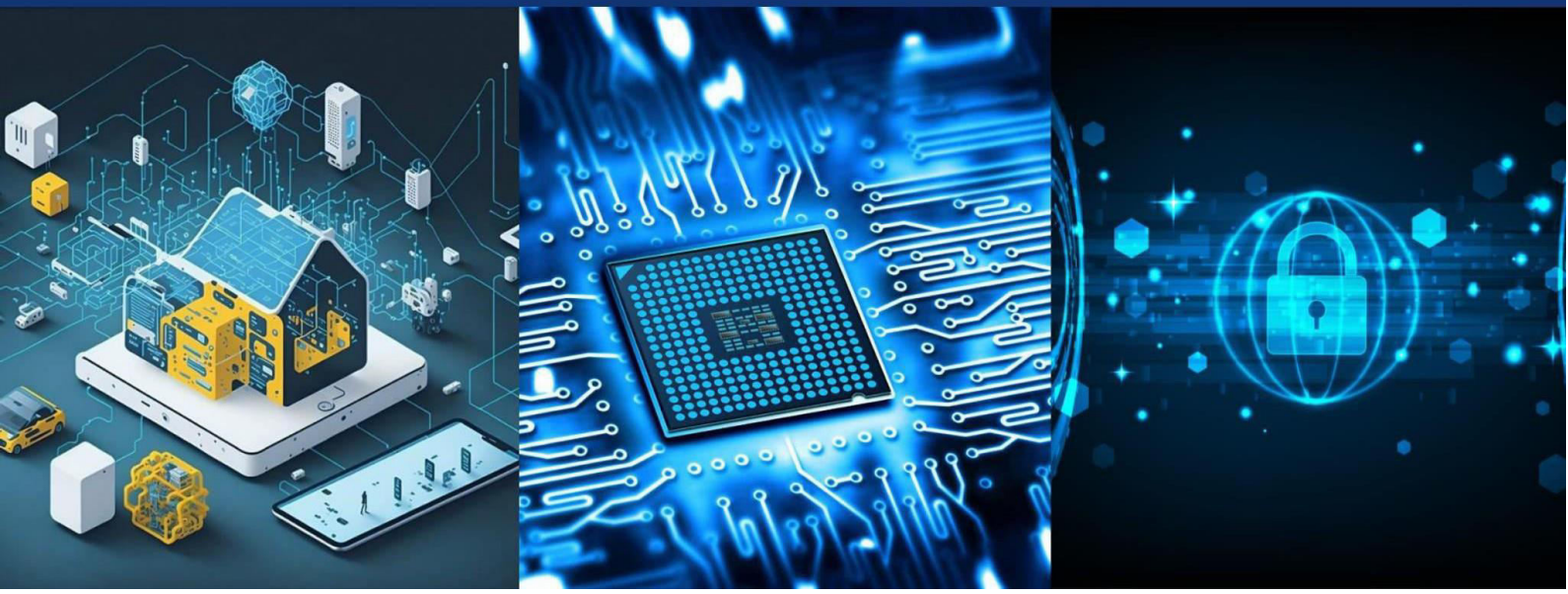
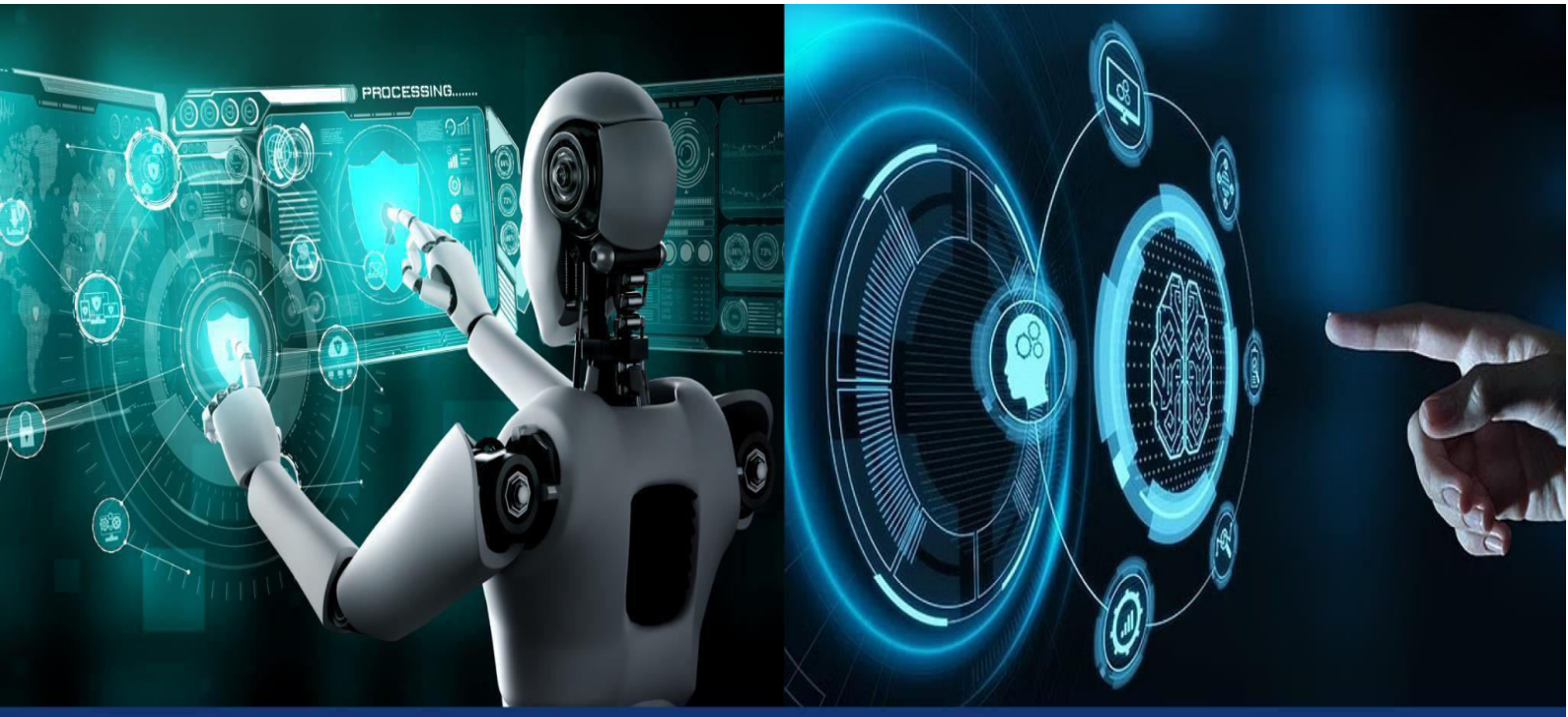
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# Protecting Agriculture Land from Animals and Theft

