SMART CROP PROTECTION SYSTEM USING DEEP LEARNING

A Mini Project Report

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In partial fulfillment of the requirements for the

award of the degree of

BACHELOR OF TECHNOLOGY

In

COMPUTER SCIENCE AND ENGINEERING-DATA SCIENCE

By

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING-DATA SCIENCE

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CERTIFICATE

This is to certify that the Mini Project Report on ***"SMART CROP PROTECTION SYSTEM USING DEEP LEARNING"*** submitted by **MARRI ANIL KUMAR, GHATTY LALITHA APOORVA, BONAGIRI MANIKANTA, MIDIDODDI DHANRAJ** bearing Hall ticket Nos. **21VE1A6741, 21VE1A6724, 21VE1A6711, 21VE1A6744** in partial fulfillment of the requirements for the award of the degree of **Bachelor of Technology** in **COMPUTER SCIENCE AND ENGINEERING-DATA SCIENCE** from Jawaharlal Nehru Technological University, Kukatpally, Hyderabad for the academic year 2024-25 is a record of bonafide work carried out by them under our guidance and Supervision.

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DECLARATION

We, "**MARRI ANILKUMAR, GHATTY LALITHA APOORVA, BONAGIRI MANIKANTA, MIDIDODDI DHANRAJ"** bearing **Roll No's 21VE1A6741, 21VE1A6724, 21VE1A6711,21VE1A6744** hereby declare that the Mini Project titled **SMART CROP PROTECTION SYSTEM USING DEEP LEARNING** done by us under the guidance of **Mrs. G. JYOTHI, AssistantProfessor** which is submitted in the partial fulfillment of the requirement for the award of the B. Tech degree in **Computer Science and Engineering Data Science** at **Sreyas Institute of Engineering & Technology** for Jawaharlal Nehru Technological University, Hyderabad is our original work.

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ACKNOWLEDGEMENT

The successful completion of any task would be incomplete without mention of the people who made it possible through their guidance and encouragement crowns all the efforts with success.

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A Special vote of Thanks to **Dr. G. Naga RamaDevi, Project Co-Ordinator and Dr. K. Rohit kumar, Head of the Department** who has been a source of Continuous motivation and support. They had taken time and effort to guide and correct me all through the span of this work.

We owe very much to the **Department Faculty, Principal** and the **Management** who made our term at Sreyas a stepping stone for our career. We treasure every moment we had spent in the college.

Last but not the least, our heartiest gratitude to our parents and friends for their continuous encouragement and blessings. Without their support this work would not have been possible.

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ABSTRACT

Agriterrorism with regard to animal damage greatly affects the crop yield for farmers, resulting to some of them recording large losses. Farm animals like buffaloes, cows, goats and birds trespass in the fields trample the crops and this can only be destructive for farmers since they cannot constantly protect their shambas. Measures such as the use of barriers, wire fences, or personnel vigilance yields most of the time insufficient results. In addition to scarecrows, which enemies can easily bypass with many animals, farmers also employ human effigies. To control these problems, we introduce an AI-based Scarecrow system using video processing in real time for crop protection from wildlife. The system uses a camera to record videos and analyzes them with YOLOv3, an object detection model together with OpenCV and the COCO names database. If any animal or bird is identified, then the system produces a sound alerting the animal not to invade the compound Moreover, if an animal has been sensed for more than one minute consecutively, the system will alert the farmer sending him/her an e-mail and dialing the farmer`s phone number. This approach thus provides an efficient and automated way of protecting crops than depending on deterrent measures.

KEYWORDS: Webcam, Image acquisition module, Animal detection, Animal Tracking, Calculate Weight CFG, Animal Detection

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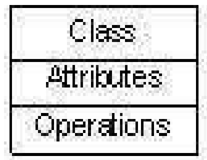
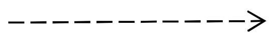
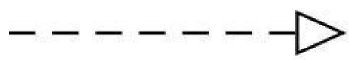
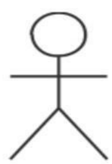
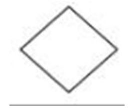
LIST OF SYMBOLS

S.NO.	NOTATION	NOTATION NAME
1.		Class
2.		Association
3.		Dependency
4.		Aggregation
5.		Realization
6.		Actor
7.		Use cases

8.		Decision box
9.		Initial State
10.		Final State
11.		Activity

CHAPTER 1

INTRODUCTION

Agriculture faces ongoing challenges from animal invasions and trespassers, leading to significant crop damage and economic loss. In order to ensure the safety and protection of crops, the farming industry requires innovative solutions that are efficient, reliable, and proactive. The goal of this project is to explore and apply the game-changing possibilities of AI technology to address these challenges.

Traditional crop protection methods often rely on manual monitoring or mechanical deterrents, which can be inefficient, prone to errors, and lack scalability. These methods not only require intensive labor but also fail to provide real-time, automated responses to threats, leaving crops vulnerable to damage and reducing the farmer's ability to maximize output and maintain security.

To address these challenges, the project utilizes AI-powered surveillance systems, leveraging computer vision and machine learning technologies to automate the detection of threats in real-time. Using a combination of YOLO (You Only Look Once) object detection algorithms and OpenCV, the system is capable of identifying animals or intruders entering the field. This ensures quick, accurate, and automated responses, drastically reducing the time and effort needed for monitoring.

The AI-based system offers numerous advantages over traditional methods of crop protection. First, the system's ability to automatically detect and classify intrusions ensures real-time responses, minimizing crop damage. Second, computer vision algorithms enable high accuracy in identifying various types of threats, ensuring that actions are taken only when necessary. Third, the system integrates with smart alert mechanisms like sound playback, email notifications, and phone alerts, ensuring that farmers are notified instantly and can take appropriate action without being physically present in the field. Finally, the integration of camera-based monitoring allows for the capture of visual evidence, which can be shared with farmers to enhance understanding and trust.

This project aims to revolutionize crop protection by providing a more advanced, automated, and reliable approach using AI technology. By implementing real-time monitoring, smart alerts, and efficient detection mechanisms, the system not only reduces manual labour but also minimizes the risk of crop loss, leading to enhanced productivity and farmer security**.**

1.1 PROBLEM STATEMENT

In contemporary agricultural landscapes, one of the most pressing and ubiquitous social issues facing rural communities across South India is the relentless assault on crops by wildlife. The adversaries in this ongoing battle are as diverse as they are formidable, ranging from the agile deer and cunning monkeys to the awe-inspiring giants like elephants. Their relentless foraging wreaks havoc on the livelihoods of countless farmers, prompting a sense of urgency and a call for an effective and immediate solution to this profound problem.

The plight of rural communities is particularly dire, as they grapple with the destructive onslaught of these wild animals on their precious crops. This situation has grown increasingly dire, with frequent stories of animal attacks reverberating through the agricultural heartland of the country. This wave of destruction is fueled by the lack of a robust and comprehensive detection and deterrent system that could protect the crops and, by extension, the very livelihoods of these communities.

Tragically, the absence of a reliable and proactive defense mechanism leaves these vulnerable villagers at the mercy of these animal intruders. The impact of these attacks extends beyond the physical destruction of crops, as they symbolize a broader issue of food security and economic stability for the farming communities. The absence of proper safety measures and an inability to counteract these threats further intensifies the challenges faced by the affected villagers.

Fencing, although a conventional means of protecting crops, is not always a feasible solution for every farmer. The vast expanse of crops, including expansive paddy fields, cannot be comprehensively shielded, rendering the possibility of losses due to livestock interference a looming threat. As a result, the agrarian landscapes are fraught with potential wastage, rendering the toil and sweat of farmers futile and leading to significant physical destruction of crops, as they symbolize a broader issue of food security and economic stability for the farming communities. The absence of proper safety measures and an inability to counteract these threats further intensifies the challenges faced by the affected villagers.

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The perpetrators of this agricultural turmoil are a diverse cast of animals, each contributing to the collective challenge in its unique way. While deer exhibit remarkable agility, foraging through fields and causing considerable harm, monkeys employ their dexterity to wreak havoc with a keen sense of cunning. The giants of the animal kingdom, such as elephants, pose a different dimension of the challenge, with their sheer size capable of obliterating vast tracts of crops in a single foray. Other culprits, including wild boars, rabbits, moles, and an array of mischievous creatures, further compound the problem.

In the face of this multifaceted agricultural crisis, the project at hand seeks to provide a beacon of hope. It aims to address this urgent issue by developing an effective, technologically advanced, and humane solution to safeguard the crops and livelihoods of the affected communities. Through innovative approaches, such as smart crop protection systems, the project strives to offer respite to the beleaguered farmers and chart a course toward a more secure and sustainable agricultural future. As we embark on this mission, we hold in our hearts the conviction that progress can indeed be achieved when humanity and technology converge to protect and nurture the fields that sustain us all.

1.2 OBJECTIVE

The objective of the "Smart Crop Protection System " project is to develop and implement a technology-based solution that safeguards crops from damage caused by animals, such as wildlife, birds, or pests. The main goals of this project include:

Crop Preservation: Protect crops from being damaged or consumed by animals, ensuring that farmers can yield a full and healthy harvest.

Reduced Crop Loss: Minimize economic losses associated with crop damage, which can be significant for farmers.

Efficiency: Implement a system that operates autonomously or with minimal human intervention, reducing the need for constant monitoring and intervention.

Species Identification: Develop the capability to identify and classify the types of animals responsible for crop damage.

Real-time Alerts: Provide farmers with real-time alerts or notifications when animal activity is detected, enabling prompt response.

Cost-effectiveness: Design a system that is cost-effective and sustainable, aiming to improve the economic viability of farming operations.

Environmental Sustainability: Minimize the enviro2nmental impact of crop protection measures,such as using eco-friendly deterrents and renewable energy sources.

Data Collection and Analysis: Gather data on animal behavior and crop protection efficacy to improve the system's performance over time.

User-friendliness: Ensure that the system is user-friendly and can be easily maintained and operated by farmers.

Adaptability: Design the system to be adaptable to different types of crops, regions, and animal threats.

Overall, the project aims to provide an intelligent and automated solution to protect crops, reduce losses, and enhance agricultural sustainability while addressing the specific challenges posed by animal interference in agriculture.

1.3 AIM OF THE PROJECT

The aim of the "Smart Crop Protection" project is to address the persistent and economically devastating issue of crop damage caused by animal and bird intrusions in agricultural settings. The primary objective is to provide an innovative, humane, and efficient solution that leverages the power of artificial intelligence and computer vision to safeguard crops and, by extension, the livelihoods of farmers.

The overarching goal is to significantly reduce the losses incurred by farmers due to animal damage, thereby enhancing food security and economic stability for agricultural communities. As traditional methods of protection, such as physical barriers and manual surveillance, often prove impractical and expensive, this project aims to offer a cost-effective and scalable alternative.

The project's specific objectives include the development of an AI-based system capable of real-time animal and bird detection using the YOLOv3 model and the COCO dataset. This system is designed to operate with the aid of a webcam, continuously monitoring the farmland and responding to intruding creatures. When an animal is detected, the system generates and plays deterrence sounds, creating an environment that discourages further incursions.

By providing a comprehensive solution that combines advanced technology with real-world agricultural challenges, the project seeks to not only protect crops but also empower farmers with a tool that is environmentally friendly and sustainable. In doing so, it aims to contribute to the well-being and prosperity of farming communities, ultimately promoting a more secure and resilient agricultural future.

In summary, the aim of the "AI-Based Scarecrow for Crop Protection" project is to revolutionize crop protection methods by harnessing the capabilities of artificial intelligence, computer vision, and audio deterrence, with the ultimate objective of minimizing crop damage, reducing financial losses, and improving the quality of life for farmers facing the persistent threat of animalintrusions.

1.3.1 SIGNIFICANCE

In the context of a project report on "Smart Crop Protection: Protecting Crops from Animals," the significance section highlights why the project is important and the potential impact it can have. Here are some points to consider when discussing the significance of the project:

1. Agricultural Importance: Explain the critical role of agriculture in ensuring food security and meeting the nutritional needs of a growing global population. Emphasize the importance of protecting crops from damage to ensure a stable food supply

2. Economic Impact: Discuss the economic significance of crop protection. Crop damage by animals can result in substantial financial losses for farmers. Highlight how smart crop protection can lead to cost savings and increased agricultural productivity.

3. Environmental Impact: Address the environmental significance of the project. Detail how traditional methods of crop protection, such as chemical pesticides, can have negative environmental consequences. Explain how smart crop protection methods can offer more sustainable and environmentally friendly solutions.

