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Bird Species Image Identification using Deep Learning

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Abstract :

These days, many inexperienced bird watchers have trouble remembering and identifying all the various bird species. Additionally, in order to save and care for diverse bird species, the general public and newly employed rescue team members lack the ability to do so. They have to go through a difficult process to locate large publications like "Birds of the Indian Subcontinent." In this study, we evaluate a deep learning-based AI model that is good at identifying birds from photographs and provide the results. One of the top Deep Learning techniques, Transfer Learning, is used in the study's Simple Web App to recognize photographs. To become more familiar with Google's InceptionV3 model,1000 photos with annotations for each of the 325 different bird species in the dataset. The article presents empirical studies that evaluate different approaches and yield insightful results.

Keywords*: *Deep Learning, InceptionV3, Bird Identification, CNN, ImageNet

1. Introduction

Deep Learning has emerged as a powerful technique in the field of artificial intelligence and computer vision, allowing machines to learn and understand complex patterns from large amounts of data. One exciting application of deep learning is in the field of bird species identification through image analysis. This technology enables us to automatically recognize and classify different bird species based on their visual characteristics.

InceptionV3 is one of the popular deep learning models used for image recognition tasks. It is a convolutional neural network (CNN) architecture developed by Google. InceptionV3 has shown exceptional performance in various computer vision tasks, including image classification. It is trained on a large-scale dataset called ImageNet, which contains millions of labeled images from a wide range of categories, including various bird species.

Bird identification using deep learning involves training a CNN model like InceptionV3 on a dataset consisting of images of different bird species. The model learns to extract discriminative features from the images and maps them to specific bird species labels. During the training process, the model adjusts its internal parameters to minimize the difference between predicted labels and ground truth labels.

2. Related work

2.1.Literature Survey

Sr.No	Author Name	Research Papers Summary
1	Prof. Pralhad Gavali et al.[1]	Classification of bird species using deep learning on the Birds dataset, achieving 80% accuracy. Combination of features like attitude, wings, color, beak, and legs improves accuracy.
2	TanuDhiman et al.[1]	Proposal of a fast and reliable object detection model using new techniques. Comparison with existing methods and evaluation on different datasets, showing impressive performance.
3	Catherine Wah et al.[1]	Highlighting the role of humans in visual categorization for computer vision. Proposed system for fine-grained visual categorization with adaptable and scalable features.
4	Cirean, D., Meier et al.[1]	Novel approach for bird species classification based on color information from uncontrolled photographs. Evaluation on a dataset with over 200 bird species, achieving high classification rates.
5	Andreia Marini et al.[1]	Expansion of the CUB-200 bird dataset, including annotations for part localization. Benchmarks and experiments for multi-class classification and part localization.
6	Catherine Wahet al.[1]	Comprehensive analysis of deep learning-based object detection frameworks addressing various sub-problems. Discussion on future research directions and advances in neural networks.
7	Peng Zheng et al.[1]	Development of a system for animal detection in images using a deep convolutional neural network (DCNN). Evaluation on camera-trap datasets, achieving 90% accuracy.
8	Gyanendra K. Verma et al.[1]	Testing of support vector machine techniques for bird species classification, achieving comparable or better performance than reference methodologies. Consideration of hierarchical topology.
9	Satya Dharanipragada et al.[1]	Description of PlantNet, an interactive platform and information system for image-based plant identification. Use of deep learning and its impact on society and various professional contexts.
10	Antoine Affouard et al.[1]	SVMs are used in applications like handwriting recognition, intrusion detection, face detection, email classification, gene classification, and in web pages.

2.2.Background

Generally speaking, birds can be recognized by sight or sound. The most important visual aspects include the bird's size, form, posture, colour, and wings, among others. Because a bird's wings increase as it ages, the season must also be considered while assessing the criterion. The acoustics components include the melodies and whistles that birds make. The characteristics that set one bird apart from another, such as breast spots, wing bars thin lines that run along the wings eye rings, crowns, and eyebrows are also helpful. The beak's shape is frequently significant because it helps identify a bird. The most common ways to identify birds

are by their physical characteristics, like shape and posture. Recognizing a bird's silhouette is a skill possessed by most experts due to the difficulty in altering this characteristic. The tail of a bird can also serve as a distinguishing feature, with variations such as notched, elongated and pointed, or rounded. Additionally, the legs of a bird can be utilized to aid in identifying its photo.

3. Methodology

3.1.Overview of Machine Learning Techniques:

Machine Learning Techniques	Description
Feature Extraction	Traditional computer vision methods used to extract discriminative features from bird images.
Deep Learning	Utilizes artificial neural networks to learn representations from data, with various learning paradigms .
CNN (Convolutional Neural Networks)	neural network architecture cused for image recognition and classification tasks.
Transfer Learning	Technique used for solving one problem and applying it to a different problem, typically done by training a neural network .