**Yogesh Golhar[1], Shreyash R. Wadibhasme[2], Rohan K. Ingle[3], Roshan S. Bhuskute[4], Akshay P. Badalwar[5], Palash W. Bhong[6]**

Assistant Professor, Dept. of C.E., St. Vincent Pallotti College of Engineering and Technology, Nagpur, India[1]

UG Students, Dept. of C.E., St. Vincent Pallotti College of Engineering and Technology, Nagpur, India[2-6]

**ABSTRACT:** Agricultural land is the support of the Indian economy, but it is under danger from wild animals and unauthorized people, and it incurs massive losses to crops. In today's era, artificial intelligence (AI), deep learning, computer vision, and smart hardware enabled the creation of solid, real-time detection and warning systems to safeguard agricultural land. These technologies enabled protection systems to become much more powerful than what they used to be. This review article provides an examination of fifteen cutting-edge studies that combined models like YOLO (v3–v8), and MobileNet SSD with IoT devices like Raspberry Pi, microcontrollers, and sensors. The solutions from the reviewed studies have worked effectively in precise detection, real-time warnings, and automation. But these systems are expensive, environmental perturbations can degrade their operation, and in some instances the boundaries thus drawn may be detrimental to birds and animals. Results show that AI-based and IoT-based smart protection systems can reduce substantially human-wildlife conflict, improve agricultural yield security, and augment farmer situational awareness and hence represent a promising and scalable solution for modern precision agriculture.

**KEYWORDS**: Crop Protection, Raspberry Pi, OpenCV, IoT, Deep Learning, Machine Learning, CNN, Animal and Person Detection.

## I. INTRODUCTION

In India farming is the primary occupation and it plays a vital role for the country's economy and culture. It involves the cultivation of crops, fisheries, horticulture and other agricultural activities. But due to the interference of animals and unauthorized persons into the farmlands leads to the economic losses for farmers and destruction of crops. To avoid these financial losses it is important to protect the farmlands from the animals.