4. Sustainability: Highlight the importance of sustainability in agriculture. Explain how smart crop protection aligns with sustainable farming practices, reducing the need for harmful chemicals and minimizing the environmental footprint.

5.Global Food Security: Discuss the broader implications of the project for global food security. Emphasize how effective crop protection contributes to a more stable and secure food supply chain, which is especially important in regions prone to food shortages.

6.Reducing Conflict: In some regions, crop damage by animals can lead to conflicts between farmers and wildlife. Smart crop protection can help mitigate such conflicts, promoting peaceful coexistence.

7.Innovation and Technology: Address the significance of technological innovation in agriculture. The project represents an opportunity to showcase how modern technology can address longstanding agricultural challenges.

8. Empowering Farmers: Explain how smart crop protection can empower farmers with better tools and data to protect their livelihoods, making agriculture a more attractive and viable profession.

9.Research and Development: Highlight the importance of research and development in finding sustainable solutions to agricultural challenges. The project contributes to the ongoing quest for innovative farming methods.

10.Human-Animal Coexistence: Discuss the significance of promoting coexistence between humans and wildlife. Smart crop protection methods contribute to conservation efforts and biodiversity preservation.

CHAPTER 2

LITERATURE SURVEY

Langar Zadeh, M., & Moghbeli, F. (2016). Applying Naive Bayesian Networks to Disease Prediction: a Systematic Review. Acta Informatica Medica, 24(5), 364.This paper aims to review published evidence about the application of NBNs in predicting disease and it tries to show NBNs as the fundamental algorithm for the best performance in comparison with other algorithms. PubMed was electronically checked for articles published between 2005 and 2015. For characterizing eligible articles, a comprehensive electronic searching method was conducted. Inclusion criteria were determined based on NBN and its effects on disease prediction. A total of 99 articles were found. After excluding the duplicates (n= 5), the titles and abstracts of 94 articles were skimmed according to the inclusion criteria. Finally, 38 articles remained. They were reviewed in full text and 15 articles were excluded. Eventually, 23 articles were selected which met our eligibility criteria and were included in this study.

- Machine Learning Techniques for Classification of Diabetes and Cardiovascular Diseases. **Berina Et Al.**
- The overview of machine learning techniques in classification of diabetes and cardiovascular diseases (CVD) using Artificial Neural Networks (ANNs) and BayesianNetworks (BNs). The comparative analysis was performed on selected papers that are published in the period from 2008 to 2017. The most commonly used type of ANN in selected papers is multilayer feedforward neural network with Levenberg-Marquardt learning algorithm.
- Automatic Diagnosis of Diabetic Retinopathy, Dinu A.JEt Al.
- DME is one of the largest causes of visual loss in diabetes. There are various machine learning algorithms that can be used to improve the accuracy of diagnosis of diabetic retinopathy.

2.1 EXISTING SYSTEM

The existing system for crop protection against animal intrusions predominantly relies on traditional and often labor-intensive methods that, while widely employed, have notable limitations. In many agricultural settings, the absence of efficient and automated protection mechanisms leaves farmlands vulnerable to a variety of animal threats, including buffalos, cows, goats, birds, and other wildlife. Among the most common practices is the physical fencing of fields, which can be costly to install and maintain, particularly in vast agricultural areas. Electric fencing is another approach, but it poses safety risks and can be impractical in certain locations. Manual surveillance, where farmers or guards must be stationed on the fields around the clock, is a resource-intensive method, often fraught with human error, fatigue, and potential lapses in monitoring.

To further exacerbate the issue, these traditional methods offer little in terms of automated deterrence. They can signal the presence of animals, but they do not provide a proactive response to discourage intrusions. Effigies and scarecrows, though widely used, are largely effective against birds but have limited utility in deterring larger animals. The lack of a comprehensive system that combines real-time monitoring, automated detection, and proactive deterrence results in substantial crop damage, leading to significant economic losses for farmers and threatening food security in many regions.

This existing system is marked by its inefficiency, high maintenance costs, and, in some cases, a negative impact on the environment. To address these limitations and provide a more holistic and effective approach to crop protection, the "AI-Based Scarecrow for Crop Protection" project aims to revolutionize existing methods by introducing a technology-driven solution that leverages artificial intelligence, computer vision, and audio deterrence. This innovative system not only enhances crop protection but also offers a more cost-effective and sustainable alternative to the challenges posed by traditional approaches. In recent times, researches are taken to solve this problem using Artificial Intelligence. Limitations of Existing System

- Electric fences are dangerous to animals and humans.
- IOT based Sensor monitoring doesn’t provide accurate results

Existing Drawbacks

- Fences causes damage to human also
- Electric fences are dangerous to animals
- Arranging fences is consumes more power
- Construction takes more time
- Fences occupies more place for construction

2.2 PROPOSED SYSTEM

The proposed system, the "Smart Crop Protection," represents a cutting-edge and holistic approach to safeguarding agricultural crops from animal and bird intrusions. It is designed to overcome the limitations of existing methods and introduce an innovative, efficient, and humane solution that leverages advanced technology to protect farmlands.

The core of the proposed system revolves around real-time monitoring and proactive deterrence. The system uses a webcam as the "eyes" of the farmland, capturing live video feeds continuously. These video feeds are then processed in real-time by an "Object Detection Software" that employs the YOLOv3 model and the COCO dataset to detect and classify animals and birds. This dynamic and automated detection mechanism allows for swift identification of intruding creatures.

Once an intruding animal is detected, the system activates an "Animal Tracking Software" that monitors and tracks the animal's movements within the field of view. This tracking mechanism is crucial for a real-time response to the animal's actions.In response to detected animal intrusions, the "Audio Generation Software" generates and plays deterrence sounds. These audio cues, designed to resemble sounds of animal extermination, are emitted through "Speakers" installed in the farmland. This audio deterrence serves as a proactive measure to discourage animals from approaching the crops further.

The proposed system aims to offer several advantages over traditional methods. It is cost-effective, scalable, and environmentally friendly. By integrating technology with agriculture, it enhances crop protection, minimizes losses due to animal damage, and contributes to the economic stability and food security of farming communities.

In summary, the proposed system represents a significant advancement in crop protection methods. It addresses the limitations of existing approaches by introducing an AI-driven solution that combines real-time monitoring, automated detection, and proactive deterrence. This holisticsystem is designed to revolutionize the protection of farmlands and empower farmers with a moreeffective and sustainable means of safeguarding their crops.

Advantages

- Efficient detection
- Proactive deterrence
- Real-time monitoring
- Cost-effective
- Scalable
- Environmentally friendly
- Reduced labor dependency
- Enhanced food security
- Economic stability
- Technology integration
- Customization
- Environmental conservation

2.2.1 YOLOv3 ALGORITHM:

YOLOv3, short for "You Only Look Once, Version 3," stands as a formidable advancement in real-time object detection, revolutionizing computer vision applications. It achieves this by promptly identifying and localizing specific objects within videos, live feeds, or images. This game-changing algorithm has its roots in the work of Joseph Redmon and Ali Farhadi, who were the masterminds behind Versions 1 to 3 of YOLO. The journey began with the inception of the first version in 2016 and culminated in the release of YOLOv3 in 2018, the focal point of this discussion.

YOLOv3 is much more than just an evolution of its predecessors; it represents a significant leap in the realm of object detection. By leveraging the power of deep learning, YOLOv3 employs a Deep Convolutional Neural Network (CNN) to extract and learn intricate features, enabling it to discern objects with remarkable precision and speed. Unlike its predecessors, YOLOv3 brings several enhancements, including improved accuracy, a larger number of classes it can recognize, and refined detection capabilities.

One of YOLOv3's defining characteristics is its capacity for handling a diverse array of objects simultaneously. This is achieved through an object detection process that partitions the input image into a grid, and each grid cell predicts bounding boxes and the probability of an object's presence within its boundaries. These predictions are refined with the help of anchor boxes, which further boost detection accuracy. Such multi-class detection is especially valuable in scenarios demanding the identification of various objects within a single frame, such as traffic surveillance and robotics.

Speed is another hallmark feature of YOLOv3, making it an ideal choice for real-time applications. This efficiency arises from its ability to process images or video streams swiftly, rendering it suitable for use in autonomous vehicles, surveillance systems, and any context where timely object detection is critical. The model's rapid performance ensures that it can keep up with dynamic scenes and provide immediate feedback to the system it serves.

In practice, YOLOv3 finds extensive application in numerous real-world scenarios, including the automotive industry, industrial automation, and security systems. Its versatility, stemming from pretraining on comprehensive datasets like the COCO dataset (short for "Common Objects In Context"), empowers it to identify an extensive range of objects across different domains. COCO dataset, renowned for its high-quality and challenging datasets, serves as a benchmark for state-of-the-art neural networks. As a result, YOLOv3 is celebrated for its role in pushing the boundaries of computer vision capabilities and is an indispensable tool for countless computer vision projects and applications.

In summary, YOLOv3's legacy extends beyond its predecessors as it combines the power of deep learning with real-time efficiency and multi-class object detection. Its wide-ranging applications make it a cornerstone in the field of computer vision, enabling innovative solutions in a multitude of industries.

Coco. Names Dataset: The COCO dataset, which stands for "Common Objects In Context," is a highly regarded collection of challenging and high-quality datasets designed for computer vision tasks. It is widely recognized for its comprehensive and diverse content, which serves as a valuable resource for training and evaluating state-of-the-art neural networks. The name "COCO" is not only associated with the dataset itself but is also used to denote the specific format in which datasets are organized and presented. COCO has become a standard benchmark for the development and assessment of computer vision models and algorithms, contributing significantly to advancements in object recognition, image segmentation, and related fields of research.

2.3 SCOPE OF THE PROJECT

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 measures, these villagers are left helpless to their fate. Also the crops of villagers are 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.

In contemporary agricultural landscapes, one of the most pressing and ubiquitous social issues facing rural communities across South India is the relentless assault on crops by wildlife. The adversaries in this ongoing battle are as diverse as they are formidable, ranging from the agile deer and cunning monkeys to the awe-inspiring giants like elephants. Their relentless foraging wreaks havoc on the livelihoods of countless farmers, prompting a sense of urgency and a call for an effective and immediate solution to this profound problem. The plight of rural communities is particularly dire, as they grapple with the destructive onslaught of these wild animals on their precious crops. The situation has grown increasingly dire, with frequent stories of animal attacks reverberating through the agricultural heartland of the country. This wave of destruction is fueled by the lack of a robust and comprehensive detection and deterrent system that could protect the crops and, by extension, the very livelihoods of these communities.

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CHAPTER 3
SYSTEM DESIGN

3.1 IMPORTANCE OF DESIGN

The purpose of the design phase is to plan a solution of the problem specified by the requirement document. It is the process of defining software methods, functions, objects and overall structure and interaction of your code so that the resulting functionality will satisfy your users requirements. It allows you to do the best abstraction, to understand the requirements better and meet them better.

This prevents redundancy and increases reusability. This phase is the first step in moving from the problem domain to the solution domain. In other words, starting with what is needed, design takes us towards how to satisfy the needs. The design of a system is perhaps the most critical factor affection the quality of the software; it has a major impact on the later phase, particularly testing, maintenance.

The output of this phase is the design document. This document is similar to a blueprint for the solution and is used later during implementation, testing and maintenance. The design activity is often divided into two separate phases System Design and Detailed Design.
System Design also called top-level design sign aims to identify the modules that should be in the system, the specifications of these modules, and how they interact with each other to produce the desired results. During, Detailed Design, the internal logic of each of the modules specification in system design is decided. During this phase, the details of the data is usually specified in a high-level design description language, which is independent of the target language in which the software will eventually be implemented. In system design the focus is on identifying the modules, whereas during detailed design the focus is on designing the logic for each of the modules. During the 13 system design activities, Developers bridge the gap between the requirements specification, produced during requirements elicitation and analysis, and the system that is delivered to the user.

3.2 UML DIAGRAMS:

Unified Modeling Language (UML) is a standardized general purpose modeling language in the field of object-oriented software engineering. The standard is managed and was created by the Object Management Group (OMG). It was first added to the list of OMGS adopted technologies in 1997, and has since become the industry standard for modeling software intensive systems.

UML is a language which provides vocabulary and the rules for combining words in that vocabulary for the purpose of communication. A modeling language is a language whose vocabulary and the rules focus on the conceptual and physical representation of a system. Modeling yields an understanding of a system. The UML is used to specify, visualize, modify, construct and document the artifacts of an object0oriented software intensive system under development.

