Deep Learning enabled Deepor Beel Migratory bird Detection system.

Abstract

This article proposes a Deep Learning enabled model to study migratory birds at Deepor Beel, an ecologically important wetland in Assam, North East, India. Migratory birds have a very important role in maintaining ecological balance and act as an indicator of ecosystem health. On the other hand, the traditional methods of bird monitoring which depends on manual observations are often very much time consuming and error prone. This article put forward an idea about how modern technologies like Deep Learning and Computer Vision can enhance wild life monitoring system. It discusses the use of techniques such as Convolutional Neural Network (CNN) and YOLO (You Only Look Once) model for automatic recognition and classification of different bird species from images and videos. The proposed system comprises of stages such as data collection, image annotation, model training and deployment.

Besides that, the article focuses on the advantages of automated monitoring system including its improved accuracy with continuous observation and support for the goal of conservation. It also deals with challenges like weather condition and species similarity for the image quality along with the future scope such as incorporating acoustic sensors and GIS technologies. In total, the article highlights the importance of technology driven procedures for an effective and efficient conservation and management of wetland ecosystem at Deepor Beel.

Keywords:

Deep Learning, CNN, YOLO, Computer Vision, Deepor Beel, Wildlife monitoring, Migratory birds Detection.

1. Introduction

Deepor Beel is one of the most ecologically important wetland in Assam Northeast, India. Situated near Guwahati, this freshwater lake has been well known as Ramsar site (**Ministry of Environment, Forest and Climate change, 2020; BirdLife International, 2021**) because of its vast ecological value and rich biodiversity. The wetland serves as a natural habitat for various aquatic plants, fish species and a wide variety of birds. Amongst all of these, migratory birds play a very vital role in maintaining the ecological balance of the wetland ecosystem at Deepor Beel.

Every year, thousands of migratory birds pass through long distances from regions such as Central Asia, the Himalayan Belt and the parts of Europe to spend the winter season at Deepor Beel to overcome the cold weather and also for reproduction or in search of food. Breeds such as the spot billed Pelican, Lesser Adjutant and several varieties of ducks and storks are normally seen in the wetland. These migratory birds depend on the wetland for feeding, resting and breeding during their migration cycle. Apart from its ecological importance, Deepor Beel is having increasing risk due to fast urban development, industrial tasks, railway transportation and environmental degradation. Theses causes are gradually and increasingly

disturbing the natural habitat of migratory birds. Consequently, monitoring bird population has become very crucial for biodiversity conservation to prevent extinction. Presently, bird monitoring in wetlands is conducted through manual examination by researchers and forest officials. These investigations include counting birds, using binoculars, cameras and field surveillance. Whereas this technique has been used for decades, it has numerous restrictions. Manual examination is very much time consuming, requires significant manpower and may lead to erroneous counts due to human error. Large flocks of birds are mainly difficult to count precisely using conventional methods. Modern progress in Artificial intelligence and computer vision presents new prospect to enhance wildlife monitoring system. Deep Learning technologies now make it promising to automatically identify and classify animals from images and video footage. By applying these methodologies to wetland ecosystems, researchers can build up automated systems that monitor bird populations more efficiently.

This article talks about the concept of Deep Learning enabled migratory bird detection system designed exclusively for monitoring bird variety in Deepor Beel.

2. Importance of Studying Migratory Birds

Migratory birds are essential measure of environmental health. Variations in bird populations often reflect changes in habitat quality, climate conditions and ecological stability. Monitoring these birds helps scientists realize ecosystem dynamics and discover probable environmental risks.

Deepor Beel plays a central role in resting and feeding ground for migratory birds during their long travel. If the wetland ecosystem is unbalanced, migratory birds may end visiting the region, which can disturb the ecological balance.

Regular observation of bird population helps conservation authorities in numerous ways:

1. Following seasonal migration patterns
2. Discovering endangered species
3. Knowing habitat changes
4. Following conservation planning etc.

But traditional manual monitoring methods cannot give continuous observation. Automated systems based on artificial intelligence can significantly advances monitoring effectiveness.

3. Role of Deep Learning in Wildlife Conservation

Deep Learning is a part of artificial intelligence that allows computers to learn patterns from large dataset **(Yann LeCun et al., 2015).** In the purpose of picture scanning, deep learning models can identify objects, categorize pictures, and differentiate patterns with high accuracy.

One of the normally used deep learning techniques for image recognition is Convolution Neural Networks (CNNs) (**Yann LeCun et al., 2015; Ian Goodfellow et al., 2016**). CNNs automatically extract features from images, such as edges, shapes, and textures. Such features aid the system to distinguish between different bird categories.

Another influential technology used in image recognition is the YOLO (You Only Look Once) model **(Joseph Redmon et al., 2016**). This is commonly used for instant recognition of object. YOLO is not as traditional identification systems that execute images in different stages, YOLO examines the whole image in a single pass and makes it appreciably fast and proper for instant supervising applications.

The combination of CNN-based feature extraction with YOLO identification algorithms can build a highly capable bird identification system.

