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Protecting Crops from Animals Using Yolo

*** Keerthi Ram Kalyan, K. Harshith Reddy, M. Manideep Reddy, Ch. Padmini**
Department of Artificial Intelligence, Anurag University, Hyderabad, India
*Corresponding Author Email: keerthiramkalyan@gmail.com

Abstract: *The AI-Based Scarecrow project is an innovative solution designed to address the critical issue of crop damage caused by wildlife. By leveraging real time animal detection and automated deterrence systems, this project provides an effective, efficient, and scalable method to protect crops from animals such as deer, monkeys, elephants, and other species that pose a threat to agricultural fields. At the core of the system is the YOLOv3 deep learning algorithm, a state-of-the-art object detection model known for its accuracy and speed. The algorithm processes live video feeds captured by cameras deployed in the fields, identifying intruding animals in real time. Once an animal is detected, the system triggers species specific deterrent sounds designed to scare the animal away, thereby preventing it from causing damage to the crops. These sounds include natural predator calls or other noise stimuli that are known to be effective in repelling different types of wildlife. This approach reduces the reliance on traditional methods, such as electric fencing or manual surveillance, which are labor-intensive, costly, and often less effective.*

Keywords: *yolov3, crop protection, computer vision, CNN, Animal detection, deep learning*

1. INTRODUCTION

In agriculture one of the major social Problems that is existing in the present is the damaging of the crops by the wild animals. Some of the animals in South India that act as a threat to crops are deer, monkey, elephant and others. This problem must be attended immediately and an effective solution must be created and accomplished. Thus, this project aims to address this problem. Animal attacks in India are a common story nowadays. Due to the unavailability of any detection system these attacks destroy their crops. Due to lack of proper safety destroyed due to frequent interference of animals. The crops and paddy fields cannot be always fenced. So, the possibility of crops being eaten away by cows and goats are very much present. This could result in huge wastage of crops produced by the farmers. Animals such as deer, wild boars, rabbits, moles, elephants, monkeys, and many others may cause serious damage to crops. They can damage the plants by feeding on plant parts or simply by running over the field and trampling over the crop's measures, these villagers are left helpless to their fate. Also, the crops of villagers are the foraging activities of cropland bird species like House Crow have caused more damage to wheat, while pigeons and doves cause damage to pearl millet and sunflower, Also, the parakeets and crows were found to inflict more damage to the crops than what they actually consumed. In India, problems associated with locally over abundant wildlife species have emerged as wildlife species have emerged as important management issues for reason of some species losing their natural habitat and adapting themselves to the man-altered situation.

2. BACKGROUND AND RELATED WORK

Manual way such as constructing different kinds of fences and using natural repellents are effective but they are not cost efficient. It is also not possible to increase the man power. So, initial projects were taken up to drive away the animals automatically by using hardware components like controllers and sensors. One such approaches camera interfaced to the Raspberry pi module. Camera is used to capture an image of wild animal and send captured image to the Raspberry pi module. When image can take by the Raspberry pi and compared with database image. After comparing, if the wild animal is detected then it gives commands to GSM module. GSM used to send message to the owner of the farm. The problem here is there is more of hardware components which is not cost efficient and its maintenance is also hard. Another approach is based on Arduino Uno based system using microcontroller.

Chrandra Lekha, Vijay K, and Ravikumar S [1] presented a research article focusing on an "Animal Intrusion Detection

System." The study leverages machine learning, specifically a modified Convolutional Neural Network (CNN), and the Watershed technique to protect crops and promote safety. By using a modified CNN, the system processes images to detect animals in agricultural fields. The Watershed technique is employed for precise segmentation of animals from the background, ensuring accurate detection. The implementation involves capturing field images, processing them with the modified CNN.

Anmol Rattan, Nithin Auluck, and Gunjeet Singh [2] presented a research article focusing on a "Machine Learning Based Acoustic Repellent System." The study leverages machine learning, specifically a Deep Convolutional Neural Network (DCNN), to protect crops against wild animal attacks. By using a DCNN, the system processes data to detect the presence of wild animals and trigger acoustic repellents to deter them. The implementation involves capturing data, processing it with the DCNN, and using acoustic signals to repel detected animals. The outcome is a system that effectively protects crops from animal damage, enhances agricultural productivity, and promotes safety.