The Unified Modeling Language (UML) is used to specify, visualize, modify, construct and document the artifacts of an object-oriented software intensive system under development. UML offers a standard way to visualize a system's architectural blueprints, including elements such as:

- Actors
- Business processes
- (logical) Components
- Activities
- Programming Language Statements
- Database Schemes
- Reusable software components

UML combines best techniques from data modeling (entity relationship diagrams), business modeling (work flows), object modeling, and component modeling. It can be used with all processes, throughout the software development life cycle, and across different implementation technologies· UML has synthesized the notations of the Booch method, the Object-modeling technique (OMT) and Object-oriented software engineering (OOSE) by fusing them into a single, common and widely usable modeling language. UML aims to be a standard modeling language which can model concurrent and distributed systems. Unified Modeling Language (UML) diagrams are a set of graphical notations used for modeling, visualizing, and documenting software systems. They help in understanding, designing, and communicating the structure and behavior of a system. There are several types of UML diagrams, each serving a specific purpose. Here are some common UML diagrams:

Use Case Diagrams: These illustrate the interactions between a system and its users, showing the system's functionality from a user's perspective.

Class Diagrams: These depict the structure of a system, including classes, attributes, methods, and their relationships. They are used for modeling the static aspects of a system.

Object Diagrams: These show a snapshot of the system at a specific point in time, highlighting instances of classes and their relationships.

Sequence Diagrams: Sequence diagrams represent the interactions between objects in a chronological order, showing the dynamic behavior of a system.

Activity Diagrams: These illustrate the flow of activities or processes within a system, providing a detailed view of the workflow.

State Machine Diagrams: State machine diagrams depict the different states that an object can be in and how it transitions between these states.

Component Diagrams: These display the physical components of a system and their relationships. They are useful for showing the organization of the code and system architecture.

Deployment Diagrams: Deployment diagrams depict the physical deployment of software components on hardware nodes, such as servers and devices.

Package Diagrams: Package diagrams show how various elements are organized into packages, helping manage the complexity of large systems.

Collaboration Diagrams: Collaboration diagrams (formerly known as communication diagrams) illustrate the interactions and relationships between objects in a system.

These UML diagrams are widely used in software engineering and system design to facilitate communication and understanding among stakeholders, including developers, designers, and project managers. The choice of which diagram to use depends on the specific aspect of the system you want to model or communicate.

3.2.1 USE CASE DIAGRAM

The use case view of a system encompasses the use cases that describe the behavior of the systemas seen by its end users, analysts, and testers. This view doesn't really specify the organization of a software system. Rather, it exists to specify the forces that shape the system's architecture. With the UML, the static aspects of this view are captured in use case diagrams; the dynamic aspects of this view are captured in interaction diagrams, state chart diagrams, and activity diagrams. To model a system the most important aspect is to capture the dynamic behavior. Use case diagrams are central to modeling the behavior of a system, a subsystem, or a class. Each one shows a set of use cases and actors and their relationships. Used to get an outside view of a system.

- Identify external and internal factors influencing the system.
- Show the interacting among the requirements are actors. The two actors are camera and animal. The functions that can be performed by the driver are start detection, stop detection, receive alert, view eye status and view score. The functions performed by the camera are analyzing animal structure eye and identifying.

A Use Case is a kind of behavioral classifier that represents a declaration of an offered behavior. Each use case specifies some behavior, possibly including variants that the subject can perform in collaboration with one or more actors.
Use cases define the offered behavior of the subject without reference to its internal structure. These behaviors, involving interactions between the actor and the subject, may result in changesto the state of the subject and communications with its environment. A use case can include possible variations of its basic behavior, including exceptional behavior and error handling.

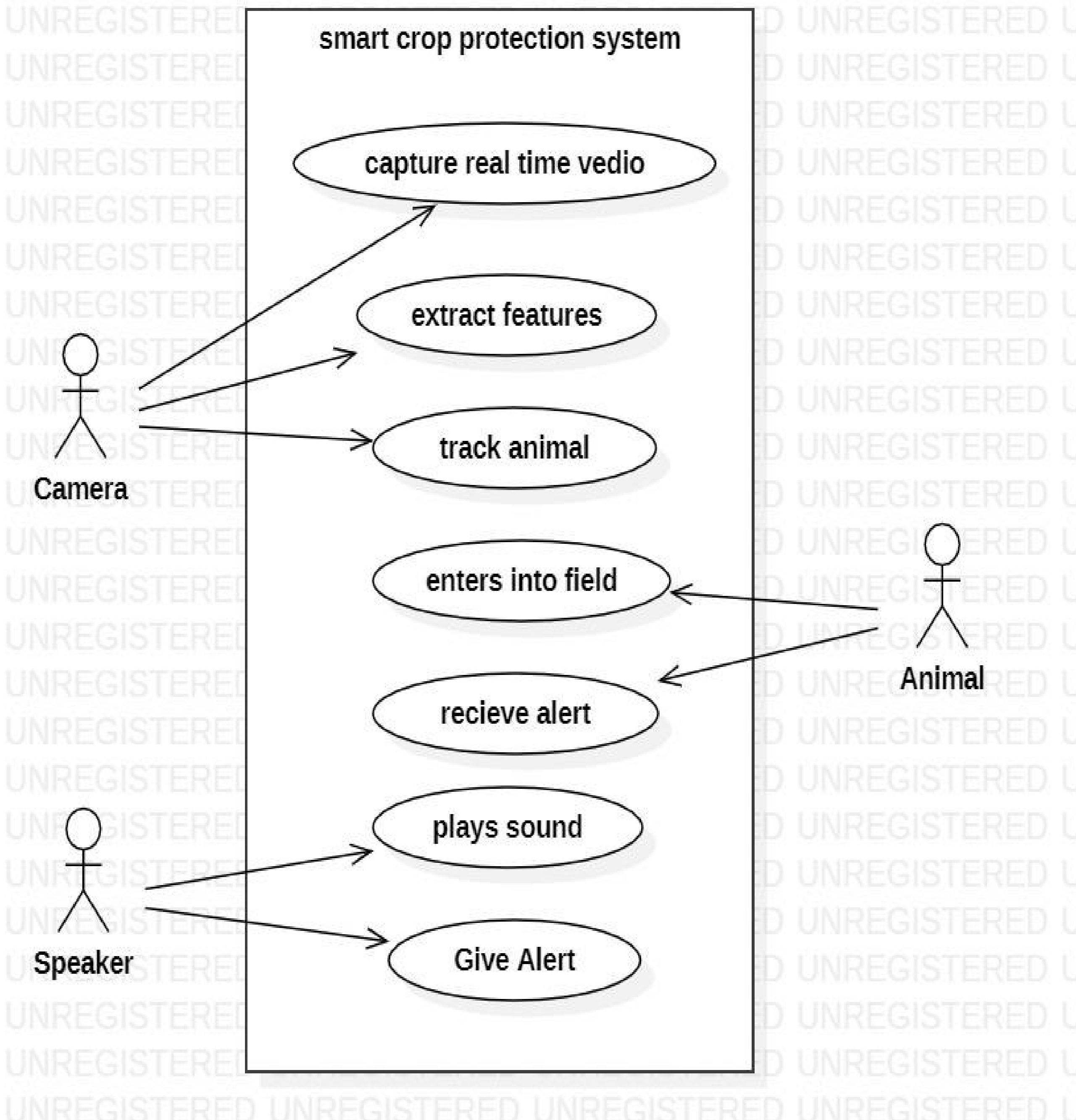

Figure 3.2.1 Use case Diagram for smart crop protection System

3.2.2 SEQUENCE DIAGRAM

The sequence diagram is used to primarily show the interaction between objects in the sequential order that those interaction occur. Much like the class diagram, developers typically think sequence diagrams were meant exclusively for them. However, an organization business staff can find sequence diagrams useful to communicate.

In a sequence diagram, participants, represented as vertical lines or boxes, play a crucial role in visualizing and documenting interactions between various objects or components in a system. These participants can be objects, classes, components, or external actors, each depicting an entity involved in the sequence of interactions. Lifelines, depicted as vertical lines with the participant's name or identifier at the top, signify the existence of a participant over a period of time, showing when they are actively engaged in the interaction.

Sequence Diagram Notations

Actors – An actor in a UML diagram represents a type of role where it interacts with the system and its objects. It is important to note here that an actor is always outside the scope of the system we aim to model using the UML diagram.

Lifelines – A lifeline is a named element which depicts an individual participant in a sequence diagram. So basically, each instance in a sequence diagram is represented by a lifeline. Lifeline elements are located at the top in a sequence diagram. The standard in UML for naming a lifeline follows the following format – Instance Name: Class Name

Messages – Communication between objects is depicted using messages. The messages appear in a sequential order on the lifeline. We represent messages using arrows. Lifelines and messages form the core of a sequence diagram. Messages can be broadly classified into the following categories:

Synchronous messages – A synchronous message waits for a reply before the interaction can move forward. The sender waits until the receiver has completed the processing of the message. The caller continues only when it knows that the receiver has processed the previous message i.e. it receives a reply message. A large number of calls in object-oriented programming are synchronous. We use a solid arrow head to represent a synchronous message.

Asynchronous Messages – An asynchronous message does not wait for a reply from the receiver. The interaction moves forward irrespective of the receiver processing the previous message or not. We use a lined arrow head to represent an asynchronous message.

Self Message – Certain scenarios might arise where the object needs to send a message to itself. Such messages are called Self Messages and are represented with a U-shaped arrow. Figure – self message for example – Consider a scenario where the device wants to access its webcam. Such a scenario is represented using a self message.

Reply Message – Reply messages are used to show the message being sent from the receiver to the sender. We represent a return/reply message using an open arrowhead with a dotted line. The interaction moves forward only when a reply message is sent by the receiver. Figure – reply message for example – Consider the scenario where the device requests a photo from the user. Here the message which shows the photo being sent is a reply message.

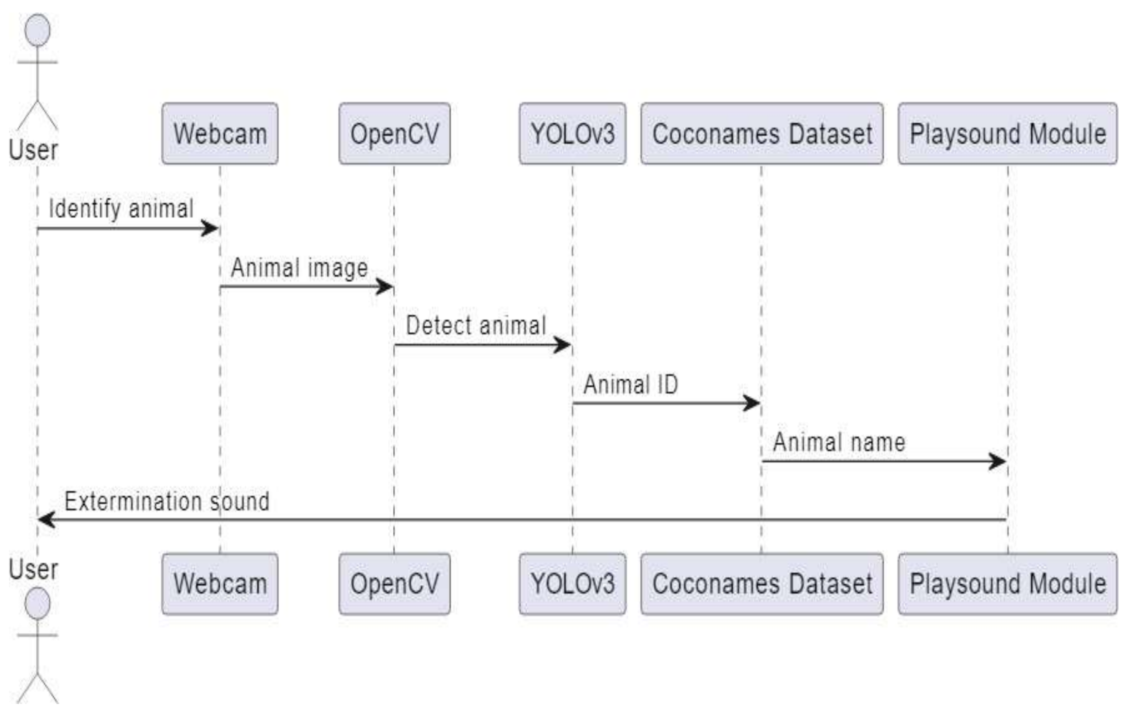

Figure 3.2.2 Sequence Diagram for smart crop protection System

3.2.3 ACTIVITY DIAGRAM

Activity diagram describes the workflow behavior of a system. Activity diagrams are similar to state diagrams because activities are the state of doing something. The diagrams describe the state of activities by showing sequence of activities performed. Activity diagram can show activities that are conditional or parallel. Activity diagrams should be used in conjunction with other modeling techniques such as interaction diagrams, state diagrams.

