Agriculture Using Artificial Intelligence Animal Beat Back System Based on Camera

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Abstract—Crop raiding by animals has become one of the most common human animal disputes as a result of human encroachment of wildlife habitats and deforestation. Wild animals can cause significant damage to agricultural crops and attack farmers working in the field. Farmers suffer huge crop loss due to crop raiding by wild animal like elephants, wild boar and deer. One of the main concerns of today's farmers is protecting crops from wild animals' attacks. There are different traditional approaches to address this problem which can be lethal (e.g., shooting, trapping) and non-lethal (e.g., scarecrow, chemical repellents, organic substances, mesh, or electric fences). Farmers has tried many ways for preventing animals raid from lighting fire crackers to maintain a watch on the field through the night but none of these were effective. Nevertheless, some of the traditional methods have environmental pollution effects on both humans and ungulates, while others are very expensive with high maintenance costs, with limited reliability and limited effectiveness. In this project, we develop a system, that combines Computer Vision using ANN for detecting and recognizing animal species, and specific ultrasound emission (i.e., different for each species) for repelling them. The edge computing device activates the camera, then executes its ANN software to identify the target, and if an animal is detected, it sends back a message to the Animal Repelling Module including the type of ultrasound to be generated according to the category of the animal.

***Keywords*—Animal Recognition, Repellent, Artificial Intelligence, Edge Computing, Animal Detection, AI, DCNN.**

I.INTRODUCTION

Agriculture has been through numerous revolutions, including the domestication of animals and plants a few thousand years ago, the systematic use of crop rotations and other improvements in farming practise a few hundred years ago, and the "green revolution" with systematic breeding and the widespread use of man-made fertilisers and pesticides a few decades ago. The exponential growth in information and communication technology (ICT) use in agriculture has sparked the fourth industrial revolution in agriculture. Robotic, autonomous vehicles have been created for use in agriculture, including mechanical weeding, fertiliser application, and fruit harvesting. The development of unmanned aerial vehicles with autonomous flight control and the lightweight and powerful hyper spectral snapshot cameras that can be used to compute biomass development and fertilisation status of crops open the field for advanced farm management recommendations. Farmers can now distinguish between different plant diseases using decision-tree algorithms that are based on optical data. Technologies for virtual fences enable cow herd management based on signals from remote sensors and sensors or actuators linked to the livestock. When combined, these technological advances represent a technical revolution that will cause significant shifts in agricultural practises. This trend is true for farming in both developed and developing nations, where ICT deployments (such as the use of mobile phones and access to the Internet) are being embraced quickly and have the potential to change the game in the future (e.g., through the use of seasonal drought forecasts and climate-smart agriculture).We made the decision to develop a more intelligent approach that would safeguard the crops from animal trespasses without endangering nature.

Workflow and convolutional neural network for automated identification of animal sounds[Zachary J.Ruff, Damon B.Lesmeister, Cara L.Appel, Christopher M.Sullivan]:This project uses convolutional neural networks to automatically identify animal sounds. With

the aid of these technologies, researchers have been able to gather vast amounts of acoustic data, which must now be processed to yield useful information, such as target species detections. Comparing this workflow to a comprehensive manual evaluation of the data, the amount of human effort required is reduced by > 99%.

Real-Time Monitoring of Agricultural Land with Crop Prediction and Animal Intrusion Prevention using Internet of Things and Machine Learning at Edge[R. Nikhil; B.S. Anisha; Ramakanth Kumar P.]:The goal of this project is crop prediction, which uses machine learning techniques to assist farmers in growing appropriate crops based on soil conditions and also aids in preventing invaders like wild animals from entering the field. The installed smart agriculture system is economical in terms of increasing agricultural farm water supplies, predicting crops, and preventing wild animals.

Animal Behaviour Prediction with Long Short-Term Memory[Henry Roberts; Aviv Segev]: The goal of this project is to effectively transform animal videos of any length into models that can predict behaviour with accuracy utilising long short-term memory (LSTM).

IoT based animal classification system using convolutional neural network[L. G. C. Vithakshana; W. G. D. M. Samankula]: The purpose of this project is to develop an Internet of Things (IoT) based acoustic categorization system that will be useful to zoologists, animal scientists, and environmentalists that are interested in monitoring ecosystems.

