a well-known problem in image processing, computer vision, and machine learning. We investigate picture categorization using deep learning in this research. Nowadays bird watching is becoming a common hobby for everyone, but more than 10,000 species are part of the ecosystem, which causes difficulty in identification and prediction. Additionally, the birds may appear in different scenarios and also in different shapes, sizes, and colors. So, we use Convolutional Neural Network (CNN) to build the models, decreasing the dimensionality of images without losing any content by using a built-in convolutional layer. This will identify the input given by the user and starts the image processing and then compares it with a trained model and predicts the species of the bird. The model will return the output with the predicted probability of the species. If the user-given image is not available in the dataset, the model automatically adds it to the dataset which will be useful in building the dataset. This model helps in the classification and recognition of the birds. Key words: Deep Learning(DL) , Convolution Neural Network(CNN) ,Image Classification.

Index Terms—component, formatting, style, styling, insert

I. INTRODUCTION

There are a lot of bird species in our ecosystem. Every year a lot of migratory birds will visit all places. It will be an eye feast for all the bird watchers. It will give them some kind of happiness to watch them like that. But also if they can identify the species, they can be even happier. But the Identification of birds and it's species is not as simple as it looks. Generally, bird categorization is often performed by ornithologists. From ages, ornithologists are undergoing through many hurdles in the bird species classification. They have to study all the details of bird species such as their presence in the ecosystem, biology, dispersion, ecological effect, and so on. Bird categorization is often performed by professional ornithologists using Linnaeus' animal . So to help humans to overcome this problem, we came up with this solutio+n of applying Convolutional Neural Network, image classification and deep learning methodologies to it. This methodology of classifying and identifying the bird is involved in the collection of large datasets of images of bird species.

II. RELATED WORK

In[1], the research is based on the color features extracted from incorrigible images of bird species. The scenarios on which they experimented are enrolled with two disparate classification procedures. In the first approach, the feature vectors generated by dividing the image planes are concatenated and input into a single classifier for classification, while in the second approach, individual classifiers are utilized for each feature vector.In addition to the above, the authors have also evaluated the proposed approach's scalability by considering two specific color spaces, namely RGB and HSV. This allows for a more comprehensive analysis of the approach's effectiveness in different color domains and its ability to handle various color formats.

In[2], The study involved the application of Deep Learning algorithms, specifically Unsupervised Learning, to analyze a dataset of images for the purpose of identifying various bird species. Through this technique, the researchers sought to develop an effective method for classifying bird species using machine learning.The study made use of a publicly accessible dataset that was accompanied by a user-friendly website. The website allowed users to upload images of birds in any format for the purpose of recognition, and returned the desired output. The system relied on identifying key bird parts and extracting CNN features from multiple Convolutional layers, as part of the process of accurately classifying different bird species.

The work in [3], uses Neural Networks for classifying the bird species on the dataset. When compared to raw spectrum data, different frequency bands' delta data augmentation doesn't quite improve classification accuracy, however, it is closest to the province and has an extra benefit over raw spectral data when computing resources are restricted.

The research [4] is based on how well the Deep Neural Networks can be used in the classification of bird-species. They have created a software platform which uses deep learning as a main static process in recognizing the bird-species. A large group of dataset containing the images of different types of bird species, which will have a model for the recognition.

III. METHODOLOGY:

A Certain number of methodologies were employed to design the system. They are outlined here: Deep Learning, Deep Convolutional Neural Network, Tensor Flow, etc
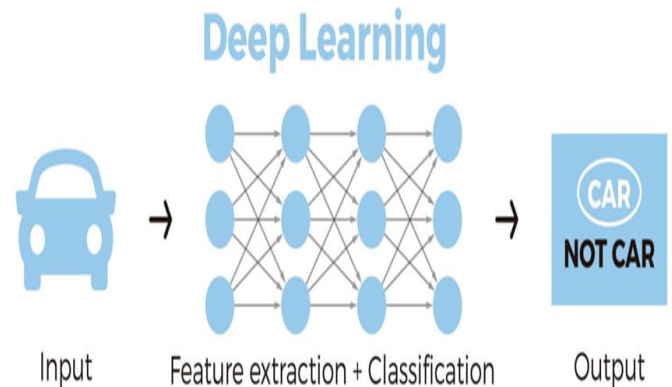

Figure 1: Deep Learning Spreads

As seen in figure 1, Upon giving the image input, the Deep Learning model will apply the Feature extraction and classification and provides the desired output.

