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Automatic Bird Recognition using Signal Processing and Neural Networks

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ABSTRACT

In this study, an automatic bird species identification system was developed. Because it requires expertise in ornithology, people do not know enough about the sp ecies to accurately describe the bird. This article presents a neural network-
based system that can identify bird species based on their sound signature. The model was trained and tested on 138 bird species using all data recorded for traini ng and testing, respectively, and when tested with test data, the system showed 80% accuracy. As input, a neural network (CNN) classifies sound clips and identif ies bird species.
A real-time model was also developed and used for the above process.

Keyword: Bird, Computer Vision, Machine Learning, Classification, Neural Network, Self-Learning, CNN , Audio Signal Processing.

INTRODUCTION

Identifying bird species is an important task in many fields, including ornithology, animal protection and environmental protection. Traditional bird identification methods involve visual inspection and manual identification, which can be time consuming, expensive, and sometimes impossible. With recent advances in music and machine learning, it is now possible to develop automated systems to identify bird species using bird sounds. This project is designed to develop a system for bird species identification using signal processing and neural networks. The system will use sound sensors to detect the bird's voice, preprocess sounds and use neural networks to classify birds.

The neural network will be trained on bird sounds data and optimize the accuracy and performance of the calculations. The system will be designed to operate in the real world with various environmental factors such as noise and background noise. Potential uses for the project range from biodiversity monitoring and conservation to ecological research and education. The system can help scientists and conservationists gather more accurate data on birds and their behavior, and is also an educational tool for bird lovers and the public. Overall, this project provides a better understanding of bird ecology and conservation and can have a positive impact on the environment.

LITERATURE SURVEY

1. Paper Name: Bird Species Identification using Audio Signal Processing and Neural Networks

Author: Dr. Amol Dhakne, Vaishnav M. Kuduvan, Aniket Palhade, Tarun Kanjwani, Rushikesh Kshirsagar

Abstract : In this work, automatic bird species recognition systems were developed, and their identification methods were investigated. Automatically identifying bird calls without physical intervention has been a large and tedious endeavor for major studies in various subfields of taxonomy and other ornithology. This task uses a two-step identification process. In the first phase, an ideal dataset was created containing all recordings of different bird species. Next, the sound clip was subjected to various sound pre-processing techniques such as pre-emphasis, framing, silence removal, and reconstruction.

2. Paper Name: A Survey On Bird Species Identification Using Audio Signal Processing And Neural Network

Author: Prof. Pooja Wale , Abhishek Mankar , Pratik Padale , Sanket Gawade , Prasanna Ghogare

Abstract: an automatic bird species recognition system has been developed and methods for their identification has been investigated. Automatic identification of bird sounds without physical intervention has been a formidable and onerous endeavor for significant research on the taxonomy and various other sub fields of ornithology. In this pa- per, a two- stage identification process is employed. The first stage in- volved construction of an ideal

dataset which incorporated all the sound recordings of different bird species. Subsequently, the sound clips were subjected to various sound preprocessing techniques like pre- ephasis, framing, silence removal and reconstruction

3. Paper Name: Automated Bird Species Identification Using Neural Networks

Author: Vemula Omkarini

Abstract : Birds are the warm-blooded vertebrates constituting of class Aves, there are nearly 10 thousand living species of birds in the world with multifarious characteristics and appearances. Bird watching is often considered to be an interesting hobby by human beings in the natural environment. The human knowledge over the species isn't enough to identify a species of bird accurately, as it requires lot of expertise in the field of Ornithology. This paper presents an automated model based on the deep neural networks which automatically identifies the species of a bird given as the test data set.

4. Paper Name: Automated Bird Species Identification using Audio Signal Processing and Neural Networks

Author: Chandu B, Akash Munikoti, Karthik S Murthy, Ganesh Murthy V, Chaitra Nagaraj

Abstract : In this paper, an automatic bird species recognition system has been developed and methods for their identification has been investigated. Automatic identification of bird sounds without physical intervention has been a formidable and onerous endeavor for significant research on the taxonomy and various other sub fields of ornithology. In this paper, a two-stage identification process is employed. The first stage involved construction of an ideal dataset which incorporated all the sound recordings of different bird species.

