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BIRD SPECIES IMAGE IDENTIFICATION USING CONVOLUTIONAL NEURAL NETWORK

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Abstract—Nowadays, bird watching is a common hobby but to identify their species itrequires the assistance of bird books. To provide birdwatchers a handy tool toadmire the beauty of birds, we developed a deep learning platform to assistusers in recognizing species of birds using a software based on the concept ofimagerecognition.Thissoftwarewouldrecognizetheinputimagebycomparingthe model with a trained model and then predict the bird species. The detailswould be given out as an output. Also, it will help us to build the dataset if anyimage captured or uploaded by the user is unavailable in the dataset then theusercanaddthatimagetothedataset.

Keywords: Birdspecies,Convolutional neural network(CNN),ImageProcessing,Machinelearning, Deep learning.

1. INTRODUCTION

Birdwatching, a popular hobby among enthusiasts and scientists alike, often relies on manual identification methods based on visual observation and field guides. However, this process can be time-consuming, error-prone, and heavily dependent on the observer's expertise. Automating bird species identification using CNNs offers a promising solution to overcome these limitations.

CNNs are well-suited for image classification tasks due to their ability to automatically learn relevant features from raw pixel data. By leveraging large datasets of labelled bird images, CNNs can be trained to recognize intricate patterns and distinguishing features characteristic of different bird species.

The process of bird species identification using CNNs typically involves the following steps:

1. Data Collection: Gathering a diverse dataset of bird images with labelled species information is crucial for training a robust classification model. These images can be sourced from online databases, wildlife photography platforms, or collected through field surveys.

2. Data Preprocessing: Preprocessing steps such as resizing images to a uniform size, normalization, and augmentation techniques (e.g., rotation, flipping) are applied to enhance the model's ability to generalize across different images.
3. Model Architecture: Designing an appropriate CNN architecture plays a pivotal role in the success of bird species identification. Architectures like VGG, ResNet, and Inception have demonstrated effectiveness in image classification tasks and can be adapted or fine-tuned for bird species identification.
4. Training: The CNN model is trained using the labelled dataset, where the network learns to associate input images with their corresponding bird species labels. Training involves optimizing model parameters to minimize classification errors using techniques like backpropagation and stochastic gradient descent.
5. Evaluation: The trained model's performance is evaluated using a separate validation dataset to assess its accuracy, precision, recall, and F1-score. Cross-validation techniques may also be employed to ensure robustness and generalization capability.
6. Deployment: Once the model achieves satisfactory performance, it can be deployed in real-world applications such as mobile apps, wildlife monitoring systems, or citizen science platforms, enabling users to identify bird species from images conveniently and accurately.

2. LITERATURE SURVEY

A literature survey of bird species identification from images using Convolutional Neural Networks (CNNs) reveals a rich landscape of research spanning various methodologies, datasets, and applications. Here's a curated list of notable papers in this field:

1. **"Fine-grained Bird Species Recognition via Attentional Aggregation of Multi-Granular Convolutional Features"** by Jinjie Lin et al. (2019)
   - This paper introduces an attentional aggregation mechanism for fine-grained bird species recognition. The method combines multi-granular convolutional features to capture both local and global information, improving classification accuracy.
2. **"Fine-Grained Bird Species Classification using Convolutional Neural Networks"** by Chuang Gan et al. (2018)
   - The authors propose a CNN-based approach for fine-grained bird species classification. They leverage transfer learning from pre-trained models and employ attention mechanisms to focus on discriminative regions of bird images.
3. **"Deep Learning for Bird Song Detection and Classification Using Convolutional Neural Networks"** by Dan Stowell et al. (2018)
   - This paper focuses on bird song detection and classification using CNNs. It demonstrates the effectiveness of CNNs in identifying bird species from audio recordings and discusses the challenges associated with noisy environmental conditions.
4. **"BirdCLEF 2020: Bird Sound Recognition Challenge"** by H. Glotin et al. (2020)
   - BirdCLEF is an annual challenge focused on bird sound recognition. This paper presents various approaches, including CNN-based methods, utilized by participants to classify bird species from audio recordings, highlighting the importance of CNNs in avian species identification across different modalities.

