**Safeguarding Agriculture: Using Deep Learning to prevent Animal Invasions**

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**Abstract.** The menace of crop damage due to animal, attacks poses a significant threat to agricultural yields. With the expansion of cultivated land encroaching upon wildlife habitats, instances of crop raiding have escalated, exacerbating the human-wildlife conflict. Conventional mitigation measures employed by farmers have proven inadequate, and the impracticality of hiring guards to surveil crops deters a viable solution. Prioritizing Safeguarding crops from animal-induced destruction is imperative to guarantee the security of both people and animals, giving the welfare of the animals top priority by safely distracting them.

To address this challenge, a pioneering project is underway to develop an algorithm for wildlife detection. By leveraging image recognition technology, this algorithm aims to classify animals based on their visual profiles, enabling more efficient monitoring. The project entails installing cameras across the farm to surveil the surroundings continually throughout the day. By implementing this innovative approach, we endeavor to mitigate crop damage caused by animals while simultaneously promoting harmonious coexistence between humans and wildlife. This Project gives software to prevent Animal Invasions.

**Keywords:** Deep Learning, Transfer Learning Models, CNN (Convolutional Neural Networks), VGG16, VGG19.

# INTRODUCTION

One of the major societal challenges affecting farming is the destruction of agricultural produce by wild animals. The disruption of wild animals by wild animals has always been a problem for ranchers. The harvest is threatened by a number of species, including deer, wild hogs, moles, elephants, monkeys, and others. The presence of these animals poses a significant threat as they can consume crops undetected by farmers, ultimately resulting in ruined harvests.

Their ability to roam freely across fields without detection exacerbates the risk of crop damage, highlighting the urgent need for effective monitoring and mitigation measures. As a result, the yield may suffer a great loss, and additional financial security will be needed to deal with the damage.

When utilizing his invention, Every farmer should understand that there are animals in the region as well, and that they must be shielded from any potential harm. An immediate solution should be found to this problem, along with a strong arrangement. As a result, our paper hopes find a solution to the central objective of the paper is to devise strategies aimed at preventing wild animals from encroaching upon agricultural fields in order to address this problem.

Additionally, it emphasizes the importance of protecting these animals by employing non-lethal methods, such as scare tactics, to deter them from the fields, rather than resorting to lethal means. Additionally, the charity works to protect people from attacks by animals. In order to build a monitoring and deterrent system to safeguard crops from animal assaults, we are employing an integrated strategy that makes use of a number of deep learning techniques and algorithms to strengthen safety precautions against animal incursion, involving IOT, sensing units, communicating devices for preliminary actions, diverting animals, and alerting farmers. Review techniques for digital image-based animal detection are presented in this research.

Applications based on sensors are useful in a variety of real-world situations. Using such devices might minimize expenses, guarantee stability and dependability, facilitate remote monitoring with less energy use, and make it easier for farmers to obtain information.

# LITERATURE SURVEY

Researchers dedicated their efforts to detecting the animals.

Wenling Xue, Ting Jiang [1]. This research proposes an there are many different manifestations of animal, human conflict throughout the nation, such as the threat posed by monkeys in urban areas and wild pigs that raid crops. One of the most important issues the world is currently experiencing is finding workable solutions to the conflict between humans and animals. This paper describes the use of a wireless sensor network based on UWB technology for intrusion detection deployment. Ultrawide band (UWB) signal features are automatically learned by feature analysis using a convolutional neural network. In the end, the SVM or Softmax classifier is used to classify people and animals.

Prashanth C Ravoor , Sudarshan T S B1 , and Krishnan Rangarajan2 [2]. This research presents a novel end-to-end design of a distributed cross-camera tracking system (a "Digital Border") based on computer vision for the purpose of detecting animal trespass using deep learning networks. In addition to sending out notifications when an animal incursion is detected, the system provides useful data like the intruders' species and number, their approximate location, and their last known direction of movement.