The main reason to use activity diagram is to model the workflow behind the system being designed. An activity diagram portrays the control flow from a start point to a finish point showing the various decision paths that exist while the activity is being executed.

We use Activity Diagrams to illustrate the flow of control in a system and refer to the steps involved in the execution of a use case. We model sequential and concurrent activities using activity diagrams. So, we basically depict workflows visually using an activity diagram. An activity diagram focuses on condition of flow and the sequence in which it happens. We describe or depict what causes a particular event using an activity diagram. UML models basically three types of diagrams, namely, structure diagrams, interaction diagrams, and behavior diagrams. An activity diagram is a behavioral diagram i.e. it depicts the behavior of a system. An activity diagram portrays the control flow from a start point to a finish point showing the various decision paths that exist while the activity is being executed. We can depict both sequential processing and concurrent processing of activities using an activity diagram. They are used in business and process modelling where their primary use is to depict the dynamic aspects of a system. An activity diagram is very similar to a flowchart. So let us understand if an activity diagrams or flowcharts are any different,

Notation of an Activity diagram

Activity diagram constitutes following notations:

Initial State: It depicts the initial stage or beginning of the set of actions.

Final State: It is the stage where all the control flows and object flows end.

Decision Box: It makes sure that the control flow or object flow will follow only one path.

Action Box: It represents the set of actions that are to be performed

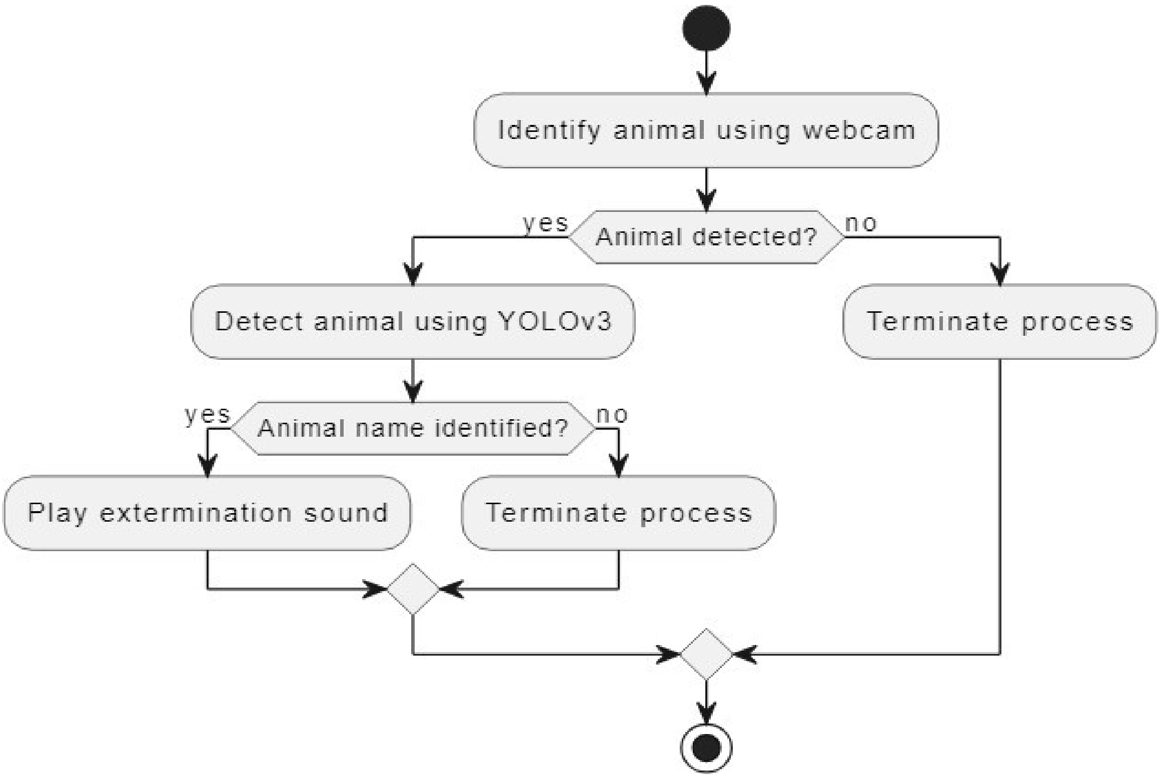

Figure 3.2.3 Activity Diagram for smart crop protection System

3.2.4 CLASS DIAGRAM

Class diagrams are one of the most useful types of diagrams in UML as they clearly map out the structure of a particular system by modeling its classes, attributes, operations, and relationships between objects. A Class Diagram in Unified Modeling Language the (UML) is a type of static structure diagram that describes the structure of a system by showing the system's classes, their attributes, operations (or methods), and the relationships among objects.

The class diagram is the main building block of object- o r i e n t e d modeling. It is used forgeneral conceptual modelling of the structure of the application, and for detailed modeling, translating the models into programming code. Class diagrams can also be used for data modelling. The classes in a class diagram represent both the main elements, interactions in the application, and the classes to be programmed.

In the diagram, classes are represented with boxes that contain three compartments.

- The top compartment contains the name of the class. It is printed in bold and centered, and the first letter is capitalized.
- The middle compartment contains the attributes of the class. They are left-aligned and the first letter is lowercase.
- The bottom compartment contains the operations the class can execute. They are also left-aligned and the first letter is lowercase.

The process to design class diagram: In Edraw max (or any other platform where class diagrams can be drawn) follow the steps:

- Open a blank document in the class diagram section.
- From the library select the class diagram and click on create option.
- Prepare the model of the class on the opened template page.
- After editing according to requirement save it.

There are several diagram components that can be efficiently used while making/editing the model. These are as follows:

Class {name, attribute, method}

Objects

Interface

Relationships {inheritance, association, generalization}

Associations {bidirectional, unidirectional}

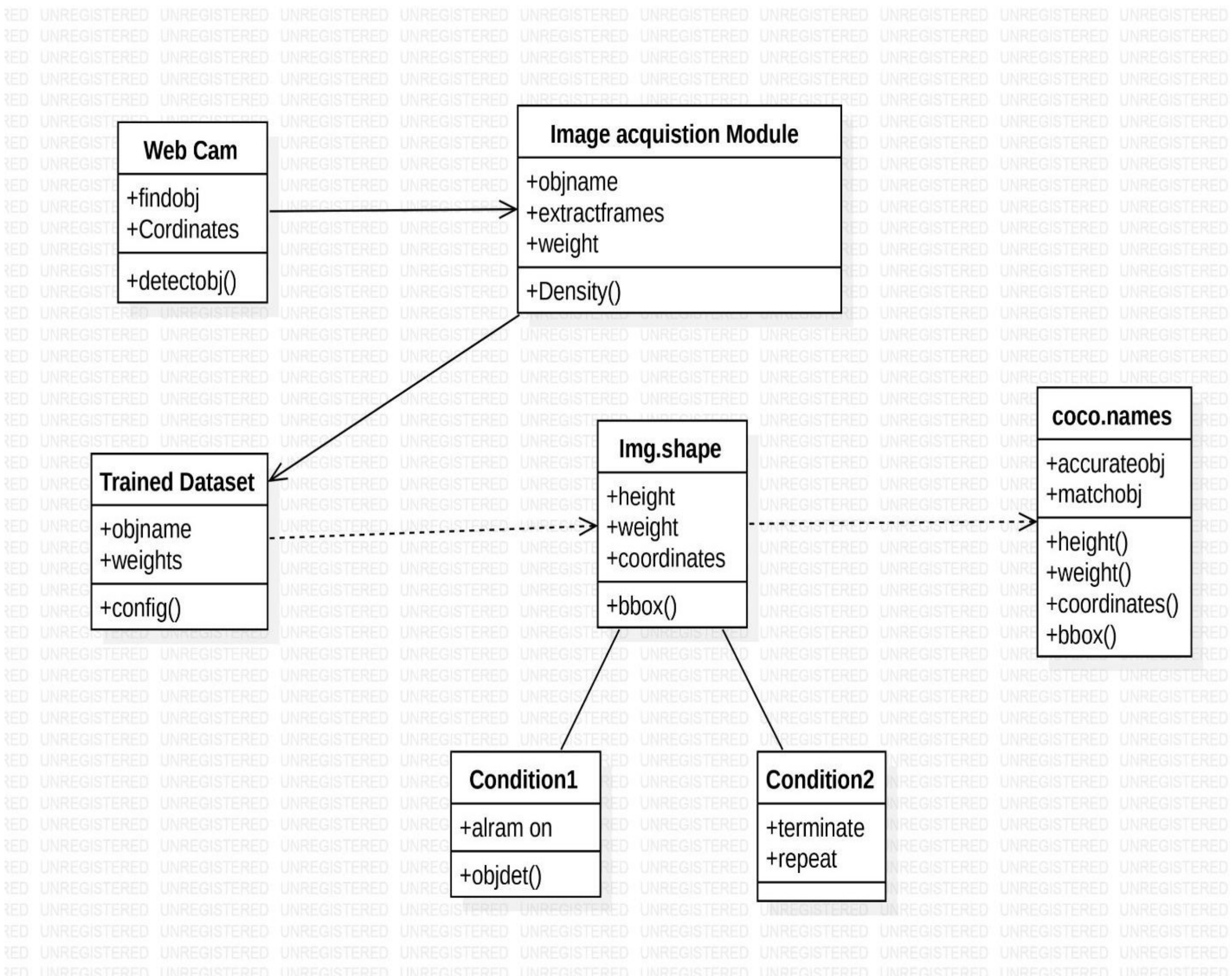

Figure 3.2.4 Class Diagram for smart crop protection System

3.2.5 DATAFLOW DIAGRAM

The data flow diagram (DFD) for the "AI-Based Smart for Crop Protection" project outlines the flow of data and information within the system. Here's an informative description of the DFD:
The system begins with the "Farmland," where the primary goal is to protect crops from animal damage. The "Webcam" serves as the initial data source, continuously capturing "Live Video Feed" from the farmland. These video feeds are then transmitted to the "Computer," which acts as the central processing unit.

Within the computer, the "Object Detection Software" takes charge, analyzing the live video feeds. It employs the YOLOv3 model and the COCO dataset to identify and classify animals and birds in real-time. Detected animals are communicated to the "Animal Tracking Software," which monitors their movements and actions. When an intruding animal is detected and tracked, the "Audio Generation Software" comes into play. It generates deterrence sounds, resembling those of animal extermination, which are played through the "Speakers" installed in the farmland. This audio output is a crucial component of the deterrence mechanism.

This DFD demonstrates the seamless flow of data and information, showcasing how the "AI-Based Scarecrow" system collaborates to detect and deter animals, safeguarding the crops effectively. It highlights the integration of hardware, software, and real-time data analysis to protect farmlands from animal damage.

Explanation:

- The DFD starts with the "Web Camera" as the primary data source, capturing "Video Feed" from the farmland.
- The "Computer" processes the "Live Video" and serves as the central processing unit.
- The "Object Detection Software" analyzes the video feed to detect and classify animals and birds.
- Detected animals are then transferred to the "Animal Tracking Software" for monitoring.
- The "Audio Generation Software" generates deterrence sounds when intruding animals are detected.
- The deterrence sounds are played through the "Speakers" installed in the farmland to deter animals.

This simplified DFD provides a high-level overview of how data and information flow through the system's components, showing how the project's key elements collaborate to detect and deter animals, thereby protecting the crops. In a real implementation, additional details and data flow paths might exist for improved functionality.

