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**AGRICULTURAL LAND PROTECTION SYSTEM FROM MONKEYS USING DEEP
LEARNING IN INDIAN SCENARIO**

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ABSTRACT

Animal damage is a significant issue for farmers, who have already lost many of their crops to pests and diseases. Specific animals frequently seen in agriculture, such as monkeys, contribute to crop destruction by consuming the majority of the vegetables and fruits planted. This paper aims to detect the monkey using machine learning and alert the farmer when they enter the agriculture field. To prevent the entry of the monkeys into the agriculture field, This System also plays shrill noise, which monkeys hate. A camera module is used to capture the presence of monkeys in the field, and using machine learning, monkeys are detected. An accuracy of 84% is achieved for the proposed model with individual monkey images, and the monkeys are detected with a reasonable confidence score. The model is connected to the Blynk cloud, which enables to notify farmers of the presence of monkeys and take necessary action.

Keywords: Agricultural land, Animal attacks, Internet of things, Deep Learning

INTRODUCTION

Indian farmers cultivate crops like vegetable fruits etc. The monkey problems look pretty, but it's causing a substantial financial burden to the farmer. Because of continuous attacks of monkeys on fruit and vegetable crops, Farmers switched to herbs such as aloe

vera or crops with medicinal properties, which monkeys generally do not attack. Many people living in areas that wild animals, such as monkeys frequently attack, are evacuating their homes. The crops destroyed by the wild animals are causing a substantial financial burden to the farmer. In some instances, few

farmers have given up farming as they can't bear the financial loss due to the attack from monkeys [1].

There has been population growth in monkeys since 1978 because the Indian government has stopped the export of these animals for biomedical research. Many treat these animals as a symbol of Hindu God and feed these animals, which increases the monkey population growth. Some farmers even went to the extent of poisoning the monkeys in Battle against them [2]. This solution leads to further problems such as the consumption of the cactus of monkeys by other animals may cause severe health issues in that animal. When The cactus of the poisoned animal falls into the water body, it will affect the health of people or animals consuming the water. Shooting the animals is another practice for the culling of monkeys, but it requires permission from the government And high expertise to shoot the animal accurately. This method is a costly affair, and the farmer may not be in a position to bear the amount for the procurement of ammunition [3].

There is a conflict between monkeys and farmers in agriculture. The number of monkeys in the population has increased during the last few decades, resulting in a steep and significant increase [4]. The number of monkeys in the population has quickly skyrocketed to levels unprecedented in all of history in the last decade. The country has no unified database containing information about monkey raids.

They utilize agricultural fields and crop ecosystems as food sources and places to live. Monkeys are generally considered pests when it comes to agriculture because they negatively impact crops and orchards. A crop that the monkeys damaged is of great concern [5, 6].

Additional activities should be implemented as part of an Integrated Farming System (IFS) strategy [7, 8].

- Enriching habitats in deep forest space, so enough food remains on the market to them, thereby localizing the monkey population in the deep forest by raising natural wild fruit plants viz, Fig, Udumbar, Kainth, Jamun Banyan, Garna, Kokua, Mulberry, etc.
- Technological interventions include putting in star fencing, electrical fencing (non-lethal), Monkey Repellents, Monkey Scare guns, optical maser-guided alarms around the field, etc.
- Use of irritating and smelling substances like dry fish packets unfold around the field.
- Maintaining a balance by cathartic predators / natural enemies (Langur).

Reducing the threat of monkeys to Agricultural Land includes guarding, pursuing, using bells or drums to make noise, and throwing stones. Employing a worker to keep monkeys away from the farm is expensive, but guarding the field is even more. To keep animals away from cropped areas, beat drums or plates. Be aware of the animals' movements,

though. Generally, the best ways to chase monkeys are using a slingshot or a homemade "gophan," although these have the negative effect of damaging the creatures. To keep the monkeys from visiting the rice fields, you should place the boiling rice, groundnut seeds, and coconut oil near the fields. When they get a whiff of the flavor, they feel scorching tongue and excessive thirst and avoid the location. Applying dry fish to the trees, or surrounding the fields, in addition to above the crop, helps deter monkeys from getting too close because of the fish's pungent odor. When it comes to keeping monkeys away from dogs and langurs, this technique is highly efficient. Capturing a dominant male among the monkeys, painting him white and red, and releasing him again, are tricks employed by farmers to repel invading monkeys. When he charges at the group of monkeys, they fear and scatter. While it is beneficial in a small number of situations, transferring all animals from one area to another is a risky endeavor and requires clearance from various organizations. It's also a high-risk activity, and there's no way to completely sterilize all the males. It is possible to alter the crops to deal with the problem. Unattractive brinjal or ginger may drive monkeys to relocate locations in search of better food. The farmer can later change the crop pattern to produce higher-value items. The land around farms or crop buffers might be made as an alternative for regions where the land has not been removed. The best choice is

to protect the forest so that the animals can survive. Monkey visits to farms will be reduced if sufficient forest habitat is found [9].