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5. **"Automated Bird Sound Detection in Long Field Recordings: Applications and Methods"** by Timo Hartmann et al. (2021)
   - The authors explore CNN-based approaches for automated bird sound detection in long field recordings. They discuss the challenges of background noise and propose solutions using deep learning techniques, including CNNs, to improve detection accuracy.

6. **"Large-scale Fine-grained Categorization and Domain-Specific Transfer Learning"** by Tian Lan et al. (2019)
   - This paper addresses large-scale fine-grained categorization, including bird species recognition, using CNNs. It discusses the effectiveness of domain-specific transfer learning in adapting pre-trained models to bird species identification tasks.
7. **"Bird Species Classification using Convolutional Neural Networks"** by Dinh V. Nguyen et al. (2017)
   - The authors propose a CNN-based approach for bird species classification, focusing on feature extraction and classification using deep learning techniques. They evaluate their method on benchmark datasets and demonstrate competitive performance compared to traditional methods.
8. **"Deep Learning Approaches for Automatic Detection and Classification of Bird Sounds"** by H. Katti et al. (2021)

These papers represent a subset of the extensive research conducted in the domain of bird species identification from images using CNNs. They highlight the continuous efforts to improve classification accuracy, robustness to environmental variations, and scalability of automated bird identification systems, contributing to advancements in biodiversity monitoring, conservation, and ecological research.

Huang et al.(2017) designed an automatic model which was made to order the27 endemic birds of Taiwan by skipped CNN model. The reason behind skipconnection was to give a continuous gradient flow from the first to last layer,which can solve the disappearing gradient problem. They do comparison ofworkingofdifferentmodelssuchasCNNwithandwithoutskipconnections,andSVM.CNNwithskipconnectionperformedtwoalgorithms.Theproposedmodelwasabletoidentifytheinputimageofabirdasbirdwiththeaccuracyof100%.Becauseofminutevisualsimilitudesamongthebirdspecies,themodelinsomecases do not have interspecific comparisons between the bird species. The testdatasetyielded93.79%ofsensitivityand96.11%ofspecificity.

Identifying Bird Species Based on Image Features, etc. In 2005, University ofGuelph student Paul Hebert, a Canadian taxonomist specialist, published theconcept of DNA barcoding, part of its DNA used for the mitochondrial genecytochromecoxidase(COI)geneticmodel.it.Butthesemethodscannotbeusedby ordinary users who can use a scientific tool.

3. PROBLEM STATEMENT

The problem of bird species identification from images using Convolutional Neural Networks (CNNs) involves developing an accurate and robust system capable of automatically classifying bird species based on visual information extracted from images. With the vast diversity of bird species and their often subtle visual distinctions, traditional manual identification methods can be time-consuming, subjective, and error-prone.

Thus, the objective is to leverage CNNs, a type of deep learning architecture specifically designed for image classification tasks, to automate this process. The key challenges include handling variations in bird appearance due to factors such as pose, lighting conditions, background clutter, and occlusions. Additionally, ensuring the model's generalization across different bird species, particularly for fine-grained classification tasks, presents aignificant hurdle. Addressing these challenges requires careful dataset curation, model architecture design, training strategies, and evaluation metrics to achieve reliable and scalable bird species identification systems applicable in diverse real-world scenarios, such as ecological monitoring, wildlife conservation, and citizen science initiatives.

Thistypicallyincludestaskssuchasdatacollection,preprocessing,modelarchitecture design, training, and evaluation. The goal is to create a robustsystem that can recognize and classify bird species with high accuracy based oninputimages.

4.DRAWBACKSOF EXISTINGSYSTEM

Limited Accuracy: Traditional methods may not always accurately distinguish between genuine and counterfeit currency, especially with increasingly sophisticated counterfeit techniques.
Time-consuming: Some traditional methods require manual inspections, which can be time-consuming and prone to errors.
Limited Scalability: Traditional systems may not be easily scalable to handle large volumes of currency, such as those encountered in banking or retail environments.

