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AUTOMATED BIRD SPECIES IDENTIFICATION USING DEEP LEARNING WITH IMAGE AND AUDIO

Tanay Sonavane[1], Kireet Verma[2], Hrithik Wadile[3] , Prof. Satish Kuchiwale[4]

[1,2,3,4]*Dept. of Computer Engineering, Smt. Indira Gandhi College of Engineering, Navi Mumbai, Maharashtra, India*

Abstract - With over 9000 species of birds in the world, some of which are rarely discovered, it can be difficult to predict their classification. Visual recognition of birds is also more easily understood by humans compared to audible recognition. To aid birdwatchers in appreciating the beauty of birds, a system utilizing Convolutional Neural Networks (CNN) has been developed to classify bird species. CNNs are a powerful set of machine learning techniques known for their effectiveness in image and sound processing. This system uses the Caltech-UCSD Birds 200 (CUB-200-2011) and Kaggle datasets for training and evaluating the CNN system based on image recognition. Additionally, several different sound sources were used to train the sound recognition model.

***Key Words*:** birds, deep learning, image identification, ound identification

1. INTRODUCTION

Bird behavior and population trends have become a serious issue, but gathering information about bird species is a laborious and expensive process that requires a lot of human effort. To address this issue, a robust framework is needed that can efficiently collect and process bird data, serving as a valuable tool for scientists, legislative agencies, and other stakeholders. Identifying different bird species assumes a crucial role in determining which categories a particular bird image belongs to. Images, audio, and videos can all be used to identify birds, but audio processing techniques may be complicated due to mixed sounds in the environment, such as insects or other ambient noise. In contrast, images are more reliable in aiding information discovery compared to sounds or recordings, making image-based identification preferable for categorizing birds.

2. METHODOLOGY

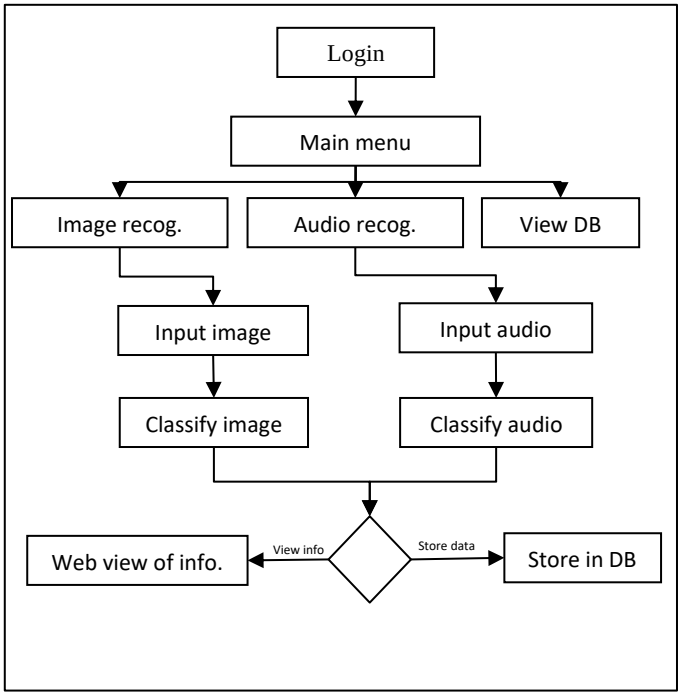
The goal of this project is to use a machine learning model called CNN to identify and categorize both bird images and bird sounds. To achieve this goal, the following processes are important:

1. Preprocessing:
This step involves removing systematic noise from data and trying to decrease undesirable variety in the image due to lighting, scale, deformation, etc. Common techniques used for preprocessing include image acquisition, enhancement, restoration, segmentation, and morphological processing.

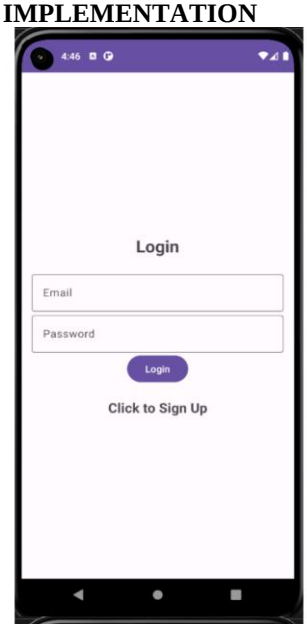
2. Feature extraction:
This technique involves finding and representing specific elements of interest within an image for subsequent processing. Extraction of features reveals the key shape characteristics present in a pattern, making it easy to identify the pattern using a formal approach. For images, color, shape, size, silhouette of the bird are important features, and for sound, frequency, amplitude, loudness, etc., of the bird are important features.