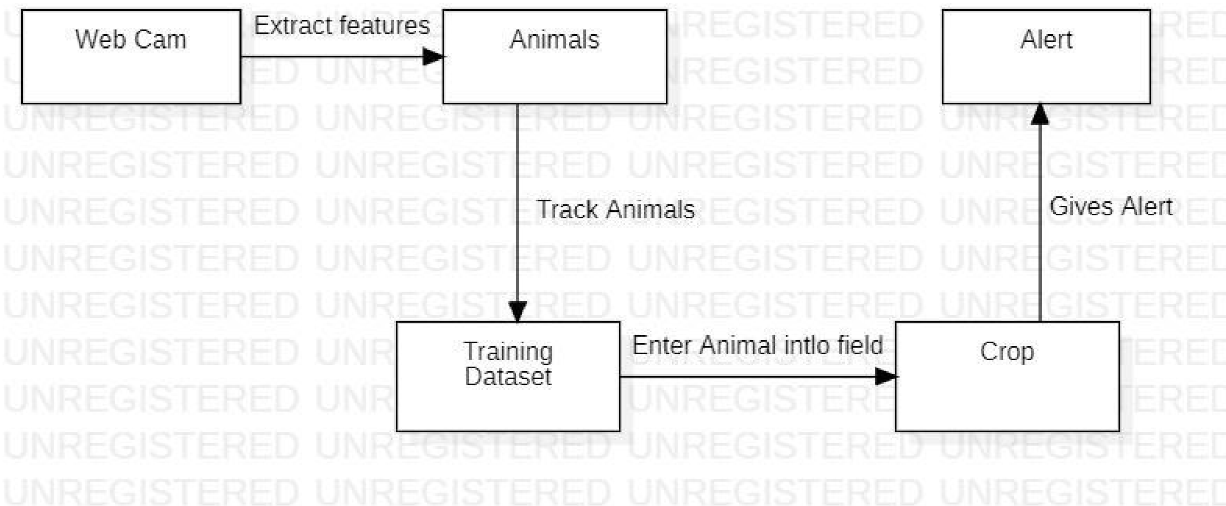

Figure 3.2.5 Dataflow Diagram for smart crop protection System

3.2 SYSTEM ARCHITECTURE

The system architecture for the "AI-Based Smart Crop Protection" project is a structured framework that outlines the components and their interactions. This architecture is crucial for the successful development and implementation of the project. It encompasses hardware, software, and data flow. Here is an overview of the system architecture:

A system architecture diagram would be used to show the relationship between different components. Usually they are created for systems which include hardware and software and these are represented in the diagram to show the interaction between them. However, it can also be created for web applications. The absence of comprehensive, effective strategies to address this challenge exacerbates the problem. Without adequate protection, farmers face not only the loss of their primary source of income but also the risk of food scarcity in the region. Moreover, the frequent conflicts between farmers and wildlife, including deer, elephants, monkeys, and other animals, have broader ecological consequences, endangering the delicate balance of local ecosystems. The need to develop a sustainable, multifaceted solution to mitigate crop damage, protect livelihoods, and promote coexistence between farmers and wildlife in South India is pressing and demands immediate attention

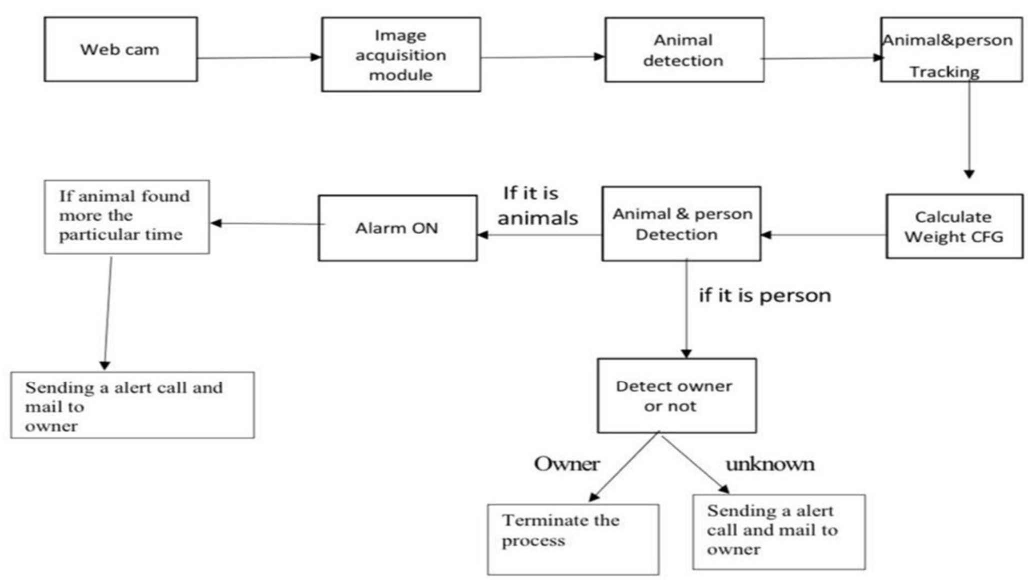

Fig. 3.2.6 System Architecture diagram for smart crop protection System

System Components

1. Webcam: The webcam is the primary hardware component that captures live video feeds from the farmland. It serves as the system's "eyes," continuously providing the video input for analysis.

2. Computer: The computer, equipped with suitable processing power, memory, and storage, hosts the software components and performs real-time video processing and object detection.

3. Object Detection Algorithms: This software module is responsible for processing the live video feeds and detecting animals and birds in real-time using the YOLOv3 model and the COCO dataset.

4. Animal Tracking Software: Once objects are detected, the animal tracking software is engaged to monitor the movements and actions of the identified animals. This tracking is essential for real-time response.

5. Audio Generation Modules: When an intruding animal is detected and tracked, the audio generation software is triggered. It generates and plays audio cues designed to deter the animals from approaching the crops.

6. Weight Configuration File (CFG): This file contains configurations and weights that fine-tune the YOLOv3 model for optimized object detection. It is an essential component to enhance accuracy.

System Workflow

The system's workflow can be summarized as follows:

1. Video Feed Acquisition: The webcam continuously captures live video feeds from the farmlandand sends them to the computer for processing.

2. Object Detection: The object detection software analyzes the video feed, leveraging the YOLOv3 model and the COCO dataset to identify and classify animals and birds.

3. Animal Tracking: Detected objects are tracked in real-time to monitor their movements and activities within the field of view.

4. Audio Deterrence: When an intruding animal is detected and tracked, the audio generation software is activated. It generates and plays an audio deterrence sound.

5.Real-Time Monitoring: The entire process is executed in real-time, allowing the system to continuously monitor the farmland and provide immediate deterrence when needed.

System Integration

The system components, including the webcam, computer, object detection, animal tracking, and audio generation software, work cohesively to create an integrated solution for crop protection. The weight configuration (CFG) file enhances the accuracy and efficiency of object detection, ensuring that the system effectively safeguards farmlands from animal damage.

This architecture ensures the timely detection and deterrence of intruding animals and provides a structured framework for the successful implementation of the project. The "AI-Based Scarecrow for Crop Protection" system architecture facilitates the creation of an automated, real-time crop protection solution that leverages technology to mitigate losses incurred by farmers due to animal damage.

3.3 FUNCTIONAL REQUIREMENTS

Hardware Requirements

- Windows 10
- Intel core i5@1.70GH processor
- 4GB RAM
- Web camera/ External camera
- Speakers
- Audio output interface
- Mounting hardware for the webcam
- Power source (e.g., electrical outlet or battery)

Software Requirements

- Python
- Open CV
- Play sound
- NumPy
- Operating system

CHAPTER 4
IMPLEMENTATION

4.1 MODULE DESCRIPTION

The proposed module to address the issue of crop damage by wild animals in South India encompasses a multi-faceted approach to protect farmers' livelihoods and promote coexistence with local wildlife. This comprehensive system consists of several key components.

First, it incorporates various crop deterrents and repellents, including visual and auditory scare tactics and the application of natural repellents, to discourage animals from entering fields.

Second, it emphasizes the use of fencing and barriers, which can range from traditional permanent fencing to more flexible electric fencing and trench-based barriers.

Third, the module advocates for the creation of designated wildlife corridors and buffer zones to redirect animals away from cultivated areas while also supporting natural habitat restoration. It further promotes farm guarding practices, utilizing human or canine presence to patrol fields and employing watchtowers for surveillance.

In addition, the implementation of early warning systems, including sensor-based technology and camera traps integrated with alarms, allows for timely response to potential threats. Collaboration within the farming community is encouraged, fostering knowledge sharing and collective action.

Government support is vital in the form of financial assistance and wildlife management programs. Moreover, research and education are key elements, providing farmers with insights into animal behaviour and ecology. Finally, promoting crop insurance as a risk mitigation strategy for farmers facing wildlife-related losses is an integral part of the module.

This comprehensive approach strives to protect crops, support rural communities, and ensure the conservation of local wildlife.

Applications

The proposed module for mitigating crop damage by wild animals in South India finds application across multiple sectors and stakeholders. In agriculture, farmers can directly implement the module's strategies to safeguard their crops from wildlife interference, ensuring economic stability and food security. Wildlife conservation organizations and government agencies can utilize the module to promote coexistence between humans and local wildlife, contributing to broader conservation goals.

Government authorities can draw from the module to formulate policies, allocate funds, and establish wildlife management programs that support affected farmers. Technology companies and startups can develop and market early warning systems and protective technology solutions to assist farmers. Educational institutions can use the module for teaching and research, while NGOs, community organizations, and environmental consulting firms can apply its principles to empower and guide rural communities in addressing crop damage and fostering sustainable agricultural practices. Additionally, international aid and development agencies can leverage the module to assist similar communities in different regions facing analogous challenges. In essence, the module's versatile applications extend to various sectors, facilitating collaborative efforts to address the complex issue of crop damage by wild animals while promoting sustainable coexistence.

1. Agriculture: Farmers in South India can directly apply this module to protect their crops from wildlife damage. They can implement deterrence, fencing, and other protective measures, and benefit from the knowledge and technology provided in the module to safeguard their agricultural livelihoods.

2. Wildlife Conservation: This module can be used by wildlife conservation organizations and government agencies to promote coexistence between human activities and local wildlife. By providing strategies for mitigating human-wildlife conflicts, it aids in wildlife conservation efforts.

3. Government and Policy: Government authorities can adopt and adapt this module to design policies and programs that support farmers facing crop damage issues. It can guide the allocation of funds for financial assistance, the establishment of wildlife management programs, and the creation of conservation policies.

4. Technology and Innovation: The early warning systems and technology integration aspects of the module can be developed and marketed by technology companies and startups. These solutions can be offered to farmers as products or services to protect their crops.

5. Education and Research: Educational institutions can use this module as a resource for teaching students about wildlife management, conservation, and sustainable agriculture. Researchers can conduct studies on the effectiveness of various strategies proposed in the module.

6. Non-Governmental Organizations (NGOs): NGOs focused on rural development and environmental protection can leverage this module to provide guidance and support to farming communities in South India. They can assist with the implementation of these strategies and the promotion of sustainable practices.

7. Crop Insurance Providers: Insurance companies can collaborate with farmers and government agencies to offer crop insurance products that align with the risk mitigation strategies outlined in the module.

8. Community Organizations: Local community organizations and cooperatives can use the module to coordinate efforts among farmers, promoting knowledge-sharing and collective action to protect their crops.

9. Environmental Consulting Firms: Companies specializing in environmental consulting can offer services to assess the local ecology and provide tailored wildlife management solutions based on the principles outlined in the module.

10. International Aid and Development Agencies: Organizations that focus on international development and agriculture can apply the module's principles and strategies to assist communities in South India and other regions facing similar challenges.

In essence, the applications of this module are wide-ranging and can be adapted to suit the specific needs and goals of different stakeholders involved in addressing the issue of crop damage by wild animals. The module serves as a versatile resource for mitigating this problem and promoting sustainability and coexistence.