Animal Sound Classification Using Dissimilarity Spaces[Loris Nanni , Sheryl Brahnam , Alessandra Lumini and Gianluca Maguolo]:The objective of this research is to automatically classify animal sounds using clustering techniques.This article describes a technique for categorising animal vocalisations utilising dissimilarity spaces and four Siamese networks.

Identification of Animal Species from Their Sounds[Gavril-Petre Pop]:In order to distinguish between different animal species based on their noises, this project will use TESPAR S-matrices using Teager cepstral coefficients, some extra characteristics, and the Random Forest classification algorithm.

The Monkeys Are Coming – Design of Agricultural Damage Warning System by IoT-based Objects Detection and Tracking[Kuei-Chung Chang; Zi-Wen Guo]:The goal of this project is to develop a warning system that uses IOT-based object identification and tracking to minimise the agricultural damage caused by monkeys in farm fields.

Animal monitoring based on IoT technologies[Luís Nóbrega, André Tavares, António Cardoso, Pedro Gonçalves]:This project's goal is to create an IoT-based platform for tracking animal behaviours. This article suggests a system architecture that spans collars, sheep-borne mobile nodes, up to a cloud platform that can perform a variety of jobs, including data analysis, processing, and storage.

II. PROPOSED SYSTEM

Animal species can be identified using AI Computer Vision-based DCNN, and they can be repelled using particular ultrasound emissions that are different for each species. An intelligent smart agriculture repelling and monitoring IoT system based on embedded edge AI was designed, implemented, and evaluated in order to detect and identify various animal species as well as produce ultrasonic sounds specific to each species. In their management and decision-making processes, farmers and agronomists can benefit from the combined technology used. Convolutional Neural Networks (CNNs) are used in deep learning to conduct the animal recognition.

System Architecture:

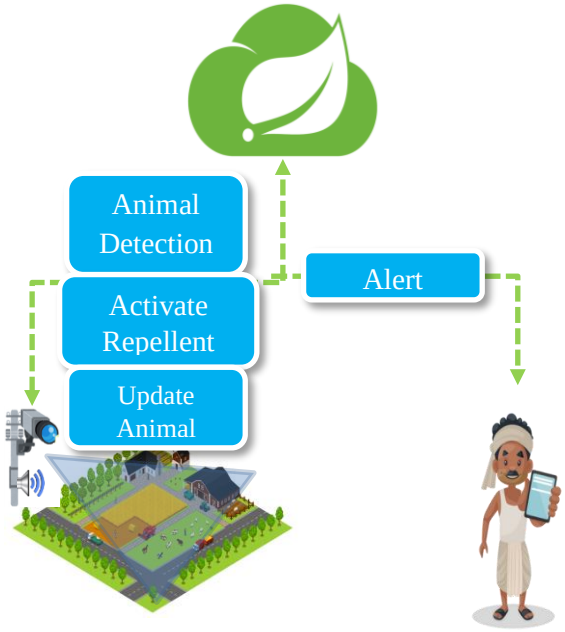


Fig:1 System Architecture

Animal Repellent Web Dashboard: To find animals in the fields, this technology operates in real time. The

device offers manual buzzer controls in case they are required and even allows the farmer to watch his fields in real time online from anywhere. As a result, the farmer effectively controls the system and has the ability to manually activate the buzzer as needed. Compared to many of the already used options, such as electric fences, brick walls, and manual field surveillance, this method is more cost-effective. This technique works well at keeping animals out of the fields and driving them away. It detects animals in the fields with accuracy and activates the buzzer. It doesn't sound the buzzer because a person is nearby or because of a chance movement. The non-noise-polluting ultrasonic buzzer is particularly effective against animals. This technique causes no harm to animals at all and is completely safe. Additionally, it doesn't injure people in any way. Additionally, this technology requires extremely little power, which lowers the risk of electric shocks.