5. Paper Name: Bird Species Identification using Deep Learning on GPU platform

Author: Pralhad Gavali, J. Saira Banu

Abstract: Today, many species of birds are rarely found, and it is difficult to classify bird species when found. For example, for different scenarios, birds come with different sizes, forms, colors and from a human viewpoint with different angles. Indeed, the images show different differences that need to be recorded as audio recognition of bird species. It is also easier for people to identify birds in the pictures. Today, using deep convolutional neural network (DCNN) on GoogLeNet framework bird species classification is possible. For this experiment, a bird image was converted into a gray scale format that generated the autograph. After examining each and every autograph that calculates the score sheet from each node and predicts the respective bird species after the score sheet analysis

6. Paper Name: Bird Species Classification with Audio-Visual Data using CNN and Multiple Kernel Learning

Author: Nanranchimeg Bold, Chao Zhang, Takuya Akashi

Abstract: Recently, deep convolutional neural networks (CNN) have become a new standard in many machine learning applications not only in image but also in audio processing. However, most of the studies only explore a single type of training data. In this paper, we present a study on classifying bird species by combining deep neural features of both visual and audio data using kernel-based fusion method. Specifically, we extract deep neural features based on the activation values of an inner layer of CNN. We combine these features by multiple kernel learning (MKL) to perform the final classification.

7.Paper Name: CONV-codes: Audio Hashing for Bird Species Classification

Author: Anshul Thakur, Pulkit Sharma, Vinayak Abrol, Padmanabhan Rajan

Abstract:We propose a supervised, convex representation based audio hashing framework for bird species classification. The proposed framework utilizes archetypal analysis, a matrix factorization technique, to obtain convex-sparse representations of a bird vocalization. These convex representations are hashed using Bloom filters with non-cryptographic hash functions to obtain compact binary codes, designated as conv-codes. The conv-codes extracted from the training examples are clustered using class-specific k- medoids clustering with Jaccard coefficient as the similarity metric. A hash table is populated using the cluster centers as keys while hash values/slots are pointers to the species identification information. During testing, the hash table is searched to find the species information corresponding to a cluster center that exhibits maximum similarity with the test conv-code.

8. Paper Name: Feature Learning for Bird Call Clustering

Author: Harshita Seth

Abstract: In this paper, a supervised algorithm is proposed for the identification and segmentation of bird calls with K-means clustering using features learnt by matrix factorization. Singular value decomposition is applied on pooled time-frequency vocalization in a class-wise manner to learn a class-specific feature representation. These representations show discriminative behavior even when unseen classes are represented. By combining the proposed feature representation with K-means clustering, we are able to effectively cluster and segment bird calls from multiple species, which are present in an input recording. Experimental results are provided on a small dataset of bird song.

9. Paper Name: Audio-based Bird Species Identification with Deep Convolutional Neural Networks

Author: Mario Lasseck

Abstract: This paper presents deep learning techniques for audio-based bird identification at very large scale. Deep Convolutional Neural Networks (DCNNs) are fine-tuned to classify 1500 species. Various data augmentation techniques are applied to prevent overfitting and to further improve model

accuracy and generalization. The proposed approach is evaluated in the Bird CLEF 2018 campaign and provides the best system in all subtasks. It surpasses previous state-of-the-art by 15.8 % identifying foreground species and 20.2 % considering also background species achieving a mean reciprocal rank (MRR) of 82.7 % and 74.0 % on the official Bird CLEF Subtask1 test set.

10. Paper Name: Automatic bird species recognition based on birds vocalization

Author: Jiri Stastny, Michal Munk and Lubos Juranek

Abstract: This paper deals with a project of Automatic Bird Species Recognition Based on Bird Vocalization. Eighteen bird species of 6 different families were analyzed. At first, human factor cepstral coefficients representing the given signal were calculated from particular recordings. In the next phase, using the voice activity detection system, segments of bird vocalizations were detected from which a likelihood rate, with which the given code value corresponds to the given model, was calculated using individual hidden Markov models. For each bird species, just one respective hidden Markov model was trained. The interspecific success of 81.2 has been reached. For classification into families, the success has reached 90.45.