3.2.Model Training and Evaluation:

Steps	**Description**
Dataset Preparation	Collect a diverse dataset of bird images covering various species and variations in poses, lighting conditions, and backgrounds.
Model Selection	Choose an appropriate deep learning model for bird species identification, such as a CNN architecture like InceptionV3.
Model Training	Initialize the selected model with random or pre-trained weights.
Model Evaluation	Evaluate the trained model using a validation set to assess performance. Calculate evaluation metrics
Model Optimization	Consider techniques like data augmentation and regularization techniques.
Deployment and Usage	Once trained and evaluated, use the model to predict bird species for new, unseen images.

3.3.Performance Metrics:

Accuracy	Measures overall correctness by dividing the number of correctly classified bird species by the total number of test samples.
Precision	Proportion of correctly identified positive samples (bird species) out of all samples classified as positive.
Positives and false positives	Higher precision indicates a lower rate of false positive identifications.
Recall	Proportion of correctly identified positive samples out of all actual positive samples.
F1 Score	Harmonic mean of precision and recall, providing a balanced measure that considers both metrics.
Confusion Matrix	Tabular representation showing counts of true positive, true negative, false positive, and false negative predictions.

4. Design and Implementation

Transfer Learning using neural network

Transfer learning using neural networks is a technique that involves leveraging knowledge gained from solving one problem and applying it to a related but different problem. It is particularly useful when there is limited labeled data available for the specific problem at hand.

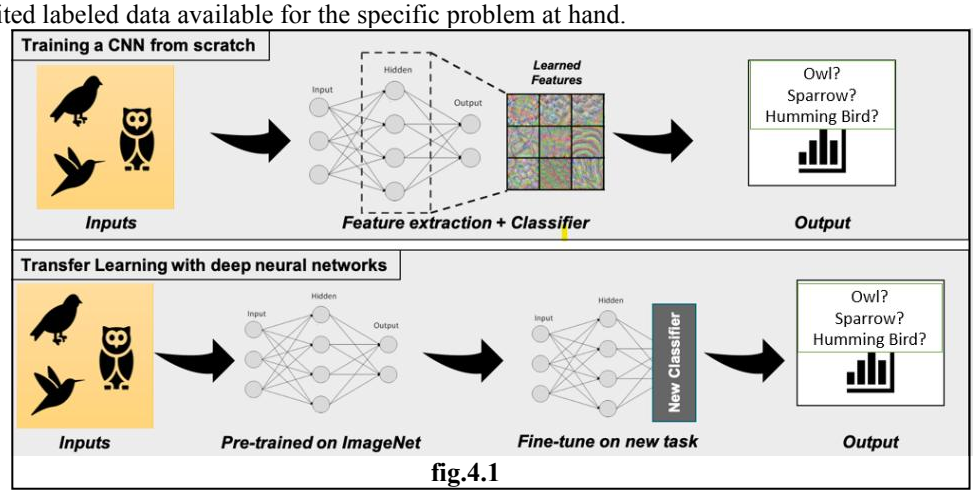

fig.4.1

fig.4.1 Illustrates two approaches for training convolutional neural networks (CNNs): training from scratch and transfer learning with a deep neural network.Training from scratch involves learning features directly from data, while transfer learning uses a pre-trained network to accelerate and improve training on a specific task by fine-tuning parameters.

5. Results and Analysis

5.1. Result:

The graph shows the results of training and validation accuracy and loss in bird species identification.

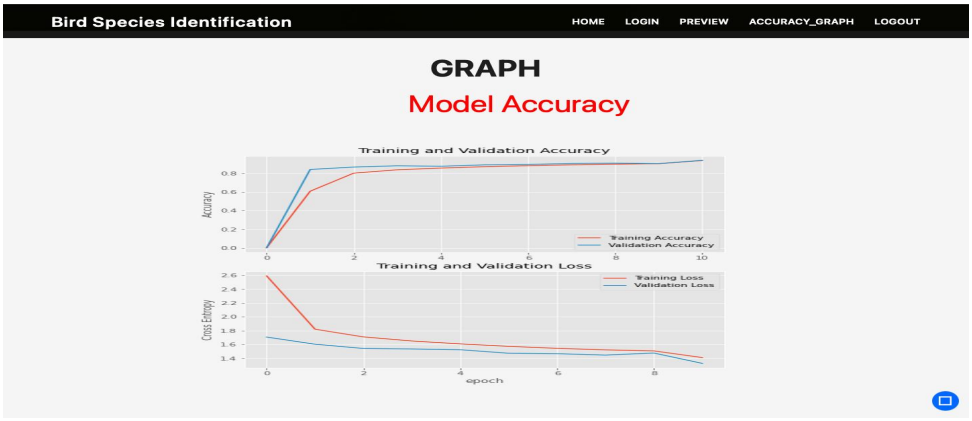

fig.5.1.1

fig.5.1.1 shows training accuracy and validation accuracy steadily increase from 0 to above 0.8, indicating that the model is improving in its ability to correctly classify bird species.

