Industrial Engineering Journal
ISSN: 0970-2555
Volume : 53, Issue 8, No.4, August : 2024

SMART FARMLAND SECURITY SYSTEM USING DEEP LEARNING

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ABSTRACT
Agriculture, the backbone of many economies, faces significant challenges, one of the most pressing being animal damage to crops. In regions like India, where cultivated land encroaches upon previous wildlife habitats, crop raiding has emerged as a major source of conflict between humans and wildlife. Farmers endure considerable risks from pests, natural disasters, and animal intrusion, all of which contribute to diminished yields and economic losses. Traditional farming methods often prove inadequate, and the feasibility of employing guards to protect crops against wildlife is limited. In response to these challenges, a novel solution is proposed, leveraging deep learning concepts, particularly convolutional neural networks (CNNs), to address the issue of animal damage in agriculture. This innovative approach combines the power of computer vision with real- time monitoring, aiming to identify and mitigate wildlife intrusion while prioritizing the safety of both animals and humans. Furthermore, upon detecting a wild animal, the system triggers an alert message to the landowner while simultaneously emitting alarm sounds to deter the animals, thus providing a comprehensive solution to the problem of animal damage in agriculture.
Keywords: CNN, Computer Vision, Deep Learning.

I. Introduction
Agriculture stands as the cornerstone of India's economy, yet it faces multifaceted challenges exacerbated by the encroachment of human settlements into wildlife habitats due to population pressures. Deforestation, driven by the burgeoning populace's demand for resources, has displaced wildlife, forcing animals into residential areas. This escalating human-wildlife conflict poses grave risks to lives, properties, and exacerbates tensions between communities and wildlife. Elephants and other creatures, seeking sustenance, inadvertently cause extensive damage to crops, food stores, and dwellings, leading to economic losses and occasional human casualties. Moreover, Indian farmers grapple with threats from natural disasters, pests, and animal incursions, resulting in diminished agricultural yields. Traditional methods, though deeply ingrained, are proving inadequate in mitigating these challenges, and hiring guards is financially burdensome and logistically impractical. Thus, there arises an urgent need for continuous monitoring systems to avert animal incursions and other unwelcome intrusions, making animal detection technology indispensable in agricultural landscapes. The agricultural sector has witnessed a technological renaissance in recent years, with the integration of advanced technologies like precision farming and enhanced efficiency. However, amidst this transformation, the security of farmlands emerges as a critical concern. Conventional security measures falter in the face of evolving threats such as theft, vandalism, and unauthorized access. To fortify sustainable agricultural practices, the adoption of Smart Farmland Security Systems has emerged as a viable solution. Leveraging cutting-edge technologies such as the Internet of Things (IoT), artificial intelligence, and sensor networks, these systems offer a comprehensive security infrastructure tailored to agricultural landscapes. Beyond safeguarding crops and assets, Smart Farmland Security Systems optimize resource allocation, monitor environmental conditions, and bolster farming resilience.
This paper endeavors to delve into the fundamental components, functionalities, and advantages of Smart Farmland Security Systems. By exploring the integration of advanced technologies, we aim to elucidate how these systems augment the security posture of agricultural environments while fostering

sustainability. Additionally, we will examine case studies, challenges, and future prospects associated with the implementation of such systems, shedding light on their potential for widespread adoption. As agriculture embraces technology, the role of Smart Farmland Security Systems becomes increasingly pivotal in ensuring the prosperity of farmers and the global food supply chain.

