Automated Bird Species Identification through Voice Using Machine Learning

[1]Keerthiraj M M, [2]Vinay Patil G L

[1]Sem MCA Student, Department of MCA, BIET, Davanagere

[2]Assistant Professor, Department of MCA, BIET, Davanagere

ABSTRACT - Now a days bird population is changing drastically because lots of reasons such as human intervention, climate change, global warming, forest fires or deforestation, etc., With the help of automatic bird species detection using machine learning algorithms, it is now possible to keep a watch on the population of birds as well as their behavior. Because manual identification of different bird species takes a lot of time and effort, an automatic bird identification system that does not require physical intervention is developed in this work. To achieve this objective, Convolutional Neural Network is used as compared to traditionally used classifiers such as SVM, Random Forest, SMACPY. The foremost goal is to identify the bird species using the dataset including vocals of the different birds. The input dataset will be pre-processed, which will comprise framing, silence removal, reconstruction, and then a spectrogram will be constructed, which will be sent to a convolutional neural network as an input, followed by CNN modification, testing, and classification. The result is compared with pre-trained data and output is generated and birds are classified according to their features (size, colour, species, etc.)

***Key Words*: Deep Learning, Automatic Identification, Artificial neural network, Pre-process, Spectrogram, Classification**

1. INTRODUCTION

The ecosystem of birds is incredibly diverse in terms of behaviour, size, and shape, but this biological diversity may be in danger due to human interference in their habitats and complete habitat destruction, which are also accompanied by environmental catastrophes like global warming, forest fires, and other natural disasters. Due to their limited and shrinking ranges, 1,481 bird species, or 13.5% of all data sufficient species, are worldwide threatened with extinction as of 2020.

One of the most essential justifications for bird monitoring is controlling and evaluating the environment. Certain bird species are impacted by water and air pollution. Hence, spotting and avoiding environmental issues can be done through bird species identification. Since they react quickly to environmental changes, birds can also help us find different types of life in the environment. It is, however, prohibitive because it takes a lot of human labour and ismore expensive to gather and compile information about bird species. In this case, a reliable system will offer a lot of information about birds and act as an essential tool for scientists and government officials.

We propose a deep learning method to identify the species of bird based on audio recordings to address this issue and support ecologists. To achieve this, we want to employ the most recent Artificial Neural Networks model (ANN model) for automatic bird species identification using audio inputs. We wanted to improve the current bird species classifier's classification accuracy in this work. The accuracy for training was 100%, and the accuracy for validation was 97%, according to this data. As a consequence, we can assert that ANN can successfully identify the bird species and easily defeat the existing implementation model.

The method includes the following steps:

1) recording bird singing outdoors;

2) using audio pre-processing techniques to enhance signal quality since these recordings are frequently made in loud locations.

3) extracting elements from the audio input and training

4) Model: ANN

5) Predict the type using proposed algorithm

1.1 PROBLEM STATEMENT

The vocal expression of birds is used to communicate a variety of information. Birds use their vocalizations to communicate a variety of threats and warnings about approaching danger, to recognize certain birds or insects within a flock, and to demarcate and delimit territory. The call specialization suggests that they are more immediate and effective vocal emotions.

The problem of recognizing birds using an automated system with the usage of bird sounds can be defined as the challenge of differentiating several bird species from their recorded songs. Experts claim that bird songs, as opposed to the bird sounds used here, are more melodious and better able to identify different species. The entire signal is pre- processed in order to identify the most pertinent portion of the signal and extract characteristics.

1.2 LITERATURE SURVEY

Many research papers have been written and published on the subject of automated bird species recognition over the course of the preceding few years. Several of them have been successful in classifying certain species, and each has advantages and drawbacks of their own

[1] Speedy Image Crowd Counting by Light Weight Convolutional Neural Network

AUTHORS: Vivekanandam, B.