Dr.r.s. Sabeeniani, N.Deivanai, B. Mythili [3]. Protecting crops from animal harm and carefully rerouting animals away from agriculture are essential since both human and animal safety are equally important. In order to get over the aforementioned problems and accomplish our objective, we use machine learning (ML) to identify animals that are visiting our farm by utilizing the deep neural network concept, a subset of computer vision. In this project, the entire farm will be periodically monitored by means of a camera that records the surroundings continuously. Using a machine learning model, we are able to detect the animal when it enters and play the appropriate sounds to frighten it away. The various CNN libraries and ideas that were used to construct the model are listed in this study.

Fazil Mohammed, C.R.Ullas, C.M.Hema, S.K.Sonakshi [4]. Animal entering is a major crop yield issue that reduces farmer earnings and jeopardizes food security. This proposed paradigm presents machine learning and the Internet of Things as solutions to this problem. The machine algorithm is interfaced with the ESP8266 Wireless Fidelity module, Pi Camera, Buzzer, and LED, and is run on a Raspberry Pi. Machine learning methods such as Single Shot Detection and Region-based Convolutional Neural Network are essential for classifying animals and identifying objects in images. Based on the experiment results, the Single Shot Detection method outperforms the region-based Convolutional Neural Network approach.

[Sanjay Santhanam](https://ieeexplore.ieee.org/author/37089308978), [Sudhir Sidhaarthan B](https://ieeexplore.ieee.org/author/37089287797), [Sai Sudha](https://ieeexplore.ieee.org/author/37089290224) [Panigrahi](https://ieeexplore.ieee.org/author/37089290224), [Suryakant Kumar Kashyap](https://ieeexplore.ieee.org/author/37089289971) [5]. Animals crossing the road unintentionally has remained to be a prominent cause of traffic fatalities over time. Cars find it challenging to notice the forest's inhabitants because of its winding, gloomy roadways. For truckers, blind spot zones provide challenges. This research proposes a model that can recognize animals and notify the driver. The system alerts the driver to an approaching animal by sounding a three-second alert when the machine recognizes an object as an animal. Since the information is openly accessible, a large variety of species are still recognized by this model. The accuracy of the neural network algorithm model is 91%.

Bindu D et al [6]. Explains the preservation of agricultural fields has been the primary focus and a challenging subject in this essay. Over the years, the crop field has been repeatedly attacked by animals from the protected areas (PAs), making its protection a top priority. The methods currently in use are ineffective, so in this article we'll present a workable method to fend them off: we'll build a system that analyses animal behaviour, recognises the animal, and produces a sound that agitates the animal in addition to notifying the designated person via message. Additionally, we offer a multi-class categorization by accurately identifying species and displaying a zero false alarm rate.

Krishnamurthy B, Divya M [7]. In this project explains how agriculture provides a range of raw materials for industry in addition to meeting people's food demands. However, because to animal intervention in agricultural areas, a major loss of crops is expected. A crop's vulnerability to wild animals exists. As a result, it's critical to keep an eye out for any animal presence nearby. After then, a number of devices should be activated to drive away the dangerous animals. We suggest a strategy to keep wild animals away from farms.

Detecting animal attack from the outside of farms is the main use of operational amplifier circuits. The recommended monitoring program's goal is to provide early warning of possible wild animal ingress and danger. To protect your property and crops, the Solar Electric Fencing system is a cutting-edge alternative to conventional fencing methods.

Kshama S. Bhise1 [8]. In this work, explains how the initiative is used to find animals in national parks or wildlife reserves. This project makes use of an RFID (Radio Frequency Identification Device) module and a GSM (Global System Mobile) modem. Radio waves are used in a technology called "radio frequency identification," or "RFID," to wirelessly broadcast an object's or person's identity (represented by a unique serial number). It is included in the broad category of automatic identification technologies. This paper is used to trace an animal's whereabouts in a national park or wildlife reserve. For this, this paper makes use of a zigbee and an RFID module. These SMS will be sent to government officials or forest officers, containing the area where the animals are observed.