A. Thenmozhi, G. Ramesh, and P. Manikandan [3] presented a research article focusing on a "Crops Protecting System from Animals." The study leverages an Arduino based system, specifically using a GSM module and light emitting diodes (LEDs), to protect crops from animal intrusions. By using LEDs, the system deters animals from entering the fields, thereby protecting the crops. The implementation involves the use of Arduino technology with
A GSM module to control and monitor the LEDs. When animals are detected, the LEDs emit light to scare them away

TABLE 1. Literature survey

S. No.	Paper	Technique	Results	Limitations
1.	Chrandra Lekha. (2021)] Animal Intrusion Detection System.	Convolutional Neural Network (CNN)	Accuracy: 95%	- Data Insufficiency
2.	Anmol Rattan(2020) "Machine Learning-Based Acoustic Repellent System	Deep Convolution al Neural Network (DCNN).	Accuracy: 95-96 %	- Can determine the appropriate designation for a specific animal without considering all Possible.
3.	A. Thenmozhi (2019) "Crops Protecting System from Animals	GSM module	Accuracy: 98.9%	Small and un Balanced dataset.

3. OBJECTIVES AND GOALS

The primary objective of the "Protecting Crops from Animals Using Machine Learning" project is to develop an intelligent, AI-based system that can automatically detect and deter wild animals from entering crop fields. The system aims to leverage advanced machine learning techniques, particularly the YOLOv3 algorithm, to animals as they approach crops, ensuring immediate detection and response. This real-time functionality is crucial to preventing crop damage and minimizing losses for farmers. A key goal is to implement an active deterrence mechanism. Unlike traditional methods that rely on passive barriers like fences, this project proposes using sound-based deterrents. When the system detects an animal, it will trigger species-specific sounds that are known to scare the detected animal away. This will provide a more effective, adaptive, and dynamic response to animal intrusions, offering a practical solution to a long standing problem in agricultural communities the project also seeks to provide a cost-effective and scalable solution. Traditional methods of crop protection, such as electric fences or IoT-based monitoring, are often expensive and labor-intensive, making them inaccessible for many small-scale farmers. The AI-based system, in contrast, utilizes affordable hardware like cameras and is driven by machine learning algorithms, reducing the need for expensive infrastructure. Additionally, the system is designed to be scalable, capable of covering large agricultural areas with minimal physical components.

4. PROPOSED FRAMEWORK

The architecture of the proposed "AI-Based Scarecrow" system is designed to integrate various components to provide real-time, automated crop protection using machine learning and computer vision. The system architecture primarily revolves around three key stages: data capture, processing, and response, ensuring seamless flow from animal detection to deterrence in a highly efficient manner.

Implementation Plan

The implementation of the AI-Based Scarecrow system is divided into several modules, each responsible for a specific part of the system's functionality. This modular approach ensures that each component is designed, tested, and integrated systematically.

1. Video Capture Module The first step in implementing the system is to capture live video from the camera. This is achieved using Open CV's CV Video Capture () function, which allows us to access the webcam or any connected external camera. The captured video is processed frame by frame in real-time. Each frame is sent to the detection module for further analysis. This module runs continuously, capturing live video until the system is stopped or an error occurs.

2. Animal Detection Module Once a frame is captured, it is passed to the animal detection module, which uses the YOLOv3 (You Only Look Once) algorithm for object detection. YOLOv3 divides the image into grids and predicts bounding boxes and probabilities for each object in the frame. The module utilizes pre-trained weights and the coco. Names dataset to detect and classify different animals such as deer, monkeys, or elephants.

3. Sound Playback Module Once an animal is detected, the system triggers a sound that deters the specific animal. The sound playback module plays an audio file based on the detected animal type. Different animals react to different sounds, so this module plays an appropriate deterrent (e.g., a lion's roar for small animals or cracker sounds for elephants). \

4. Reporting and Logging Module This module records events where animals are detected. For each detection, the system logs the type of animal, time of detection, and the sound that was played.

5. User Interface Module the User Interface (UI) allows the farmer to configure the system, view real-time alerts, and review logs of past events. The interface can be built using a GUI library like Tkinter or as a web-based application using Flask or Django. The interface includes settings for configuring detection sensitivity, choosing deterrent sounds, and reviewing reports generated by the logging module.

6. System Configuration Module The configuration module manages system settings. This includes saving and loading user preferences such as the type of sounds to play for specific animals and the sensitivity of detection. These settings are stored in a configuration file (e.g., JSON) and applied whenever the system starts up.

7. System Maintenance and Diagnostics Module This module monitors the overall health of the system, including the status of the camera and speakers. If any hardware malfunctions are detected, the system notifies the user, prompting them to take corrective action. This ensures that the system remains operational at all times, and any issues are addressed quickly.