11. Paper Name: Deep Learning Based Audio Classifier for Bird Species

Author: Aarti Madhavi, Rajni Pamnani

Abstract: The effect of human activities on the environment has reached a point where it has become necessary to track the effects before it causes irreparable dam- age to the environment. One of the ways to track such effects is to monitor the breeding behavior, biodiversity and population dynamics of animals. Birds are one of the best species to track as they do tend to be the most reactive ones for any change in the environment e.g., deforestation or forest fires. Till now, the tracking of the birds was done manually by experts, which is very tedious at the same time consuming and non-viable method. As a result to alleviate this issue and provide assistance to the ecologists we proposing a machine learning method to recognize the bird's species based on the audio recordings.

12.Paper Name: Large-Scale Bird Sound Classification using Convolutional Neural Networks

Author: Stefan Kahl , Thomas Wilhelm-Stein , Hussein Hussein , Holger Klinck , Danny Kowerko , Marc Ritter , and Maximilian Eibl

Abstract: Identifying bird species in audio recordings is a challenging field of research. In this paper, we summarize a method for large-scale bird sound classification in the context of the Life CLEF 2017 bird identification task. We used a variety of convolutional neural networks to generate features extracted from visual representations of field recordings.

13. Paper Name: Bird Call Identification using Dynamic Kernel based Support Vector Machines and Deep Neural Networks

Author: Deep Chakraborty, Paawan Mukker†, Padmanabhan Rajan†and A. D. Dileep

Abstract: In this paper, we apply speech and audio processing techniques to bird vocalizations and for the classification of birds found in the lower Himalayan regions. Mel frequency cepstral coefficients (MFCC) are extracted from each recording. Asa result, the recordings are now represented as varying length sets of feature vectors. Dynamic kernel based support vector machines (SVMs) and deep neural networks (DNNs) are popularly used for the classification of such varying length patterns obtained from speech signals.

14. Paper Name: Identification of Bird Species from Their Singing

Author: Sujoy Debnath, Partha Protim Roy

Abstract: Biodiversity is one of the mysterious phenomenon that we are understanding more and more as time passes by. Aiding the process of understanding nature is an initiative by BIOTOPE society; an open platform to bring together researchers to retrieve information by identifying bird species from calls or singing of different bird species. The main idea behind this work is to identify bird species from their calls or songs. The work presented in this article explores the automated method to identify bird species based on songs and calls of different bird species. This will help in archiving and identifying new species or subspecies.

15. Paper Name: Feature Set Comparison for Automatic Bird Species Identification

Author: Marcelo Teider Lopes

Abstract: This paper deals with the automated bird species identification problem, in which it is necessary to identify the species of a bird from its audio recorded song. This is a clever way to monitor biodiversity in ecosystems, since it is an indirect non-invasive way of evaluation. Different features sets which summarize in different aspects the audio properties of the audio signal are evaluated in this paper together with machine learning algorithms, such as probabilistic, instance-based, decision trees, neural networks and support vector machines.

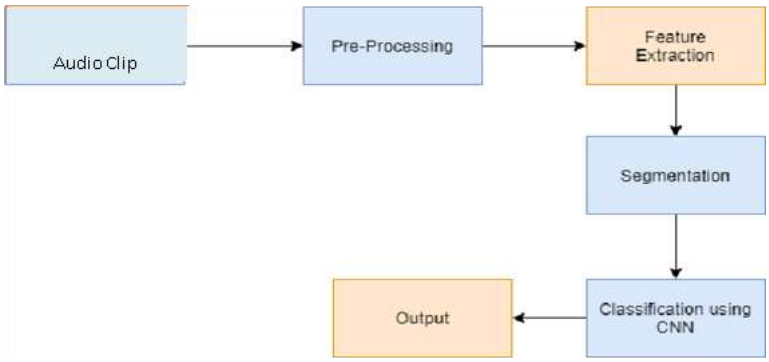
16. Paper Name: Time-Frequency Segmentation Of Bird Song In Noisy Acoustic Environment