II. Literature

Table.1. Comparison of Smart Farmland Security System

Title of paper	Description	Advantages	Disadvantages
1)Smart Farmland For Crop Prevention And Animal Intrusion Detection	The proposed Smart Farmland system offers a low-cost solution for preventing crop damage from animal intrusion. The use of artificial intelligence, neural networks, and modern technologies aims to provide an efficient and user-friendly approach to protect farmlands and improve agriculture outcomes	The integration of Internet of Things (IoT) technology enhances the system's capabilities and gives alerts to the farmers for improving communication and enabling quick decision-making.	Using frame differencing algorithm for motion detection, it detects the motion due to the movement in air.
2)Smart Intrusion Detection System for Crop Protection by using Arduino	the proposed work has used a motion sensor and IR sensor, which efficiently detects any movement of intruders. This idea of protecting crops is easy to implement and can be implemented without causing harm to any animals or humans.	-TFT display and buzzer provides both visual and audio warnings. -The components used in the system are cost-effective	Installation of more sensors cause the project expensive**.**
3)IoT Based Automated Crop Protection System	The system uses a combination of PIR sensors, cameras, TensorFlow image processing, Raspberry Pi, ultrasound speakers, and a frequency generator. The goal is to detect animals, identify them using image processing, and emit ultrasound frequencies to scare them away from the crops.	TensorFlow image processing helps in accurately identifying and classifying animals, enhancing the precision of the system.	While ultrasound frequencies are claimed to be irritating for animals, the potential impact on the environment and non-target species is not discussed.
4)IoT Solutions for Crop	The primary focus is on preventing potential damages caused by both	The device is using a solar panel along with LiPo batteries, which	The use of PIR sensors for animal detection may have limitations in distinguishing

Protection against Wild Animal Attacks	wild animal intrusions and adverse weather conditions. The authors introduce a repelling and monitoring system that employs IoT devices to enhance agricultural practices. The system includes ultrasound Repeller devices, weather monitoring stations, and a back-end system for data processing and analysis.	makes it an autonomous energy device able to work even in periods of partial or total darkness.	between different animal species.
5)Smart Irrigation And Crop Protection From Wild Animal	The proposed system integrates a smart irrigation system with animal detection capabilities. It uses sensors, including soil moisture sensors, DHT11 (temperature/humidity sensor), PIR sensors (motion detection), and IR sensors, along with Arduino microcontrollers.	The system integrates various sensors, such as soil moisture sensors, DHT11 for temperature and humidity, PIR sensors for motion detection, and IR sensors for animal detection.	The DHT11 sensor module typically includes a non-replaceable sensor element. If the sensor element becomes damaged or malfunctions, the entire module may need to be replaced
6)Design And Implementation of An Advanced Security System For Farm Protection from Wild Animals	This approach for security system not only aims to prevent intrusion by wild animals but also strives to lessen false alarms, providing farmers with a efficient means of safeguarding crops. Use of image recognition enhances the system's ability to discern between harmless and harmful animals, reducing likelihood of unnecessary interventions.	Users can customize and expand the capabilities of Raspberry Pi by connecting various peripherals, sensors, and modules.	GSM modules is that they offer relatively slower data transfer speeds compared to some other wireless communication technologies.
7)Detection of animal intrusion using CNN and image processing	The authors leverage deep learning, specifically CNNs, to continuously monitor farms through cameras recording the surroundings. The CNN	ROI (Region of Interest) pooling is considered for multiple object detection in a single image, improving the precision of the system.	The multistage CNN architecture, while beneficial for feature extraction, may result in a complex model

	algorithm, along with LBP and XGBoost, is employed to identify and classify animals entering the farm. The primary goal is to provide farmers with real-time alerts when such intrusions occur, allowing for timely responses.		
8)A Smart Farmland Using Raspberry Pi Crop Prevention And Animal Intrusion Detection System	The entire process done by using Raspberry pi and it consist of three stages for animal repellent. In this method the alert message not only sent to the forest officer it also send the message to the living people in the farmland by using GSM.The RFID tag is injected in the animal skin by the RFID injector which is the recent technology.	It utilizes RFID technology to detect the presence of animals through RFID injectors and GSM technology to send alerts to forest officers and farmers.	The system heavily relies on electronic components such as Raspberry Pi, RFID, GSM, and fog machine. Any technical failure, power outage, or malfunction in these components may affect the system's performance
9)Real-Time Monitoring of Agricultural Land with Crop Prediction and Animal Intrusion Prevention using Internet of Things and Machine Learning at Edge	The system addresses challenges in monitoring distant lands and irregular soil conditions. It emphasizes the importance of reducing farmers' time commitment and resources, aiming to assist farmers in making informed decisions about crop cultivation. The key components and functionalities of the proposed system include automated irrigation, crop prediction, and prevention of wild animal intrusion.	The integration of IoT technology enables real-time monitoring of agricultural land.	the use of CNN for wild animal detection is innovative, the accuracy of animal recognition may not be perfect
10)*Smart Crop Protection System Against Wild Animals	The system aims to address the issue of crop damage caused by wild animals by employing a combination of sensors, microcontrollers, and IoT	the system captures images of intruding animals using an LDR, providing visual evidence to farmers. The images are	microcontrollers and IoT devices typically operate on limited power resources. Continuous monitoring and data transmission can drain the battery quickly, leading