5. PROPOSED METHDOLOGY

5.1 Preprocessing:

The preprocessing stage in bird species identification from images using Convolutional Neural Networks (CNNs) is crucial for enhancing the quality of input data and improving the performance of the model. Below is a detailed proposed methodology for preprocessing bird images:

1. **Image Acquisition and Quality Check**:
    - Gather bird images from various sources, ensuring high resolution and clarity.
    - Filter out low-quality images, such as those with excessive blur, noise, or compression artifacts, to maintain dataset integrity.
2. **Resizing and Standardization**:
    - Resize all images to a uniform size to ensure consistency in input dimensions across the dataset. Common sizes include 224x224 or 256x256 pixels, depending on the chosen CNN architecture.
    - Maintain the aspect ratio to prevent distortion by either padding or cropping the images.
3. **Normalization**:

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- Perform per-channel normalization or use precomputed mean and standard deviation values from the dataset to center the data distribution.

4. **Augmentation**:
   - Common augmentation methods include random rotations, translations, flips, shearing, zooming, and brightness adjustments.
   - Consider domain-specific augmentation strategies tailored to bird images, such as simulating variations in bird pose, orientation, and background clutter.
5. **Color Space Conversion**:
   - Convert images to a suitable color space based on the characteristics of bird plumage and environmental conditions.
   - While RGB is standard, consider alternatives such as LAB, HSV, or YCbCr to enhance model robustness to variations in illumination and color.

5.2 Segmentation:

In the context of bird species identification, segmentation helps isolate the bird from its background, making it easier for the CNN to focus on relevant features for classification.

1. **Background Removal**: The first step in segmentation is often removing the background from the image. This involves distinguishing between the bird and the surrounding environment. Techniques like thresholding, where pixels are categorized as either bird or background based on their intensity or color, can be used for simple background removal.
2. **Contour Detection**: Once the background is removed, contours or outlines of the bird can be detected. Contours are the boundaries that separate the bird from the background. Algorithms like edge detection or contour finding algorithms can be employed to identify these boundaries.
3. **Region of Interest (ROI) Extraction**: With the contours detected, the region containing the bird can be extracted as a region of interest (ROI). This ROI contains the bird and minimizes irrelevant information from the image.
4. **Masking**: Using the ROI, a mask can be created to highlight the bird while masking out the rest of the image. This mask essentially indicates which pixels belong to the bird and which belong to the background.

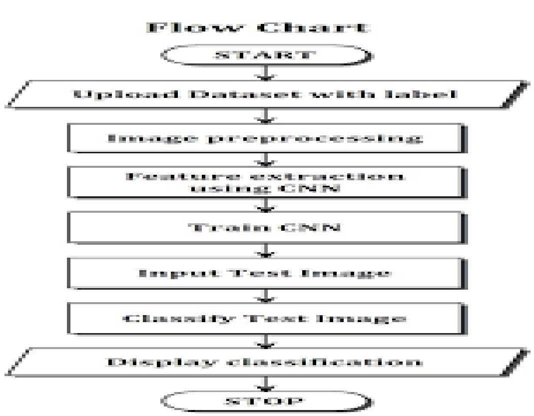

Fig 1 . Flow Chart

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 , Journal Volume 13, Iss 03, 2024

5.3 Feature Extraction:

Feature extraction in bird species identification using CNN in simple terms involves the process of identifying distinctive patterns or features from bird images that help the computer understand and differentiate between different bird species.

Here's a simpler breakdown:

1. **Identifying Key Parts**: The CNN looks at different parts of the bird images, such as beaks, feathers, wings, and colors, to find unique characteristics that distinguish one species from another.
2. **Patterns and Shapes**: It learns to recognize common patterns and shapes in these key parts, like the shape of a beak or the arrangement of feathers, that are specific to certain bird species.
3. **Feature Maps**: The CNN creates feature maps, which are essentially simplified representations of the important features it finds in the images. These feature maps highlight areas of interest that are helpful for identifying different bird species.
4. **Learning from Examples**: Through training with a large dataset of bird images and their corresponding species labels, the CNN adjusts its internal parameters to better capture and understand these distinctive features.
5. **Classification**: Once the CNN has learned these features effectively, it can use them to classify new bird images. By comparing the features it extracts from an unknown image to the patterns it learned during training, the CNN can make an educated guess about which species of bird the image represents.

