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CNN based image detection system for elephant directions to reduce human-elephant conflict

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Abstract*:* Human-Elephant Conflict has been a major issue in the forest border areas, where the human habitat is destroyed by the entry of wild elephants. This conflict depends due to the shared field of humans and elephants. Conflict often occurs over access to water and competition for space and food. Economic losses happen due to agricultural destruction or loss of cattle during predation. The major aim of the study is to minimize the human-elephant conflict in the forest border areas and the conservation of elephants from human activities as well as protect human lives from elephant attacks. Humans use various technical and nontechnical methods to reduce this conflict. As this research is using neural networks and image processing technologies, forest authorities can detect how many elephants are in the nearby forest border areas and distinguish elephants from other animals easily. Then authorities can inform villagers and tourists hence reducing the human-elephant conflict. Convolutional Neural Network (CNN) is playing a major role in elephant detection by supporting efficient image classification. CNN's performance

was evaluated by training and testing the dataset by increasing the number of training and testing images. The dataset includes 5000 images of elephants. The trained model is designed for identifying the elephants. The conclusions drawn from work prove that the achievement percentage is 92% accuracy.

Keywords: Human ElephantConflict, Elephant detection system, Convolutional Neural Networks(CNN)

Introduction

HEC is a real-world application, which is taken as a case study for this proposed research work. The idea is to provide an early warning indicating elephant detection; therefore it is useful forest officials to chase the pachyderm back into the forest and to help the public save their property and life, which is located near the forest boundary(Eikelboom *et al.*, 2019). Many implementations in the real world include border control networks, environmental monitoring, etc. This paper may have made the first attempt to exploit the benefits of deep learning in forest boundaries for real-world problem detection of elephants(Suganthi, Rajathi and M, 2018). The proposed work is inspired by the automatic identification of species from the camera trap and the identification of elephant images from other photos of specifics according to the literature, cameras played a vital role in elephant detection using different database comparisons utilizing image processing techniques. But the inclusion of false alerts is unavoidable. The objective of the proposed work is to minimize HEC by efficient detection of camera images utilizing the advancement in technical contributions of deep learning. Human elephant conflict affects two broad categories('ele_survey_2011.pdf', no date).

One is a problem faced by humans, another one is a problem faced by elephants. The solution for these problems targets to save our life from elephants attack as well as to protect the elephant from human attacks.

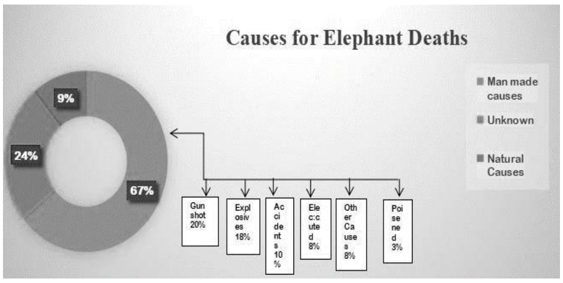

Figure 1. Causes of elephant deaths

Elephants cause more than $10 million in property damage annually and the farmers kill the elephants in revenge. On average 225 elephants have been killed by peoples annually and elephants have killed about 60-80 people annually, most in their villages and fields (Krötzsch, Simanˇ and Horrocks, 2013).

The boundary between Wasgamuwa National Park and the main water and food source of the elephant is important to elephants but it is also used by villagers living adjacent to the forest reserve(Li *et al.*, 2018). It is not unusual to see children, men, and women walking and biking while elephants are present, always fearful of an elephant attack. And they harass the elephants to scare them away, and unfortunately, this action makes elephants more aggressive than people's fears.

Sri Lanka Conservation Wildlife Society (SCWS) purchases a bus to provide service through the elephant corridor(Sahlol, 2017) The bus will provide secure transport for the villagers while allowing the elephants to use the corridor without being harassed, injured, or chased from their habitat. In general, there are two kinds of losses, human death, and elephant death. Thinking in a short while, the root cause of these losses is caused by both humans and elephants.