MATERIALS AND METHODS

The primary application of image annotation for deep learning is to improve object detection precision and to enhance the look of objects in images for neural network analysis. We have software tools that enable us to label Photographs by segmenting and categorizing them using anchor boxes. Once the photos have been annotated, we will run the Python script XML to csv.py to convert the XML files to a CSV. We will generate train.csv and test.csv for you. You must provide object detection inputs in the form of tf records when using the Tensor flow Object Detection API. Thus, we will construct train. record and test. record from train.csv and test.csv, respectively, using a python script build tfrecord.py. The Tensor Flow Object Detection API includes a variety of pre-trained models for the Common Objects in Context (COCO) dataset.

The Monkey Identification model is built by going through these four steps:

- Pointing out details in the photographs and saving them in XML files
- Converting XML documents to CSV,
- Generation of TensorFlow records
- Modifying object detector to measure the effectiveness of the model.

The monkey identification is made by looking at a picture as an input and splitting the input visual into regions. Consider each portion as a

single image, then work on it in segments. Convolutional Neural Network (CNN) was used to classify these images by classifying them after passing them through the Convolutional Neural Network. And once the items are recognized, we should display them with their labels, such as "Monkeys."

Pre-trained weights for any model you wish can be downloaded, or your custom object detector can be created. Whether a pre-trained model is utilized for training or not, each model has its unique setup for training. Several variables need to be adjusted, which includes the "num classes" variable, which specifies the number of object types to be detected, the "num steps" variable, which specifies the number of training iterations the algorithm should perform, and the "num examples" variable, which specifies the number of examples in the test folder. Along with the files mentioned above, the Tensorflow object detection folder will contain the following files: "train.record", "test.record", "config file", and "labelmap.pbtxt". The method will be initiated by running the python script train.py. Each loop can take between 5 and 8 minutes on the local GPU. For instance, it would take approximately 7 to 9 hours to workout 4000 times. When the models are training, their weights are regularly recorded to checkpoints in the checkpoint CKPT format. Our most recent weights will be exported using the Python script "export inference graph.py" to the directory "fine-tuned model," where the model will be saved as a

".pb" file. This type is typically found in devices with a high computing capacity. A "tflite" version of the model is preferable because it may be used on low-power devices such as cell phones and raspberry pi.

The model's performance should be verified on test data, and when the model's performance is satisfactory, it can be deployed. However, when the model's performance is not satisfactory, the model is optimized using hyperparameters and retraining it until a better fit is found. The precision of the model is computed by the ratio of true positive and true (positive+ false positive). The model has 800 monkey images for training and 200 images for testing.

A model is considered good if it excels on the "validation/test" dataset. Various statistics are used to quantify this performance: accuracy, precision, etc. Individual to the specific application and use scenario, the statistics of selection can be considered. Without seeking out a metric that will be used to compare models, you won't be able to compare models. In this section, the most commonly used measure for object detection selection problems MAP, which is also known as the Mean Average exactness, is discussed. Object detection disadvantage images may contain several instances of multiple sorts of items. The categorization and localization of a model should be examined as indicated previously. Due to this, the classifier's exactness measurement cannot be directly applied in this instance. MAP (Mean Average- Precision) is widely used in this location.

The image taken by Raspberry Pi camera has ground truth annotations. The training and validation information has all pictures annotated in the same manner. Thus, the model would have countless predictions. However, most of them can be associated with low confidence; predictions above a threshold confidence score are considered monkeys detected. The camera runs the image through the model, and this is what the proposed detection algorithmic program returns confidence thresholding value for the monkey object present in images as seen in **Figure 3**. The bounding boxes are drawn when the confidence score reaches above a threshold value (70%).

The correctness of each of these detections needs to be measured. The quantitative relation that links the intersection and ground truth could be referred to as an intersection over union (IOU Metric). This state is additionally called the Jaccard Index. To get the intersection and union values, we tend to first overlay the prediction boxes over the bottom truth boxes.