Animal Recognition:

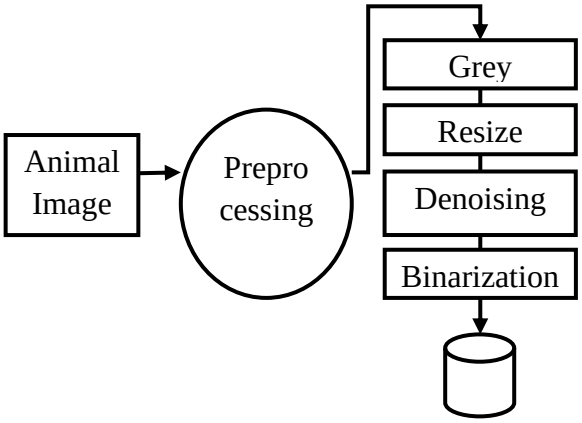


Fig.2 Animal Detection

Consequently, in this module, Region Proposal Network (RPN) constructs RoIs by swiping windows on the feature map through anchors with various scales and aspect ratios. Using a better RPN, a way for segmenting and detecting animals. RoI Align consistently maintains the precise spatial locations after RPN is used to construct the RoIs. For the purpose of the RPN's initial prediction of item positions, these are in charge of supplying a present set of bounding boxes in various sizes and ratios.

Animal Identification: After capturing the animal image from the Farm Camera, the image is given to animal detection module. This module detects the image regions which are likely to be human. After the animal detection using Region Proposal Network (RPN), animal image is given as input to the feature extraction module to find the key features that will be used for classification. The module composes a very short feature vector that is well enough to represent the animal image.

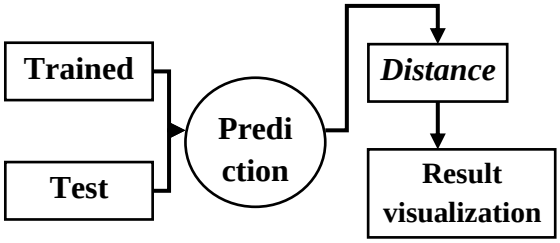


Fig:3 Animal Identification

Repellent: Since the production of ultrasounds has recently been demonstrated to be an alternative, successful approach for defending crops against anticipated animals, monitoring window that detects the presence of animals can then enable the repeller module to repel them through that method. Animals often have much greater sound sensitivity thresholds than do humans. They are able to hear noises with lower frequencies than the human ear can. For instance, whereas humans can hear between 64Hz and 23KHz, goats, sheep, domestic pigs, dogs, and cats can hear between 78Hz and 37KHz, 10Hz to 30KHz, 42Hz to 40.5KHz, 67Hz to 45KHz, and 45Hz to 64KHz, respectively.

Monitoring and Visualizing: The system works in real time detect the animals in the field, in addition the farmers can access the view of their fields remotely. Type of animal and also the count can be given. The animal recognition module will share the data over the cloud regularly through a Wi-Fi connection. A private cloud instance running on a computer will make up the cloud configuration. The shared data will be used to examine the behaviours and patterns of wild animals. If there are any errors, the farmer may see them, fix them, and get better results.

Notification: The email and SMS notification consisting of captured image is notified to the user regarding the detected motion in this phase. Both the email and the SMS are sent to the user's registered email address and registered mobile number respectively.

Performance Analysis: Using SENSITIVITY, SPECIFICITY, AND ACCURACY of the data, we are

able to determine the performance of our system in this module. The datasets data are separated into two classes: animal and type (the positive class) and animal and not animal (the negative class).

Based on the context of this project, the key points associated with the performance indicators are discussed:

True Positive (TP): The algorithms identify the name of the Animal, which is present.

False Positive (FP): The algorithms mistakenly identify something as an animal while there isn't one there.

False Negative (FN): There is an animal present, but the algorithms fail to identify it.

True Negative (TN): Nothing is being found and there is no animal.

- Accuracy

Accuracy is a statistic that shows how well a model or algorithm performs and whether it was properly trained. Accuracy in this thesis refers to how well it works to find humans in an underwater setting. For calculating accuracy, use the formula below.

Accuracy = T P + T N / T P + T N + F P + F N.

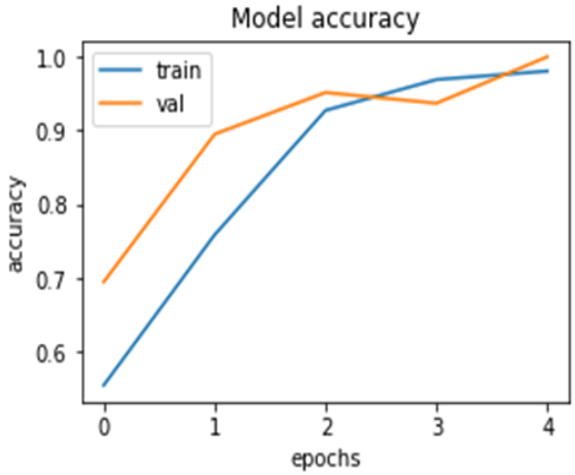


Fig.4 Accuracy

- Precision

It represents the proportion of cases that were projected to be positive but turned out to be so. In the context of this thesis, accuracy refers to the percentage of items that are present in farm environments that are both expected to be animals and are in fact animals. The formula below is used to determine precision.