fig.5.1.2

fig.5.1.2 shows the terms of cross entropy, which is a commonly used loss function in classification tasks, the training loss decreases from an initial value of 2.6 to 1.6. Similarly, the validation loss decreases from 1.7 to 1.3. These decreasing loss values indicate that the model is becoming more accurate in its predictions and reducing its prediction errors.

5.2.Analysis

Parameters			
Classifier:	**Individual Function Extractor:**	**Integrated Feature Extractor:**	**Initial Weighting:**
A pre-trained model is used directly to classify newly captured photographs into different categories.	The pre-existing model is utilized for performing image pre-processing and identifying important features.	The process involves combining a pre-existing model, or a portion of it, with an integrated feature extractor to create a new model.	The pre-existing layers of a trained model are utilized and fine-tuned in combination with a new model.

Bird Species Detection Method	Identified Parameters
Visual observation	Plumage color, size, shape, beak morphology
Bird call analysis	Vocalizations, song patterns
Nest monitoring	Nest structure, location
Bird banding	Individual identification through leg bands
DNA analysis	Genetic markers
Radio telemetry	Location, movement patterns
Radar	Flight patterns, presence
Thermal imaging	Heat signatures
Camera traps	Visual identification, behavior
Citizen science platforms	Sightings, photographs, audio recordings

6. Conclusion

This study aims to explore the application of modern deep learning techniques in the recognition and differentiation of various bird species. Transfer Learning outperformed traditional Deep Learning Techniques like RNN, CNN, and many others to produce the greatest results. The model was trained using the Kaggle open source image dataset, which comprises of 325 species and approximately 600 images per species. Additionally, InceptionV3, one of the best model architectures, was employed to obtain the needed accuracy. Future studies will focus on creating the same technology for usage on smartphones.

Summary of Findings	Contributions of the Study	Future Research
Transfer learning outperformed traditional deep learning techniques such as CNN.	Demonstrated effectiveness of transfer learning in bird species recognition.	Explore transfer learning in other domains related to bird species identification.
High accuracy achieved with the Kaggle open source image dataset.	Provided the Kaggle dataset as a valuable resource for future research.	Expand the dataset to include more species and images for improved performance.

References

[1] Prof. Pralhad Gavali, Ms. Prachi Abhijeet Mhetre Bird Species Identification using Deep Learning International Journal of Engineering Research & Technology (IJERT) ISSN: 2278- 0181 Vol. 8 Issue 04, April-2019

[2] TanuDhiman Mtech (Cse) ,Object Detection and Recognition in Image Processing ,International Journal of Management, IT & Engineering Vol. 8 Issue 11, November 2018

[3] Similarity Comparisons for Interactive Fine-Grained Categorization, Catherine Wah, Grant Van Horn, Steve Branson, 13 Feb 2012

[4] Cirean, D., Meier, U. and Schmidhuber, J., 2012. Multicolumn deep neural networks image classification. arXiv preprint arXiv:1202.2745.

[5] Andreia Marini, Jacques Facon and Alessandro L. Koerich Postgraduate Program in Computer Science (PPGIa) Pontifical Catholic University of Paran´a (PUCPR) Curitiba PR, Brazil 80215–901 Bird Species

[6] The Caltech-UCSD Birds-200-2011 Dataset, Catherine Wah, Steve Branson,Peter Welinder, Pietro Perona, Serge Belongie

[7] Object Detection with Deep Learning: A Review Zhong-Qiu Zhao, Member, IEEE, Peng Zheng, Shou-tao Xu, and Xindong Wu, Fellow, IEEE

[8] Wild Animal Detection Using Deep Convolutional Neural Network Gyanendra K. Verma and Pragya Gupta on 04 June 2018.

[9] Bird Species Recognition Using Support Vector Machines, Satya Dharanipragada, Hindawi Publishing Corporation EURASIP Journal on Advances in Signa

Processing Volume 2007, Article ID 38637, 8 pages doi:10.1155/2007/38637

[10] PlantNet project, AMAP joint research unit, France , Antoine Affouard, Herve Goeau, Pierre Bonnet, June 2015

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