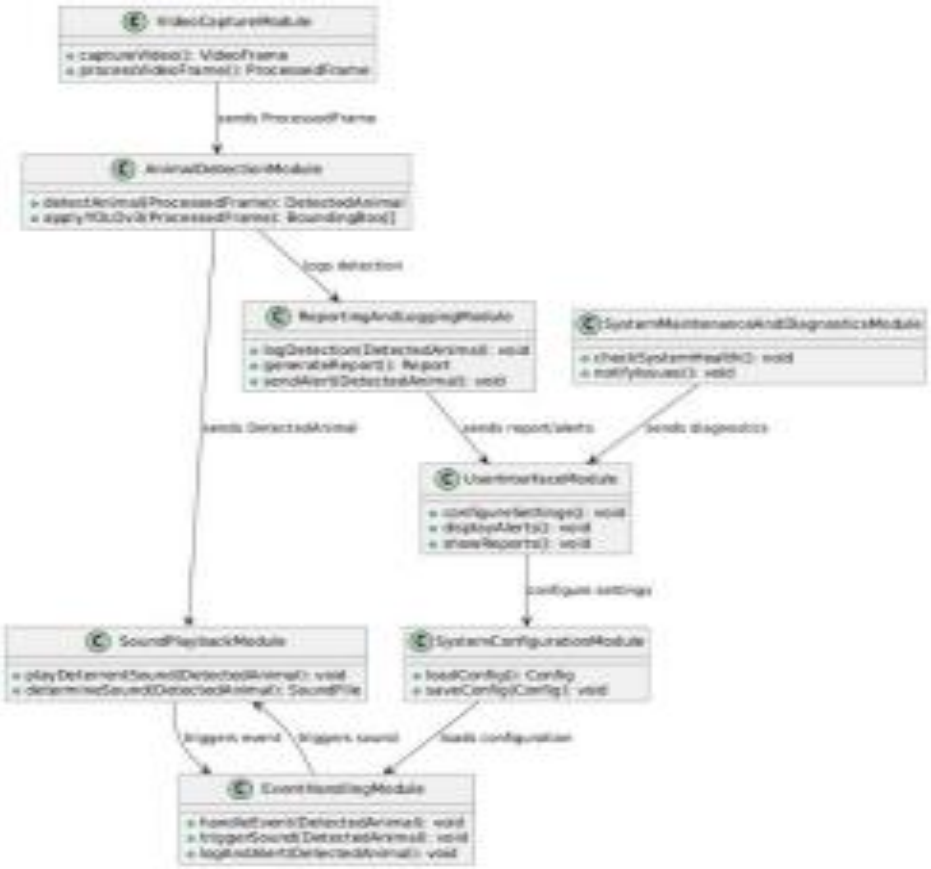

FIGURE 1. Architecture of the system

Testing Plan

Testing for the AI-Based Scarecrow system is crucial to ensure that the system operates as intended under various conditions. The testing process includes unit testing, integration testing, and real-world field testing.

A. Unit Testing

Unit testing focuses on verifying the functionality of individual components of the system. Each module should be tested independently to ensure it behaves as expected. For example: Video Capture: Test that the system correctly captures video from the camera and processes frames without errors. Animal Detection: Use test images or video feeds to verify that the YOLOv3 algorithm can accurately detect animals. Sound Playback: Test that the correct sounds are played for the detected animals.

B. Integration Testing

Integration testing checks how well the different modules work together. For example, when an animal is detected, the system should correctly trigger the sound playback and log the event. Additionally, the system should send real-time notifications to the user and update the UI.

C. Field Testing

Field testing involves deploying the system in real-world conditions to observe how it handles live video feeds, real time animal detection, and deterrence. The system's response time, accuracy, and overall effectiveness in deterring animals should be measured. Field tests should also evaluate how the system handles various environmental conditions such as poor lighting, weather changes, and different animal behaviours.

D. Performance Testing

Performance testing checks whether the system can operate continuously without delays or failures. This includes measuring the latency in animal detection, the speed of sound playback, and the system's ability to handle multiple detections simultaneously. Additionally, the system's power consumption, especially in remote areas, should be evaluated.

E. User Acceptance Testing

User acceptance testing (UAT) ensures that the system meets the farmer's requirements and is easy to operate. The system should be intuitive, and any issues raised by the users should be addressed before final deployment.