To overcome this we proposed a solution in which we addressed to protect the farm land by detecting the persons and animals using cameras and provide an alert to the farmers on his mobile phone so that he is able to keep an eye on his farm when he is not around his farmland. To implement such solution we used an IoT device Raspberry Pi 4B model, cameras, speakers etc.

The cameras are activated 24 hrs so that when an animal or an unauthorized person motion is detected inside the farmland it will capture the picture of the object using YOLO model and sends mail to the farmer from where he can easily access or watch the object and by using the voice modulation he can send the message to the speakers to threaten the animals and the persons.

In recent research, advanced technologies such as deep learning, computer vision and intelligent hardware [12] have been used to detect animals and unauthorized persons entering the farm and provide immediate alerts. After studying the selected research papers, their achievements are mainly highlighted as – integration of AI-powered detection systems using CNNs and YOLO models.[10][5].

## II. LITERATURE REVIEW

In this review paper, we have reviewed research papers published from 2018 to 2025. In total, we have studied 19 research papers. These published research papers are related to farm security, in which the problem statement used,

research gap, methodology, data collection, techniques, algorithms, performance, limitations, future research and on what basis they are doing detection - all these aspects are presented in this section.

To select published research papers, we used Google search engine, in which we resorted to keywords, research paper platforms and new technologies currently being used. Research papers were selected using platforms such as Journal/Conference or based on searches related to keywords. The selected published research papers are mainly based on IoT systems and artificial intelligence (AI).

Vikas Bavane, Arti Raut, Swapnil Sonune, Prof. A.P.Bawane4, Dr.P.M.Jawandhiya, "Protection of Crops from Wild Animals Using Intelligent Surveillance System"[1], 2018, Crop damage by wild animals is frequent and severe; existing systems primarily provide surveillance for humans but do not effectively protect from animal intrusion or distinguish between animals and humans in real time. The field movements were detected using Raspberry Pi and PIR sensors. The workers working in the fields were identified using RFID. The intrusion was monitored using cameras and alerts were sent via GSM. Apart from this, electronic firecrackers, animal repellent, and rotten egg spray were also used. Key Points, Discriminates between human and animal intruders, automatically activates deterrents appropriate to animal size, monitors attendance of legitimate farm workers. Mechanical spraying of repellents needed, possible false positives due to non-target movement, expense of electronic parts.

A.P. Jaya Krishna,M. Amutha, S. Jeya,D.L. Karpagavalli, M. Kavibharathi,B. Lohitha, "Surveillance of Farms from Birds Using Raspberry Pi."[2], 2020, The Animals often cause damage to farms, but there are not enough measures available to monitor them and keep them away from the fields. The PIR sensors installed in the Raspberry Pi detect movement. An ultrasonic sensor installed on the stepper motor rotates 360°. When there is any movement, the camera records the video and the farmer gets an alert via GSM and Android app.Sound frequency-based bird-specific deterrence, real-time video recording and alert mechanism, energy efficient and low-cost implementation. Failure to view all directions at once without rotating the sensors, stability of the network connection being necessary.

R. Sai Sree, P. Chandu, B. Pranavi, "Real Time Object Detection Using Raspberry Pi"[3], 2023, Real-time object recognition is difficult on a small hardware device like Raspberry Pi due to its low processing power. Available models are slow and not accurate enough for surveillance or crop protection. Raspberry Pi 3 with camera module on MobileNetSSD and OpenCV for rapid object detection on live video feed, real-time processing of video. Lightweight and speedy detection appropriate for embedded platforms, detection precision >95% for ordinary objects, affordable hardware. Speed limits of Raspberry Pi hardware for processing, accuracy-speed trade-off, overheating problems with prolonged use.

B.Vijay Kumar, P Sreenivasulu, "Smart Crop Protection System From Wild Animals Using Arm7"[4], 2023, Wild animals frequently enter the fields and cause huge damage to crops. The methods currently used such as electric fences are very expensive and are not safe for animals. Therefore, an economical and long-lasting system is necessary that can keep animals away from the fields. ARM7 microcontroller-based system employing PIR sensors and ultrasonic frequency deterrent tuned to the hearing capabilities of animals, IoT-based alert through GSM. Affordable and power-efficient, employs animal-specific ultrasonic frequencies to deter without injury, real-time detection and notification. Restricted processing capability compared to current platforms, effectiveness of ultrasonic frequency varies by species, infrastructure subject to GSM coverage.

