International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 10 Issue: 01 | Jan 2023 www.irjet.net p-ISSN: 2395-0072

Detection and classification of animals using Machine Learning and Deep Learning

Shivam M. Butale[1], Kanchan D. Dongare[2], Suraj T. Sawant[3]

[1]*Department of Computer Engineering and IT, COEP Technological University, Pune, India*
[2]*Department of Computer Engineering and IT, COEP Technological University, Pune, India*
[3]*Department of Computer Engineering and IT, COEP Technological University, Pune, India*

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Abstract - *Human-Animal Conflict is a major problem where an enormous number of resources is lost, and human life is in danger. So, it is necessary to continuously monitor and prevent animal intrusion. We aim to develop an animal detection and identification system from images taken through monitoring videos captured by motion-triggered cameras, called camera-traps. For these types of videos, existing approaches often super from low detection rates due to low contrast between the foreground animals and the cluttered background, as well as high false-positive rates due to the dynamic background. To address this issue, we will first develop an approach to generate animal object region proposals using Advanced Image Processing and then apply Artificial Intelligence techniques to detect and classify the animal. We aim to implement the animal detection and identification steps using the following techniques: eXtreme Gradient Boosting (XGBoost), Particle Swarm Optimization (PSO), Convolutional Neural Network (CNN). We first determine if these region proposals are true animals or background patches. We then identify animals using the above algorithms. This Animal Detection System can be used in a variety of applications like: Animal Intrusion Detection in Industries set up in forest areas / remote location, in residential areas, Agriculture fields and to avoid Animal-Vehicle collisions.*

Key Words: **Image processing, Artificial Intelligence, eXtreme Gradient Boosting, Particle Swarm Optimization, Convolutional Neural Network, etc**

1. INTRODUCTION

Man-animal conflict is seen in a variety of forms. When it comes to deforestation, the wild animals come out of the jungle in search of food. Many times, they have been seen crossing highways and getting hit by vehicles [1], intruding into residential areas and causing loss to human life and property and intruding into fields resulting in destruction of crops. Human eyes cannot work 24 hours a day to perform animal detection. Animal detection is a very important and emerging area due to many real-life applications. With advancement, computer science has brought vast opportunities in different areas. Animal Detection is one of the fields where computer science can be used. Application areas of computer science vary from metrology to ocean engineering. Computer science tools are being used in animal detection on large scale. In the last decade artificial intelligence has gained its moment because of advancement in computation power. Deep Learning is one such tool which is widely utilized in different domains because it does not require different algorithm for different dataset. This feature of reusability of code gives an advantage in the field of animal detection. Various animal detection methods and warning systems are used for indicating the presence of animals on the roads or residential area. Applications which are very important in real life are preventing animal vehicle collision on roads, preventing dangerous animal intrusion in residential area, knowing locomotive behavioral of targeted animal etc. [2]. Detection of animals is applied in various fields of real-life applications. As an example, hundreds of camel-vehicle accidents were reported every year causing numerous deaths and loss of property running into millions of Saudi Riyals. To address this problem, a deployable and intelligent Camel Vehicle Accident Avoidance System (CVAAS) was designed using global positioning system technology [2]. Animal detection systems have been used to enable fisherman to find the right location of fishes in deep sea, for maintaining human safety and security by detecting possible dangerous animal intrusions into the residential area [2]. Existing animal detection systems are not 100% accurate. They suffer from problems like low accuracy, high false positives, etc. Accuracy of classification depends highly on which algorithm is used for classification. This Animal detection system aims to solve the problem of animal detection with a high accuracy. It can help in preventing many human-animal conflicts resulting in saving many lives and property.

2. LITERATURE SURVEY

Aditiba Rao, Viral Parekh [1] presents a survey on animal detection methods used to avoid animal vehicle collision.

Sharma, Sachin, and D. J. Shah [2] presents a brief overview on different animal detection methods.

Kumar, YH Sharath & et al [3] presents the technique to classify animals using Probabilistic Neural Networks (PNN) and K-Nearest Neighbors (KNN) classifiers. Here, the proposed KNN classifier achieves relatively good classification accuracy when compared to PNN classifier. The accuracies achieved were not very high. The execution time observed was large and a large amount of space was required in memory. The KNN classifier showed an accuracy of 66.98% and the PNN classifier showed an accuracy of 56.66%.

Favorskaya, Margarita & et al [4] presents animal classification using Convolutional Neural Networks (CNN). It displayed a good accuracy on a balanced dataset and a relatively lesser accuracy on an unbalanced dataset. The results show 80.6% Top-1 and 94.1% Top-5 accuracy on a balanced dataset and a 38.7% Top-1 and 54.8% Top-5 accuracy on an unbalanced training dataset.