In image/video analysis, crowds are actively researched, and their numbers are counted. In the last two decades, many crowd counting algorithms have been developed for a wide range of applications in crisis management systems, largescale events, workplace safety, and other areas. The precision of neural network research for estimating points is outstanding in computer vision domain. However, the degree of uncertainty in the estimate is rarely indicated. Point estimate is beneficial for measuring uncertainty since it can improve the quality of decisions and predictions. The proposed framework integrates Light weight CNN (LWCNN) for implementing crowd computing in any public place for delivering higher accuracy in counting. Further, the proposed framework has been trained through various scene analysis such as the full and partial vision of heads in counting. Based on the various scaling sets in the proposed neural network framework, it can easily categorize the partial vision of heads count and it is being counted accurately than other pre-trained neural network models.

[2] Study of Variants of Extreme Learning Machine (ELM) Brands and its Performance Measure on Classification

Algorithm

AUTHORS: Manoharan, J. Samuel

Recently, the feed-forward neural network is functioning with slow computation time and increased gain. The weight vector and biases in the neural network can be tuned based on performing intelligent assignment for simple generalized operation. This drawback of FFNN is solved by using various ELM algorithms based on the applications issues. ELM algorithms have redesigned the existing neural networks with network components such as hidden nodes, weights, and biases. The selection of hidden nodes is randomly determined and leverages good accuracy than conservative methods. The main aim of this research article is to explain variants of ELM advances for different applications. This procedure can be improved and optimized by using the neural network with novel feed-forward algorithm. The nodes will mainly perform due to the above factors, which are tuning for inverse operation. The ELM essence should be incorporated to reach a faster learning speed and less computation time with minimum human intervention. This research article consists of the real essence of ELM and a briefly explained algorithm for classification purpose. This research article provides clear information on the variants of ELM for different classification tasks. Finally, this research article has discussed the future extension of ELM for several applications based on the function approximation.

[3] Automated Bird Species Identification using Audio

AUTHORS: Chandu B, A. M

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 endeavour 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. Subsequently, the sound clips were subjected to various sound pre-processing techniques like pre-emphasis, framing, silence removal and reconstruction. Spectrograms were generated for each reconstructed sound clip. The second stage involved deploying a neural network to which the spectrograms were provided as input. Based on the input features, the Convolutional Neural Network (CNN) classifies the sound clip and recognizes the bird species. A Real time implementation model was also designed and executed for the above-described system.

[4] Bird Sound Identification based on Artificial Neural Network

AUTHORS: M. M. M. Sukri, U. Fadlilah, S. Saon, A. K. Mahamad, M. M. Som and A. Sidek

Due to effect of climate changes and count of endangered animal, many researchers proposed animal species recognition system to help them for specific study. This paper proposes to identify bird sound identification using Artificial Neural Network (ANN). Each bird has a different tone of sounds. ANN is applied to classify and recognise the bird sounds using MATLAB software. Firstly, all required data in term of power spectral density of bird is used in order to obtain data for each bird types. The next process is to train ANN to identify species of birds. Only one bird can identify in one time. Lastly, the graphical user interface (GUI) of bird sound identification have been developed that required the user to fed audio input of bird sound in order to recognise bird species. This project is done successfully and can be used to identify bird species.

[5] Deep Learning Based Audio Classifier for Bird Species AUTHORS: Aarti Madhavi, R. P.

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 damage to the environment. One of the ways to track such effects is to monitor the breeding behaviour, 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. To achieve this goal, we intend to use the state of art convolutional neural network architecture called the deep residual neural networks as compared to the traditionally used classifiers like SMACPY, SVM and other relatively less sophisticated methods. We leverage methods like data augmentation and the existing carefully crafted datasets from Neural Information Processing Scaled for Bioacoustics to showcase the effectiveness of our method.