Blynk App:

Using the deep learning model, monkey presence is detected, and an alert is sent using Blynk App (*Blynk IoT Platform: For Businesses and Developers*, n.d.). Hardware components, such as Raspberry Pi, ESP8266, Particle, etc., can be used in Blynk apps with Blynk's proprietary application. Currently, a Raspberry Pi controller is being used in the research. When a PUT request is made to a certain location, the

status of that location will be automatically updated both in applications and on the hardware. Every request to the provided Pin will return the current state/value.

Steps involved in creating the Blynk project:

Make an account on Blynk to use the Blynk App. To store projects and be able to view them from many devices from anywhere, an account is required. It also functions as a security measure. Project settings access is allowed using email ID and authentication token. Every time you create a new project, a new number is produced. Project widgets can be added according to the requirement.

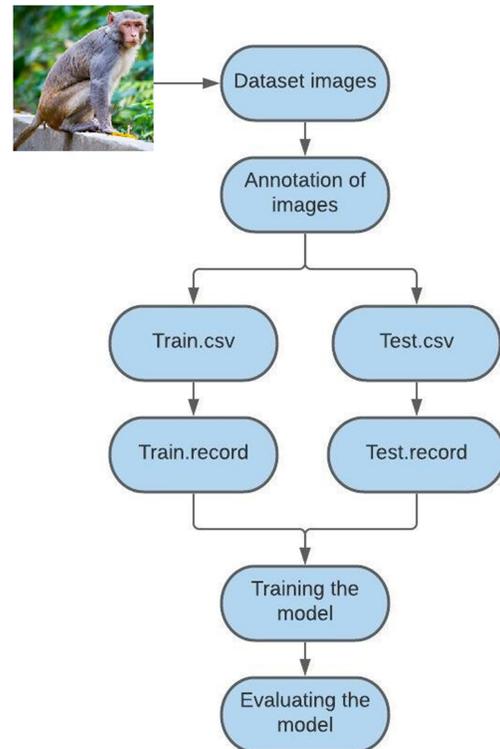


Fig 1 Flowchart for monkey detection

Drone integrated with deep learning model:

A quadcopter (**Figure 2**) is used in our research to detect the monkey, and it is designed using various components such as brushless dc motors

(BLDC), a 30A Esc motor controller, a 5000mah LIPO rechargeable battery, a KK2.1.5 flight controller board, an FSi6 2.4GHz radio-controlled transmitter, propellers, and an FS-IA6B 2.4GHz radio controlled receiver. A Raspberry Pi 4 4GB Model B is used to dump the learned deep learning model and attached a camera module for field image capture, which are subsequently mounted on the drone to identify the monkeys in agriculture fields.

SSD MobileNet V1 model:

Single Shot Multibox Detection (SSD) It's a single-networked unified framework for object detection.

MobileNet V1 is a customized version of the MobileNet concept for edge devices. MobileNet is a CNN architecture that is both efficient and portable, and it is employed in real-world applications. To develop lighter models, MobileNet typically uses depth-wise separable convolutions instead of the usual convolutions used in previous architectures. MobileNet adds two new global hyperparameters (width multiplier and resolution multiplier) that let model creators trade-off latency or accuracy for speed and small size, depending on their needs.

MobileNet is composed of depth-wise separable convolution layers. A depth-wise convolution and a pointwise convolution make up each depth-wise separable convolution layer. A MobileNet contains 28 layers if depth-wise and pointwise convolutions are counted separately. The width multiplier hyperparameter can be

adjusted to reduce the number of parameters in a typical MobileNet to 4.2 million.

The input picture is 224x224x3 pixels in size

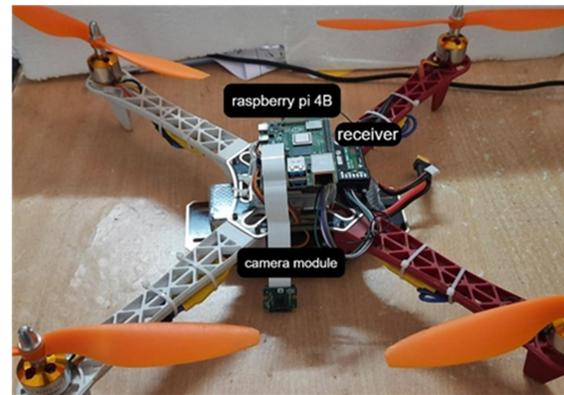
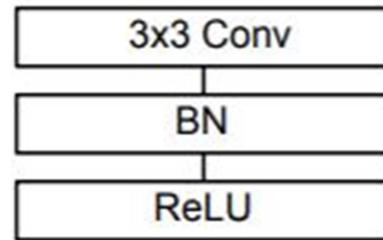