Figure 2: Loss of Property

Throughout the forest boundary regions, there are many common methods used to drive away from the elephants once they reach the human settlement regions. They mainly use noise-making techniques including firecrackers, pipe cannons, vehicle horns, shouts, rifle- shots, and banging on things such as drums, tins, etc. Sometimes, they create a fence strung with beehives made out of hollow logs and burn elephant dung along with chili or any other material that will smolder to create a heavy acrid smoke(Ahmed, Jalal and Kim, 2019). However, as time goes on, elephants become accustomed to these approaches and gain the ability to conquer conventional techniques. Therefore a monitoring and detection system is required to send the incoming elephants an alert in advance so that appropriate safety measures can be taken. We are introducing a detection system based on convolutional neural networks.

This detection system helps to find the elephants are nearing the forest border area, thus disseminating warning at the appropriate times and thereby helping in reducing human-animal conflicts in forest areas.

Methodology

In this paper, the Convolution Neural Network is used as an object detection algorithm. Object detection relates to both machine learning and image processing which is .used to detect the instances of the object. The algorithms for object detection are popularly used in realtime applications.

A. Convolutional Neural Networks

Convolutional neural network (CNN) is a deep-rooted type, the artificial neural network used for feed-forward to deliver correct computer vision results tasks, for example, classification and identification of images. CNN they 're like conventional neural networks, but with deeper strata. This has weights, biases and a nonlinear efficiency Switch on(S, Ramesh and Divya, 2016).

The CNN neurons are organized in a volumetric fashion li ke height, width, and depth. Illustration figure 3 shows CNN architecture, it consists of completely linked layer, convolutionary layer, pooling layer. Usually, traditional layer and pooling layer are alternated, and each filter's dept h increases from left to right, while the output size (height and width) decreases.

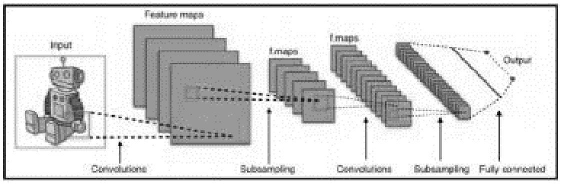

Figure 3. Layered architecture

The input is an image that contains values for pixels. The example is [50 x 50 x 3], it has three dimensions such as width, height, and depth (RGB channels). The convolutionary layer shall measure the output of theassociated neurons output to regional areas (Dharmaratne and Magedaragamage, 2014). The parameters of the layer are composed of a series of learnable filters (or kernels) that translated over the width and height of the input volume extending through its depth, computing the dot product between the input and the filter entries(Wijnhoven and De With, 2010). It provides a 2-dimensional activation map of the filter, and therefore, the network learns filters that occur when a specific type of feature is detected at some spatial location in the input.

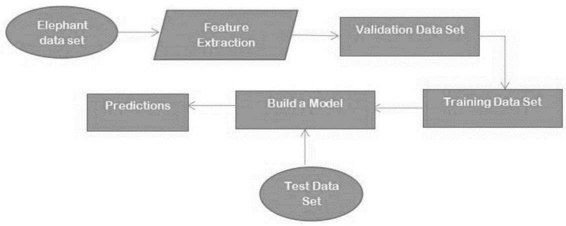

Figure 4. Flowchart of the process

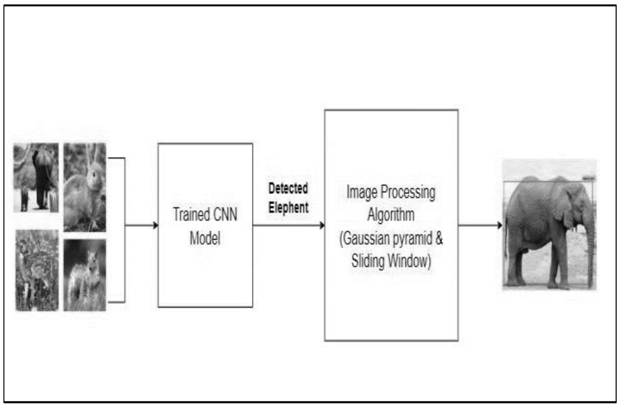

Figure 5. The overall methodology for elephant detection

B. Create the Model

The image is passed through a series of convolutional, non-linear, pooling and fully connected layers, and then generates the output. A neural network consists of several different layers such as the input layer, hidden layers, anan output layer. They are best used in object detection. The secret layers function as a filter receiving input first, transforming it using a particular template, and sending it to the next layer.