2. METHODLOGY

The discussion's main goal is to anticipate bird species based on their voice/audio. The suggested framework contains five major phases, as depicted in Figure 1:

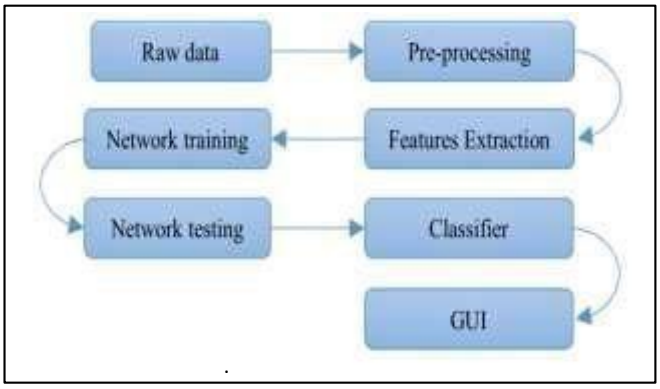

Fig – 1 Flowchart of methodology

1. Data is collected from respected dataset.
2. On the dataset, data pre-processing techniques such as framing and noise removal are used.
3. The data is processed using the Convolutional Neural Network approach.
4. Model output is displayed on the screen.

A. Dataset

The first step of implementation is gathering data from dataset which is obtained from XENO-canto/Kaggle. The audio recordings of the birds in MP3 format are included in this resource. This dataset contains audio recordings of the birds in MP3 format. XENO-canto/Kaggle are open websites dedicated for dataset where users upload their own recordings. In case of our survey, bird audio related dataset is required. Genus, species, subspecies, locality, type, color, size, and bird sound quality are all labelled in this dataset (from A to E, Where A is the best quality). Since many features are defined in dataset, combination of them are used to define class (like genus and species, etc.) and classify birds according to them.

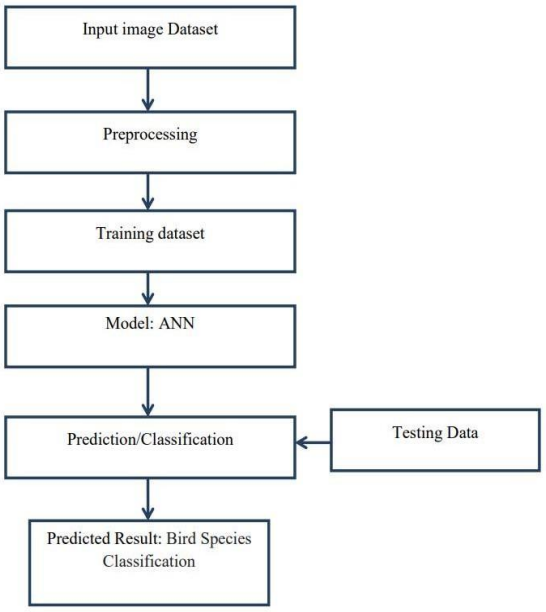

Fig -2: Data Flow Diagram

B. Data/Sound pre-processing

Following data collecting, sound recordings are preprocessed. The WAV format is used to convert the MP3 files obtained from the dataset. These Wav files are normalized after being separated into equal-length segments. Threshold filtering is used to create chunks/segments with a high amplitude and no noise or disruption. The waveform was created using power spectral density (PSD). The PSD was a metric that measured the amount of power per unit of frequency.

C. Classification with Neural Network

An Artificial Neural Network (ANN) classification algorithm is a popular method for analyzing and recognizing

bioacoustics signals. As a classification model, the multilayer perceptron (MLP) is used. The MLP takes a set of predetermined attributes as input and produces a unique outcome for each bird species to be identified. Training and testing are the two steps in this identifying procedure. In the training process, syllables of specified bird sounds were utilized to train the multilayer perceptron, resulting in the right MLP output being triggered. The training process is carried out by repeatedly delivering known sounds to the network and then iteratively adjusting the network's weighting. The goal of this training is to lower the total between the supplied and expected results till a predefined error requirement is accomplished.

D. Output

For the output, user can use GUI i.e., Graphical User

Interface to analyze the species of the bird. With the help of GUI user can record, process and show the outcome.

3. RESULT

The waveform of a bird's voice can be obtained using MATLAB software. Dataset can be individually captured in mp3 format, which must be converted to a.wav file, and it is evident that each bird has a distinctive voice. Through a process of training, an ANN is tuned for a specific purpose, such as pattern classification.

