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# A Review of Crop Protection Methods in Agricultural Fields

**Jaya Rubi[1], Shivani.V[2], A.Josephin Arockia Dhivya[3], A. Vijayalakshmi[4]**

[1,2,3]Department of Biomedical Engineering, Vels Institute of Science Technology and Advanced Studies, Chennai, India

[4]Department of Electronics and Communication Engineering, Vels Institute of Science Technology and Advanced Studies, Chennai, India

**E-mail:** [1]jayarubiap@gmail.com, [2]shivx06@gmail.com, [3]a.dhivya.se@velsuniv.ac.in, [4]vijayalakshmi.se@velsuniv.ac.in

**Abstract**

This study offers a brief overview of existing methods for crop protection using existing systems. It discusses several approaches that are available to prevent wild animals from damaging crops on farms. Various technologies capable of providing continuous protection for farms are explored. The discussed methods and tools underscore the importance of safeguarding valuable crops. The utilization of technologies such as Arduino, Raspberry Pi microcontrollers, sensors, GSM modules, solar panels, and others in farm security systems is studied. However, it's essential to note that these systems operate differently and can be costly for farmers. Additionally, the paper suggests the integration of modern technology in agriculture, such as the application of Deep CNN using Python, to offer an enhanced crop protection methods and an affordable cost.

**Keywords:** Smart farming, Crop safety, Real-Time Image Recognition, Deep CNN, YOLO

## 1. Introduction

Over the last three years, there has been a significant increase in wild animal invasions in Tamil Nadu and certain coastal regions. Agriculture plays a crucial role in the economy and serves as the primary source of nourishment for all living beings. Therefore, it is the


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responsibility of every farmer to protect such valuable crops. Successful farmers employ the best crop protection strategies. Wild animals, including wild pigs, elephants, monkeys, deer, and others, because substantial crop damage in adjacent forested and hilly areas during each harvesting season. As a result, our objective is to design a crop monitoring system to provide a solution, especially since farmers may not be able to protect their crops at night. The proposed system aims to be affordable and easy to use, utilizing readily available components. Researchers and planners are actively seeking potential solutions to these farmer-related issues. Farmers near wooded or hilly areas face uncertainty regarding maintaining a good yield of their crops and providing for their families. While strategies like wire fences and electric fences can be implemented to protect crops from wild animals, they are expensive and pose risks to wildlife. To address this, technology is used carefully to deter animals without harming them as they venture out of the forest. This deep convolutional neural network-based animal detection approach involves experimentation with a large dataset. This framework helps us fend off wild animals from farmlands and can be mechanized to minimize manual labor, thereby saving time. The article at present provides a short overview of the existing methods and describes the workflow of the process involved in the proposed system, along with the current progress and future scope. To construct the model, we employ the Convolutional Neural Network (CNN) technique, known for its powerful image processing capabilities, treating each image as an input and applying filters accordingly.

## 2. Literature Survey

This study proposes a device for identifying intruders and tracking threats, utilizing sensors and cameras with PIR sensors having a detection range of over 10 meters. The solution aims to protect crops, offering farmers a means to secure their farmlands from attacks or trespassing. The paper focuses on using IoT for dangerous animal detection, connecting network devices with sensors for data collection. It utilizes low-cost hardware like Arduino Uno to detect and alert against animal damage without harm. It also addresses the safety of students and animals on school campuses, providing monitoring and protection measures [1] .

This study presents a system for automatic wildlife monitoring in remote areas using IoT technology. The crop monitoring system alerts animals before they enter fields. The

system is installed and customized at the U.S. Sedgwick Research Reserve, identifying bears, deer, and coyotes with motion-triggered cameras. The multi-tier IoT system, called WTB, connects cameras to an on-site internet device (edge cloud). Its main goal is to protect crops from wild animal attacks. The module is easy to use and accessible to farmers, providing a cost-effective solution.[2]

The proposed system operates by playing sound and detecting light intensity using an LDR. If the light intensity is low, it will focus the light to deter wild animals from entering the farm, causing them to run away. Additionally, a GSM module sends a message to the farmer to alert them. The device is highly beneficial and affordable for the farmer. Importantly, the design ensures the safety of both animals and humans while effectively protecting the farm.[3]

