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Enhancing Crop Yield with Animal Detection in Agricultural Land using Convolutional Neural Network and Sound Based Scare Tactics

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Abstract: *Agricultural sector faces a major loss that is caused by animal assaults and is one of the greatest threats in diminishing crop production. Pests, natural disasters, and animal damage pose severe risks to Indian farmers, lowering productivity. Crop raiding is one of the most acrimonious human-animal conflicts as a result of the extension of farmed land into former animal habitat. Traditional methods followed by farmers are not that effective and it is not feasible to hire huge manpower to keep an eye on crops and prevent animals from destroying them. Since safety of both human and animals is equally vital, it is important to protect the crop from damage caused by animal as well as divert the animal without any harm. The goal is to develop a model that can accurately detect animals in agricultural lands. The system will use deep learning to detect animals entering into the farm by using convolutional neural network concept. This system will monitor the entire farm at regular intervals through a camera which will be recording the surrounding throughout the day. With the help of a deep learning model, the system detect the entry of animals and also use sound based scare tactics to deter animals from the agricultural land.*

Keywords: Ungulates, Convolutional neural network, Object Detection, Scare-based system

I. INTRODUCTION

In India, agriculture has historically been the most significant economic sector. The majority of people in India work in agriculture, but farmers still confront many difficulties. Overpopulation causes deforestation, which deprives forest regions of water, food, and shelter. As a result, there is a rising threat to human life and property as well as conflict between humans and animals as a result of animal intrusion into residential areas. Agriculture is the foundation of the economy, yet animal intrusion would cause significant crop loss. Elephants and other animals that interact with people negatively impact human life in a number of ways, including crop destruction, harm to food and water supplies, damage to homes and other property, injuries, and human fatalities.Conflict between people may also be a major issue where a lot of money is squandered and lives are in danger. These conflicts are becoming more frequent in recent years. Farmers in India are under severe threat from tragedies caused by nature, pests, and animal damage, which lowers production. Ancient tactics being followed by farmers aren't very successful and it's not feasible to employ massive manpower to keep an eye fixed on the crops and forestall the animals.For instance, the automation of agricultural production has made it possible to manage weeds intelligently and continuously monitor crop growth.Compared to previous methods, which are manual, labor-intensive, expensive to produce, and prone to error, this aids in the provision of precise and efficient solutions to assist agricultural activities. one of the primary issues with modern effectiveness. The recent animal detecting technologies are not perfect as they face issues like poor accuracy, numerous false positives, etc. The classification algorithm being employed has a significant impact on accuracy. With this animal detection technology, farmers will no longer need to worry about animals attacking their crops.In reality, during the past three decades, the amount of harm caused by predatory animals has substantially increased throughout India. There are a variety of traditional strategies to address this problem, both lethal (such shooting and trapping) and non-lethal(Scarecrows, chemical repellents, organic materials, mesh, or electric fences are a few examples). Some earlier technologies still have environmental pollution effects on both people and ungulates, even if some are highly expensive,