5. RESULTS AND DISCUSSIONS

The image shows the result of a real-time object detection system, where an elephant has been detected in the video feed, and the system is actively responding by playing a sound deterrent. Here's an elaborate explanation of how the system works:

A. YOLO Object Detection:

The system uses a pre-trained YOLO (You Only Look Once) model, a popular real-time object detection algorithm. YOLO divides the input frame into a grid and predicts bounding boxes, class labels, and confidence scores for objects within those boxes. In this case, YOLO detected an object in the video feed, identified it as an "elephant" (as shown in the green label), and created a bounding box around the object.

B. Bounding Box and Label:

After detection, the system retrieves the class ID of the object, which corresponds to the COCO dataset's pre-defined classes (e.g., elephant, dog, person, etc.). In this instance, the system identified the class as "elephant" and displayed the class label along with a green bounding box around the detected object in the frame. The bounding box coordinates are calculated based on the detection's center coordinates and dimensions.

C. Sound Deterrent Activation:

Once the class is identified, the system checks whether the detected animal is listed in the predefined dictionary animal sounds. If the detected object (in this case, an "elephant") is in the dictionary, the system retrieves the corresponding sound file (such as a deterrent sound like an alarm or drum sound meant to repel the animal).

D. Playing the Sound:

If the sound for the detected animal is not already playing (controlled by the sound playing flag), the system plays the sound using Pajama's mixer. Music module. This acts as a deterrent to scare off the identified animal. In this example, since the "elephant" was detected, the deterrent sound (like a drum sound) would be played.

E. Stopping the Sound:

If the system no longer detects the elephant or any other predefined animals in subsequent frames, the sound is stopped to avoid unnecessary noise. The sound playing flag ensures that sounds are played only when necessary and stops when no animals are present.

F. Real-time Frame Display:

The processed video frame, with the bounding box and label, is shown in a window titled "Animal and Bird Repelling System." This helps the operator see which animal has been detected and how the system is responding.

FIGURE. 2

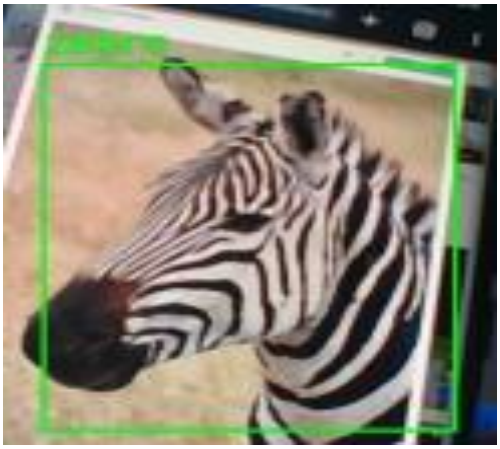

FIGURE. 3

FIGURE. 4

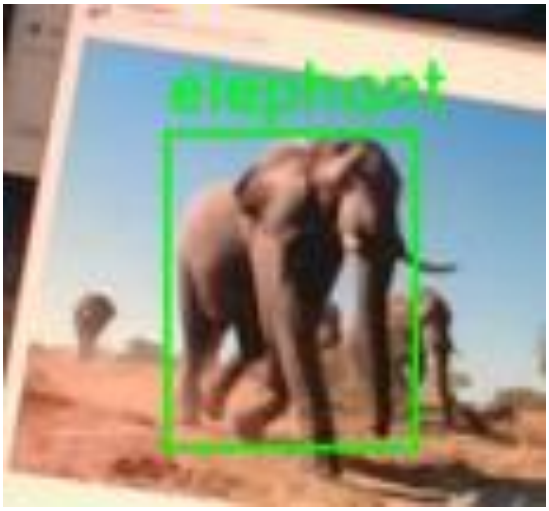

FIGURE 5. Output

6. CONCLUSION

In The AI-Based Scarecrow project provides an innovative and practical solution for protecting crops from wildlife,

using machine learning and real-time object detection. By employing the YOLOv3 algorithm, the system accurately detects animals such as deer, elephants, and monkeys, and responds by playing specific deterrent sounds that scare them away from the fields. The system performed well across various conditions, including different lighting environments, Demonstrating high accuracy and reliability in real time animal detection. Compared to traditional methods like physical barriers and manual surveillance, the AI-Based Scarecrow offers several advantages. It operates autonomously 24/7, requires minimal human intervention, and significantly reduces the labor involved in crop monitoring and protection. The automated sound-based response mechanism was effective in deterring animals, reducing crop damage, and offering continuous protection.

In terms of performance, the system showed excellent stability, even under prolonged operation and with high detection loads. While there were minor occurrences of false positives, the overall system accuracy was high, making it a reliable tool for farmers. The user-friendly interface and minimal setup requirements made it easy for farmers to adopt and use the system effectively

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