In this paper, a new algorithm for animal recognition is proposed. W-CoHOG, a Histogram of Oriented Gradients (HOG)-based feature vector, demonstrates higher accuracy compared to the existing Co-occurrence Histograms of Oriented Gradients (CoHOG). The algorithm utilizes the LIBLINEAR classifier to improve accuracy for high-dimensional data. Experimental results indicate that W-CoHOG outperforms state-of-the-art algorithms, achieving higher accuracy on two benchmark datasets. [4]

The study found Himachal Pradesh's economy relies on agriculture, with crop damage from wild animals prompting farmer suggestions for field fencing and compensation. Water sources and festivals, like 'Van Mahotsav,' aim to foster harmony between farmers and wildlife, ensuring coexistence and mitigating crop damage risks.[5]

Efficiently tracking wild animals in their natural habitat is important. This project creates rules to find animals in wildlife. Since there are many different species, identifying them by hand is hard. These rules classify animals by their pictures to monitor them better. Animal detection and classification can help prevent accidents and theft. Using deep-learning algorithms is an efficient way to do this.[6]

Recently, wildlife encroachment into populated areas has surged as forests shrink. The existing alarm system activates only when animals intrude. The proposed system integrates Passive Infrared Sensors (PIR) along borders, triggering a centralized alert system and activating electric fences upon animal motion detection. This reliable and environmentally friendly solution aims to safeguard wildlife by deterring harm through IoT devices.[7]

This paper focuses on a smart agriculture software employing computer vision and ultrasound emission to create virtual fences, protecting crops from ungulate attacks and significantly reducing production losses. The proposed prototype utilizes software to recognize and classify animals, developed with openCV and deep learning algorithms. Embedded with an ultrasonic repellent hardware device, it drives animals away from the farm while alerting the farmer. This cost-effective solution aims to deter animals without causing harm or death, preserving natural resources. When an intrusion is detected, the model, trained using Keras and TensorFlow to identify animals, activates to check and recognize the animal intrusion. If identified among trained classes, the ultrasonic repellent is activated to drive the animal away.[8]

The increase in GVA in agriculture and allied sectors reached 4% in FY20. A deep learning method for animal detection was proposed to address the environmental impact of animal agriculture. The system aims to detect wild animals trespassing agricultural fields, preventing land damage and crop loss. Face recognition techniques identify unknown individuals to prevent trespassing. Baseline models like MobileNetV1, ShuffleNet M, and MobileNetV2 were utilized, with training completed at 60K iterations. A mobile application developed using React Native alerts users with live streaming when an unknown individual or animal enters agricultural land. Automatic crop protection machines using microcontroller-based systems and GSM technology send SMS alerts and sound buzzers to prompt action during emergencies.[9]

Crop guarding is a common practice for rural farmers to protect their crops from wild animals like elephants and pigs. It also deters human predators and thieves. Farmers engage in crop guarding to stay vigilant and combat boredom, often using noise-making techniques like drums and crackers. Electric fences are used to keep elephants away, but if damaged, animals can freely enter farmland. To prevent this, poles can be camouflaged to avoid detection by animals [11].

The paper and study introduce a water system to increase water supply for efficient irrigation. Sensor estimates are sent to an Arduino Uno microcontroller for computation. Crop protection is ensured through voice and motion detection, emitting high-frequency sounds to

deter insects, pests, and small animals. Additionally, a low-frequency sound emitter protects crops from pests and bugs that emerge at night [12].

The proposed device in [10] aims to detect and recognize wildlife using digital pixels, utilizing YOLOv3 and YOLOv3-Tiny algorithms with mean average precision rates of 75.2% and 68.4% respectively. It conducts experiments on a commodity computer to evaluate detection accuracy. The solution involves data pre-processing, feature selection, object detection, and wildlife recognition. Additionally, a low-cost monitoring system using IoT is designed to track animals entering farmlands. MATLAB confirms the animal's presence, triggering alerts via GPRS and GSM to deter them. Feasibility studies show that installing acoustic systems in croplands can yield an annual payoff of INR 42,700, aiding farmers and local communities. Solar-powered audio systems can be implemented on a larger scale to safeguard crops and support the area's inhabitants. The Table.1 presents some of the method employed in protecting the crops from wild animals.