Using IOT	technology. The proposed system detects the presence of animals, captures images, and sends alerts to farmers via SMS, providing a comprehensive approach to crop protection.	uploaded to a server for analysis.	to frequent replacements

III. Methodology

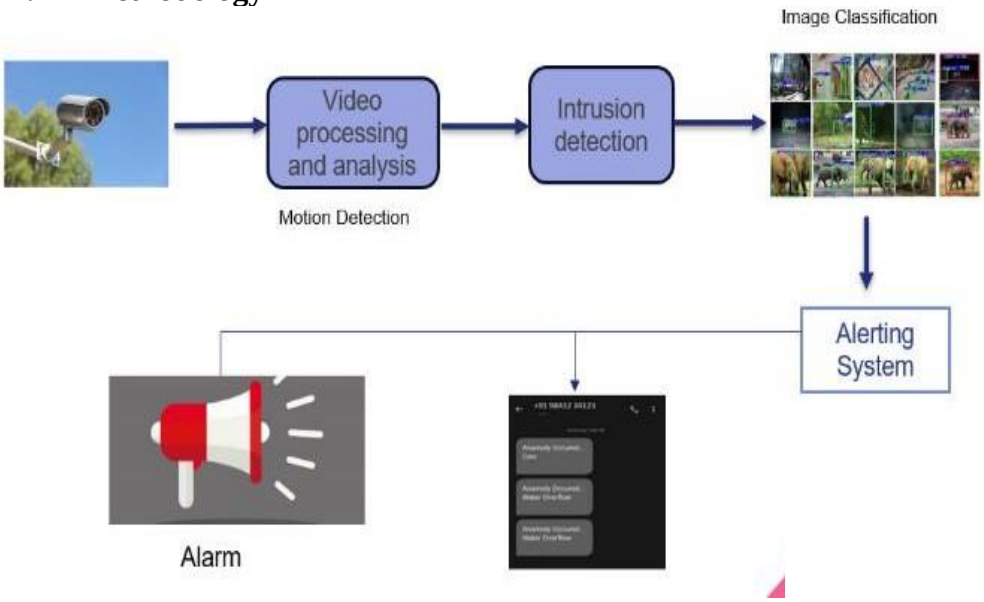


Fig 1: System Architecture

3.1 Modules

The system is divided into four main modules: Training Images, Data Augmentation, CNN Classification, and Prediction and Alert

3.1.1 Training Image

The Training Images Module is the foundational step in the animal intrusion detection system, responsible for gathering and preparing the initial dataset. Field cameras, strategically placed in farming areas, capture real-time images of potential animal intrusions. These cameras either operate continuously or are triggered by motion sensors to ensure comprehensive coverage. The images collected are uploaded to a central server and stored in a structured database, categorized by date and time. This organization facilitates easy access and management of the dataset. Once collected, the images undergo annotation using tools like Roboflow. During annotation, bounding boxes are drawn around animals, and each animal is labeled according to its species. This labeled dataset is crucial for training the machine learning model, as it provides the necessary ground truth for learning. High-quality and accurate annotations directly impact the model's performance, making this step vital for the system's overall effectiveness.

3.1.2 Data Augmentation

The Data Augmentation Module is designed to enhance the quality and diversity of the dataset, ensuring that the model can generalize well to new, unseen images. Initially, the dataset undergoes a cleaning process to filter out noisy, irrelevant, or low-quality images. This step ensures that only high-quality data is used for training, thereby improving the model's performance and robustness. To further improve the dataset, various augmentation techniques are applied. These techniques include rotation, scaling, horizontal and vertical flipping, and adjustments in brightness, contrast, and

saturation. By creating multiple variations of each image, data augmentation simulates different conditions under which animals might be captured. This increased variability helps the model learn to recognize animals in diverse scenarios, ultimately enhancing its accuracy and robustness in real-world applications.