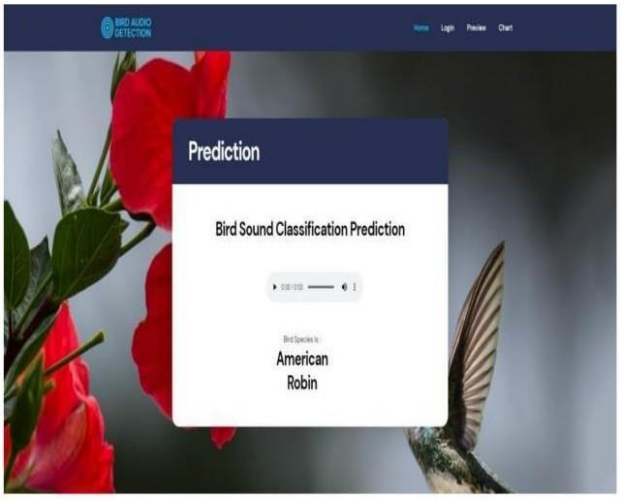

Fig -3: Following shows the expected GUI:

4. ADVANTAGES

Systematic recordings of outdoor noises are now possible thanks to automated audio recorders, which have recently opened up new opportunities for environmental conservation and restoration. Due to the fact that many bird species have extraordinarily high vocal frequency, audio recordings have become one of the most effective techniques to do study on them. Biological sounds of birds can give detailed and standardized data on the dynamics and distribution of wildlife habitats. Audio research and surveys are a good tool to analyze the species' density, abundance, and occupancy because many bird species produce distinct and consistent sounds. Furthermore, picturized monitoring is problematic for many small and sensitive birds, enigmatic species, and species living in environments that environmentalists find difficult to reach. Bird audio tracking is also useful for other environmental operations, such as assessing the impact of wildfires and determining the extent of forest regeneration.

5. LIMITATION

Audio signals provide much more information about a bird, as it can be further classified into songs, calls, and sounds so noise in these various types of audios can be an issue. Having this kind of extra set of properties and classifications, also makes identification of birds little difficult.

6. FEASIBILITY STUDY

An artificial intelligence system called the Convolutional

Neural Network (CNN) has been used to classify bird noises. Other scholars have tested a range of methods for identifying bird songs. The following list offers some applications for automated systems: -

1. Continuous ambient recordings that use automatic bird sound recognition would significantly advance ornithology and biology studies. This technology will be helpful to government organization and investigators because it takes a lot of time and money to manually identify different bird species.

2. Since birding is a popular activity in many nations, such systems have a great deal of potential for profit. Hardware like the Raspberry Pi can be used to operate the CNN. These technological advancements can benefit animal sanctuaries, preservation parks, and environmental parks.

3. Users may utilize their smartphones as tools for bird sound identification and assessment by designing and publishing an android application for a variety of mobile devices.

4. Both a local hard disc and the cloud can be used to store the collected data. The information acquired will be very helpful in studies of the demographics, variety, and migration patterns of birds in a certain area.

7. FUTURE SCOPE

This method enables the identification and classification of a larger number of bird species, leading to more precise results.

If this programming is used well, it may be a very helpful tool for determining the size of bird populations, identifying natural habitats, and monitoring a variety of other species. A user-friendly application can also be advantageous to environmentalists and wildlife enthusiasts. Additionally, by employing RNN for classification, accuracy may be increased because it has internal storage to recall its input.

8. CONCLUSIONS

In this study, an artificial neural network model (ANN model) for automatic bird species recognition is provided. Numerous researchers suggested an animal species recognition system to aid them in conducting particular research because of the impact of climate change and the number of endangered species. In this research, we created a system to recognize bird sounds using an artificial neural network (ANN). Each bird makes noises with a distinctive tonality. Python is used to use ANN to categorize and identify the bird noises. In order to get data for each species of bird, the necessary information on the power spectral density of birds is first employed. The next step is to teach ANN to recognize the different bird species. A bird can just identify at a time. Finally, a graphical user interface (GUI) for bird sound identification has been created, requiring audio input from the user to identify the species of bird. Successful completion of this project allows for the identification of several bird species.

1) Develop an iOS or Android app rather than a website for user convenience.

2) The system might be built utilizing the cloud, which offers great computational power for processing (in this case of neural networks) and can store a lot of data for comparison.

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