4.2 Sample Code:.

```
import cv2
import numpy as np
import os
import pygame
from threading import Thread
import smtplib
from email.mime.text import MIMEText
from email.mime.multipart import MIMEMultipart
from email.mime.base import MIMEBase
from email import encoders
import time
from twilio.rest import Client

# Initialize pygame mixer
pygame.mixer.init()

# Global variables to track state
sound_playing = False
animal_detected = False
person_detected = False
start_time_animal = None
start_time_person = None
detected_animal_name = None  # Variable to store the name of the detected animal

# Email configuration
email_user = 'agriculture19092002@gmail.com'
email_password = 'cppu iywx lagm kstk'
email_send = 'marrianilkumar19@gmail.com'

# Twilio configuration
account_sid = 'AC6200b2aa63018ea521a6870074630416'
auth_token = 'b6aec52693a5ae60b27d647a34d272ed'
twilio_number = '+13059308868'
farmer_number = '+919347977098'

# Animal detection model configuration
cap = cv2.VideoCapture(0)
wht = 640  # Increased frame width and height for better interface
hgt = 480
confThreshold = 0.5
nmsThreshold = 0.3

classesFile = r'C:\Users\Anil kumar Marri\OneDrive\Desktop\myexp\coco.names'
modelConfi = r'C:\Users\Anil kumar Marri\OneDrive\Desktop\myexp\yolov3.cfg'
modelwei = r'C:\Users\Anil kumar Marri\OneDrive\Desktop\myexp\yolov3.weights'

classNames = []
with open(classesFile, 'rt') as f:
    classNames = f.read().rstrip('\n').split('\n')
```

```
net = cv2.dnn.readNetFromDarknet(modelConfi, modelwei)
net.setPreferableBackend(cv2.dnn.DNN_BACKEND_OPENCV)
net.setPreferableTarget(cv2.dnn.DNN_TARGET_CPU)

# Face recognition model configuration
face_cascade = cv2.CascadeClassifier(cv2.data.haarcascades + 'haarcascade_frontalface_default.xml')
registered_face_image_path = r"C:\Users\Anil kumar Marri\OneDrive\Pictures\Camera
Roll\WIN_20240911_12_35_55_Pro.jpg"
registered_face_img = cv2.imread(registered_face_image_path, cv2.IMREAD_GRAYSCALE)

registered_face_cascade = face_cascade.detectMultiScale(registered_face_img, scaleFactor=1.1,
minNeighbors=5, minSize=(30, 30))
if len(registered_face_cascade) == 0:
    raise ValueError("No face detected in the registered image.")

x, y, w, h = registered_face_cascade[0]
registered_face = registered_face_img[y:y+h, x:x+w]

# ORB detector for face recognition
orb = cv2.ORB_create()
keypoints1, descriptors1 = orb.detectAndCompute(registered_face, None)
bf = cv2.BFMatcher(cv2.NORM_HAMMING, crossCheck=True)

# Function to play sound based on animal type
def play_sound(sound_path):
    global sound_playing
    sound_playing = True
    try:
        pygame.mixer.music.load(sound_path)
        pygame.mixer.music.play()
        while pygame.mixer.music.get_busy():
            time.sleep(1)
    except Exception as e:
        print(f"Failed to play sound: {e}")
    sound_playing = False

# Function to send email
def send_email(subject, body, attachment_path=None):
    msg = MIMEMultipart()
    msg['From'] = email_user
    msg['To'] = email_send
    msg['Subject'] = subject

    msg.attach(MIMEText(body, 'plain'))

    if attachment_path:
        # Open the file in binary mode
        with open(attachment_path, 'rb') as attachment:
            part = MIMEBase('application', 'octet-stream')
            part.set_payload(attachment.read())
```

```
            encoders.encode_base64(part)  # Encode the payload
            part.add_header('Content-Disposition', f'attachment; filename=
{os.path.basename(attachment_path)}')
            msg.attach(part)

    try:
        server = smtplib.SMTP('smtp.gmail.com', 587)
        server.starttls()
        server.login(email_user, email_password)
        text = msg.as_string()
        server.sendmail(email_user, email_send, text)
        server.quit()
        print("Email sent successfully")
    except Exception as e:
        print(f"Failed to send email: {e}")

# Function to make phone call
def make_phone_call():
    client = Client(account_sid, auth_token)
    try:
        call = client.calls.create(
            twiml='<Response><Say>Alert: An issue has been detected on your property. Please check
immediately.</Say></Response>',
            from_=twilio_number,
            to=farmer_number
        )
        print("Call initiated successfully")
    except Exception as e:
        print(f"Failed to make phone call: {e}")

# Function to handle object detection
def findobj(outputs, img):
    global animal_detected, start_time_animal, detected_animal_name

    ht, wt, ct = img.shape
    bbox = []
    classIds = []
    confs = []
    detected = False

    for output in outputs:
        for det in output:
            scores = det[5:]
            classId = np.argmax(scores)
            confidence = scores[classId]
            if confidence > confThreshold:
                w, h = int(det[2] * wt), int(det[3] * ht)
                x, y = int((det[0] * wt) - w / 2), int((det[1] * ht) - h / 2)
                bbox.append([x, y, w, h])
                classIds.append(classId)
                confs.append(float(confidence))
```

```
            detected = True

    indices = cv2.dnn.NMSBoxes(bbox, confs, confThreshold, nmsThreshold)

    if len(indices) > 0:
        for i in indices.flatten():
            box = bbox[i]
            x, y, w, h = box[0], box[1], box[2], box[3]
            cv2.rectangle(img, (x, y), (x + w, y + h), (255, 0, 255), 2)
            cv2.putText(img, f'{classNames[classIds[i]].upper()} {int(confs[i] * 100)}%', (x, y + 10),
                        cv2.FONT_HERSHEY_SIMPLEX, 0.6, (255, 0, 2))
            detected_animal_name = classNames[classIds[i]]  # Store the detected animal's name

            if detected_animal_name in ["bird", "horse", "cow", "elephant", "bear", "zebra", "giraffe"]:
                if not sound_playing:
                    Thread(target=play_sound, args=(r'C:\Users\Anil kumar
Marri\OneDrive\Desktop\myexp\firecrackers-178799.mp3',)).start()
            elif detected_animal_name in ["cat", "dog", "sheep"]:
                if not sound_playing:
                    Thread(target=play_sound, args=(r'C:\Users\Anil kumar Marri\OneDrive\Desktop\myexp\lion-
roars-with-growls-and-inhales-195839.mp3',)).start()

    if detected:
        if not animal_detected:
            animal_detected = True
            start_time_animal = time.time()
        elif time.time() - start_time_animal > 60:
            email_subject = f'Animal Detected for 1 Minute: {detected_animal_name.upper()}'
            email_body = f'An animal ({detected_animal_name.upper()}) has been detected continuously for 1
minute. Please check your property.'
            # Capture image before sending email
            captured_image_path = capture_image(img)
            send_email(email_subject, email_body, captured_image_path)  # Send the email with the image
            make_phone_call()
            start_time_animal = time.time()
    else:
        animal_detected = False
        start_time_animal = None

# Function to capture image
def capture_image(frame):
    captured_image_path = 'captured_image.jpg'
    cv2.imwrite(captured_image_path, frame)  # Save the captured image
    return captured_image_path

# Function to handle face recognition
def recognize_person(frame):
    global person_detected, start_time_person

    gray = cv2.cvtColor(frame, cv2.COLOR_BGR2GRAY)
    faces = face_cascade.detectMultiScale(gray, scaleFactor=1.1, minNeighbors=5, minSize=(30, 30))
```

```
    for (x, y, w, h) in faces:
        face = gray[y:y+h, x:x+w]
        keypoints2, descriptors2 = orb.detectAndCompute(face, None)

        if descriptors2 is not None and len(descriptors2) > 0:
            matches = bf.match(descriptors1, descriptors2)
            good_matches = [m for m in matches if m.distance < 50]

            if len(good_matches) > 10:  # Check if enough good matches are found
                cv2.rectangle(frame, (x, y), (x+w, y+h), (0, 255, 0), 2)
                cv2.putText(frame, "Owner Detected", (x, y - 10), cv2.FONT_HERSHEY_SIMPLEX, 0.6, (0, 255,
0))
                person_detected = True
                start_time_person = time.time()
            else:
                cv2.rectangle(frame, (x, y), (x+w, y+h), (0, 0, 255), 2)
                cv2.putText(frame, "Unknown Person", (x, y - 10), cv2.FONT_HERSHEY_SIMPLEX, 0.6, (0, 0,
255))
                person_detected = False
                start_time_person = None
        else:
            person_detected = False
            start_time_person = None

    if person_detected:
        if time.time() - start_time_person > 60:
            # No action needed as the owner is detected
            pass
    else:
        # Check if unknown person detected for 1 minute
        if start_time_person and time.time() - start_time_person > 60:
            email_subject = 'Unknown Person Detected'
            email_body = 'An unknown person has been detected on your property for 1 minute. Please check
immediately.'
            # Capture image before sending email
            captured_image_path = capture_image(frame)
            send_email(email_subject, email_body, captured_image_path)  # Send the email with the image
            make_phone_call()
            start_time_person = time.time()

# Function to process frames from the camera
def main():
    global start_time_person, start_time_animal

    while True:
        success, img = cap.read()
        img = cv2.resize(img, (wht, hgt))  # Resize frame for better performance

        # Object detection
        blob = cv2.dnn.blobFromImage(img, 0.00392, (wht, hgt), (0, 0, 0), True, crop=False)
```

```
        net.setInput(blob)
        outputs = net.forward(net.getUnconnectedOutLayersNames())

        # Find objects in the frame
        findobj(outputs, img)

        # Recognize person in the frame
        recognize_person(img)

        # Show the frame
        cv2.imshow("Video Feed", img)

        if cv2.waitKey(1) & 0xFF == ord('q'):
            break

    cap.release()
    cv2.destroyAllWindows()

if __name__ == "__main__":
    main()
```

CHAPTER 5

TESTING

5.1 IMPORTANCE

Testing is a process, which reveals error in the program. It is the major quality measure employee during software development during software development. During testing, the program is executed with a set of test cases and the output of the program for the test cases is evaluated to determine if the program is performing as it is expected to perform. Software testing is a critical element of software quality assurance and represents the ultimate review of specification, design and coding.

The increasing visibility of software as a system element and attendant costs associated with a software failure are motivating factors for we planned, through testing. Testing is the process of executing a program with the intent of finding an error. The design of tests for software and other engineered products can be as challenging as the initial design of the product itself.

5.2 TYPES OF TESTING

In order to make sure that the system does not have errors, the different levels of testing strategies that are applied at different phases of software development are:

Unit Testing

Unit testing is done on individual modules as a computer and become executable. It is confined only to the designer’s requirements. Each module can be tested using the following strategies.

Black Box Testing

In this strategy some test cases are generated as input conditions that fully execute all functional requirements for the program. This Testing has been uses to find errors in the following categories:

- Incorrect or missing functions
- Interface errors

- Errors in data structure or external database access
- Performance errors
- Initialization and termination errors In this testing the output is checked for correctness. The logical flow of the data is not checked.

White Box Testing

In test cases are generated on the logic of each module by drawing flow graphs of that module and logical decision are tested on all the cases. It has been uses to generates the test cases in the following cases:

- Guarantee that all independent paths have been executed.
- Execute all logical decisions on their true and false slides.
- Execute all loops at their boundaries and within their operational bounds.
- Execute internal data structure to ensure their validity.

Integrating Testing

Integration testing ensures that software and subsystems work together a whole. It tests the interface of all the modules to make sure that the modules behave properly when integrated together.

System Testing

Involves in-house testing of the entire system before delivery to the user. Its aim is to satisfy the user system meets all requirements of the client's specifications.

Acceptance Testing

It is a pre-delivery testing in which entire system is tested at client's site on real world data to find errors. Testing can be done in two ways:

- Bottom up Approach
- Top down Approach

Bottom up Approach

Testing can be performed starting form smallest and lowest level modules and proceeding one at a time. For each module in bottom up testing a short program executes the module and provides the needed data so that the module is asked to perform the way it will when embedded within the larger system. When bottom level modules are tested attention turns to those on the next level that use the lower-level ones they are tested individually and then linked with the previously examined lower-level modules. Begins construction and testing with atomic modules.

As modules are integrated from the bottom up, processing requirement for modules subordinate to a given level is always available and need for stubs is eliminated. The following steps implements this strategy.

- Low-level modules are combined in to clusters that perform a specific software sub function.
- A driver is written to coordinate test case input and output.
- Cluster is tested.
- Drivers are removed and moving upward in program structure combines clusters.

Integration moves upward, the need for separate test driver's lesions.

If the top levels of program structures are integrated top down, the number of drivers can be reduced substantially and integration of clusters is greatly simplified.

Top-down Approach

This type of testing starts from upper-level modules. Since the detailed activities usually performed in the lower-level routines are not provided stubs are written. A stub is a module shell called by upper-level module and that when reached properly will return a message to the calling module indicating that proper interacting occurred. No attempt is made to verify the correctness of the lower-level module.

Modules are integrated by moving downwards through the control hierarchy beginning with main program. The subordinate modules are incorporated into structure in either a breadth first manner or depth first manner. This process is done in five steps:

- Main control module is used as a test driver and steps are substituted or all modules directly to main program.
- Depending on the integration approach selected subordinate is replaced at a time with actual modules.
- Tests are conducted.
- On completion of each set of tests another stub is replaced with the real module
- Regression testing may be conducted to ensure trha5t new errors have not been introduced

This process continuous from step 2 until entire program structure is reached. In top-down integration strategy decision making occurs at upper levels in the hierarchy and is encountered first. If major control problems do exist early recognitions is essential. If depth first integrationis selected a complete function of the software may be implemented and demonstrated.

Some problems occur when processing at low levels in hierarchy is required to adequately test upper-level steps to replace low-level modules at the beginning of the top-down testing. So, no data flows upward in the program structure.

Validation

The system has been tested and implemented successfully and thus ensured that all the requirements as listed in the software requirements specification are completely fulfilled. In case of erroneous input corresponding error message are displayed.