Tanaya Mane, Rajeshvari Ghatage, Samruddhi Shinde, C. P. Shinde, "Wild Animal Intrusion Detection System Using Raspberry PI" [5], 2024, Wild animals cause damage to farms, available detection systems are not reliable enough for real-time monitoring and prevention. Raspberry Pi with camera, OpenCV, and TensorFlow deep learning-based animal detection, sends sound alarm and SMS alerts. Affordable and scalable wildlife observation solution, employs deep learning to improve classification, real-time alerts for prompt farmer response. Restricted by camera range and illumination, stable network necessary for alerts, model training required for varied fauna.

T.Manikandan, S. Joshua Kumaresan, A. Muruganandham, V. Nandalal, R. Babuji, "IoT Based Animal Detection and Alert System for Farm Fields"[6], 2024, Domesticated animals cause a lot of damage to farmer's crops. The old methods of protecting the fields are slow and ineffective. Arduino UNO and ultrasonic sensors are used to detect animals. GSM module is used to send SMS alerts. NodeMCU is used to connect to cloud via IoT. Camera is installed to send live pictures via Telegram. Animal sounds are played through speakers to scare the animals, and smoke (fog) and

LED lights are used to prevent them from entering the field. Real-time detection of animals and alerting, manual and automatic mode of control, multiple deterrent mechanisms, image and SMS notification to farmer. Reliance on network infrastructure to transmit data in real-time, sensor range and environmental factor dependency.

Jaya Rubi , Shivani.V, A.Josephin Arockia Dhivya, A. Vijayalakshm, "A Review of Crop Protection Methods in Agricultural Fields"[7], 2024, Increasing wild animal entry into farms leads to major crop damage. Old methods like fences and repellents have problems – they are costly, can hurt animals, and often don't work well. So, we need crop protection systems that are low-cost, working correct, and are safe for animals. Overview of multi-dimensional crop protection technologies such as IoT sensors, deep CNNs, sound repellent, and W-CoHOG computer vision algorithms.Stresses low cost, effective, and animal-friendly technologies, significance of integrating sound, image, and sensor information for detection, underscores necessity for ongoing monitoring. Costs of implementation, time spent training AI models, rural adoption barriers for technology.

Nitika Goyal, Dr Navneet Kaur Sandhu, " Animal Intrusion Detection and Alert System for Crop Protection" [8], 2024, Detecting and monitoring farm animals is essential to prevent damage to crops. YOLOv5 is used to detect and track animals in real-time from video captured by farm cameras. This is integrated with IoT to send instant alerts to farmers via SMS and app notifications. Real-time detection of animals with 85-95% accuracy, use of night vision cameras, flexibility to detect various types of animals, instant notification to farmers. Initial and permanent setup cost, reliance on stable internet connectivity, camera durability with varied weather conditions.

G G. Jyothi, M.Anilkumar, G.Apoorva, B.Manikant, M.Dhanraj, "Smart Crop Protection System Using Deep Learning", [9], 2024, Damage to crops by livestock and wild animals is common, and some traditional measures such as fences and fences are not effective, as well as being labor intensive. An automated, real-time detection and alert system is needed. YOLOv3 deep learning object detection integrated with real-time video monitoring, audio alarms, email and call notifications. Multitarget detection at high speed and accuracy, real-time alerting and logging, recognition of owner's face to minimize false alarms. Needs stable internet and power, complexity of system to implement in rural locations, potential false negatives during bad weather.

Gulzar Ahmad, Adeel Khan, Muhammad Sajjad, Ayesha Saddiqa, Muhammad Mudassar Naveed, Zaigham Riaz, "Transfer Learning-Based Smart Crop Protection System For Animal Detection And Deterrence",[10], 2025 Wild and stray animals cause a lot of damage to crops and fields. We need pictures to identify these animals and find effective measures to control them. YOLOv9 and deep learning are used to detect and track animals. Edge computing and IoT are added to process data on the farm. Sound alarms and lights are used to scare animals away, and real-time alerts are sent. High detection accuracy (93-96%), sturdy under changing conditions, non-lethal deterrent system, scalable AI and IoT integration. Availability of hardware and internet connectivity in rural developing areas, region-wise model training for different species due to variable species, computational resource requirements.