With more convolutionary layers they are modifietion layer. CNN's have a standard organization: the system includes the multi-layered architecture of feature identifying neurons. Every layer will address all of its previous layere's input combination(Dhanaraj and Kumar Sangaiah, 2018)

C. Training the model

Now we will train our model. To train, we will use the 'fit()' function on our model with the following parameters: training data (train_X), target data (train_y), validation data, and the number of epochs. For our validation data,

we will use the test set and split into X_test and y_test.The number of epochs is the number of cycles that data go through the model. The more epochs we run, the model will improve, up to a certain point. After that point, the model will stop improving. For our model, we will set the number of epochs to 50.

Layer (type)	Output Shape	Param #
conv2d_1 (Conv2D)	(None, 798, 598, 32)	896
activation_1 (Activation)	(None, 798, 598, 32)	0
max_pooling2d_1 (MaxPooling2	(None, 399, 299, 32)	0
conv2d_2 (Conv2D)	(None, 397, 297, 32)	9248
activation_2 (Activation)	(None, 397, 297, 32)	0
max_pooling2d_2 (MaxPooling2	(None, 198, 148, 32)	0
conv2d_3 (Conv2D)	(None, 196, 146, 64)	18496
activation_3 (Activation)	(None, 196, 146, 64)	0
max_pooling2d_3 (MaxPooling2	(None, 98, 73, 64)	0
flatten_1 (Flatten)	(None, 457856)	0
dense_1 (Dense)	(None, 64)	29302848
activation_4 (Activation)	(None, 64)	0
dropout_1 (Dropout)	(None, 64)	0
dense_2 (Dense)	(None, 2)	130
activation_5 (Activation)	(None, 2)	0

Figure 6. Output after applying CNN

D. Image Processing

Image processing is a process of mutating which converts input picture in digital form, and some more added submit image operations to receive a renovation image or to derive any valuable knowledge from the embedded picture. In this method, the input and output of which is often in the form of photographs involve processes that extract features from images up to the end, including the recognition of individual objects in the image.(Lin *et al.*, 2010)

There are two algorithms used for image processing.

1). Gaussian pyramid*:* The idea of a gaussian pyramids are constructing smoothed copies of a given image at different scales. In the object detection phase, it is important to classify windows at multiple scales. This algorithm is written in python with the help of OpenCv library. may be pretty big. Smaller pictures mean our model can practice more quickly.

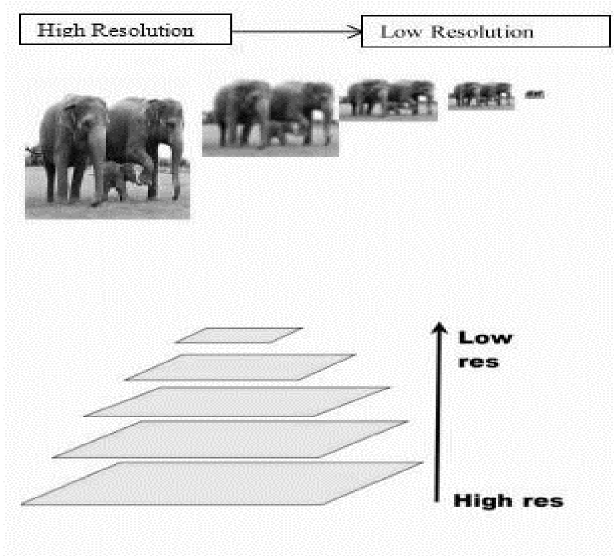

Figure 7. Gaussian pyramid

Sliding window algorithm: In the context of image processing and computer vision, a sliding window algorithm is simply a rectangular region of fixed width and height that slides across an image. For each window location we apply an image classifier to determine if the window has an object that interests us. We can construct image classifiers combined with image pyramids that can identify objects at varying sizes and positions in the picture.(Song and Zhang, 2008)