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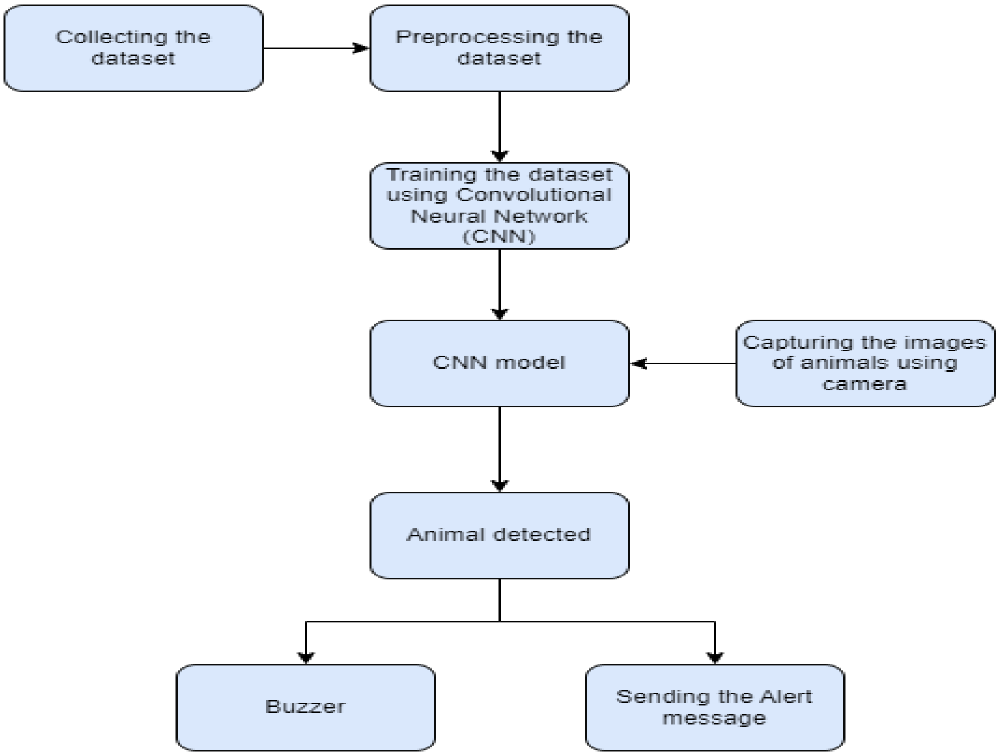
have large maintenance costs, are unreliable, and have a limited animal detection problem. We suggest a method to address this problem that integrates sound-based fright approaches with computer vision methods, notably Convolutional Neural Networks (CNNs). The proposed system uses cameras to take pictures of the farmland and uses the CNN model to identify the animals. When an animal is found, a sound-based scare method is used to frighten it away and stop additional crop damage.

II. RELATED WORK

Image classification, object identification, and image verification are all topics covered in this paper. The review of related work on these issues is provided in the paragraphs that follow. Deep learning technology has been widely applied in agriculture-related applications as machine learning applications spread quickly across several industries [12]. Among other things, deep learning can be used to classify crops and identify animals. In recent years, the advancement of CNN has produced positive results for weed categorization, facial recognition, behavioral recognition, handwritten character recognition, licence plate recognition, and crop detection for fruits and vegetables like strawberries, mangoes, and apples. Moving to animal identification, animal detection has been explored by various researchers for the goals of estimate, localisation among others. Animal detection is often done with the help of camera traps, which combine a camera and a motion sensor. The motion sensor causes the camera to snap a picture when it detects certain movements. We can identify the species and behavior of animals using image analysis [1] [2]. Trail cameras are representative devices of camera traps. A large array of commercial trail cameras with diverse features is available [3]. By adjusting the trail camera's motion sensor sensitivity, image size, and communication frequency, we can alter the battery life.Several studies have looked into the use of DL to find wild animals. The majority of these studies focus on automating the detection of animals because it takes a long time to manually examine the massive volume of images captured