3.1.3 CNN Classification

The CNN Classification Module forms the cornerstone of our detection system, employing Convolutional Neural Networks (CNNs), specifically utilizing the YOLOv5 model. Tailored for pixel data manipulation, this module excels in image recognition and processing, leveraging a series of layers to extricate critical features from the grid-like data structure.

At its essence, the CNN algorithm is engineered to discern image features while preserving data integrity. Rooted in neuroscience principles, CNNs comprise artificial neurons tasked with parsing visual data. When applied to image processing, the algorithm interprets pixel values, pinpointing significant visual attributes. Initially, it identifies image edges before proceeding to isolate corners and colour clusters. Through iterative pooling processes, the image size diminishes, yet essential features for activation functions remain intact. Ultimately, this iterative journey culminates in image prediction, with Region of Interest (RoI) pooling facilitating the extraction of pertinent features crucial for subsequent processing stages.

The CNN Classification Module operates by first applying convolutional layers to the input image, which extract features such as edges and textures. These features are then passed through activation functions to introduce non-linearity. The resulting features are flattened and passed through fully connected layers, which perform high-level reasoning. Finally, the output layer provides classification predictions, assigning probabilities to different classes. Through training on labelled datasets, the CNN learns to accurately classify new images based on the features it has learned.

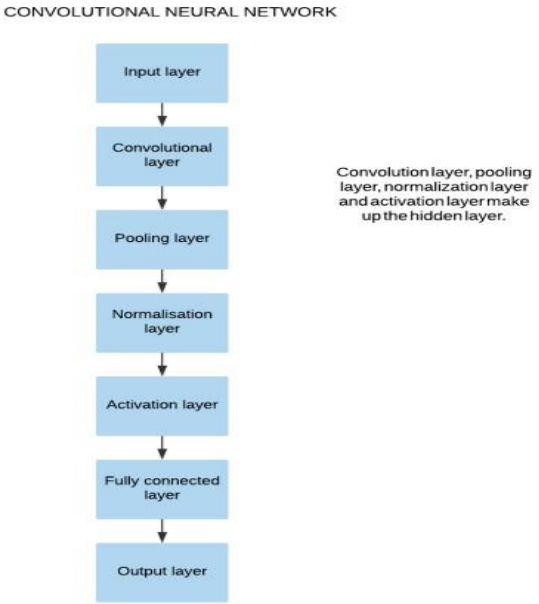


Fig 2 : CNN

3.1.4 Prediction and Alert

The Prediction and Alert Module is responsible for deploying the trained model into a real-world application and making it accessible to end-users. This module utilizes Flask, a lightweight Python web framework, to create a web application that facilitates user 18 interaction with the system. Users can upload images via the web interface, and the system processes these images to provide real-time detection results. The module integrates the trained YOLOv5 model into the Flask application, enabling it to handle incoming images from both user uploads and field cameras. When an image is received, the module preprocesses it, runs the detection model, and displays the results to the user. For real-time alerts, the module employs Telegram Bot Integration, to send SMS notifications to

farmers whenever an animal intrusion is detected. This immediate notification system helps farmers take swift action to prevent potential damage to their crops. Additionally, for on-site alerts, the module uses Python libraries to trigger alarms. These alarms provide an immediate auditory warning to scare away animals, further protecting the fields.

IV. Results

Our system leverages YOLOv5 for real-time animal intrusion detection in farming fields, utilizing a custom dataset created through Roboflow. This dataset, meticulously curated and annotated, ensures optimal performance of our intrusion detection model. When an intrusion is detected, alerts are promptly sent using Telegram Bot Integration, ensuring farmers are immediately informed of potential threats. Additionally, for on-site alerts, the module uses Python libraries to trigger alarms.