Sudhakar, Sreerambabu, Rajkumar, Santhosh, "Camera Vision Based Animal Repellent System for Agriculture using Machine Learning", [11], 2023, Increasing the crop damage due to animals like elephant, deer, and other different species aggravated by habitat encroachment and deforestation. Existing systems lack precise species recognition and targeted deterrent mechanisms. Uses Deep Convolutional Neural Network (DCNN) for species detection via an edge computing device with a camera. Upon detection, species-specific ultrasonic sounds are emitted to repel animals. Python and OpenCV used for vision-based detection. CNN model trained with extracted features (color, gabor, LBP) and symbolic classifiers. Alerts sent via mobile. High accuracy (~98%) in species recognition, real-time detection, non-lethal ultrasonic deterrence, time-stamped recordings, AI-based automated operation. Potential limitations in detecting animals under poor lighting or obstructed views, reliance on high-quality training data, need for continuous power supply for edge devices, ultrasound range may vary by species.

G. Ramya, J. Sreeja, K. Jyothi, J. Radhika, R. Vigneshwari, "Animal Detection for Crop Protection Using Deep Learning: Insights from YOLO V3, R-CNN, Random Forest", [12], 2025, Traditional crop protection methods (manual monitoring, scarecrows, barriers) are labor-intensive, inefficient, and often ineffective against persistent wildlife. Need for automated, accurate, real-time animal detection and deterrence. YOLO V3, R-CNN, Random Forest trained on local dataset; deployed on Jetson Nano; high-res cameras; triggers sound deterrents; alerts farmers. 91.2% mAP; robust under varied conditions; low false positive rate; localized training boosts accuracy. Misses small/hidden animals, hardware cost, connectivity limits.

Divya M. Angadi, Bhagyashree Chikkamath, Roopa B. Jorapur, Prof. Muktha Patil, "Farm Protection from Animals Using Deep Learning" [13], 2023, Small farms face huge losses from animal intrusion; traditional guards/scarecrows inefficient, MobileNet SSD on MS COCO dataset; live camera feed; siren deterrent; OpenCV preprocessing. Detects multiple animals; real-time alerts; low manual work. High cost, seasonal limits, equipment needs.

Aarthi B, Abinayashri K, Haritha M, Hemadharshini K, Santhana P, "Camera Vision Based Animal Repellent System for Agriculture Fields Using Machine Learning ", [14], 2023, Crop damage from wild animals; need safe, automated, accurate deterrence. R CNN, Feature Extraction, Ultrasound Repellent, Cloud monitoring; SMS alerts, Species Recognition, Remote Monitoring, Harmless deterrent. Speed–accuracy trade-off, ultrasound safety, lighting sensitivity.

A. Samuvel, Dr. G. Manikandan, Ms. Vilma Veronica, Ms. S. Hemalatha, "Smart Agriculture: Enhancing Security Through Animal Detection Via Deep Learning and Computer Vision" [15], 2023, Crop damage from wild animal intrusions; manual protection methods inefficient. YOLOv5 with Raspberry Pi and camera for real-time detection; IoT alerts to farmers; automated deterrent activation. Accurate detection; real-time monitoring; minimal human intervention. Accurate detection; real-time monitoring; minimal human intervention.

Table01. Analysis of Crop Production Methods

| Paper Citaion Parametes | [1] | [2] | [3] | [4] | [5] | [6] | [7] | [8] | [9] | [10] | [11] | [12] | [13] | [14] | [15] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Overall System Design | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Animal and Object Detection | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Movement Tracking and Location Identification | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Alerts and Notifications | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Intrusion Prevention Methods | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Data Storage and Presentation | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | × |
| Environmental and Ethical Considerations | × | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | × | ✓ | ✓ | × |
| System Maintenance and Updates | × | ✓ | ✓ | ✓ | × | × | ✓ | ✓ | ✓ | ✓ | ✓ | × | ✓ | ✓ | × |
| Integration with | × | × | × | × | × | × | × | × | × | × | × | × | × | × | × |

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| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Farming Practices** | | | | | | | | | | | | | | | |
| **Challenges and Limitations** | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| **Future Improvements** | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

## III. CHALLENGES

The investigated works reflect diverse approaches to farmland protection, focusing on various parameters, yet sometimes neglecting others. Most systems highlight general system design, object and animal recognition, activity tracking, and real-time monitoring and notification alerts for intrusion detection. Integration with agricultural practice is still largely unknown, limiting practical implementation in real-life applications. Although many works have been implemented involving intrusion prevention, data storage, and maintenance of systems, challenges remain from environmental and ethical perspectives, and little attention has been paid to the environmental impact of the implementation of this technology. Several systems suggest future improvements and bring forth challenges and weaknesses, indicating the need for optimization for cost, scalability, and flexibility. Therefore, while the proposed solutions provide adaptive approaches to intrusion detection and prevention, the lack of comprehensive frameworks integrating technical effectiveness with environmental sustainability and agro-compatibility is a critical research gap for future development.