Prof Abhinav, V. Deshpandey [9]. This study explains the suggested strategy for using widely used wired network devices to protect farms from wild animals. This strategy is used in conjunction with other established techniques to increase the effectiveness of farm animal protection. A functioning amplifier circuit's main use is to detect animal infiltration from the outside of farms. The goal of the suggested monitoring programme is to alert people in advance to potential wild animal intrusion and damage.

S. R. Chourey , P. A. Amale [10]. The approach in order to protect farmers' crops from wild animals, this paper reviews a comprehensive technical solution that combines wireless sensor networks (WSN) and the Internet of Things (IOT). It has every kind of sensor, controller, and actuator needed for WSN, with the Raspberry Pi serving as the system's central component.

# PROPOSED SYSTEM

In this project, we suggest a unique methodology that blends Convolutional Neural Networks (CNN) with the VGG16 model as a key component Setting up a network of surveillance cameras strategically placed around the farm. These cameras will continuously capture images of the surrounding throughout the day. The system will be designed to send email notifications to farmers, alerting them to the presence of intruders in real- time, allowing for prompt response.

# MATERIAL AND METHODOLOGY

FIGURE 1: Block diagram for suggested approach

## Methodology Overview

### Fetching Data

Fetch, in the realm of computing, entails the retrieval of data through software, scripts, or hardware. Subsequently, once retrieved, this data can either be transferred to another location or presented on a screen for user interaction.

### Dataset

Loading the Images Dataset involves retrieving a collection of images representing various aspects. Researchers typically employ data loading techniques using programming languages like Python and libraries such as TensorFlow or PyTorch. This dataset is essential for training and evaluating machine learning models, especially those designed for tasks such as quality assessment or classification in the context of image analysis.

### Data Cleaning

The laborious process of preparing data for analysis is known as data cleaning. This is accomplished by eliminating or altering data that is inconsistent, absent, superfluous, repetitious, or handled in an improperly structured manner. However, it goes beyond merely arranging rows or deleting information to accommodate new data. Data cleaning demands substantial effort. Its significance cannot be overstated, particularly in fostering a data-driven culture and ensuring precise forecasts. It entails correcting grammatical and syntactic mistakes and standardizing data sets. Making corrections for errors like blank fields finding redundant data points.

### Data Preprocessing

Many machine learning algorithms necessitate data to adhere to specific formatting guidelines, thus datasets typically require preparation before yielding valuable insights. Some datasets contain missing, invalid, or challenging values for algorithms to process effectively. Missing or invalid data impedes algorithmic use, resulting in less accurate or misleading outcomes. While some datasets are relatively clean but require shaping, others lack essential business context, emphasizing the necessity for feature enrichment. Effective data preparation entails the creation of clean and meticulously curated data, ultimately leading to more practical and accurate model outcomes.

*Model Training*

A dataset that an ML algorithm utilizes to become trained is called a training model. It consists of matched sets of input data that influence the output along with sample output data. This model is used to input data into the algorithm by comparing the processed output with the sample output. The model is modified through this iterative process called "model fitting," taking into account the correlation findings. The link between the training and validation datasets is a crucial component in ensuring the accuracy of the model. In order to help an ML algorithm find patterns and provide predictions, model training entails feeding it data.

**System Implementation**

***A. Data Prepocessing***

Preparing raw data for analysis is known as data pre-processing, and it's a crucial the initial stage of developing a machine learning model. Raw data is frequently unclean and poorly formatted, requiring cleaning and formatting before any additional processes can be carried out. This process is crucial for ensuring that the data is in a usable state for training and testing machine learning algorithms.