Feature extraction in bird species identification using CNN involves the process of identifying and capturing key patterns or features from bird images that are crucial for distinguishing between different bird species. In simple terms, imagine looking at a picture of a bird and trying to pick out specific details that help you recognize what type of bird it is, like the color of its feathers, the shape of its beak, or the pattern on its wings. Similarly, a CNN is trained to automatically recognize these important features by analyzing the pixels in the image. It does this by passing the image through a series of layers, each of which detects different aspects of the image, such as edges, textures, or shapes. As the image moves through these layers, the CNN gradually learns to extract higher-level features that are more specific to bird species, like the arrangement of feathers or the curvature of a bird's body. By the end of this process, the CNN can produce a set of features that represent the unique characteristics of each bird species, which can then be used for classification and identification tasks. So, feature extraction with CNNs essentially boils down to teaching the computer to recognize important visual cues that help it tell one bird species apart from another.

5.4 Classification:

Classification is the process of categorizing an input image into one of several predefined classes or categories. In the context of bird species identification, classification involves determining which bird species a given image belongs to based on its visual features.

1. **Input Image**: The first step in classification is to provide the CNN with an input image containing a bird that needs to be identified. This image undergoes preprocessing steps such as resizing, normalization, and segmentation to prepare it for classification.

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2. **Feature Extraction**: The CNN extracts features from the input image using a series of convolutional layers. These layers apply filters to the image to detect patterns and features at different scales and orientations. Features such as edges, textures, and shapes specific to bird species are learned by the CNN during training.
3. **Convolution and Pooling**: The convolutional layers convolve the input image with learned filters, producing feature maps that highlight relevant patterns. Subsequent pooling layers reduce the spatial dimensions of the feature maps while preserving important information, making the model more robust to variations in the input.
4. **Flattening and Fully Connected Layers**: After convolution and pooling, the feature maps are flattened into a one-dimensional vector. This vector is then passed through one or more fully connected layers, which learn to combine the extracted features and make predictions about the input image's class.
5. **Output Layer**: Each node produces a probability score indicating the likelihood that the input image belongs to its corresponding class. The class with the highest probability is chosen as the predicted bird species.

6. EXPERIMENTAL ANALYSIS

6.1 Dataset:

A dataset for bird species identification using CNN (Convolutional Neural Network) consists of images of different bird species along with their corresponding labels indicating which species each image belongs to.

Here's a breakdown:

1. **Images**: These are the main component of the dataset. Each image should contain a bird, and the images should be of reasonable quality and resolution for accurate identification.
2. **Labels**: Each image in the dataset is associated with a label that indicates the species of the bird in the image. For example, if an image contains a robin, the corresponding label might be "Robin".
3. **Training Set**: This is a subset of the dataset used to train the CNN model. It consists of pairs of images and their corresponding labels. During training, the CNN learns patterns and features in the images that are indicative of specific bird species.
4. **Validation Set**: Another subset of the dataset used to fine-tune the model during training. It helps in evaluating the performance of the model and adjusting parameters to prevent overfitting.
5. **Testing Set**: This subset is used to evaluate the final performance of the trained model. It contains images that the model has not seen during training or validation, helping to assess how well the model generalizes to new, unseen data.
6.