Author: Lawrence Neal, Forrest Briggs, Raviv Raich, and Xiaoli Z. Fern

Abstract: Recent work in machine learning considers the problem of identifying bird species from an audio recording. Most methods require segmentation to isolate each syllable of bird call in input audio. Energy-based time-domain segmentation has been successfully applied to low-noise, single-bird recordings. However, audio from automated field recorders contains too much noise for such methods, so a more robust segmentation method is required.

Methodology

SYSTEM ARCHITECTURE



1. Data Collection

The first step is to collect data. Collecting high-quality audio clips of bird voice and calls is need to train and validate the performance of the neural network. Recordings should cover a wide range of bird species and different environments. Data collection involves the collection of audio signals of different bird species from dataset. Ensure that audio samples are of good quality and have minimal background noise.

Link of dataset - Bird audio dataset for 138 species | Kaggle

2. Data Pre-Processing

After collecting data, the next step is data preprocesses it. Data preprocessing of audio data involves cleaning, filtering, and segmenting the audio data. Cleaning removes noise or

artifacts found in the recording. Filtering reduces background noise to improve the signal-to-average ratio. Segmentation divides the recording into a single bird song or song.

3. Feature Extraction

Feature extraction will convert segmented audio data into numerical features that will be fed into neural networks. Popular feature extraction techniques for audio data include Mel Frequency Cepstral Coefficients (MFCC), Mel Spectrogram, and Constant-Q Shift (CQT).

Audio feature extraction is a necessary step in signal processing and is a subfield of signal processing. Controls the operation of the audio signal or by converting digital and analog signals.

4. Model Selection

The Neural networks can be designed to classify bird species based on their audio vocalization. The most popular neural network architectures for audio classification include Convolutional Neural Networks (CNNs).

Convolutional Neural Network(CNN): Convolutional Neural Network (CNN) is a deep learning algorithm that especially suitable for image recognition and processing. It has many layers like convolutional layers, pooling layers and all layers.

Convolutional layers are main building blocks of CNNs, where filters are applied to the input images to extract features such as edges, texture, and shape. The output of the convolutional layers is then passed through a pooling layers used to sub-sample the feature maps, which reduce the spatial size while preserving the most important information. The output of the pooling layer is then via one or more links, with the layers used to predict or recognize audio signals.

5. Model Training

The neural network is trained on recorded data of bird species. The training including tuning weights and trends of the network to minimize performance loss. The trained models are then validated on a separate dataset to evaluates its performance.

6. Model Evaluation

The performance of the training model is evaluated by metrics such as Accuracy, Precision, Recall, and F1 Score. The model can be refined and reworked based on the evaluation results to improve its performance.

7. Deployment

The final step is to deploy the trained model in a real-world setting, such as a mobile application or a web platform, to enable automated bird species spotting. The model's performance should be regularly monitored and evaluated to ensure it remains accurate and reliable over time.

CONCLUSION

The project “Automatic bird recognition using signal processing and neural networks” is a commitment to enable bird species identification based on their vocalizations. This project uses the Convolutional Neural Networks (CNN) algorithm to describe audio clip and identify bird species. The project achieved great results in confirming the accuracy of bird species. The CNN algorithm can classify bird species with an accuracy approximately 80% accuracy. Overall, this project demonstrates the potential of bird species identification using advanced machine learning techniques, such as CNN, for automatic. This has important implications for ecological research and conservation efforts because it allows for more efficient and accurate monitoring.

FUTURE SCOPE

• This model helps to create application that helps birds shelter visitors identity.

• An application can be developed and distributed for mobile devices will help users to predict and identify bird sounds using their smartphones as handled devices.

• Equipment will be installed in ecological parks, conservation parks and bird areas. The resulting data can stored locally or in the cloud, so the obtained data will be important for studying bird migration patterns, population distribution, biodiversity and bird statistics in a region.

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