by camera traps. They can be divided into the creation of DL models for the identification or categorization of animals [4] through [10] and the creation of a tool for animal detection [11]. Although these studies were successful at detecting animals, they tended to concentrate on the model performance rather than providing information on both the model performance and its platform implementation. Moreover, just a small number of images were used in these investigations.As a result, these techniques have some drawbacks when it comes to detecting animals in a wide range of circumstances. In this study, Nikhil R et al. [21] created a system utilizing the CNN algorithm, a few cameras, and sensors. This model aids in crop protection, which in turn aids farmers in preventing wild animals from entering the field, to grow suitable crops depending on the soil parameters, and to conserve water by only providing the necessary amount of water automatically. Soil moisture sensors are used to do this, and this irrigation status willbe wirelessly updated to the farmer by emails and SMS.The dataset utilized here consists of pictures of monkeys since Kuei-Chung et al.[22] have mostly focused on monkeys. In this system, hybrid recognition mechanisms are employed. Images of monkeys are taken using IP cameras. The algorithm for image recognition will be applied to that picture. Following this procedure, the picture will be labeled as either showing a monkey or not. If it's a monkey, the system will issue a few warnings, such as a loud noise to frighten the monkeys, and it will also alert farmers. The accuracy of this experimental model is 91%. Stefano Giordano et al. created an IoT application in this paper. Here, they have employed open-source platforms and low-power gadgets where one thread is used for animal detection and another thread is used for animal movement detection. With this weather monitoring system, numerous sensors are connected to an Arduino ESP-8266 board, and the ultrasound system repels animals in addition to giving farmers real-time information about the weather conditions. This work proposes a real-time monitoring approach based on DL to address the concerns of crop damages against animals without any harm.