Results

*A.*Experimental dataset

Before train the model, need to gather lots of images. In here used 20500 images. Objects in terms of lighting and context should be different from one another so that the model can generalize better. Detailed information about the no. of images in each class are tabulated in Table 1.

Like this gather data and put that data into two folders, training dataset and testing dataset. After gathering the data, we need to resize our images because some of them

Further, the dataset is increased by performing image augmentation such as flip, rescale, zoom the image, and by varying contrast.

Combining a total of 10500 images are used. From 10500 image, 7000 images are used for training, and 3500 images are used for testing. Resizing of images with padding is performed to ensure that the images are of uniform dimension.

Table 1. No of images collected from different datasets

Name	Number of Elephants
Elephant	5000
Deer	800
Bear	600
Hen	3100
Tiger	950
Cat	50

*1).Dataset preparation:*The preparation of data sets plays a significant role in detecting elephants. The neural network will perform better if it is trained using a large dataset. Increasing the dataset will result in making our neural network to learn more feature and perform more accurate identification. In this paper, own dataset of images is collected from numerous website which includes many classes (elephant, bears, buffalo, cat, cheetah, deer, hen), where each class contains about an 10500 images as represented in Table 1. Data augmentation is performed to improve the invariance property of the images. The dataset split is about a 2:1 ratio.

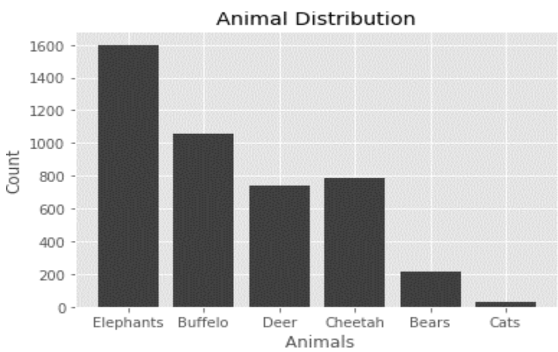

Figure 8. Summerized data graph

The collected dataset includes various image sizes of different aspect ratios. To retain the same size and aspect ratios, all images collected are redimensioned using an online image resize tool.

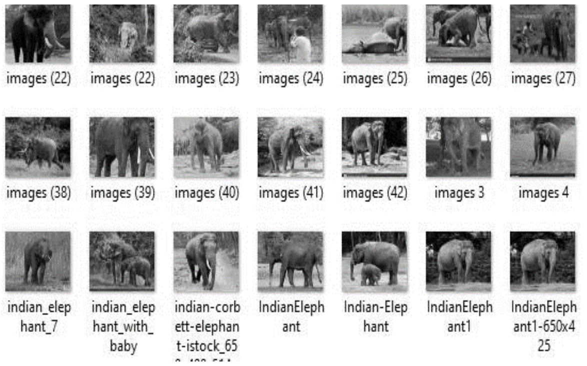

Figure 9. Sample images of elephants used for training(elephants, 2020)

2).Data Augmentation: Initially, the collected dataset contains images captured under controlled conditions but our target application is of a diversified condition such as variation in orientation, location, brightness, color, some added noises, etc. In order to overcome those conditional variation properties, the dataset is augmented in such a way that the invariance property is be minimized. The augmentation used for the dataset is Flip, rescale, and zoom.

B.Feature Extraction

Features are extracted from the foreground. Here shape feature is considered. Orientation, eccentricity, major axis length, minor axis length, convex area, equivdiameter, solidity, and extent are the shape features that are extracted from each of the segmented images.