Figure 2: Drone with raspberry pi

Standard Convolution layer :
A single standard convolution unit looks like this :



Depth wise separable Convolution layer

A single depthwise separable convolution:

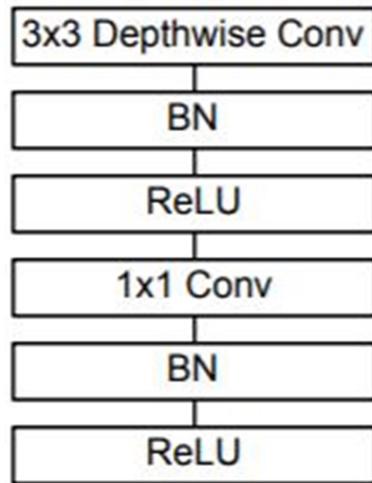
Width Multiplier:

A global hyperparameter known as the width multiplier is used to build smaller and less computationally costly models.

Its value ranges from 0 to 1. The number of input channels 'M' becomes $\alpha * M$ and the number of output channels 'N' becomes $\alpha * N$ for a given layer and value of α , lowering the cost of computation and the size of the model at the expense of performance.

The cost of calculation and the number of parameters both drop by around a factor of two.

The most often used values of α are 1,0.75,0.5,0.25



Resolution Multiplier:

The resolution multiplier, indicated by ρ , is the second parameter introduced in Mobile Nets. This hyperparameter is used to lower the input image's resolution, which then reduces the input to each layer by the same factor. The input image's resolution becomes $224 * \rho$ for a given value of ρ . The computational cost is reduced by a factor of ρ^2 .

RESULTS AND DISCUSSION

The proposed system used the SSD MobilnetV1 model to test and train the monkey images. An Average precision of 84% and 81% is achieved for test and train data, respectively as shown in

Table 1.

Table 1 Average precision

Average precision		
dataset	Train data(%)	Test data(%)
Monkey	84	81

Using SSD Mobilnet Monkeys are detected with a confidence score. In the current research, if the confidence score of the monkey

object is more than 70%, a box is drawn around the monkey, and a label with monkey and confidence score is displayed above the box. In Fig 3 the images captured are given on the left-hand side, and the monkeys detected were given on the right-hand side. By using this label, an alert is sent to the farmer using Blynk App, as shown in **Figure 4**. A shrill noise can also be played, which will prevent the entry of monkeys into the agriculture field. A buzzer is added to intimate the farmers in the presence of monkeys. The notification widget in the Blynk will alert the farmers regarding the monkey's presence. The current research has been carried out in the region of Guntur, Andhra Pradesh, India.

The identification of monkeys and alerting the farmers is discussed in this research paper. In addition to using all the technological equipment, UAVs can fly through the field, watching for and recording monkeys in agriculture. Having a raspberry pi gives us the ability to identify any type of object. This drone now provides farmers with countless benefits, thanks to a single display linked in one place and the drone being able to move in all directions around the land. Deep learning techniques are used to find monkeys in the crop fields, and the farmers can be alerted to take appropriate measures using the Blynk app. By detecting the monkeys using deep learning, a noise is played to distract the monkeys.

CONCLUSION

The identification of monkeys and alerting the farmers are discussed in this research paper.

In addition to using all the technological equipment, UAVs can fly through the field, watching for and recording monkeys in agriculture. Having a raspberry pi gives us the ability to identify any object. This drone now provides farmers with countless benefits, thanks to a single display linked in one place and the

drone being able to move in all directions around the land. Deep learning techniques are used to find monkeys in the crop fields, and the farmers can be alerted to take appropriate measures using the Blynk app. By detecting the monkeys using deep learning, a noise is played to distract the monkeys.