A. Deep Learning

In [2], Deep learning is purposefully used to classify and analyse visual images. Deep Learning is a specialized branch of artificial intelligence (AI) that enables machines to learn and improve from data, without being explicitly programmed to do so. This advanced technology utilizes complex algorithms to automatically identify patterns and features in large sets of data, which can be used to make predictions or decisions. Deep learning incorporates computer systems known as neural networks. Neural networks, a fundamental component of Deep Learning, are designed to mimic the functioning of the human brain, albeit with varying degrees of success. By processing vast amounts of data, these networks are able to "learn" and improve their ability to perform specific tasks, such as image or speech recognition, making them a valuable tool for many applications in machine learning and artificial intelligence. Deep neural networks are made up of numerous layers of interconnected nodes, with each layer boosting and optimizing the prediction or segmentation. Forward propagation is the process of computing the output of a neural network by moving the input data through the network. The input layer of a deep neural network captures the raw data to be processed, and the output layer produces the final prediction or classification based on the information learned by the network. In between the input and output layers, there are hidden layers that transform the input data into a more useful representation for the task at hand. During forward propagation, the input data is passed through each layer in the network, and the output of one layer serves as the input to the next layer until the final output is produced by the output layer.

B. Deep Neural Networks

From [3], Deep neural networks (DNNs) are a class of artificial neural networks (ANNs) that have multiple hidden layers between the input and output layers. The depth of a neural network refers to the number of hidden layers it contains. A simplified version of a Deep Neural Network (DNN) can be thought of as a hierarchical organization of artificial neurons, with connections between them that allow them to communicate with each other. These neurons receive input data, process it through a series of non-linear transformations, and then pass the transformed data to other neurons in the network. The connections between neurons are weighted, and the weights are adjusted during training to optimize the network's performance on a specific task. The overall structure of the network is organized into layers, with each layer responsible for performing a specific type of computation. The layers are connected through the neuron connections, forming a complex network that can learn from input data with feedback mechanisms. In Neural Networks, in the input image, design elements like lines, gradients, circles, or even eyes and faces are extremely successfully accumulated. They can run directly on an underdone image and do not need any preprocessing. The figure 2, given below will represent the working model of the Deep Neural Networks.
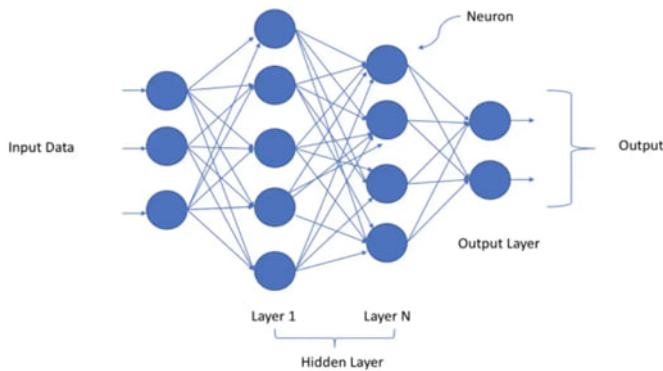
Figure 2 : The block diagram of Deep Neural Network

C. Image Classification:

From [4], it is observed that Image classification divides the data into classes by assessing numerous attributes of distinct image features. Training and testing are often used as the two steps for categorization in classification systems. An individual representation of each scenario, or "training class," is made using the properties of the picture features that are mostly extracted during the training phase. These feature-space segments are then utilised to categorise image characteristics in the testing phase. In an effort to develop the ideal classifier, there exists multiple difficulties as it is reasonably simple for an individual to recognise a complex view.
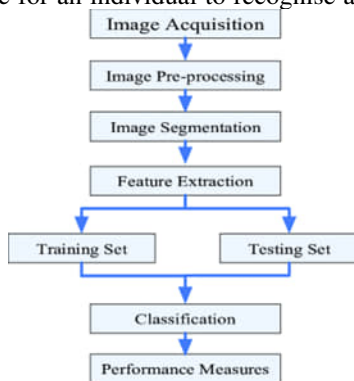

Figure 3 : Flow chart for image classification

D. Process

By using the above-mentioned methodologies- Deep Learning, Deep Neural Networks, Image Processing, Tensor flow, and the large dataset which consists of 400 bird species.58388 training images, 2000 test images(5 images per species) and 2000 validation images(5 images per species). So, when a user sends an image for the classification and analysis, it will get stored in the database. Then the work starts from the end of the neural Networks. For only the purpose of training the model upto 90 percent of the dataset is allocated. Then the feature extraction will come into play. It will extract all the required features for the classification process like size, face, colour, etc. After which they will be compared with the training model and the required input will be provided to the user.