III. SYSTEM MODEL

3.1 Architecture



Gathering images of animals that could endanger crop yields on agricultural land is the initial phase in the project's collection and preprocessing of the dataset. When the dataset has been gathered, it must be preprocessed to eliminate any noise or extraneous data and to extract the features required for animal detection. When the model has been trained, the following step is to gather real-time photos using a camera positioned in the farmland. The CNN model will analyze these images in real-time and look for any animals in the area. The system will activate a sound-based scare tactic if an animal is detected, which will prevent the animal from entering the agricultural field.The sound-based scare tactics could be a pre-recorded sound that is played through speakers or a device that generates loud, sudden noises that are known to scare animals. Finally, if an animal is detected, the system will send an alert message to the farmer, notifying them of the animal's presence and the action taken by the system.

The alert message could be sent via SMS or email, providing the farmer with real-time information about the situation in the agricultural land.

3.2 Algorithm

A. Convolutional Neural Network

Deep neural networks, which include convolutional neural networks (CNNs), are extensively used for the analysis and processing of structured data, including images.. By utilizing the convolution algorithm, which enables the network to extract features from input data in a hierarchical fashion, CNNs are created to automatically find patterns in data. The fundamental principle of a CNN is to perform classification or regression tasks using one or more fully connected layers after using a succession of convolutional layers to extract features from the input data. In order to minimize the discrepancy between its anticipated output and the actual output, the network learns the ideal set of weights and biases for each layer throughout the training phase.CNNs have the advantages of learning feature representations automatically from the raw input data, handling large-scale data with high-dimensional features, and generalizing well to new, untried data. CNNs have achieved state-of-the-art performance on a wide range of computer vision tasks, including image classification, object detection, semantic segmentation, and more.

3.3. CNN's Layers

- Input layer
- Convolutional layer
- Pooling layer
- Fully connected layer
- Softmax layer
- Output layer

A. Input layer

The input layer is responsible for receiving the input data, which could be images, audio, or other types of multidimensional data. The input layer is typically a 3D tensor with dimensions of (height, width, channels), where: Height: the height of the input image or volume. Width: the width of the input image or volume. Channels: the number of color channels or input channels in the input image or volume.

B. Convolutional Layer

A convolutional layer is a fundamental building block of a Convolutional Neural Network (CNN). It is used to extract features from the input data by applying a set of learnable filters, also known as kernels or weights, to the input..The purpose of the convolutional layer is to learn spatially local patterns in the input data, such as edges, corners, and blobs, which can then be used by subsequent layers to learn higher-level representations of the input data. The use of convolutional layers is one of the main reasons why CNNs are highly effective for tasks such as image recognition and object detection. They have the ability to learn hierarchical representations of input data, which allows them to capture complex patterns and structures. The Rectified Linear Unit (ReLU) layer is typically added after the convolutional layer. The ReLU layer serves two main purposes in a CNN. First, it introduces nonlinearity into the network, allowing it to learn more complex and abstract features. Second, it helps to prevent the vanishing gradient problem that can occur during backpropagation