Feasibility Study

The major step in analysis is to verify the feasibility of the proposed system. “All projects are feasible given unlimited resources and infinite time “. But in reality, both resources and time are scarce. Project should confirm to be time effective and should be optimal in their consumption of resources. This plays a constant role in approval of any project.
Three key considerations involved in the feasibility analysis are:

1. Technical Feasibility
2. Operational Feasibility

3. Economical Feasibility

1. Technical Feasibility

This study is based on the compatibility of proposed system working in another environment. It includes software and hardware maintenance for successful running of the project. The organization should maintain the required software. Android project uses the android-based technologies, which is rampantly employed these days worldwide.

2. Operational Feasibility

The developed application should be user friendly. It should satisfy all the client requirements in the requirement analysis phase of software development life cycle. This system is operationally feasible since the users are familiar with the android technologies and hence there is no need to gear up or train the personnel to use the cell phones.

3. Economical Feasibility

This deals with the cost analysis of the proposed project. This analysis is based on the effectiveness of the proposed system. It should attain maximum benefits in the estimated cost. It requires average computing capabilities and access to the internet, which are very basic requirements hence it doesn’t incur any additional economic overheads, which renders the system to be economically feasible

5.3 Test Cases

The following table consist of possible testcases for the smart crop protection system and we need to check whether this animal has detected or not.

Req id	Animal	Description	Result	Output
1	Cow	Animal	Detected	Lion roaring sound
2	Parrot	Bird	Detected	Cracker sound
3	Elephant	Animal	Detected	Cracker sound
4	Monkey	Animal	Detected	Cracker sound
5	Pig	Animal	Detected	Cracker sound
6	Dog	Animal	Detected	Lion roaring sound

CHAPTER – 6

RESULTS

A.Owner Training Image:

Beginning, the Smart Crop Protection System learns to give the protection to the crop owner, establishing a safety area, minimizing the false alarms, and improving the effectiveness by giving alerts only when the owner gets closer.

Figure 4:Training data owner image and coco.names dataset

B. Identifying Owner Image

Another feature of the system means the use of computer vision compare real-time video to the trained model to make sure the owner is the only person allowed near crops without causing false alarms.

Figure 5:Identifying owner figure

C. Identifying Unknown Image

it employs facial detection to identify any unfamiliar people that may be approaching the crop producing region. If the person is not recognized, an alarm is also produced and this informs of security threat to the crops.

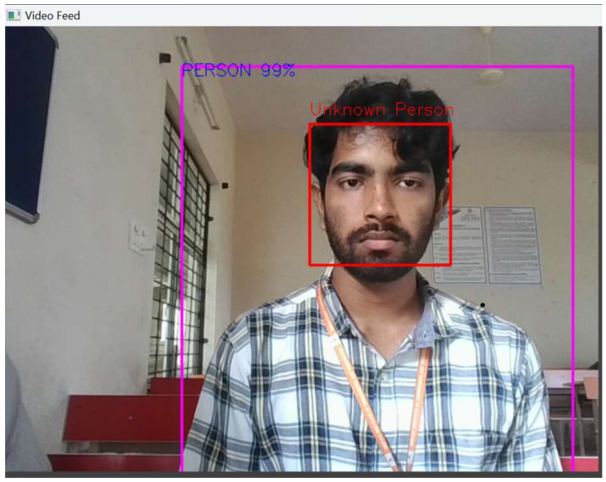

Figure 6:Identifying the unknown image

D. Identifying Animal and Making Sound Image

The system accuses animals such as deer's or herds that may cause damage to crops through image processing techniques. When detected, a beep sound is produced to scare away the animal, thus reduce destruction.

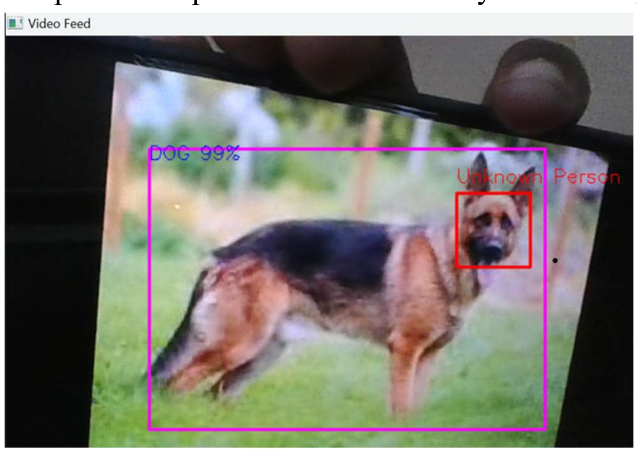

Figure 7 : Identifying animal

E. Call Getting Image

Should an intruder or an unauthorized animal be spotted, the system immediately sends a notification to a user's mobile and dials the owner to provide real-time information on the breach.

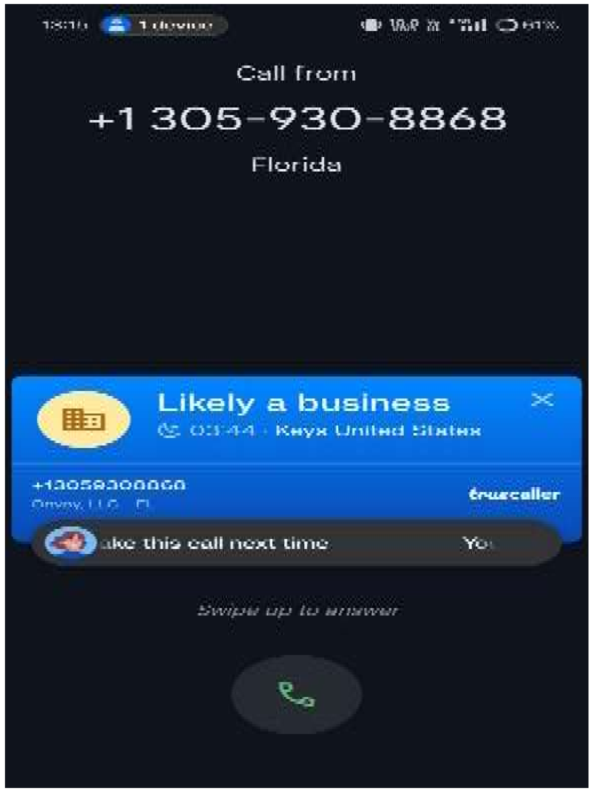

Figure 8:Call getting image

F. Mail Getting Image

It marks an alert accompanied with a mail included with the detection time, the pictures of the intruder, or animal, the action taken. This double alarm system hence gives fast response to the threats.

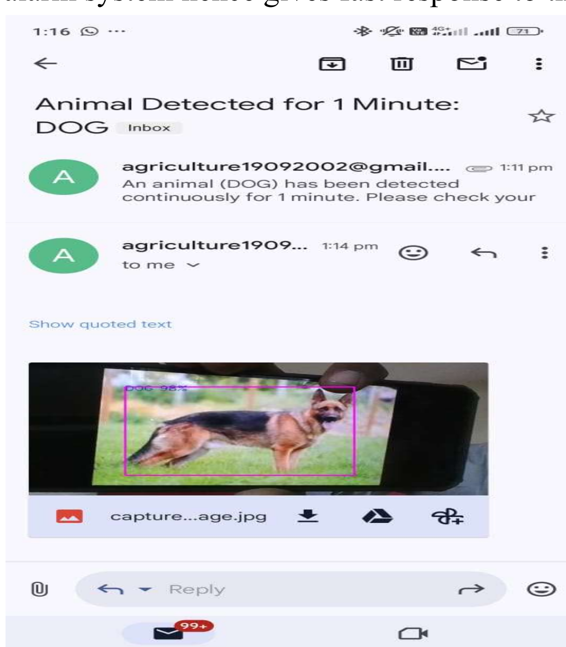

Figure 9:Mail view

CHAPTER – 7

CONCLUSION

In conclusion, the persistent problem of crop damage by wild animals in South India presents a complex challenge, but the proposed module offers a multifaceted and holistic approach to address it. The module's diverse components, including deterrents, fencing, wildlife corridors, and farm guarding practices, emphasize the importance of adaptability to different contexts and species-specific behaviors. Moreover, the integration of early warning systems and modern technology enhances the timeliness and efficiency of responses to potential threats. Community collaboration and government support are integral to the success of these measures, as the burden of solving this issue cannot rest solely on farmers' shoulders. Encouraging knowledge-sharing and cooperation within the farming community is essential, as it empowers individuals to adopt best practices and collectively protect their crops. Additionally, government support through financial assistance and the establishment of wildlife management programs demonstrates a commitment to rural livelihoods and wildlife conservation. Education and research are pivotal components, as informed farmers can make more effective decisions regarding wildlife management and conservation. Gaining insights into animal behavior and ecology is crucial for designing tailored solutions that minimize harm to both crops and wildlife. Lastly, promoting crop insurance as a risk mitigation strategy not only safeguards farmers against losses but also encourages the adoption of sustainable practices. By combiningthese efforts, we can significantly reduce the economic losses caused by animal attacks, foster coexistence between humans and wildlife, and contribute to the long-term conservation of local wildlife populations.

The success of this comprehensive module hinges on the collaboration of various stakeholders, collectively working towards a more secure and harmonious environment for all parties involved.

The use of advanced technology, data analysis, and real time monitoring enables proactive and precise responses to animal threats, reducing losses and increasing overall crop productivity Prevention is always better than cure. Farmers can effectively migrate the damage caused by animals to their crops. Smart crop protection system is not only a boon to agriculturebut also a crucial part of the broader efforts to address food security and the sustainable use of natural resources and environment

Advantages:

1. Economic Stability:

- Implementing effective wildlife management strategies can significantly reduce economic losses caused by crop damage. This stability is crucial for the livelihoods of farmers, ensuring their financial security and preventing food scarcity.

- By implementing effective wildlife management strategies, farmers can experience reduced crop losses and increased agricultural productivity. This, in turn, ensures a more stable source of income and food supply. It protects farmers from financial uncertainties caused by wildlife-related damage.

2. Biodiversity Conservation:

- The module promotes coexistence with local wildlife, encouraging practices that minimize harm to animal populations. This contributes to the conservation of biodiversity and supports ecological balance.

- The module's emphasis on coexistence means that wildlife populations are less likely to be harmed or culled due to conflicts with humans. This contributes to the conservation of local biodiversity, maintaining healthy ecosystems and protecting endangered species.

3. Sustainability:

- By adopting the module, farmers can protect their crops while also adhering to sustainable practices that have a reduced environmental impact. This is crucial for the long-term health of ecosystems.

- Sustainable farming practices are crucial for long-term agricultural viability. The module encourages the adoption of environmentally friendly and sustainable techniques, minimizing the ecological footprint of farming activities.

4. Community Collaboration:

- The focus on community collaboration fosters a sense of unity and shared responsibility among farmers. Knowledge-sharing and collective action can lead to more effective solutions and social cohesion.

- Encouraging knowledge-sharing and collaborative efforts within the farming community fosters a sense of unity and shared responsibility. This not only makes the module more effective but also strengthens social bonds and community resilience.

5. Government Support:

- Government involvement and support, including financial assistance and wildlife management programs, can alleviate the financial burden on individual farmers and ensure that conservation efforts are well-coordinated.

- Government involvement ensures that financial assistance and coordination of wildlife management efforts are provided to farmers. This support is essential for implementing protective measures at a broader scale and preventing crop losses.

6. Technology Integration:

- The incorporation of early warning systems and modern technology enhances the efficiency and timeliness of responses to potential threats, making wildlife management more effective.

- The inclusion of early warning systems and modern technology enhances the efficiency and effectiveness of wildlife management. Farmers can respond promptly to potential threats, reducing crop damage and economic losses.

7. Education:

- The emphasis on education empowers farmers with knowledge about animal behaviour and ecology, enabling them to make informed decisions and employ wildlife management practices that are both effective and humane.

- Farmers' access to knowledge about animal behavior and ecology empowers them to make informed decisions. Understanding the habits of local wildlife allows for the development of more targeted and effective deterrence strategies

8. Crop Insurance:

- Promoting crop insurance as a risk mitigation strategy offers financial protection to farmers and incentivizes the adoption of sustainable and protective farming practices.

- Promoting crop insurance as a risk mitigation strategy not only safeguards farmers against losses but also incentivizes the adoption of protective farming practices. This encourages the adoption of sustainable techniques and provides a safety net for farmers.

9. Reduced Conflict:

- By providing practical solutions to mitigate crop damage, the module can reduce conflicts between farmers and wildlife, which often lead to negative consequences for both parties.

- By offering practical solutions to mitigate crop damage, the module reduces conflicts between farmers and wildlife. Such conflicts can often lead to negative consequences, including harm to both farmers and animals.

10. Environmental Stewardship:

- By protecting their crops while minimizing harm to wildlife, farmers can position themselves as stewards of the environment, contributing to the broader goals of sustainability and conservation.