Table 1: Training images

|	Filepath	Label
0	../input/100-bird-species/train/WATTLED CURASS...	WATTLED CURASSOW
1	../input/100-bird-species/train/WATTLED CURASS...	WATTLED CURASSOW
2	../input/100-bird-species/train/WATTLED CURASS...	WATTLED CURASSOW
3	../input/100-bird-species/train/WATTLED CURASS...	WATTLED CURASSOW
4	../input/100-bird-species/train/WATTLED CURASS...	WATTLED CURASSOW
...	...	...
58383	../input/100-bird-species/train/GOLDEN EAGLE/0...	GOLDEN EAGLE
58384	../input/100-bird-species/train/GOLDEN EAGLE/0...	GOLDEN EAGLE
58385	../input/100-bird-species/train/GOLDEN EAGLE/0...	GOLDEN EAGLE
58386	../input/100-bird-species/train/GOLDEN EAGLE/0...	GOLDEN EAGLE
58387	../input/100-bird-species/train/GOLDEN EAGLE/0...	GOLDEN EAGLE

58388 rows × 2 columns

IV. RESULTS
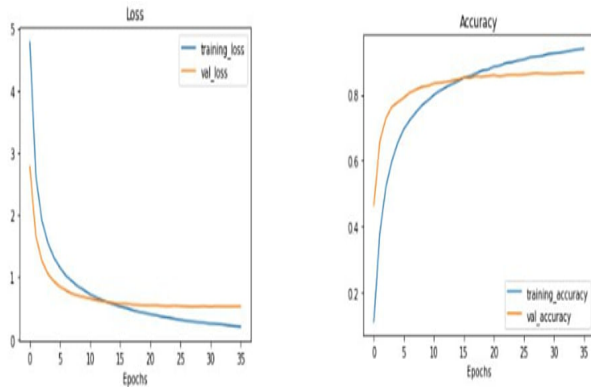
Figure 4: Visualising the loss and accuracy curve

CLASSIFICATION REPORT:

	precision	recall	f1-score	support
ABBOTTS BABBLER	0.58	0.71	0.64	21
ABBOTTS BOOBY	0.71	0.55	0.62	40
ABYSSINIAN GROUND HORNBILL	0.92	0.89	0.90	37
AFRICAN CROWNED CRANE	0.95	0.97	0.96	37
AFRICAN EMERALD CUCKOO	0.79	0.67	0.72	39
AFRICAN FIREFINCH	0.81	0.62	0.70	21
AFRICAN OYSTER CATCHER	0.92	0.83	0.87	29
ALBATROSS	0.65	0.76	0.70	17
ALBERTS TOWHEE	0.90	0.78	0.84	36
ALEXANDRINE PARAKEET	0.97	0.93	0.95	30
ALPINE CHOUGH	0.89	0.89	0.89	36
ALTAMIRA YELLOWTHROAT	0.70	0.88	0.78	24
AMERICAN AVOCET	0.97	0.94	0.96	35
AMERICAN BITTERN	0.92	0.95	0.94	38
AMERICAN COOT	1.00	0.97	0.98	33
AMERICAN GOLDFINCH	0.95	0.78	0.86	27
AMERICAN KESTREL	0.91	0.88	0.89	24
AMERICAN PIPIT	0.84	0.93	0.88	40
AMERICAN REDSTART	0.85	0.85	0.85	34
AMETHYST WOODSTAR	0.81	0.81	0.81	27
ANDEAN GOOSE	0.86	0.86	0.86	22
ANDEAN LAPWING	0.86	0.68	0.76	28
ANDEAN SISKIN	0.69	0.73	0.71	30
ANHINGA	0.88	0.90	0.89	31
ANIANIAU	0.73	0.87	0.79	31
ANNAS HUMMINGBIRD	0.64	0.76	0.70	21
ANTBIRD	0.76	0.79	0.78	33
ANTILLEAN EUPHONIA	0.77	0.71	0.74	24
APAPANE	0.73	0.76	0.75	25
APOSTLEBIRD	0.84	0.91	0.88	35
ARARIPE MANAKIN	0.96	0.92	0.94	24
ASHY THRUSHBIRD	0.64	0.61	0.62	23
ASIAN CRESTED IBIS	0.91	0.94	0.93	34
AVADAVAT	0.64	0.61	0.62	38
AZURE JAY	0.88	0.76	0.81	29
accuracy			0.86	11678
macro avg	0.87	0.86	0.86	11678
weighted avg	0.87	0.86	0.86	11678

Figure 5:Classification report

Figure 6: Visualising 16 pictures of the dataset with their labels

In the Figure 6, 16 pictures of different bird species from the dataset is visualised,just as a sample of which type the bird species pictures will be stored. These are used in the process of training and testing the model which is very large in number.