C. Pooling

Pooling layer would lessen the number of parameters when a large image is given as input. Max pooling is done by taking the largest element from the revised feature map. The objective of max pooling is to down sample an input image, reducing its dimensions etc

D. Fully connected

The hidden layers inside a Convolutional Neural Network that are called Fully Connected Layers. These are a specific type of hidden layer which must be used within the CNN. This is used to combine the features into more attributes that predict the outputs more accurately

E. Softmax layer

It takes the output from the previous layers, which can be a feature map or a fully connected layer, and computes the probability distribution over the possible classes. The softmax layer works by taking the input values and applying the softmax function, which normalizes the values and converts them into a probability distribution. The output of the softmax layer is a vector of probabilities, with each element representing the probability of the input belonging to a particular class.

F. Output layer

The output layer is the final layer that produces the network's predictions. The specific structure of the output layer will depend on the particular task being performed by the network, such as image classification.

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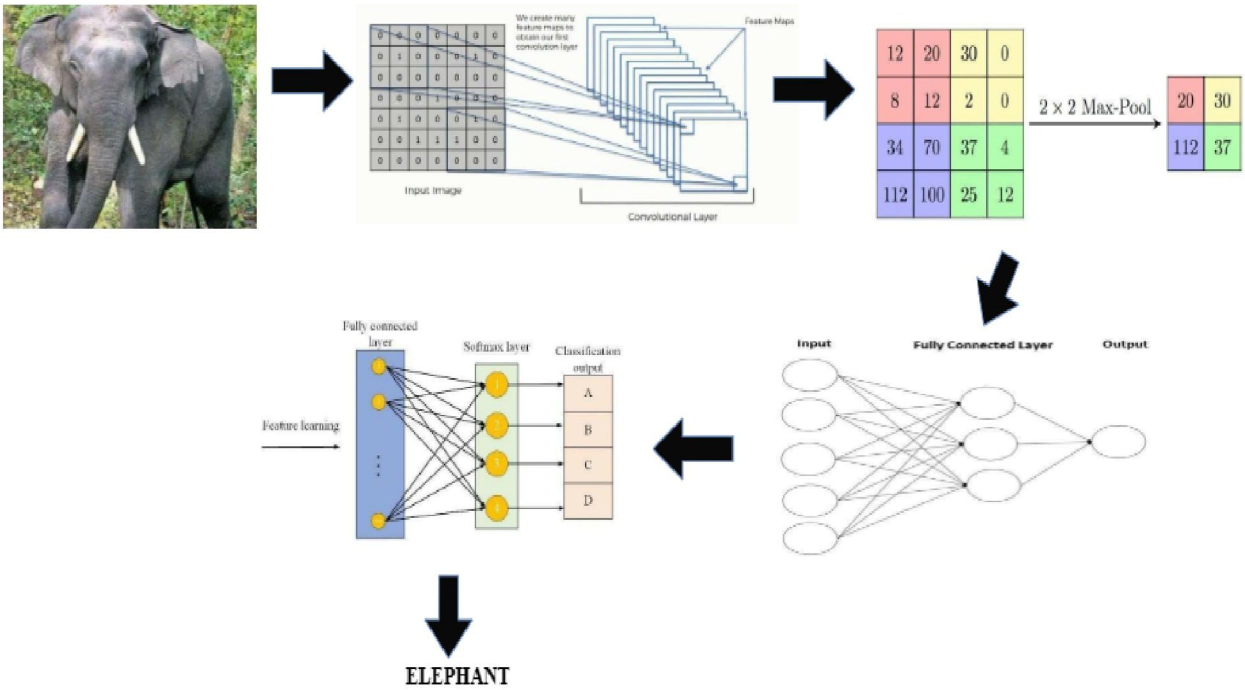

IV PROPOSED METHODOLOGY

- Image dataset collection
- Image preprocessing
- Camera interfacing
- Connecting cameras to CNN for animal detection

4.1 Image Dataset Collection

The dataset used here is a collection of image data that contains various images of animals. Identify the types of animals that are problematic for crop yields in the agricultural region of interest. Collect images of the identified animals. The images should be diverse, representing different angles, lighting conditions, and poses. And also collect images of the agricultural land without animals. These images can serve as negative examples for CNN to learn from. The dataset is splitted into train and test respectively. Image dataset helps algorithms learn to identify and recognize information in images and perform related cognitive activities.