4. Proposed Model of the Migratory Bird Detection System

The system is designed to automatically identify, classify, and compute bird categories at Deepor Beel using Deep Learning methods. The system use images and videos captured from different sources and study them using trained deep learning model. The system mostly contains the following modules:

Module-1. Data Collection

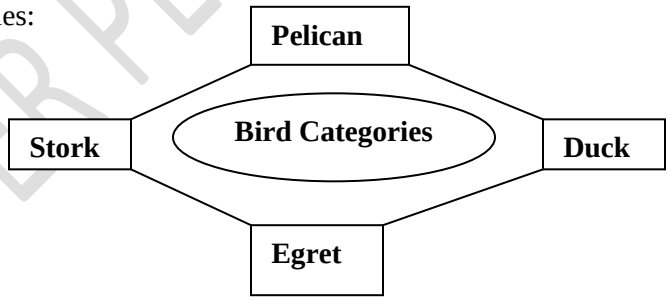
The first step in building the identification system is to collect bird images from the wetland. Data can be gathered using multiple sources such as:

- high-resolution cameras attached to drones
- permanently installed cameras for supervising the wetland.
- DSLR cameras used at the time of bird surveys.
- Uses of drone technology is suitable because it can catch images from large areas of the wetland without disturbing the birds.
- The captured images from distinct seasons and climate conditions help in making a varied dataset to train the deep learning model.

Module-2. Image Explanation and Dataset Creation

After the collection of images, the next step involves organizing the dataset. The images must be labeled as Deep learning model needs them to learn how to identify distinct bird categories. Explanation tools such as Labellmg or Roboflow can be utilized to outline bordering boxes around birds in the images. All birds are labeled according to its type.

Different Bird Categories:



After the completion of dataset labeling, dataset is divided into three parts like training, validation, and testing sets. This guaranties that the model learns from the data and can be tested on new images.

Module-3. Training the Deep Learning Model

The training process includes inputting labeled images into the deep learning model so that it can learn to distinguish birds automatically.

At the time of training, the CNN model retrieves necessary visual features from the images. Then the retrieved features are used by the YOLO identification system to identify and search out the birds inside an image.

For improving the presentation of the model, data enhancement methods can be useful. The methods synthetically enhance the dataset size by generating modified versions of existing images. We can mention the methods as follows:

- Image Rotation
- Horizontal Flipping
- Cropping
- Brightness Adjustments

The above methods support the model to become more effective and capable of handling real-world variations.

Module-4. Measurement of System Performance

After completion of training of the model, its results must be tested using standard evaluation metrics.

Some important and frequently used metrics are mentioned below:

PRECISION: It evaluates the accuracy of the identification.

RECALL: It counts the number of birds that are correctly identified.

F1-SCORE: It integrates precision and recall

MEAN AVERAGE PRECISION (mAP): It measures entire identification accuracy

A well trained model can accomplish high identification accuracy and making it consistent for practical supervising applications.

Module-5. Utilization of the Identification System

After the completion of model training and testing, it can be applied in real world scenarios. There are many ways to utilize the system.

One way is edge computing, where a small AI device can be used to run the model .e.g. NVIDIA Jetson Nano. This type of device can process images directly on-site.

Another way is a cloud-computing monitoring tool. Images collected through cameras can be uploaded to a cloud computing server where the deep learning model analyzes them and provide outputs through a online dashboard.

The dashboard can demonstrate necessary information like –

- Day to day bird observations
- Habitat distribution of species
- Migratory patterns across seasons

Besides, mobile apps can alert forest authorities of abnormal bird population.

5. Advantages of Computerized Bird Identification for Wildlife Conservation:

A computerized bird identification system can provide distinct benefits for the ecological conservation at Deepor Beel.

It reduces the effort required for traditional bird counting methods. Also the system can help constantly in observing the bird populations during the entire year. Additionally, it provides reliable data that can support policymakers and conservation authorities in making well informed decisions. By generating a long term database of bird populations, researchers can also study trends related to climate change and habitat change with biodegradation.

6. Limitations and Way Forwards

Although we know Deep learning comes with its own benefits and learning dimensions, but like a coin has its two faces, so does deep learning and as such ,it comes with its own limitations or challenges, which will be associated with it.

When it comes to birds, most of which tend to travel in large flocks, this could make it worse. In addition, most birds look alike, and this could prove to be a challenge.

Finally, the weather, such as when it is foggy or has a lot of dew, could also prove to be a challenge. Furthermore, different weather circumstances like fog, poor lightening quality raise challenges.

Increasing the size of dataset and training models on large and diverse data can help solve these challenges. Future developments could include combining bird sound identification systems with visual recognition.

Bringing together acoustic sensors and computer vision may improve the accuracy of species identification.

An additional highly promising direction involves combining the system with geographic information system(GIS). This approach would allow researchers to produce geographical maps showing how birds are distributed across the wetland.

7. Conclusion

Deepor Beel is an environmentally fragile wetland and so it is very essential to support migratory bird populations. The conservation of this ecologically important wetland requires optimal and efficient supervising systems that can provide proper and real-time information with respect to bird populations.

A Deep Learning based migratory bird identification tool gives an advanced solution for computerized wildlife supervising. Through the integration of drone imagery, CNN based feature extraction and YOLO based object identification tool can programmatically identify and calculate bird categories with remarkable precision.

This type of advanced technology-based conservation tool can lead to significant improvement of ecological monitoring and supporting environment-friendly wetland management. Through the effective implementation and cooperative efforts among researchers and environmental authorities, this approach can play an important role in safeguarding migratory birds assuring the long term conservation of Deepor Beel.

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