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Non-Harmful Intelligent Wildlife Detection and Crop Protection System

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ABSTRACT

Human–wildlife conflict is a serious problem in many agricultural regions. Wild animals entering farms can damage crops and create economic losses for farmers, while conventional deterrent methods may be expensive, ineffective, or potentially harmful to wildlife. This project proposes a Non-Harmful Intelligent Wildlife Detection and Crop Protection System designed to detect animals approaching agricultural fields and provide an appropriate warning without physically harming them.The proposed system combines motion and distance sensing with intelligent decision-making. Sensors such as PIR and ultrasonic sensors can detect movement and estimate the presence and proximity of an approaching animal. In an advanced version, a camera-based system can be incorporated to identify the type of animal. Based on the detected situation, the system can activate non-harmful deterrents such as controlled sound or light signals and simultaneously send an alert to the farmer. Solar power can be incorporated to make the system suitable for farms with limited access to electricity.The main objective is to create a low-cost, scalable and environmentally responsible crop-protection system that protects both farmers and wildlife.1.Agriculture plays an important role in the livelihood of millions of people. Farmers invest significant amounts of time, money and effort in growing crops. However, agricultural fields located near forests and wildlife habitats can experience crop damage caused by wild animals.Traditional methods of preventing animals from entering fields include physical fencing, manual monitoring, loud sounds and other deterrent techniques. These approaches may require continuous human effort and may not always respond effectively when an animal approaches.Modern sensors, microcontrollers, communication systems and artificial intelligence provide an opportunity to develop smarter solutions. Instead of continuously monitoring a field, an intelligent system can detect an approaching animal and respond automatically.This project proposes such a system with a central principle:Protect crops without harming wildlife.

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INTRODUCTION

Agriculture plays an important role in the livelihood of millions of people. Farmers invest significant amounts of time, money and effort in growing crops. However, agricultural fields located near forests and wildlife habitats can experience crop damage caused by wild animals.

Traditional methods of preventing animals from entering fields include physical fencing, manual monitoring, loud sounds and other deterrent techniques. These approaches may require continuous human effort and may not always respond effectively when an animal approaches.

Modern sensors, microcontrollers, communication systems and artificial intelligence provide an opportunity to develop smarter solutions. Instead of continuously monitoring a field, an intelligent system can detect an approaching animal and respond automatically.

This project proposes such a system with a central principle:

Protect crops without harming wildlife.

PROBLEM STATEMENT:

Farmers need an affordable and reliable method to detect animals approaching their fields and discourage them from entering without causing injury.

The major problems are:

Difficulty in continuously monitoring large agricultural fields.

Crop damage caused by animal intrusion.

Lack of affordable automated monitoring systems.

Ineffectiveness of simple motion alarms in distinguishing useful events from animal movement.

Risk of inappropriate deterrent methods affecting wildlife.

Limited electricity and internet connectivity in some rural areas.

AIM:

The aim of this project is to develop a smart, low-cost and non-harmful wildlife detection and crop-protection system** that can:

1. Detect approaching animals.
2. Estimate their distance and movement.
3. Distinguish significant animal activity from ordinary movement where possible.
4. Activate an appropriate non-harmful deterrent.
5. Notify the farmer about the event.
6. Operate with low power consumption.
7. Reduce unnecessary human intervention.

PROPOSED INNOVATION:

A basic animal alarm simply follows:

Motion detected → Alarm ON**

Our proposed system aims to improve this approach:

Detection → Distance estimation → Intelligent assessment → Appropriate response → Farmer notification → Event recording**

The system can use multiple sensors instead of depending on a single sensor. This can reduce false alarms caused by wind, small objects or unrelated movement.

An advanced version can incorporate a camera and an AI-based classification model. Instead of simply detecting movement, the system could attempt to identify whether the detected object is an animal and classify it into predefined categories.

The proposed design therefore focuses on **intelligent, selective and non-harmful intervention** rather than continuous alarming.

WORKING PRINCIPLE:

The system can be divided into five stages.

Stage 1: Detection

Passive Infrared (PIR) sensor movement in the monitored area. When movement is detected, the microcontroller activates additional sensing.

Stage 2: Distance Estimation

An ultrasonic sensor can estimate the distance of an object from the sensor. Multiple sensor readings can be used to determine whether the object is approaching.

stage 3: Intelligent Decision

The microcontroller analyses sensor readings according to predefined conditions.

For example:

* No significant movement → system remains in monitoring mode.

* Movement detected but object is distant → continue monitoring.

* Object approaches a defined boundary → activate warning.

* Repeated movement in the protected zone → send an alert to the farmer.

In the advanced version, camera-based classification can be added to improve identification.

Stage 4: Non-Harmful Deterrence

When an intrusion is confirmed, the system can activate a controlled warning such as a sound or light signal intended to discourage animals from approaching.

The deterrent should be designed to avoid physical injury and should not involve dangerous traps, harmful chemicals or electric shocks.

Stage 5: Farmer Notification

A communication module can send an alert to the farmer when significant activity is detected.