4.2 Image Preprocessing

After gathering all the images, pre-processing is required. Preprocessing helps to ensure that the input images are in a format that is suitable for the CNN to learn from. Thus not all images can convey information clearly. So that we may prepare the images by renaming, resizing, and labeling them. Resizing the images to a common size can help to reduce the computational requirements of the CNN and ensure that all input images have the same dimensions. These image preprocessing steps can help to ensure that the input images are in a suitable format for the CNN to learn from and can improve the accuracy of the system.

4.3 Camera Interfacing

Install the drivers and software required to operate the camera on the computer that will be used for image capture. Connect the camera to the computer using a USB cable or other appropriate interface. Ensure that the camera is recognized by the computer. Position the camera in a location that provides a clear view of the agricultural land. Adjust the camera settings, such as resolution and frame rate, to capture images that are suitable for the CNN to learn from.

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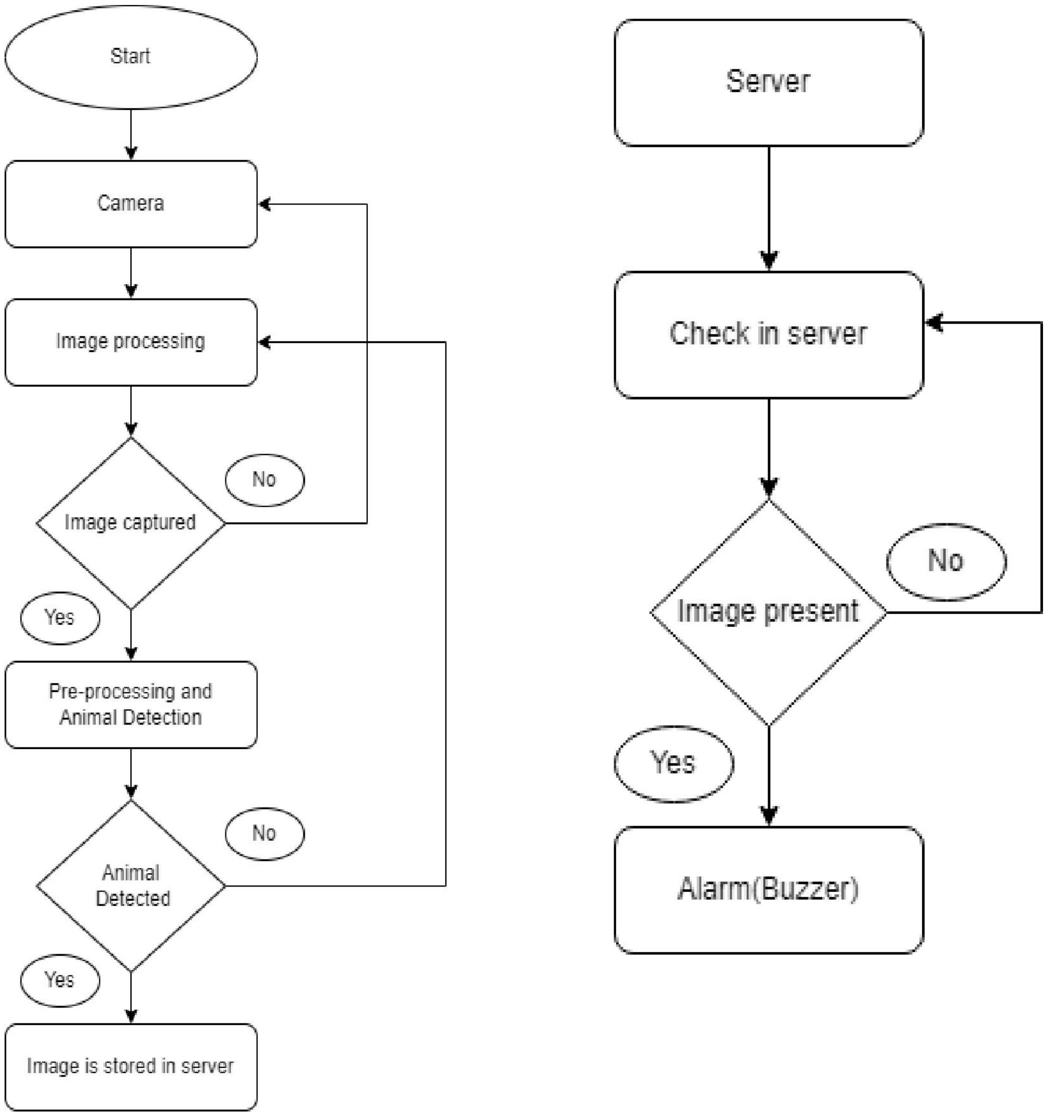
Start image capture: Use the camera software to start capturing images. Preprocess the live images using the steps such as resizing, normalization, and segmentation. Ensure that the images are being saved in a format that is compatible with the CNN.