Radhakrishnan, Saieshwar & et al [5] presents a Support Vector Machine (SVM) with Gabor Features for animal intrusion detection in agriculture fields. The approach has the benefit of using only 7 filters. However, the accuracy observed was low. An accuracy of 54.32 % was reported.

Chen, Guobin & et al [6] proposes the first attempt to a fully automatic computer vision based species recognition for wildlife monitoring on real camera-trap images. A Deep Convolutional Neural Network (DCNN) has been used for the same. However, it was not able to meet the requirements of full automation. The results showed an accuracy of 38.315%.

Parham, Jason & et al [7] have used the You Only Live Once (YOLO) classifier for animal classification. As per the paper, better ecological information was provided to conservationists. But the accuracy observed was not high: 72.75%.

R.Pavithra & et al [8] have used the Cascaded Random Classifier for classification in the presented 'Automatic Object Detection and Collision Avoidance System'. This system successfully detects the animal and gives a warning. The accuracy of lion detection was observed to be 82.5%.

Christiansen, Peter & et al [9] presents automated detection and recognition of wildlife using thermal cameras using a K-Nearest Neighbor (KNN) classifier. It is observed to be partly invariant to translation, rotation, scale and posture. But there were difficulties in recognizing animal objects correctly in far-range altitudes.

Kellenberger, Benjamin & et al [10] proposes fast animal detection in UAV images using Convolutional Neural Networks. They were able to reduce the latency in wildlife monitoring and significantly less false positives were reported. However, a high rate of false negatives was observed. The average speed of processing was 73.62 images per second. The reported values were Precision=0.60, Recall=0.74, F1=0.66.

Villa & et al [11] presents very deep convolutional neural network-based classifiers. The species chosen was Grant's Gazelle. The accuracies for Citizen Science and ConvNet were 82.1% and 65.0% respectively.

Sharma, Sachin Umesh & et al [12] presents an animal detection system and collision avoidance system which uses HOG and Cascade Classifier. It successfully detects cows in different conditions, but the detection is limited to only one animal. An overall accuracy of 82.5% was obtained in detection.

Boukerche, Azzedine & et al [13] presents classification based on Support Vector Machines (SVM) and AdaBoost. It shows successful moose detection through roadside cameras. It was able to detect more than 83% of moose. The downside of the same is that it could only classify moose from side-view.

Nguyen, Hung & et al [14] proposes a Deep Convolutional Neural Network based 'Lite AlexNet' model for animal recognition and identification for automated wildlife monitoring. The model is robust, stable and suitable for dealing with images captured from the wild. 80% of the images were used for training and 20% for validation. The accuracy observed was 82.49% and the F-measure was 81.40%.

3. PROPOSED SYSTEM

Fig 1 shows the system architecture of the proposed animal detection system

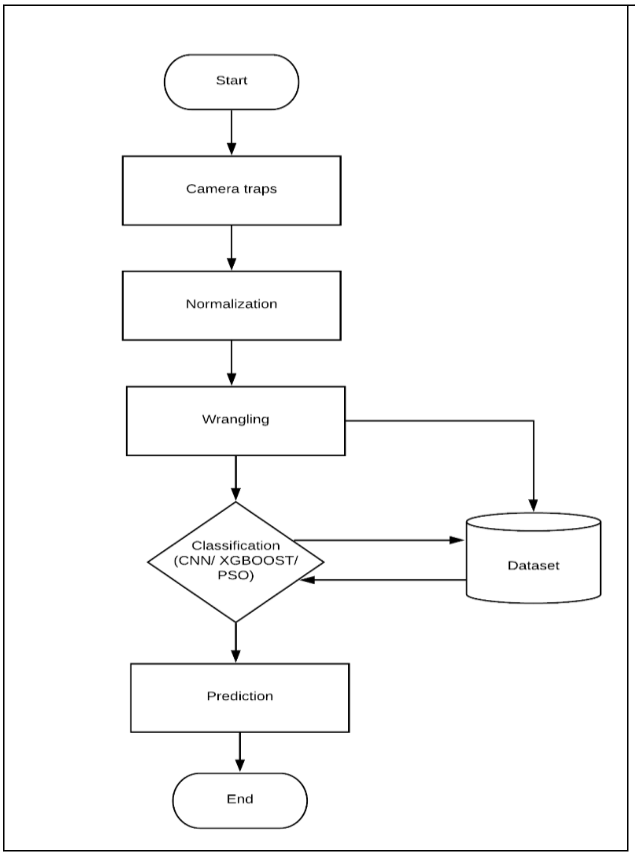

Fig 1. System Design and Architecture

3.1 Modules

1. Camera Traps
2. Normalization
3. Wrangling
4. Dataset
5. Classification
6. Prediction

3.1.1 Camera Traps

This stage involves collection of images from camera traps. There are multiple ways in which the images could be collected. These images would serve as input to the further steps. In this paper, images from "Missouri Camera Trap Images" and "Oregon Wildlife Dataset" datasets are used. These would be used to train and test the models.