The message could contain information such as:

Detection time

Approximate location/zone

Detection status

Approximate distance

BLOCK DIAGRAM:

PIR Sensor ─┐
**Ultrasonic Sensor ─┤
Camera (Advanced) ─┤ → Microcontroller/Processing Unit → Decision System
Environmental Sensors ─┘
↓
Non-Harmful Deterrent
↓
Farmer Alert / Data Recording

MAJOR COMPONENTS:

Hardware

Arduino UNO or ESP32

PIR motion sensors

HC-SR04 ultrasonic sensors

Camera module for advanced version

Buzzer/speaker

LEDs

GSM/Wi-Fi communication module

Breadboard and jumper wires

Rechargeable battery

Optional solar panel

Weather-resistant enclosure

Software

Arduino IDE

Microcontroller programming

Optional machine-learning/computer-vision software for animal classification

Optional mobile/web notification system

BASIC ALGORITHM:

1. Start the system.
2. Continuously monitor the field.
3. Check the PIR sensor.
4. If no movement is detected, continue monitoring.
5. If movement is detected, measure distance.

6. Compare the readings with predefined thresholds.
7. If the event appears insignificant, return to monitoring.
8. If animal intrusion is suspected, activate the appropriate warning.
9. Send an alert to the farmer if communication is available.
10. Record the event.
11. Return to monitoring mode.

EXPECTED ADVANTAGES:

The proposed system could provide several advantages:

Non-harmful: Designed to discourage animals without physically injuring them.

Automated Reduces the need for continuous manual monitoring.

Low-cost: Basic versions can be developed using commonly available electronic components.

Scalable Multiple sensor units can be placed around a large field.

Energy efficient: Solar power can be incorporated.

Early warning: Farmers can receive information before or during an intrusion.

Data collection: Repeated events can help identify patterns of animal movement.

Environmentally responsible: Encourages coexistence between agriculture and wildlife.

LIMITATIONS:

The proposed system also has limitations.

PIR sensors alone cannot reliably identify the species of an animal.

Ultrasonic sensors have limited sensing ranges.

Weather conditions can influence sensor performance.

Camera-based AI requires suitable training data and processing capability.

Communication-based alerts may not work in areas without network coverage.

Different animals may react differently to the same deterrent.

A prototype tested in a small area may not directly represent performance on a large farm.

These limitations can be addressed through further testing and development.

TESTING PLAN:

To evaluate the prototype, controlled tests can be performed using objects or simulated animal movement at different distances.

The following parameters can be measured:

Parameter	Measurement
Detection accuracy	Percentage of test events detected
False alarms	Number of incorrect detections
Detection distance	Maximum reliable detection range
Response time	Time between detection and warning
Power consumption	Energy used during operation
Alert reliability	Percentage of successfully delivered alerts

Actual experimental values should be added after testing the prototype. No results should be claimed until they have been experimentally measured.

ENVIRONMENTAL AND SOCIAL IMPACT:

The project aims to address two needs simultaneously: protecting agricultural production and reducing unnecessary harm to wildlife.

A successful system could help farmers respond to animal intrusion earlier while encouraging non-destructive methods of crop protection. It could also demonstrate how electronics, automation and artificial intelligence can be applied to rural problems.

The system supports the broader idea of **human–wildlife coexistence**, rather than treating wildlife as a problem that must simply be eliminated.

FUTURE SCOPE:

The system can be further improved by incorporating:
AI-based animal classification.
Solar-powered autonomous operation.
GPS-based location information.
Mobile application integration.
Long-range wireless communication.
Multiple coordinated sensor stations.
Machine-learning-based prediction of animal movement.
Historical data analysis.
Improved weather-resistant hardware.
Adaptive deterrent selection based on animal type and repeated observations.
In the future, a network of smart monitoring units could provide farmers with a real-time map of animal activity around agricultural fields.

ESTIMATED PROTOTYPE COST:

The basic prototype can be developed using relatively inexpensive components.

Component	Approximate Cost
Arduino/ESP32	₹400–₹700
PIR sensors	₹100–₹200
Ultrasonic sensors	₹100–₹200
Buzzer/LEDs	₹50–₹100
Breadboard & wires	₹150–₹250
Battery	₹150–₹300
Communication module	₹300–₹600
Optional camera	₹300–₹800
Enclosure	₹100–₹300
Estimated basic prototype	**₹1,350–₹2,650**

The actual cost will depend on the components selected and whether advanced features such as camera-based AI and solar power are included.

CONCLUSION

The Non-Harmful Intelligent Wildlife Detection and Crop Protection System** proposes a technology-based approach to one of the challenges faced by farmers near wildlife habitats. Rather than relying on continuous human monitoring or harmful deterrents, the proposed system combines sensors, intelligent decision-making and communication technology to detect possible animal intrusion and respond appropriately.
The most important feature of the project is its focus on **protecting crops while respecting wildlife. With further development, testing and field trials, the concept could evolve into a practical and affordable agricultural safety system.
The project demonstrates how engineering and innovation can be used not only to improve productivity but also to create solutions that promote coexistence between humans, agriculture and nature

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