4.4 Connecting cameras to CNN model for animal detection

Feed the preprocessed images into the CNN model using appropriate input layers. The CNN will process the images and output a prediction of the animal category. Use the prediction from the CNN to activate sound-based scare tactics to deter the animals away when they are detected. Evaluation of the system is important to ensure that it is accurately detecting animals and effectively scaring them away.

V. FLOWCHART



Alerting System

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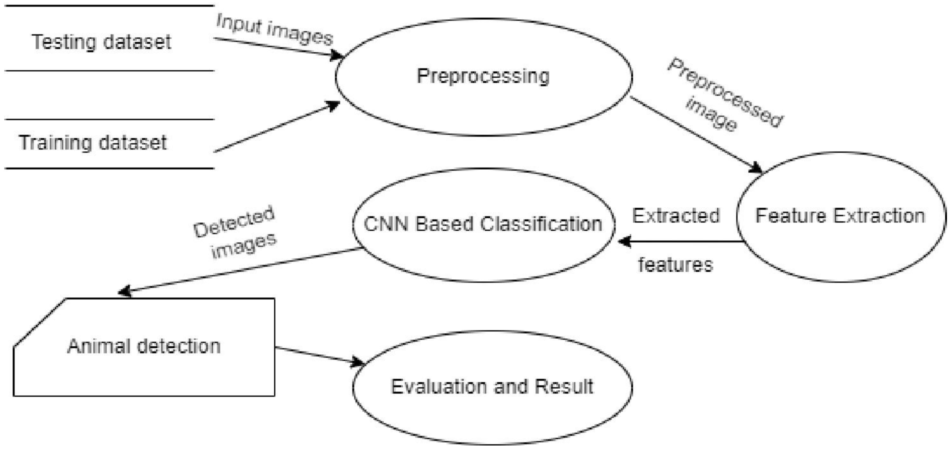
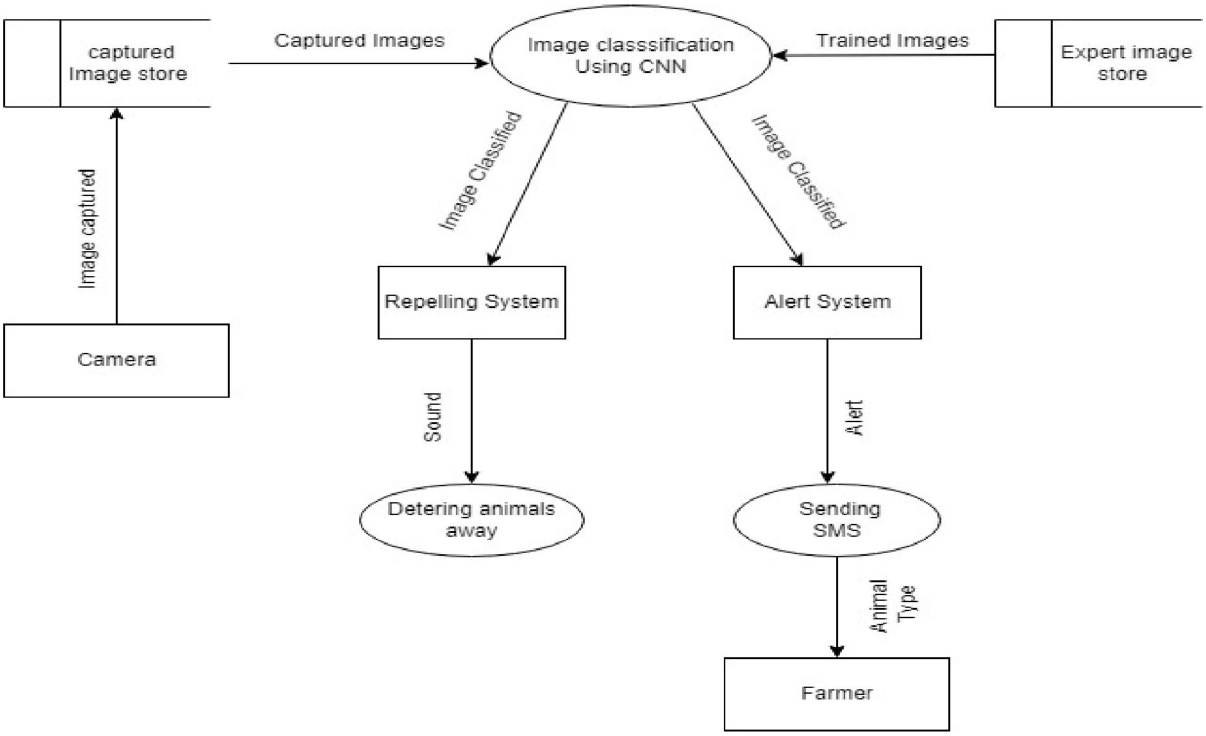
VI. DATA FLOW DIAGRAM

LEVEL 1 DFD DIAGRAM



LEVEL 2 DATA FLOW DIAGRAM



VII. RESULTS AND DISCUSSIONS

Deep learning models for animal detection are typically evaluated on metrics such as precision. These metrics reflect the accuracy of the model in identifying animals and minimizing false positives and false negatives. Depending on the dataset and evaluation criteria, the performance of these models can vary widely. Animal detection may be compared to other deep learning methods, such as CNN algorithm which involves using a pre-trained model on a large dataset and fine-tuning it for a specific task, is often used in animal detection. This approach can improve performance by leveraging the knowledge and features learned from the pre-trained model.

Our image dataset comprises 1,000 JPEG images of elephants, cows, tigers, dogs, and foxes, annotated with corresponding class labels for use in computer vision tasks.