Includes the following steps:

* *Obtaining the dataset***:** In image reconstruction using CAEs, the encoder is responsible for transforming input images into a compressed latent representation. This encoded representation contains essential features extracted from the input, facilitating efficient storage and subsequent reconstruction during the decoding phase. The encoder's role is crucial in capturing meaningful information for faithful image representation.
* *Importing Libraries:* Typically, the initial step involves importing the necessary libraries participating in the program. A library is a collection of modules that may be used and called from within an application
* *Importing Datasets:* First, finding the CSV file's directory is necessary because many datasets are in CSV formats and then use the read.csv method in R- Studio to read it.
* *Finding Missing Data :* Following data pre-processing, the subsequent step involves addressing missing data within the datasets. The effectiveness of machine learning models can be significantly impacted by missing data. Implementing strategies for handling missing values present in the dataset is imperative.
* *Encoding Categorical Data :* Whenever we have a text data need do apply text processing and clean it. In this text preprocessing first step punctuation symbols removal. First step want to remove some punctuation removal there is no using this symbol and get create some high dimensionality. In the second step, we can remove stop words from the dataset using NLTK and then proceed with tokenization. Stop words are common words that often carry little meaning and can be removed to improve text analysis accuracy. In this step split the sentence into words and apply stemming. Stemming is nothing but convert the word into base form for example beautiful, beauty, be stain the base form is beauty.
* *Dataset Splitting into Training and Test Sets: The next important step is to divide our dataset into two separate sets: a training set and a test set.* The purpose of this division is to train our machine learning models on the Training set, then measure their predicted accuracy by assessing how well they perform on the test set. It's essential to ensure that our model performs well not only on the Training set but also on unseen data, represented by the test set. This practice helps prevent over fitting, when a model fails to generalize to new data despite doing remarkably well on the Training set. By striving for robust performance on both the Training, Test sets, we aim to develop machine learning models capable of accurately predicting outcomes across different datasets.

***B. Normalizing Numeric data***

In data preprocessing for machine learning purposes, normalization is a common technique utilized. Its goal is to maintain the intrinsic variations in the ranges of values while standardising the values of numerical columns within a dataset to a scale. This process becomes necessary when features exhibit disparate ranges, ensuring that each feature contributes equally during model training.

Normalization in the context of machine learning refers to transforming data to a unit sphere or, alternately, translating it into a specific range, usually [0,1]. For several machine learning techniques, normalization and standardization are helpful, particularly when Euclidean distance is being used.

**C**. ***Deep Learning Algorithms***

*A. CNN*

The ability of artificial intelligence to link human and computer skills has advanced significantly. To pull off incredible accomplishments, both beginners and specialists concentrate on different aspects of the subject. The domain of computer vision is among these many. Enabling machines to perceive and comprehend the world similarly to humans is the aim of this field.

A plethora of activities, including picture and video identification, recommendation systems, natural language processing, image analysis, and classification, will be possible for these robots to accomplish with the use of this enormous amount of data. Deep Learning has made significant strides in computer vision throughout time, mostly thanks to one particular algorithm called CNN.

Send the data straight to the model after image processing and data splitting are finished; CNN architecture must first be defined. Initial import model sequentially, followed by an input layer that fixes the input shape images and provides the activation function. The input layer is then added, where 32 filters, a (5,5) kerner size, max pooling, and dropouts are added.

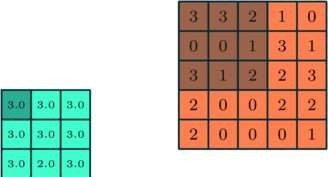
This dropout aids in preventing over fitting in our model. Added two input layers with 64 and 128 filters, the same max pooling, a 5.5% kernel size, and dropouts using the Relu activation function once more.

## 

FIGURE 1: Flattening of a 3x3 image matrix into a 9x1 vector

For incredibly simple binary images, the technique could be able to predict the class with an average precision score, but it performs badly or not at all for complex images with relationships between individual pixels. The image measures five inches in height, five inches in width, and one number of channels (such as RGB).

## *Pooling layer*: The Pooling Layer's function is to reduce the spatial extent of the Convolved Feature, just like the Convolutional Layer does. By doing this, the dimensionality of the data will be minimized and less processing power will be required to handle it. Additionally useful for creating positionally and rotationally invariant dominating features, which sustains the model's training process.