Precision = T P/ (T P + F P)

- Recall

It is the ratio between actual positive cases that are predicted to be positive. In the context of this thesis, recall measures the fraction of animals that are predicted as animals. Recall is calculated using the following formula.

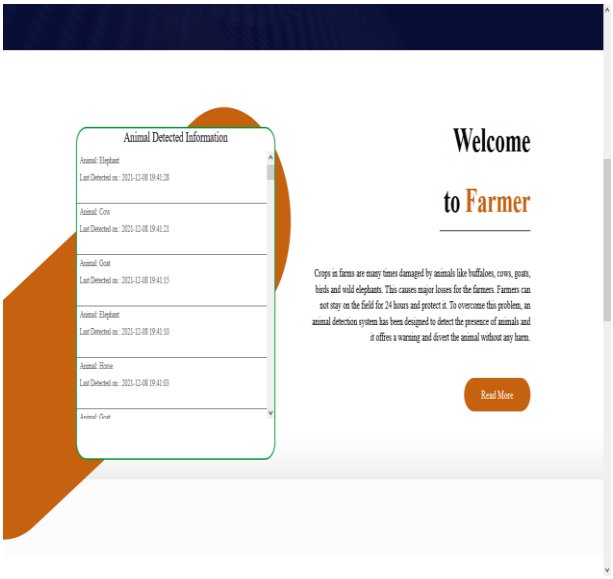
Recall =T P/ (T P + F N)

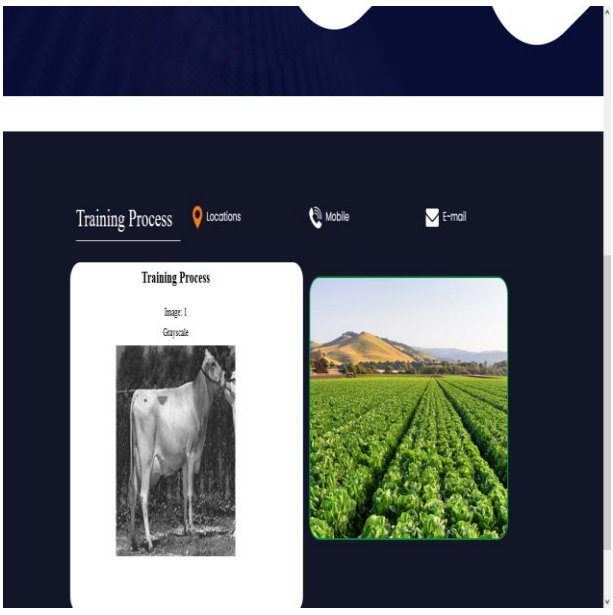
- F1 Score

Other names for it are balanced F-score and F-measure. If the F1 score is 1, a model or algorithm is deemed perfect. It is calculated using the formula below.

F1 = 2 × (Precision × Recall /Precision + Recall)

III.RESULTS





IV. CONCLUSION

Modern agriculture requires a lot of technology for farm security. A vision-based system is suggested as a means of doing this, and agricultural farm security technology is currently in high demand. This is done by developing an Animal Repellent System to blow the animals away and proposing a vision-based system that is constructed using Python and OpenCV. The creation of a sophisticated system for intelligent animal repulsion was necessary for the application's implementation. This system integrates recently created software components and allows for the real-time identification of the presence and species of animals, as well as the prevention of crop damage brought on by the animals. When an animal is detected, the edge computing device uses its DCNN Animal Recognition model to identify the target based on the animal's category. If an animal is found, it then sends a message to the animal repelling module with information about the type of ultrasound that should be produced in that case. A database of animals was built, which was used to assess the proposed CNN. Using various numbers of training photos and test images, the total performances were achieved. The collected actual findings of the completed experiments demonstrate that the suggested CNN provides the best recognition rate for a larger number of input training images (accuracy of roughly 98%). An AI-based real-time monitoring solution was presented in this research to deal with the issue of crop damage from animals. Farmers and agronomists may find this technology useful in the management and decision-making processes.

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