Hybrid Learning models for real time detection of wild boar in farms

ABSTRACT:

Wild boars (Sus scrofa cristatus) are known for causing a range of disasters and negative impacts, including agricultural damage, ecological disruption, property damage, human-wildlife conflicts, and environmental degradation. Their destructive behaviour, overpopulation, and invasive activities contribute to these disasters, result in significant challenges for agriculture, ecosystems, public health, and safety. In order to prevent the intrusion of Wild boar, lot of measures and innovation has been undergone. In this research, we detect and analyse wild boar presence in the farms by integrating Convolutional Neural Network, K-Means clustering and Optical Flow.

In this approach, CNN is used to detected the wild boars in farm lands using footages. Then, K-Means is applied to analyse the distributed patterns of detected wild boars. To track the movement of wild boars and to assess their interactions with different repellents we use Optical Flow method.

The CNN automatically detects the wild boar and K-Means targets the area where there are high wild boar densities. Optical Flow analyses the wild boar behaviour and response to repellents and it also track their movements. This research contributes to wild boar management practices and improves farming techniques.

INTRODUCTION:

Farm Agriculture:

Wild boar attacks have become major concern for the farmers. As these incidents occur across various agricultural farms, but there are certain farms which are prone to Wild boar’s attack. Wild boar assaults are more widespread in fields with crops like sugarcane, maize, wheat, and vegetables, particularly rooted plants, for a variety of reasons.

* These crops are an important food source for wild boars. Sugarcane, maize, wheat, and vegetables are high in carbs and other nutrients, making them appealing to foraging animals such as wild boar.
* Crops like sugarcane, maize, and wheat give plenty of cover and shelter for wild boar. These dense crops offer hiding areas and predator protection, allowing boars to browse safely. This sense of security may lead them to stay longer in specific areas, increasing the likelihood of encounters with humans.
* Vegetables and other rooted plants are particularly appealing to wild boars because they are easy to dig up from the ground. Boars have robust, powerful snouts designed for rooting and digging, allowing them to quickly access and consume these crops.
* Human activities such as agriculture can fragment habitats, causing wild animals like boars to seek food and shelter in cultivated areas. Wild boars are losing their native habitats.

Detection of wild boars:

The increasing frequency of wild boar invasions into agricultural regions necessitates innovative and effective measures to reduce agricultural losses. **Due to the limits of traditional deterrent strategies, a highly sophisticated and data-driven strategy is required. Within this framework, the integration of Convolutional Neural Networks (CNNs) for automated wild boar detection is the main emphasis of this research. Furthermore, in order to assess the effectiveness of different repellents in preventing wild boar activity, we investigate the effects of placing them in various locations. We want to track the movements of observed animals using optical flow analysis, offering insights into their speed, entry and exit timings and reactions to repellent measures.**

The main goal of this project is to improve the management of conflicts between humans and wildlife by creating a reliable system for the detection and tracking of wild boars on farmlands. Particular objectives consist of:

1. Using Convolutional Neural Networks (CNNs) to identify wild boars in agricultural surveillance film in real-time.
2. Applying various repellents in various settings to evaluate how they affect the behavior and activities of wild boar.
3. Tracking the movement patterns of identified wild boars using optical flow analysis to obtain vital information on their speed, times of entry and departure and responses to repellent interventions.
4. Assessing the integrated system’s overall efficacy in offering a thorough remedy for managing wild boar in agricultural settings.
5. Producing insights that can guide the creation of long-lasting plans to lessen the risks that wild boar poses to agricultural areas.

LITERATURE SURVEY:

Wild boars can cause a range of disasters and negative impacts, particularly in areas where their populations are more and in close to human settlements. Wild boars are notorious which can lead to significant damage to agricultural crops such as maize, rice, wheat, and vegetables. This damage can result in substantial economic losses for farmers and agricultural communities. To prevent the entry of wild boar certain traditional measures have been taken.

Preventive methods used for managing wild boar populations:

Visual and auditory repellents: Some repellents use visual or aural cues to deter wild boars. Flashing lights, loud noises, or motion-activated gadgets can deter boars from accessing a certain location. However, habituation might develop over time, lowering the efficacy of these repellents.

Chemical repellents: It is typically based on chemicals having strong scents or tastes that are undesirable to animals. Common constituents include capsaicin (the primary element in chilli peppers), garlic, and predator urine. These repellents can be used on specific locations or crops. However, effectiveness can vary, and reapplication may be required after rain or over time.

Electric fences: There are efficient at deterring wild boars. When boars come into contact with the electric fence, they are shocked, causing them to avoid the area. Electric fencing is frequently regarded as a more dependable and long-term solution. Physical repellents include fences and nets.

Natural barriers: Planting dense vegetation or thorny shrubs helps deter wild boars from entering specific regions. Boars may find it difficult to cross such obstructions, making this natural deterrent more sustainable.

Hunting: Controlled hunting programmes aimed at lowering wild boar populations and minimising agricultural harm.

Trapping and Removal: Capturing wild boars with traps and then removing or relocating them to regulate population numbers and reduce human-wildlife conflicts.

Environmental Modification: This involves changing environmental characteristics to make locations less appealing to wild boars, such as plant management and habitat restoration.

Rodenticides: Investigating the use of rodenticides to manage wild boar numbers indirectly by secondary poisoning, while taking into account the dangers to nontarget species.

Integrated Pest Management: A comprehensive technique that combines several preventive methods, such as habitat alteration and targeted eradication strategies.

Biological control: This involves using natural predators of wild boars, such as wolves, to regulate population numbers through predation pressure.