Figure 7: Displaying 25 random pictures from the dataset with theirlabels

From Figure 7, It is observed that randomly 25 images are selected after training the model which provides the images with the labelled data.
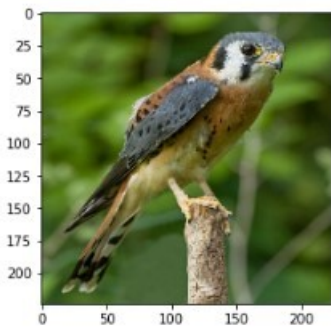

Figure 8:AMERICAN KESTREL

From figure 8, It is observed that when a user uploads an image into the system, the model has predicted and delivered the output as "AMERICAN KESTREL" with a probability of 99.75
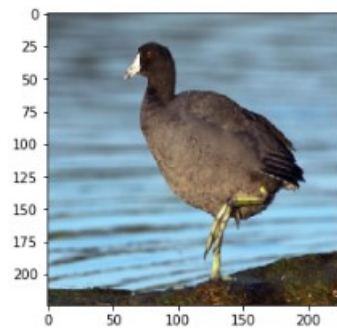

Figure 9:AMERICAN COOT

From figure 9, It is observed that when a user uploads an image into the system, the model has predicted and delivered the output as "AMERICAN COOT" with a probability of 99.85
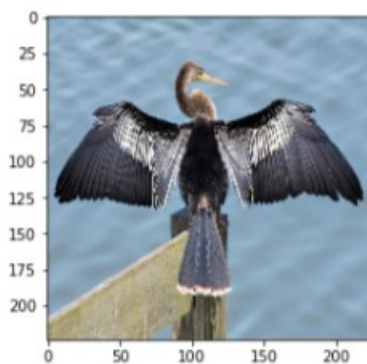

Figure 10:ANHIGA

From figure 10, It is observed that when a user uploads an image into the system, the model has predicted and delivered

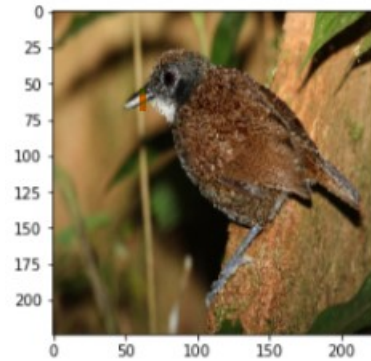the output as "ANHIGA" with a probability of 26.17

Figure 11:ANTBIRD

From figure 11, It is observed that when a user uploads an image into the system, the model has predicted and delivered the output as "ANT BIRD" with a probability of 53.88
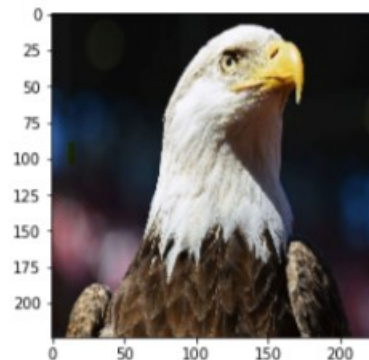

Figure 12:BALD EAGLE

From figure 12, It is observed that when a user uploads an image into the system, the model has predicted and delivered the output as "BAD EAGLE" with a probability of 98.75

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	precision	recall	f1-score	support
ABBOTTS BABBLER	0.576923	0.714286	0.638298	21
ABBOTTS BOOBY	0.709677	0.55	0.619718	40
ABYSSINIAN GROUND HORNBILL	0.916667	0.891892	0.90411	37
AFRICAN CROWNED CRANE	0.947368	0.972973	0.96	37
AFRICAN EMERALD CUCKOO	0.787879	0.666667	0.722222	39
...	...	...	...	...
YELLOW CACIQUE	0.769231	0.909091	0.833333	33
YELLOW HEADED BLACKBIRD	0.882353	0.857143	0.869565	35
accuracy	0.864103	0.864103	0.864103	0.864103
macro avg.	0.86517	0.86228	0.86053	11678

Figure 13:Confusion Matrix

V. CONCLUSION

The present study is based on image classification using deep learning, in which a user will provide the image of a bird, and based on the Deep Neural Networks, the features in the image are extracted which will be used to classify and analyze the data. For this purpose, a special database is considered which consists of a large variety of bird-species images. Then it will be used to create the model and test and train it with the current database model. The features after this phase are collected and sends to the classifier. The classifier will classify the image and visualizes the output to the user.This study can also be used in varous fields like image processing, fraud detection and much more.

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