C.Recognition Results

Classification is done using CNN. Elephant acceptance is denoted by 'YES' and 'NO' otherwise. This elephant recognized as an elephant and all other animals are not recognized as elephants. The graph below shows the exactness and the loss of each epoch. A number of iterations here have improved precision, too. The data set was divided into data sets for training and testing, and the accuracy of both data sets in iterations is seen in the two graphs below.

!) Accuracy and Loss graph: We got a very good accuracy as a result of checking the model: 90% after 50 epochs of accurate classification samples. We have decided to develop two parcels for this.

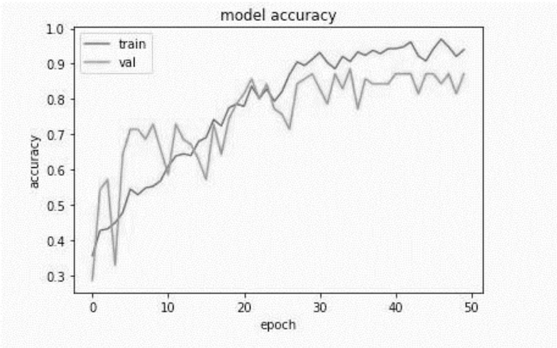

Figure 10. Accuracy with training and validation data

The first demonstrates how much the accuracy of the measurement depends upon the number of epochs. The accuracy of the evaluation was determined using 400 images from other datasets. The second plot demonstrates the exactness and validity of the number of epochs during the study.

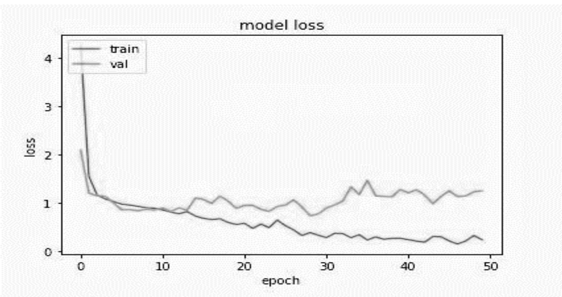

Figure 11. Loss with training and Validation data

2) Object detection: The recognition of objects in image processing is the method of in the image sequence or video search for a given target object. There are a number of 'features' in a picture of any object that is the best points on the item to be processed for output. Object information function. Such information derived from a target image training will then be used to identify the object when attempting to locate the target object in the entire image that includes other objects in check.

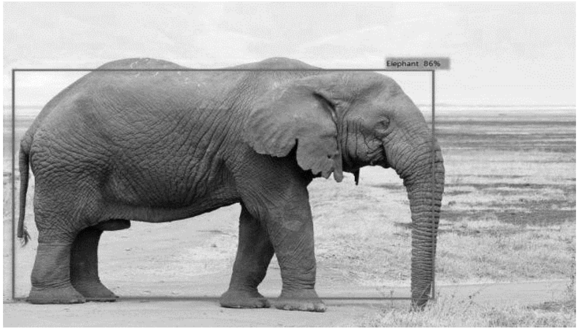

Figure 12. Result of the elephant detection

Discussion and Coclusion

In conclusion, the findings of work contribute to elephant conservation issues. The work provides solutions to human-elephant conflict. The real-time elephant identification system provides solutions to the problem of human-elephant conflict in forest border areas and provides a solution for the unsupervised process of individual species identification specifically for elephants. Human-Elephant conflict have been continuously proposed and evaluated in the literature.The identification of artifacts has become one of the main fields of image processing. In this paper, the object is described as an elephant. More significantly, these findings show the importance of consistency in the detection of elephants entering human living spaces and provide early warning about the entry of elephants into human habitat. This technique of real-time image processing for recognizing an approaching individual elephant as well as a group of elephants.

The real-time automated solution minimizes manual work which is not always feasible because it is difficult to manually track the presence of elephants as the herd's march towards the forest boundaries.

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