Genetic Management: Investigating genetic tools, such as gene drive technology, for population management, despite environmental concerns about their use.   
Regulatory Measures: Enforcing restrictions on feeding bans, waste management, and land-use planning to reduce attractants and human-wildlife conflict.

Deep Learning:

Deep Learning techniques like CNN have been used in classifying the detected animals to particular class. Computer Vision is used to extract features from the images then Supervised Machine Learning models are used to classify the animals based on the trained dataset. Then CNN is used to analyse the animal detected and used to drive away the animals automatically. In this approach the model is trained with dataset and the captured image will be the test set. If the boar is detected then audio is played as output.

Later on, F. Schindler and V. Steinhage focused researches on environmental issues such as disease transmission, invasive species, and climate and land-use change. Camera traps outfitted with infrared cameras and flashlights were used to monitor deer, boars, foxes, and hares, mostly at night. Traditional techniques included the use of video traps, which provide non-invasive continuous monitoring, efficient operation over long periods of time, and permanent documentation of animal presence and behaviour. However, limitations include the reliance on grayscale video clips, which are predominantly captured at dusk and nighttime, the difficulty of tracking locomotion behaviour due to the lack of observable facial features, and the need for cutting-edge instance segmentation and action recognition techniques to accurately detect and classify individual animals and their actions in video clips.

A. Vecvanags *et al.* in his study, discussed the importance of effectively monitoring wild ungulate populations in order to manage their movements and limit their effects on ecosystems and human society. The paper introduces a novel dataset of wild ungulates gathered in Latvia and uses two detection methods, RetinaNet and Faster R-CNN, for animal localization and classification, as well as training parameter optimisation and data augmentation methodology assessment. The results reveal that both techniques achieve average precision more than 25% for wild boar and deer detection, with RetinaNet having consistent precision dynamics and Faster R-CNN initially showing higher precision but experiencing fluctuations. However, difficulties in managing outlier circumstances such as obscured animals and reflections in water persist, showing limitations in real-world use.

Another study by A. Alameer *et al.,* presents a two-stage system for automated identification and quantification of head-to-tail contact behaviour in pigs, which has predictive value for tail biting epidemics and can be expanded to quantify contacts between additional body parts. The proposed method employs low-cost 2D cameras and does not rely on pig marking or invasive sensors. It was trained on a dataset compiled from two experimental sites, which included 51,193 occurrences of pig parts annotations (26,533 AFBI + 24,660 AUF) across 2781 photos. To recognise and associate pig parts in harsh agricultural environments, the system employs a custom deep learning architecture based on the YOLO detector with extra detection heads to provide a reasonable trade-off between feature depth and spatial resolution. A lightweight processing module uses the IoU measure to quickly score wild boar intersections. The system was evaluated for tail-biting epidemics on the AUF dataset, and the interaction changed significantly on the day of the indicated outbreak. Despite the hopeful outcomes, this study is not without limits. First, the algorithm performed somewhat poorer at detecting pig heads than pi rears, and the rate of wrong categorization increased with higher contact rates. Second, the method was demonstrated to be robust in a variety of farm situations, however it may have a lower influence on false negative detections produce. Third, the dataset employed to study tail-biting outbreaks was insufficient, and additional testing is needed to draw conclusive findings.

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MACHINE LEARNING:

Tydén, A., and Olsson, S [2] proposed that machine learning was utilized to detect animals bypassing cameras, integrating object detection.Four models were examined, and SSD MobileNet V2 emerged as the best balance between speed of inference and accuracy. The system is suggested to provide tracking, identification and classification of animals with potential application in real life.Moreover, diverse data sets were used during the study for training these models coming from different environments and animal species. The training sets were meticulously selected to encompass many pictures and videos showing different situations where these animals are found thus enhancing the models’ reliability and precision. As a result, this all-encompassing approach towards data gathering as well as development of the training set influenced on whether or not it did work out successfully according to what they believe in. Nevertheless, overcoming "open-set recognition problem" is difficult when trying to identify objects while simultaneously working with very many other categories. In addition, further research is needed to embed support for open set recognition into the object detection models since it influences data collection procedure and evaluation experiments.

Kommineni, M., Lavanya, et al. (2019) provides an approach for animal detection and alarm system based on farming which could help reduce the damage inflicted by wildlife to humans and the environment. Machine learning techniques combined with computer vision can be used to identify and scare animals away from the farm. The device then emits sounds as well as signals in order to distract them thereby giving field owners and other officials ample time to take necessary precautions before any harm is done. This methodology protects crops from farm animals thus saving farmers’ investment on crops. To achieve their desired outcomes, they relied on a combination of pre-trained models and customized trained models; however, it has been identified that there are false alarms generated by the system especially in large or remote farming areas leading to vulnerability of certain crop varieties to wildlife attacks. By incorporating extra sensors such as thermal or infrared cameras can improve its performance at all levels.

S.Thylashri, Rajalakshmi N R, et al., proposed solution combines IoT devices with machine learning algorithms to protect crops from wild animals. Arduino UNO is one of the microcontrollers used in the system besides PIR sensors, sensors and ultra-sonic repellants. Logistic Regression, K-Nearest Neighbors, Support Vector Machine (SVM) are some of the machine learning algorithms used for animal classification based on PTZ camera images. This system also utilizes Python programming language to detect wild animals and help farmers secure their farms against unwanted activities that could lead to a loss of money and time. The CCTV model uses Closed Circuit Television footage as input where images are analyzed and anticipated hence making it emit sound of a repellent chasing away detected animals. However, this approach has its own drawbacks like limited coverage area; over reliance on CCTV footage; possible false alarms because computer vision algorithms do not accurately distinguish between wild animals and other objects or movements. These shortcomings could warrant unnecessary scare tactics or even disruption of wildlife habitats entirely.

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