- Farmers implementing this module can position themselves as stewards of the environment. By adopting practices that protect crops while minimizing harm to wildlife, they contribute to broader goals of environmental conservation and sustainability.

- This module offers a comprehensive approach that not only addresses the immediate issue of crop damage but also fosters a more sustainable and harmonious relationship between farmers and local wildlife. It leads to economic stability, biodiversity conservation, and stronger, more resilient communities, all while promoting responsible.

CHAPTER-8

FUTURE SCOPE

The future scope of addressing crop damage by wild animals in South India using the proposed module is both promising and dynamic. Technological advancements are expected to play a pivotal role, with the development of more sophisticated early warning systems and non-lethal deterrents, enhancing the effectiveness of wildlife management efforts. Data-driven solutions will become increasingly prevalent, as big data and analytics offer insights into animal behavior and crop damage patterns, enabling the fine-tuning of strategies. Robotics and dronesare likely to become more integral for real-time surveillance and rapid response. Eco-friendly farming practices, driven by sustainability concerns, are poised to gain prominence, benefiting both farmers and the environment. Policymakers will continue to refine legal frameworks to balance agricultural needs with wildlife conservation. Community empowerment will strengthen as local residents become more self-reliant in addressing crop damage, possibly serving as models for other regions. International collaboration is anticipated as lessons learnedfrom South India are shared globally, fostering best practices in wildlife management. Education and awareness campaigns will reinforce a culture of coexistence, and climate change considerations will lead to adaptations in wildlife management. Research and innovation will remain essential, driving the development of new, effective solutions. Furthermore, this module aligns with global sustainable development goals, contributing to international efforts aimed atachieving zero hunger, preserving life on land, and promoting responsible consumption and production. The future of addressing crop damage by wild animals using this module is characterized by adaptability and innovation, ensuring the long-term sustainability of agriculture and the harmonious coexistence of farmers and wildlife.

1. Technology Advancements:

- As technology continues to evolve, more sophisticated early warning systems and non-lethal deterrents may become available. These innovations can enhance the effectiveness of wildlife management efforts and reduce human-wildlife conflicts.

- Future advancements may include the development of more advanced early warning systems, such as AI-powered cameras and sensors capable of recognizing specific animal species. Non-lethal deterrents could become more effective and humane, with innovations like laser-based repellent systems or automated drones that use sound and light to deter wildlife. These advancements will enable more precise and targeted responses to prevent crop damage.

2. Data-Driven Solutions:

- Big data and analytics can be used to analyze patterns of animal behavior and crop damage. This data-driven approach can help fine-tune wildlife management strategies and improve their efficiency.
- The future of wildlife management will heavily rely on data analytics. Farmers and wildlife experts can collect and analyze extensive data on animal behavior, movement patterns, and crop damage incidents. Machine learning algorithms can then predict and prevent future incursions more accurately, optimizing resource allocation.

3. Drones and Robotics:

- The use of drones and robotics for monitoring and guarding agricultural fields can become more prevalent. These technologies can provide real-time surveillance and response to wildlife threats.
- Drones and robotics may become essential tools for farmers. Advanced drones with thermal imaging capabilities can monitor fields day and night, while autonomous ground-based robots can patrol farms to scare off or deter animals. These technologies offer a round-the-clock defense against wildlife threats.

4. Eco-Friendly Farming Practices:

- The module can lead to a shift towards more sustainable and environmentally friendly farming practices, including organic farming and agroforestry. This could benefit both farmers and the environment.
- The future of agriculture in South India may shift towards more sustainable and eco-friendly practices. Organic farming, agroforestry, and permaculture could gain prominence, reducing the environmental impact of farming while still ensuring high yields and crop protection.

5. Policy and Legal Frameworks:

- Governments may develop and refine policies and legal frameworks to better address human-wildlife conflicts, balancing the needs of agriculture and wildlife conservation.
- Governments will likely refine existing policies and legal frameworks to ensure a balanced approach to wildlife management and agriculture. Stricter regulations on wildlife conservation, together with financial incentives for farmers to adopt protective measures, could become more common.

6. Community Empowerment:

- Communities may become more self-reliant and empowered in addressing crop damage issues, collaborating with experts and authorities to implement effective solutions.
- Communities affected by crop damage will become more self-reliant and proactive. They might establish local organizations dedicated to wildlife management, pooling resources, knowledge, and technology to protect their crops effectively.

7. International Collaboration:

- Lessons learned from addressing this issue in South India can be shared globally, leading to international collaboration on wildlife management and conservation practices.
- As South India's experiences and best practices in wildlife management become more widely recognized, international collaboration on research, strategies, and technology transfer may expand. Joint efforts to address human-wildlife conflicts could yield global benefits.

8. Education and Awareness:

- Continued education and awareness campaigns can promote a culture of coexistence and responsible farming practices, reducing conflicts between farmers and wildlife.
- Continuous education and awareness campaigns will reinforce the importance of coexistence and sustainable farming practices. Local schools, community workshops, and online resources may be used to educate the public about wildlife behavior and

management.

9. Alternative Livelihoods:

- Efforts can be made to create alternative livelihoods for communities affected by crop damage, reducing their dependence on agriculture as the sole source of income.
- Communities facing persistent crop damage may explore alternative livelihoods to reduce their dependence on agriculture. This could involve eco-tourism, cottage industries, or skill development programs, providing additional sources of income.

10. Climate Change Considerations:

- With changing climate patterns, wildlife behaviour and migration may be affected. The module can adapt to address new challenges arising from climate change and its impact on agriculture and wildlife.
- Climate change will influence wildlife behavior and migration patterns. The module will need to adapt to address new challenges arising from altered climatic conditions, potentially necessitating changes in the timing and nature of protective measures.

11. Research and Innovation:

- Ongoing research into animal behavior, crop protection, and sustainable agriculture will lead to the development of innovative and effective solutions for crop damage prevention.
- Ongoing research in animal behavior, ecological relationships, and agricultural practices will lead to the development of innovative solutions. New approaches for humane deterrence, habitat restoration, and eco-friendly farming will continue to emerge.

12. Integration with Global Sustainable Goals:

- The module aligns with global sustainable development goals, particularly those related to zero hunger, life on land, and responsible consumption and production, contributing to the broader international agenda.
- The module aligns with international sustainable development goals, contributing to

broader efforts to end hunger, conserve terrestrial ecosystems, and promote sustainable consumption and production. The module's impact extends beyond South India, potentially serving as a model for addressing similar issues worldwide.

The future scope of this module is dynamic and adaptable, allowing for the integration of new technologies, practices, and strategies to ensure the long-term sustainability of agriculture and the coexistence of farmers and wildlife in South India

Other Applications

The "Smart Crop Protection System from Animals" application serves as the user interface and control center for the entire system. It allows farmers and users to interact with and manage the system effectively. Here are key features and functions of the application:

User Registration and Login:

Users can create accounts and log in securely to access the system.

Dashboard:

A visual dashboard provides an overview of the status of the crop protection system, including real-time updates on the fields and sensors.

Field Management:

Farmers can define and manage the fields or crop areas they want to protect within the application.

Alerts and Notifications:

Users receive instant alerts and notifications when the system detects animal activity or potential threats to the crops.

Remote Monitoring:

The application allows users to remotely view live camera feeds and sensor data, helping them assess the situation in the fields in real-time.

Historical Data:

Users can access historical data on animal activity, environmental conditions, and system performance for analysis and decision-making.

Configuration and Settings:

Farmers can customize system settings, including the activation of deterrents, control of smart fencing, and environmental thresholds for alerts.

Reporting:

The application generates reports on crop protection effectiveness, animal behavior patterns, and other relevant insights.

User Support and Help Center:

Provides resources, FAQs, and access to technical support for troubleshooting and maintenance.

Weather Integration:

Integrates with weather data services to provide users with weather forecasts and real-time weather conditions relevant to crop protection.

User Collaboration:

Users can collaborate and share information with other farmers or experts, enhancing collective knowledge and strategies for crop protection.

Map Integration:

A map feature displays the location of sensors, cameras, and fields, allowing users to visualize the system's layout.

Security and Access Control:

Ensures secure and authorized access to the application and the connected system.

Mobile Accessibility:

The application is accessible on mobile devices, enabling farmers to monitor their fields on the go

Energy Management:

Users can monitor the energy status of the system, such as battery levels and solar panel efficiency.

The application acts as the central hub for managing the smart crop protection system, providing users with the tools and information they need to make informed decisions and protect their crops effectively. It enhances the convenience, efficiency, and effectiveness ofthe entire system.

Other Hardware Devices

Creating a smart crop protection system from animals involves various hardware devices to implement the system's components. Here are some essential hardware devices commonly used in such systems:

Sensors:

Motion Sensors: Passive infrared (PIR) or ultrasonic sensors can detect animal movement in the fields.

Environmental Sensors: These sensors monitor factors like temperature, humidity, and light, providing data for environmental analysis.

Camera Surveillance: Surveillance cameras capture images and videos for object detection and identification.

Acoustic Sensors: Some systems use microphones to detect animal noises or bird calls.

Deterrent Devices:

Scarecrows: Automated scarecrows with motion and sound features to scare off animals.

Ultrasonic Devices: Emit high-frequency sounds that are unpleasant to animals.

Water Sprayers: Automated water sprayers can startle animals and deter them from the crops.

Fencing and Barriers:

Smart Fencing: Fencing with embedded sensors or electric fencing to create physical barriers.
Gate Control Systems: Automated gates that can open and close based on sensor data.

Communication Devices:

Wi-Fi/Cellular Modules: Enable data transfer to remote servers or farmer notifications.
LoRa (Long Range) Transceivers: Useful for long-range communication in rural areas.
Mesh Networks: Devices can create their own network to communicate over a wide area.

Control Units:

Microcontrollers/Embedded Systems: Control the operation of various components, process sensor data, and trigger deterrents.

Microprocessors: Used for data analysis and decision-making, especially in complex systems.
Power Management:
Solar Panels: Provide sustainable power sources, especially in remote locations.

Batteries: Store energy for nighttime or cloudy days.

Energy-Efficient Components: Minimize power consumption.

User Interface:

Smartphones or Tablets: Farmers can use mobile apps to monitor the system and receive alerts.

Computers: For more in-depth system monitoring and configuration.

Storage Devices:

Data Loggers: Store sensor data and system logs for analysis.

Cloud Storage: Data can be uploaded to cloud services for remote access.

Alarms and Notification Devices:

Sirens or Speakers: Emit loud sounds to alert animals or humans.

LED Lights: Used for visual alerts.

Mobile Communication Modules: Send SMS or app notifications to farmers.

Security Devices:

Cameras: Beyond surveillance, cameras can also serve as security devices to deter trespassing.

Access Control Systems: Prevent unauthorized access to the system components.
Support and Maintenance Tools:
Diagnostic Tools: Hardware for troubleshooting and maintenance.

Remote Access Devices: Allow for remote system monitoring and support.

The choice of hardware devices will depend on the specific requirements of your project, including the types of crops, the local fauna, environmental conditions, and the level of technology integration needed.

Environmental Sensors: These sensors monitor factors like temperature, humidity, and light, providing data for environmental analysis.

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6. Adami, D., Ojo, M. O., & Giordano, S. (2021) Development of an Embedded Edge-AI-based work, this paper proposes a smart agriculture system with emphasis on animal trespass protection, particularly Uganda's ungulates such as wild boar and deer through the edgecomputing. It uses YOLOv3 and the faster Tiny YOLO for real-time object identification on systems such as the Raspberry Pi and NVIDIA Jetson Nano. The system uses species-specificultrasound signals to scare the animals and use IoT for links and control. The work evaluates the performance of models, power consumption, and the cost-to-performance ratio for the concept of edge-AI to help farmers in decision-making.

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coordinates of the boxes that probably contain an object and also the class probabilities of an object. It is good for real time applications since it will provide fast results without compromising accuracy, for instance in agriculture, the discrimination algorithm will easily detect intruders on the farmland and prompt defensive actions.

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9. Reddy KV, Goutham V Knowledge and practice: An Indian perspective Analysis of the year 2024.

10. Edge AI in Sustainable Farming: An IoT Framework Based on Deep Learning to Protect Crops from Wildlife Predation. This paper proposes a real-time animal intrusion detection system based on TinyML with a lightweight deep learning model, namely EvoNet. It incorporates Internet of Thing for surveillance and prevention, with add-on that allow farmer to have a bird-eye view of threats from a remote control intelligent rover. The system integrates high energy efficiency, and high detection accuracy, it is a stable solution for protection of crops.

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