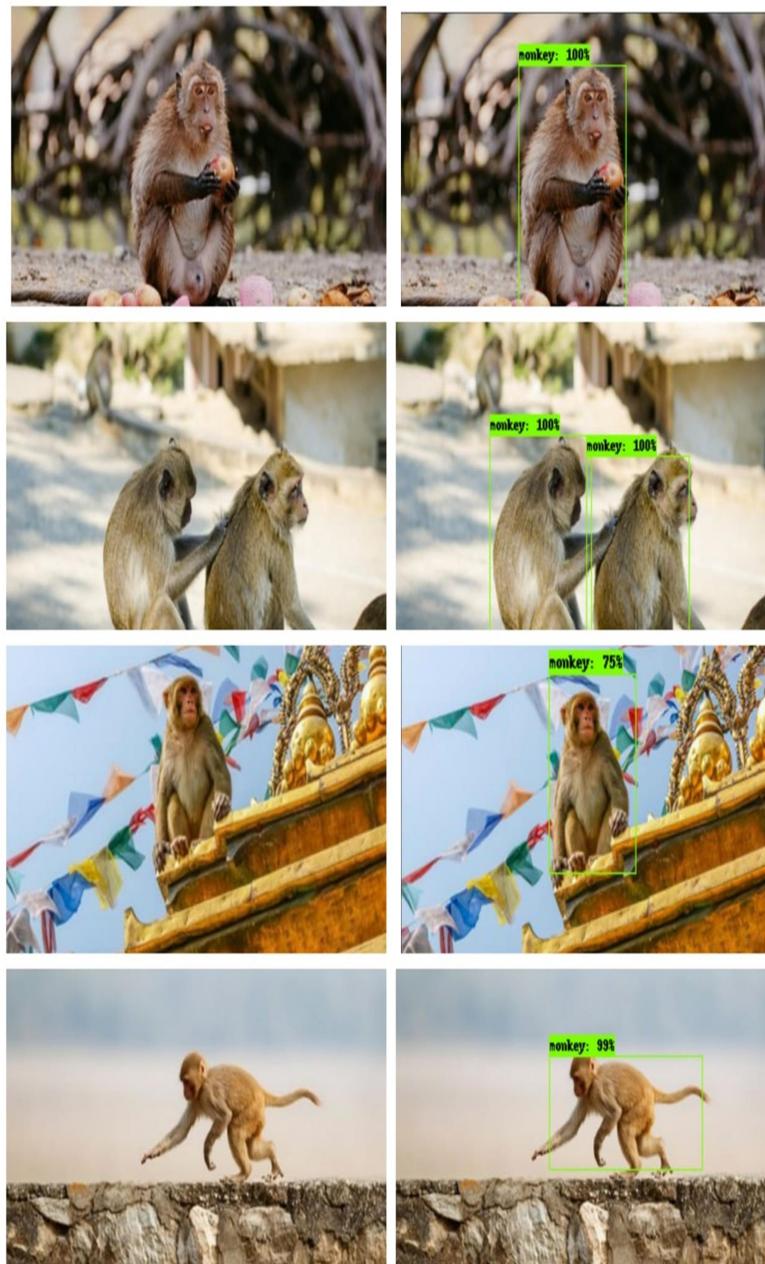


Fig 3 Monkey Detection results using SSD Mobilenet

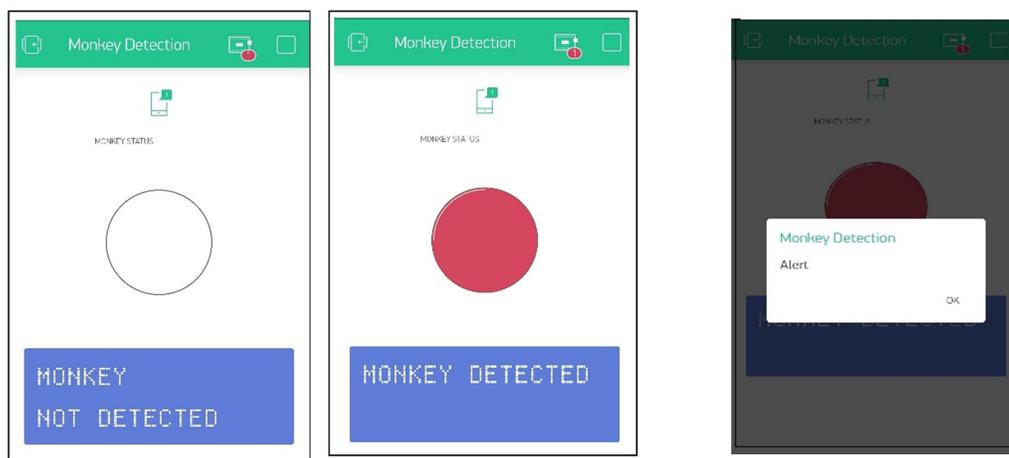


Figure 4: Blynk App with notification for detected monkey

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