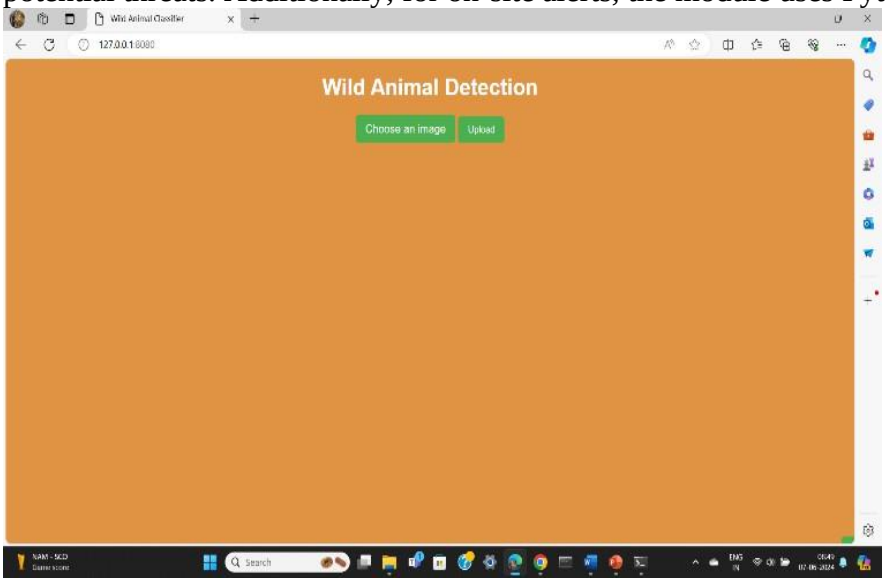
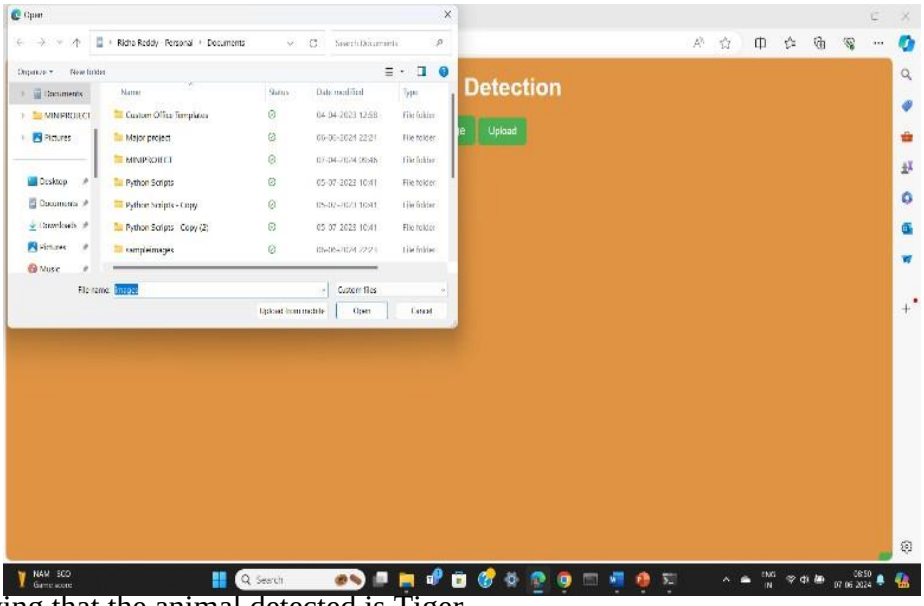


Fig 3 : Home Page

Uploading the image to detect wild animal intrusion



Here, it is showing that the animal detected is Tiger

Industrial Engineering Journal
ISSN: 0970-2555
Volume : 53, Issue 8, No.4, August : 2024

Fig 5: Result

Fig 6: Alert Message

V. Conclusion

Agriculture forms the backbone of the Indian economy, and safeguarding it is our foremost duty. The proposed system utilizes a camera to effectively detect intruder movement and records entry and exit times. This crop protection concept is simple to implement and does not harm humans or animals. Moreover, the system's relatively low cost makes it economically feasible, making it an ideal solution for protecting farm crops. This approach offers a significant improvement over current methods, addressing agricultural issues conveniently while maintaining records efficiently. The system is practical and effective, recording all movement within its range. Although the animal recognition algorithm is trained to distinguish between flying objects and animals, the motion detection algorithm identifies all movements in the video without differentiating between various moving objects.

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