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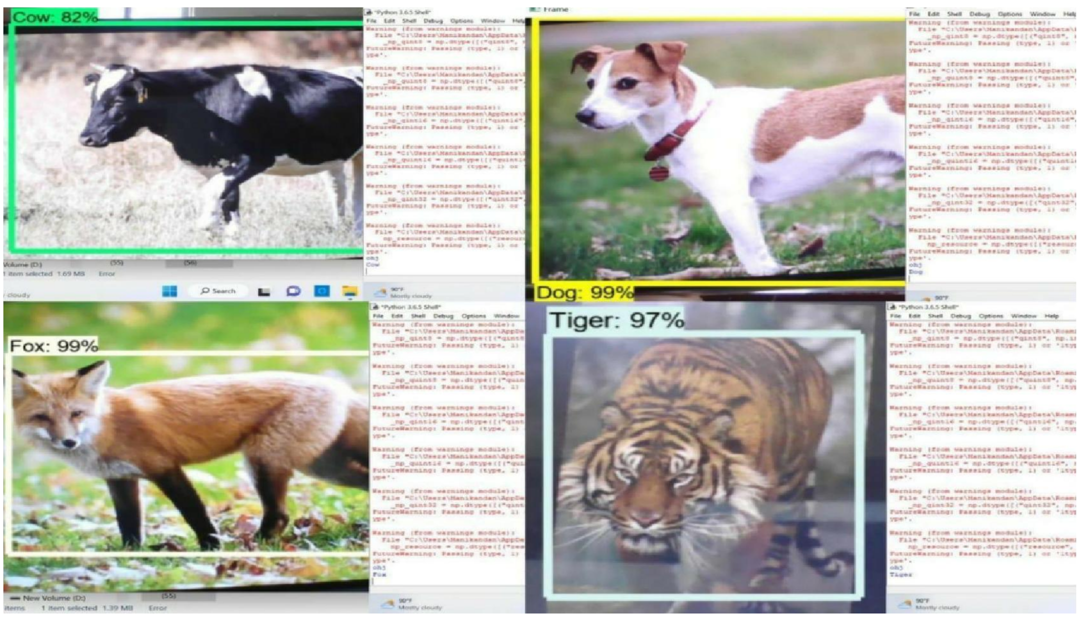

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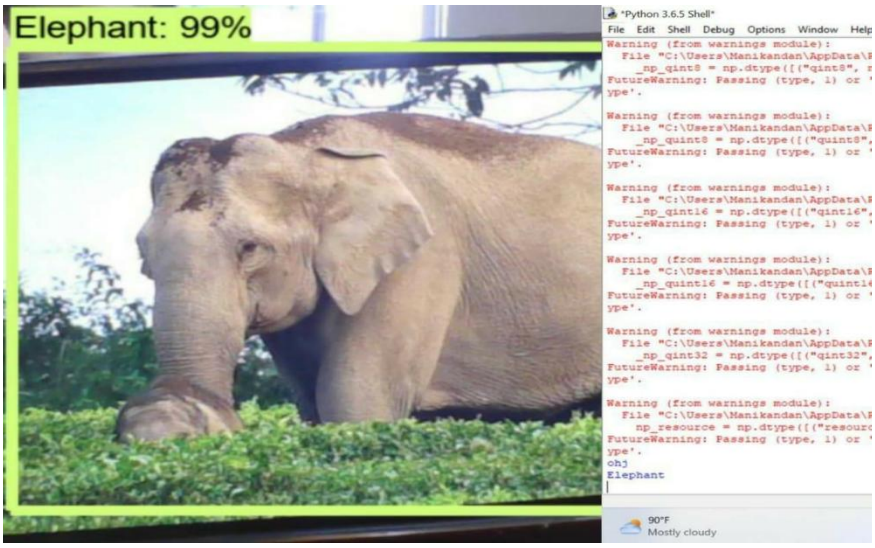

Our CNN-based animal detection model achieved a high accuracy in detecting elephants, cows, tigers, dogs, and foxes in the test dataset

VIII. CONCLUSION

The project proposes the use of a Convolutional Neural Network (CNN) for animal detection and scare-based tactics, such as scarecrows and loud sounds, to deter animals from entering agricultural lands. The results of the project showed that the use of the proposed system could detect animals accurately and efficiently, and the scare tactics effectively reduced animal interference in agricultural lands. Furthermore, the project's proposed system has the potential to significantly reduce losses due to animal damage, resulting in an increase in crop yield and higher profitability for farmers. It is also a sustainable and humane solution to animal interference in agricultural lands, as it avoids the need for harmful animal control practices. Overall, the project demonstrates the effectiveness of integrating animal detection technology with scare-based tactics for enhancing crop yield and reducing animal damage in agricultural lands, which can benefit farmers and the agriculture industry as a whole.

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