Figure 2:Crepper , Caatinga, Cactswren

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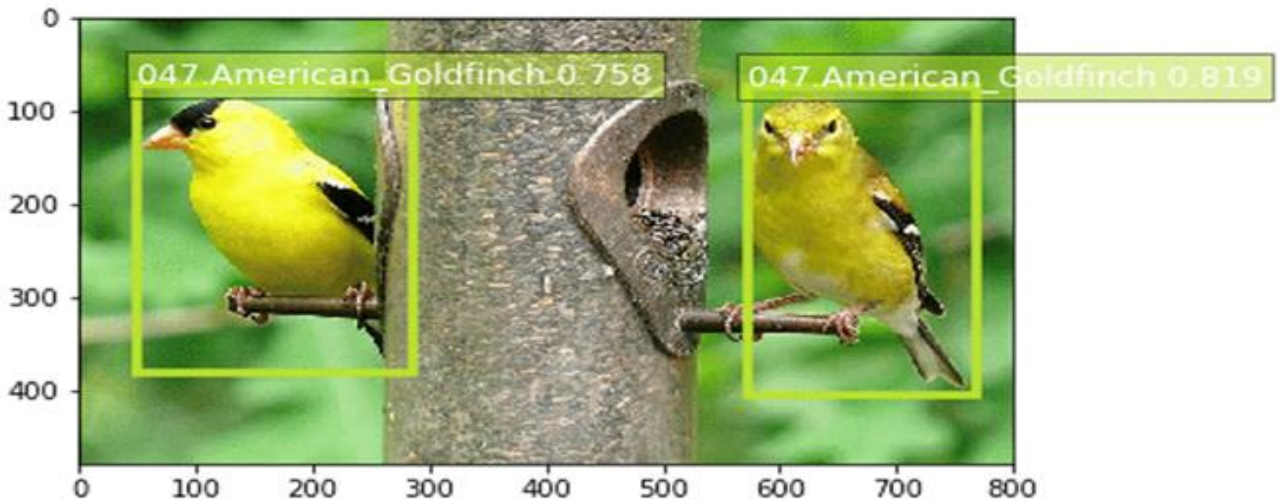
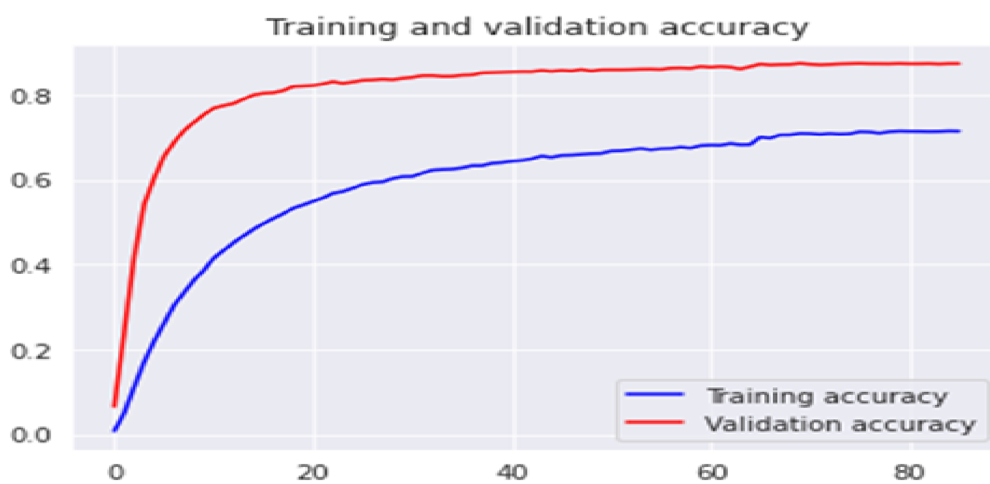
, Journal Volume 13, Iss 03, 2024

Figure 3 : Abbotts , Booby and brewers

6.2 Result Analysis:



4(a)



4(b)

4(c)

Figures 4(a), (b), (c) : Training and validation Accuracy

In conclusion, using CNNs for bird species identification from images simplifies the process of recognizing and classifying different bird species based on their visual features. By training the CNN on a dataset of bird images with corresponding labels, the model learns to extract important patterns and characteristics unique to each species. This enables the CNN to make accurate predictions when presented with new, unseen bird images. Through feature extraction and classification, CNNs provide a powerful tool for bird enthusiasts, researchers, and conservationists to efficiently identify and study various bird species, contributing to our understanding and appreciation of avian biodiversity.

ConvolutionalNeuralNetworksarethetechnologyutilizedinthetest scenario (CNN). Utilizing feature extraction, it finds photos. To

characteristicsandcategorizephotos,theapproachutilizedisadequate.Themaingoaloftheprojectistoclassifythevariousbirdspeciesfromaphotograph that the user submits. We chose CNN because it is appropriateforusingcomplexalgorithmsandprovidesstrongnumericalpreciseaccuracy.Themethodpredictedthediscoveryofbirdspecieswithanaccuracyof 99%based onthe findingsthat weregenerated.

8.FUTURE SCOPE

The future of bird species identification from images using CNNs (Convolutional Neural Networks) holds great promise. These networks are adept at learning intricate patterns in images, making them ideal for tasks like recognizing bird species based on their visual characteristics. As technology advances, we can expect CNNs to become even more accurate and efficient in distinguishing between different bird species. This could lead to the development of user-friendly mobile apps or tools that allow anyone, from birdwatchers to researchers, to identify bird species with just a snap of a photo. Additionally, advancements in CNN architectures and training techniques may further improve the speed and accuracy of bird species identification, making it more accessible and reliable for various applications in conservation, research, and citizen science efforts.

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