**Table 1.** Crop Production Methods

| **Crop protection method** | **Characteristic** | **Advantages** | **Disadvantages** | **Environmental Impact** |
|---|---|---|---|---|
| Wire Fences and Electric Fences | Physical barriers to prevent wild animal intrusion | Effective in keeping animals out | Expensive to install, Harmful to wildlife | Negative impact on wildlife habitats |
| CNN-Based Animal Detection | Uses deep convolution neural for real time animal detection | Automatic detection without physical barriers, Quick response | Initial setup and training time, Cost of technology implementation | Depends on energy source for technology |
| IOT-Based Monitoring System | Utilizes IoT devices, sensors, and cameras for monitoring and alerting | Real time monitoring and alerts, low cost hardware implementation | Initial setup and technology adoption challenges. | Low impact with proper disposal of electronic waste |

| | | | | |
|---|---|---|---|---|
| Acoustic System with GSM | Users sound to deter wild animals and sends alert via GSM | Non harmful to animals and humans, Low-cost. | Limited range of sound effectiveness. Dependency on GSM network | Low impact if using renewable energy sources |
| W-Co-HOG Algorithm | User histograms of Oriented Gradients for animal recognition | Higher accuracy in animal recognition, Better performance compared to existing algorithms | Initial setup and algorithm implementation, Training and testing time | Depends on energy source for computing |
| Laser Fence | Virtual fence using laser technology to deter animals | No physical Barrier visible to animals, Alerting mechanism included | Initial setup and Technology adoption challenges, Cost of laser technology | Low impact if using energy efficient lasers |
| Smart Agriculture with ultrasound Emission | Uses computer vision and ultrasound for virtual fences | Reduction in production losses, Non-lethal deterrent to animals | Initial setup and technology adoption challenges, Cost of computer vision and ultrasound hardware | Depends on energy sources for ultrasound emission |

## 2.1 Challenges

While each proposed system offers unique advantages, they also come with their own set of disadvantages. Wire and electric fences, although effective in preventing wild animal intrusion, are expensive to install and maintain, and can be harmful to wildlife, negatively impacting their habitats. CNN-based animal detection systems, while offering real-time detection without physical barriers, require significant initial setup and training time, as well

as high costs for technology implementation. Similarly, IoT-based monitoring systems provide real-time monitoring and alerts at a low cost, but face challenges in initial setup and technology adoption. Acoustic systems with GSM, while non-harmful and cost-effective, have a limited range of sound effectiveness and depend on GSM networks. The W-Co-HOG algorithm, while offering higher accuracy in animal recognition, requires initial setup and implementation, as well as training and testing time. Laser fences, although providing a virtual barrier without physical obstructions, face challenges in initial setup and technology adoption, along with the cost of laser technology. Finally, smart agriculture systems using ultrasound emission, while reducing production losses and offering non-lethal deterrence to animals, also face challenges in initial setup and technology adoption, as well as the cost of computer vision and ultrasound hardware, and reliance on energy sources for ultrasound emission

## 3. Proposed System

To overcome the challenges in the existing system and to especially enhance the protection of crops while ensuring animal safety and reducing the cost of implementation, the proposed method utilizes the YOLOv5 for the processes of extracting features, object detection, and classification. The flowchart in Figure.1 below shows the work flow of the proposed process.

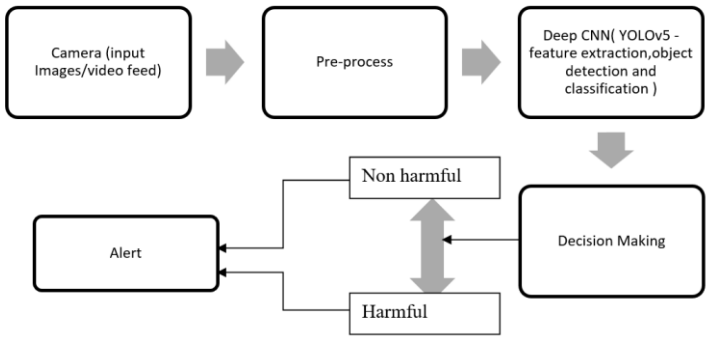


**Figure 1.** Proposed Work Flow

### 3.1. Current Progress and Future work

The selection of the hardware and the software components are underway, along with the prototype development and evaluation of the proposed system.

## 4. Conclusion

Many people use electric fences, artificial repellents, and acoustic systems to protect crops from wild animals. Continuous use of these methods can lead to health issues. None of the current systems use computer vision technology for animal detection. The proposed approach uses real-time image detection, utilizing models Deep CNN for accurate and quick detection. This technology will notify authorities in real time and help reduce animal mishaps and conflicts. It aims to protect crops, humans, and wild animals. Future work entails further developing the prototype, selecting hardware and software components, and implementing the system.

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