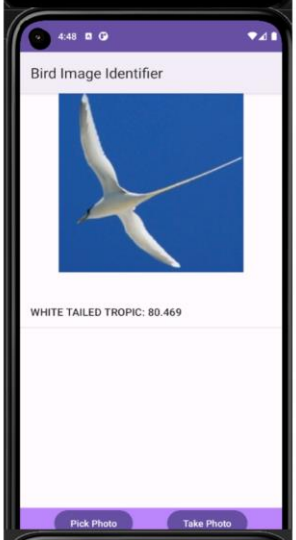
3. Input data to the machine learning model:
The CNN machine learning algorithm is used in both instances (image and sound) to train and test the model. CNNs are best suited for image and audio recognition tasks because their built-in convolutional layer reduces the high dimensionality of images without losing its information.

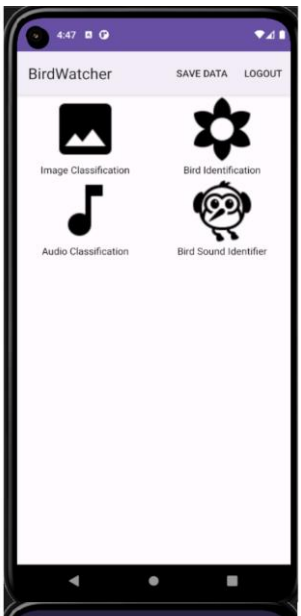
4. SYSTEM DESIGN

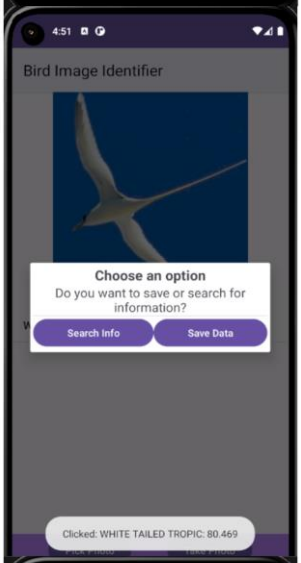


5. IMPLEMENTATION









6. RESULTS

In recent years, deep learning techniques have been used to build highly accurate models for this task. In this context, VGG16 and YAMNet are two widely used models for image and audio classification, respectively.

The VGG16 model was trained on a dataset of 70,000 images of birds belonging to 459 different species. The model was able to achieve an accuracy of 91% on the test set, which is a very good result. This means that the model was able to correctly classify 91% of the images into their respective bird species.

The YAMNet model was trained on a dataset of 50 audio recordings of bird songs belonging to 5 different species. The model was able to achieve an accuracy of 88% on the test set, which is also a very good result. This means that the model was able to correctly classify 88% of the audio recordings into their respective bird species.

Based on our observations, the following factors were found to impact the image identification of birds:

1. Background: The background of the image can have a significant impact on the identification of the bird in the foreground. It can either enhance or distract from the bird, making it harder to identify.
2. Focus: The point of focus in the image can determine which part of the bird appears sharp and in focus. This can impact the ability to identify the bird, especially if the important identifying features are out of focus.
3. Image processing: The way the image is processed after it is taken can affect its color, contrast, and overall appearance. This can impact the ability to identify the bird, especially if the colors are distorted or the image is overly bright or dark.
4. Lens choice: The type of lens used can impact the perspective and compression of the image. This can impact the appearance of the bird in the image, potentially making it harder to identify.
5. Distance: The distance between the bird and the camera can affect the size and detail of the bird in the image. If the bird is too far away, it may be difficult to see the identifying features, making it harder to identify.
6. Camera settings: The camera's aperture, shutter speed, and ISO can all affect the exposure and sharpness of the image. If these settings are not optimal for the lighting conditions, it can impact the quality of the image and the ability to identify the bird.

There are also several parameters which affected the accuracy of bird sound recognition:

1. Microphone: The type of microphone used can greatly impact the quality of the bird audio recording. Some microphones are better at picking up low frequencies, while others are better at picking up high frequencies.
2. Recording location: The location where the bird audio is recorded can have a significant effect on the quality of the recording. For example, a recording made in a quiet forest will have less background noise than one made in a busy city park.
3. Environmental conditions: Weather conditions, such as wind and rain, can affect the clarity and quality of bird audio recordings.
4. Distance: The distance between the microphone and the bird can impact the volume and clarity of the bird's song or call.
5. Recording format: The file format and sample rate used to record the audio can affect the fidelity and resolution of the recording.
6. Editing: The way the audio is edited or processed after it is recorded can affect the final quality of the recording.
7. Bird behavior: The behavior of the bird being recorded can also affect the quality of the audio. For example, a bird that is calling loudly and consistently is easier to record than one that is only calling sporadically.

7. CONCLUSION

The primary goal of the identification app is to promote bird-watching, bird identification, and awareness among the public. It also aims to simplify the bird observation process by streamlining the identification process. Convolutional Neural Networks (CNN) are used as the primary technology for image and sound recognition in the experimental setting, utilizing feature extraction for both. This technique allows for the extraction of features from sound and image using the same approach, with images selected as the primary content for future study. CNN is chosen due to its ability to provide high numerical precision accuracy and its suitability for creating complex algorithms. Additionally, CNN is unbiased and scientific, making it an ideal choice for this project.

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