## IV. PROPOSED SYSTEM

To overcome the limitations of the existing system and enhance crop protection, as well as ensure the safety of wild animals and reduce costs, the proposed method uses YOLOv8 for feature extraction, object detection, and classification. The Figure 01 shows the workflow of the proposed system.

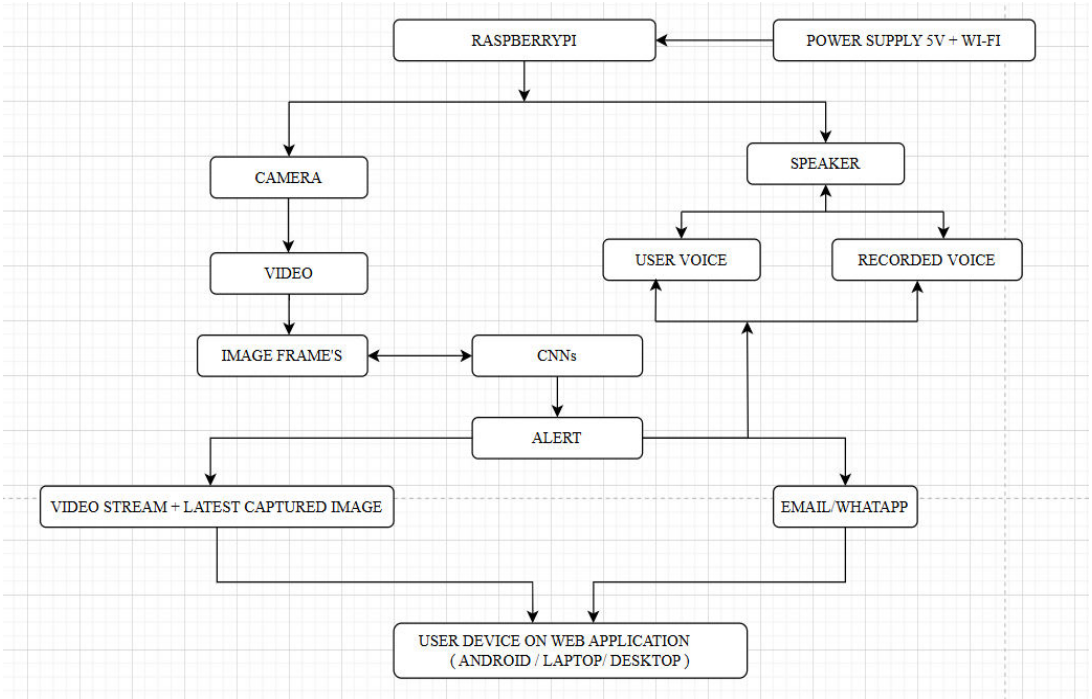



Fig.1. Proposed System Work Flow

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## V. CURRENT PROGRESS AND FUTURE WORK

Hardware component selection has been completed while software programming is still in progress, about 66% of the processes have been implemented and the remaining 34% is yet to be developed.

## VI. CONCLUSION

Wild animal and human intrusions in farmlands have been one of the major problems facing the farmers. Those who live next to woods are especially affected. The AI and IoT-based solution proposed in this research can be considered as a convenient, cheap, and animal-friendly answer to the problem that can be achieved by uniting the hardware of Raspberry Pi, the deep learning models like YOLOv8, and the real-time communication technologies. Around the clock surveillance, correct identification of the objects, quick notifications together with the snapshot, and the use of scare tricks through speakers for example, have been introduced by the system thus creating the conditions for the farmers to get in touch with their farms even if they are at a distance. As compared to conventional methods such as fencing and chemical repellents, this method can guarantee the safety of the animals, lower the destruction of the crops, and facilitate quicker reaction. Although the practicality of the system might still hinge on environmental factors and the stability of the internet connection, its extension, low cost, and non-lethal design are what make it a bright and long-lasting technology for modern precision agriculture.

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