## FIGURE 3: Pooling layer

Ordinary pooling and severe pooling are the two categories of pooling. Max Pooling delivers the largest value from the region covered by the kernel, whereas Average Pooling yields the mean of all the values from the image covered by the kernel.

*B. VGG16*

In the field of image recognition, K. Simonyan and A. Zisserman's convolutional neural network, known as VGG16, is a seminal model. It sprang to prominence after achieving an astounding using the ImageNet dataset, which contains over 14 million images distributed over 1000 categories, the test accuracy was 92.7% top-5, during the ILSVRC-2014 competition. What sets VGG16 apart is its architectural innovation: the replacement of larger kernel-sized filters in the initial layers with multiple consecutive 3x3 kernel-sized filters.

This design choice allows for deeper network architectures without overly increasing the number of parameters, striking an optimal balance between model complexity and computational efficiency. By leveraging this configuration, VGG16 excels at capturing intricate features and patterns within images, enabling robust and accurate classification. The cascading arrangement of smaller filters enhances the model's ability to extract meaningful features while maintaining a deep architecture.

VGG16's success underscores the significance of architectural advancements in deep learning, paving the way for subsequent models and further advancements in computer vision research.

*C. VGG19*

Neural Convolution The massive dataset that contained more than a million photos was used to train VGG-19. ImageNet compilation. This neural network building architecture boasts an impressive depth of 19 layers, making it proficient at classifying images into one of 1000 object categories. These categories include a broad range of products, from commonplace goods like mouse, pencils, and keyboards to different animals. Through its rigorous training process, VGG-19 has acquired a nuanced understanding of features present in images across this broad spectrum. When processing input images, VGG-19 expects a fixed size of 224x224 pixels with RGB channels, resulting in a matrix shape of (224,224,3).

In essence, VGG-19 serves as a powerful tool for image classification tasks, leveraging its deep architecture to extract intricate features and make accurate predictions. The layers within the VGG-19 model are structured to progressively abstract and refine features from the input image, enabling it to discern intricate patterns and classify images with high accuracy. After being trained on a million photos from the ImageNet database, a convolutional neural network with 19 layers named VGG-19 was able to identify 1000 different objects, including a mouse, keyboard, pencil, and different animals.

Consequently, a vast array of image-rich feature representations have been trained into the network. An RGB fixed-size picture with dimensions of (224 \* 224) was the network's input, indicating that the matrix's structure was (224,224,3).

1. As a single preprocessing step, the mean RGB value of every pixel across the whole training set was eliminated.
2. They used kernels with a size of (3 \* 3) and a stride size of one pixel to cover the entire image. Spatial padding was used to preserve the image's spatial resolution.

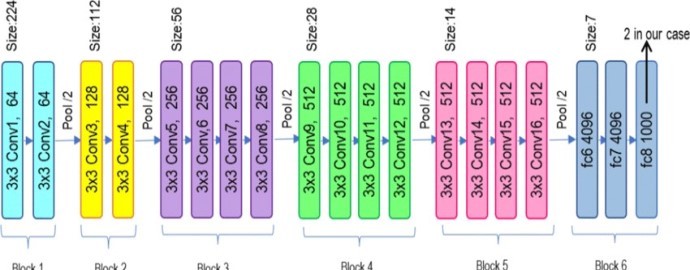


FIGURE 4: VGG19 Architecture

# EXPERIMENTS AND RESULTS

### The suggested model will train the elephant, boar, and monkey picture collection by creating Convolutional Neural Network and transfer learning models. The saved model will be run on the driver code in order to compare the learned images with the new test images from the live capture. By means of speakers, an unpleasant noise is generated. If one of the trained animals is found during the live capture in order to scare it away.