3.1.2 Normalization

Normalization is a process of standardizing the images of the dataset. Normalization maintains the pixel values of images in a particular range. This is done to scale the images before providing them as input to the model.

3.1.3 Wrangling

Sometimes, raw data from datasets may not be accurate enough to train a machine learning model. Wrangling is a process to convert the images from a raw format to a usable format. In this paper, wrangling involved cleaning up images that had missing data and wrong data. For example, there were some images with no animals at all, and some images with animals of different species occurring in them. Such images were removed from the dataset.

3.1.4 Dataset

Dataset is the collection of images produced as an output of the above stages. This dataset will be used to train as well as test the models.

3.1.5 Classification

Three models were developed and used independently for classification. Convolutional Neural Network (CNN), Extreme Gradient Boosting (XGBoost) and Particle Swarm Optimization (PSO) were the algorithms used. CNN is a type of Artificial Neural Network which performs a mathematical operation called 'Convolution' behind the scenes. It is generally used for image classification. XGBoost is a Machine Learning algorithm based on Decision Trees and uses a Gradient Descent algorithm to minimize losses. It is generally used for both regression and classification. PSO is a computational method to find the optimal solution by improving candidate solutions called particles. The dataset of 4330 images was divided into training and validation data. 85% of the images were used for training the models and 15% were used for validation. Based on the training, the models perform the classification of the input image.

3.1.6 Prediction

In this stage, the model predicts the class (species) of the animal in the image. It also performs localization on the image, highlighting the face of the animal and specifying the species name and the accuracy of the prediction.

4. RESULT

In this paper, CNN, XGBOOST and PSO were used as classification algorithms. The result is animal name and accuracy of detection. We obtained training and validation accuracies of 98.1% and 91.4% using CNN, 100% and 89.19% using XGBoost, 48.72% and 49.13% using PSO respectively. On test data, CNN showed an accuracy of 87%, XGBoost showed an accuracy of 86%, and PSO showed an accuracy of 60%. Fig 2 is a tabular representation of the same.

ALGORITHM	TRAIN ACCURACY (%)	VALIDATION ACCURACY (%)	TEST ACCURACY (%)
CNN	98.1	91.4	87
XGBOOST	100	89.19	86
PSO	48.72	49.13	60

Fig 2. Train, Validation and Test Accuracy

Fig 3 shows animal wise accuracies and F1 Scores of the models on test data.

ALGORITHM	DEER ACCURACY (%)	FOX ACCURACY (%)	RACCOON ACCURACY (%)	OVERALL ACCURACY (%)	F1 SCORE DEER	F1 SCORE FOX	F1 SCORE RACCOON
CNN	90	80	90	87	0.86	0.75	0.8
XGBOOST	100	90	67	86	1	0.86	0.8
PSO	60	70	50	60	0.33	0.67	0

Fig 3. Animal-wise Accuracy and F1 Score

Fig 4 shows a bar-graph of the test accuracies of the models.

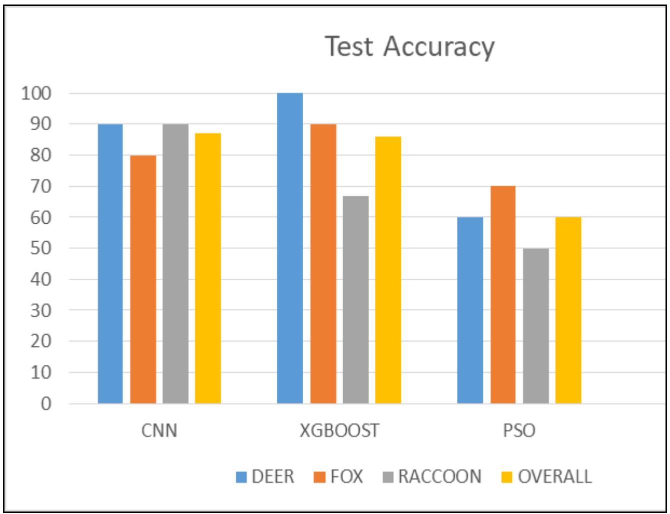

Fig 4. Test Accuracy

Figures 5, 6, 7 show Confusion Matrices for CNN, XGBoost and PSO respectively.