### Various test images are given, and the model's accuracy is confirmed by identifying their classes.

## CNN ,VGG Model Graphs

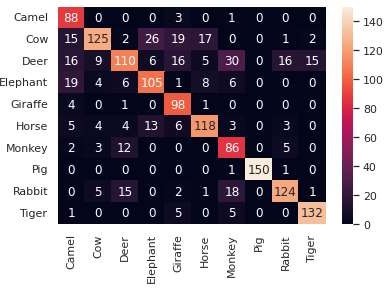
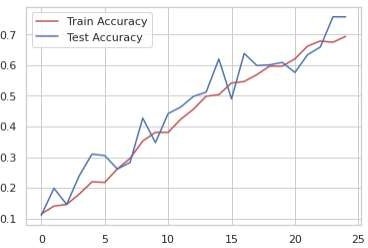
 

FIGURE 5: Confusion Matrix of CNN FIGURE 6: Train and Test Accuracy of CNN

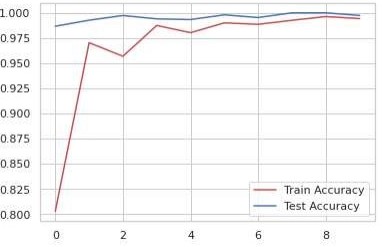
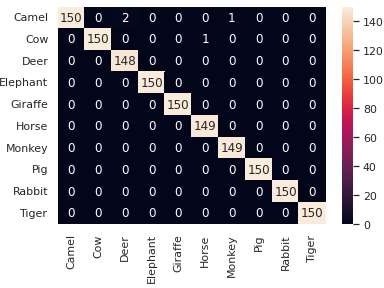
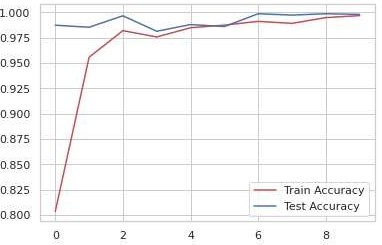


FIGURE 7: Confusion Matrix for VGG16 FIGURE 8: Train and Test Accuracy for VGG16



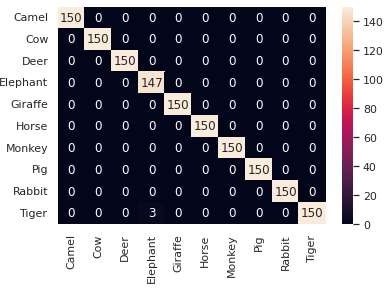


FIGURE 9: Confusion Matrix for VGG19 FIGURE 10: Train and Test Accuarcy for VGG19

By using CNN got 75% accuracy we can check it from confusion metric also. Seeing this confusion matrix which class images are correctly classified and which class images Misclassified we can identify easily. Some camel images classified into cow, deer and elephant and some deer images classify into monkey and rabbit.

These all are the miss classified data points. We need to decrease these are miss classified data points. So, we can see train and test data accuracy each class.

By using VGG models we can predict animals with more accuracy then CNN. By using VGG16 predict animals with accuracy of 96% and VGG19 with accuracy of 98%.

# CONCLUSION

In the current day, The problem of wild animals eating crops has become quite significant. Put differently, every farmer should utilize the crop productivity that he or she should be conscious of and mindful of the reality that animals are sentient beings who require protection from potential harm. It must be dealt with right away and successfully. As a result, this initiative has a great deal of social significance because it will free farmers from the needless labor associated with field protection, assist them in safeguarding their farms and preventing them form suffering large financial damages.

# Acknowledgments

We extend our sincere gratitude to the contributors and collaborators involved in the development of this project aimed at safeguarding agriculture to prevent animal invasions. Special thanks are extended to the teams and researchers who pioneered the utilization of neural networks, particularly Convolutional Neural Networks (CNN) and VGG Model, in the realm of agriculture prevention. Their ground-breaking research serves as the basis for our strategy, which enables us to use machine learning to classify animal images more accurately and effectively. The knowledge and combined efforts of those committed to developing agricultural and animal prediction technology made this initiative possible.

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