	DEER	FOX	RACCOON
DEER	3	1	0
FOX	0	3	0
RACCOON	0	1	2

Fig 5. Confusion Matrix for CNN

	DEER	FOX	RACCOON
DEER	4	0	0
FOX	0	3	0
RACCOON	0	1	2

Fig 6. Confusion Matrix for XGBoost

	DEER	FOX	RACCOON
DEER	1	1	2
FOX	0	3	0
RACCOON	1	2	0

Fig 7. Confusion Matrix for PSO

5. CONCLUSION

The animal detection system helps in automatic animal detection in cases of animal intrusion in industries set up in remote locations and forest areas, residential areas, agricultural fields and in animal-vehicle collisions. It eliminates the need of 24x7 animal monitoring done by humans. This system is tested on three species of animals: deer, fox, and raccoon. Models were developed based on 3 algorithms: CNN, XGBOOST and PSO. They are tested on the animals and the obtained results are presented.

REFERENCES

[1] Aditiba Rao, Viral Parekh. "A Survey on Animal Detection Methods used to avoid Animal Vehicle Collision." IJSRD { International Journal for Scientific Research & Development| Vol. 6, Issue 01, 2018 | ISSN (online): 2321-0613

[2] Sharma, Sachin, and D. J. Shah. "A brief overview on different animal detection methods." Signal & Image Processing 4.3 (2013): 77.

[3] Kumar, YH Sharath, N. Manohar, and H. K. Chethan. "Animal classification system: a block based approach." Procedia Computer Science 45 (2015): 336-343.

[4] Favorskaya, Margarita, and Andrey Pakhirka. "Animal species recognition in the wildlife based on muzzle and shape features using joint CNN." Procedia Computer Science 159 (2019): 933-942.

[5] Radhakrishnan, Saieshwar, and R. Ramanathan. "A Support Vector Machine with Gabor Features for Animal Intrusion Detection in Agriculture Fields." Procedia computer science 143 (2018): 493-501.

[6] Chen, Guobin, et al. "Deep convolutional neural network based species recognition for wild animal monitoring." 2014 IEEE International Conference on Image Processing (ICIP). IEEE, 2014.

[7] Parham, Jason, et al. "An Animal Detection Pipeline for Identification." 2018 IEEE Winter Conference on Applications of Computer Vision (WACV). IEEE, 2018.

[8] R. Pavithra, M. Jagadeesan, Automatic Object Detection and Collision Avoidance System using Cascaded Random Classifier." International Journal for Research in Applied Science & Engineering Technology (IJRASET) ISSN: 2321-9653(2018).

[9] Christiansen, Peter, et al. "Automated detection and recognition of wildlife using thermal cameras." Sensors 14.8 (2014): 13778-13793.

[10] Kellenberger, Benjamin, Michele Volpi, and Devis Tuia. "Fast animal detection in UAV images using convolutional neural networks." 2017 IEEE International Geoscience and Remote Sensing Symposium (IGARSS). IEEE, 2017.

[11] Villa, Alexander Gomez, Augusto Salazar, and Francisco Vargas. "Towards automatic wild animal monitoring:

Identification of animal species in camera-trap images using very deep convolutional neural networks." Ecological Informatics 41 (2017): 24-32.

[12] Sharma, Sachin Umesh, and Dharmesh J. Shah. "A practical animal detection and collision avoidance system using computer vision technique." IEEE Access 5 (2016): 347-358.

[13] Boukerche, Azzedine, Abdul Jabbar Siddiqui, and Abdelhamid Mammeri. "Automated Vehicle Detection and Classification: Models, Methods, and Techniques." ACM Computing Surveys (CSUR) 50.5 (2017):62.

[14] Nguyen, Hung, et al. "Animal recognition and identification with deep convolutional neural networks for automated wildlife monitoring." 2017 IEEE international conference on data science and advanced Analytics(DSAA). IEEE, 2017.

BIOGRAPHIES

Shivam M. Butale has completed Bachelor of Technology in the year 2020 from COEP Technological University (Formerly College of Engineering Pune). He is currently a working professional in the IT industry. His area of research includes AI, Machine Learning, Deep Learning.

Kanchan D. Dongare has completed Bachelor of Technology in the year 2020 from COEP Technological University (Formerly College of Engineering Pune). She is currently pursuing MS in Computer Science. Her research area is Data Science.

Prof S.T. Sawant, Assistant Professor at Department of Computer Engineering and Information Technology, COEP Technological University (Formerly College of Engineering Pune). His research area is Artificial Intelligence.