Visvesvaraya Technological University
Belagavi

A Mini Project Report on

"Bird detection and deterrence system for crop protection"

Submitted by

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ABSTRACT

In recent years, the technological strides in this area have increased the ease of implementing real-time systems with machine learning: innovative solutions in many areas-there are wildlife monitoring.Smart systems are used for species detection, tracking, and management in wild and human-altered ecosystems. The prime objective of this system is to detect birds in realtime within the camera feed and send an alert when a bird is spotted.The system works on its own with minimal intervention from humans.It is very practical for agricultural or ecological contexts, where automated monitoring must occur.

The heart of this bird detection system is in YOLOv5 or"You Only Look Once." This object detection framework was chosen because of the significant accuracy and efficiency in its operation when detecting objects in real-time conditions. YOL5v is very popular as it can process images in real-time, a condition of the applications since quick decisions need to be made when identifying birds moving. The model was trained using live feeds of video feeds of birds and thus gives the capabilities of recognizing some species of birds even in cluttered scenes or dynamic scenes. Once a bird is identified, it sends an alarm to alert personnel in the surrounding areas or, in some cases, triggers a repulsion mechanism.

The audio and visual output parts are both incorporated into the system to make it even more functional. Every time a bird is detected, a buzzer or speaker sounds the alarm; this provides an immediate auditory signal. It visually displays the outcome of the bird detection to a laptop connected to the system so that users can continually monitor their surroundings.

This system application transcends just bird detection. This will be especially useful in agriculture settings where birds could easily destroy crops; thus, being able to automatically detect and deter birds is incredibly valuable. It can help cut down crop loss and allow faster inter- vent ion time for preventing or reducing crop damage.It can help monitor bird populations, Observe migrations, and potentially protect endangered species.

Chapter - 01

LITERATURE SURVEY

New Horizon College of Engineering Modules of 3rd Semester,

Year: 2023

- Data structures and Algorithms in C language provided deep understanding of basics of programming.
- Building strong fundamental and core knowledge about the coding world.
- Python basics introduced in 3rd semester induces the knowledge about the python world and instantiates the learning curve needed to implement this project.

Book 1:"Introduction to Machine Learning with Python" by Andreas C.Müller and Sarah Guido Published: 2016

- Introduction to machine learning algorithms, which can be applied inreal-time object detection, such as YOLO (You Only Look Once).
- Overview of image processing techniques, essential for extracting features from video streams for bird detection.
- Practical examples and coding with Python, which can be directly used to build your object detection pipeline for birds.
- Implementation details for creating machine learning models that perform in real-time, essential for a system like yours where low latency is critical.

Book2:"Deep Learning for Computer Vision" by Rajalingappaa Shanmugamani Published: 2018

- Focus on deep learning techniques used in image classification and object detection, including CNNs (Convolutional Neural Networks).
- Techniques like YOLO (You Only Look Once) and Faster R-CNN that can be leveraged for detecting birds in real-time video feeds.
- Provides code examples and implementation guides for real-time applications, making it a good fit for adapting deep learning models for your bird detection system.

Book3:”Practical Machine Learning with Python” by Di-panjan Sarkarand Raghav Bali Published: 2017

- Practical machine learning methods using Python, including how to preprocess image data and implement models efficiently.
- Focus on real-world machine learning applications in various domains, including wildlife monitoring.
- In-depth discussion on real-time prediction and model deployment, which could aid in devel- oping a system for detecting birds in video streams with minimal delay.
- Optimizing algorithms for performance and scalability, which is critical in environmental mon- itoring applications like bird detection.

Paper1:”Real-time Object Detection with YOLOv5 for Smart Surveillance Systems” Published: 2021

- Overview of the YOLOv5 object detection model, its performance, and accuracy improvements over its predecessors.
- How to deploy YOLOv5 on real-time video feeds and integrates it with alert systems (such as audio alerts, which are essential for your project).
- Discussion on trade-offs between performance and computational requirements, which is relevant for your low-cost, standalone system implementation.
- Insights on model tuning and optimization for real-time applications in wild life monitoring, which directly applies to bird detection.

Paper2:”Bird Detection and Monitoring in Agricultural Environments Using Convolutional Neural Networks” Published: 2020

- Detailed use case of CNNs in detecting birds in agricultural environments.
- Techniques for detecting specific bird species based on visual data and distinguishing them from other objects in the environment.
- Challenges in environmental monitoring, such as dealing with lighting conditions and moving objects, and how to overcome them using CNN architectures.

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PROBLEM STATEMENT

Birds, especially in agricultural areas, are considered one of the major pests because they can cause significant damage to any crop.Birds, although they cause problems to agricultural processes, also pose some sorts of challenge in ecological surveys, as real-time monitoring must be done to trace biodiversity and all conservation activities. Traditionally, birds'detection, as well as response mechanism, was always a time-consuming and rather inefficient process. The present solutions are reactive, dependent mostly on scaring tactics, visual deterrents, and surveillance that is time-consuming, expensive, and most often inefficient. This calls for an approach that is automated, efficient, and more reliable for bird detection.

Challenges in Agricultural Environments

Birds are the most destructive agents in agricultural settings, especially during harvest time.The old scare methods, such as scarecrows, sound devices, and netting, have not been a consistent solution to bird damage. The scare mechanisms require frequent maintenance, and the effectiveness of these scare methods reduces overtime as birds tend to habituate to them. The lack of real-time bird detection and the inability to activate timely deterrence measures contributes significantly to crop losses.

Farmers need an inexpensive, autonomous system that would alert birds' presence and triggera warning alarm or a repellent. Without such a system, farmers have to rely on manual checks that are labor intensive, inefficient, and prone to human error. Thus, the demand for a low-cost, scalable, efficient bird detection system that works autonomously in real time is very high.

Challenges in Ecological and Conservation Research

Bird populations, migration patterns, and species distribution have always required the use of ecological and conservation research, based heavily on accurate, real-time data.Traditional methods like manual bird watching or banding with tracking devices are very resource-intensive and, as a result, limited in the scale and scope of their research. In

Addition, these methods do not include automation and cannot be continuously used for real-time monitoring; therefore, they fail to provide comprehensive data overtime.

In conservation, the timely detection of some bird species is crucial to safeguarding them, especially for endangered species.Presently, there is a lack in the monitoring practice since it lacks a scalable and automatic system that can monitor birds' activity and send instantaneous alerts. This makes research and conservation hard and is recognized at a collection that becomes impossible while responding to environmental changes on a timely basis is quite complicated.

year	region	Cropaffected	Estimatedloss	Impactonyield
2023	Global	Alltypesofcrops	over 1 billion	+10 percent loss in yield
2022	Punjab	Rice,Wheat,Maize	15million	10-15 percent reduction in rice yield
2021	WestBengal	Rice,Maize,Barley	8million	10-20 percent loss in crop yield
2020	Maharashtra	Grapes, Orchards	5million	10-30 percent loss in grape yield
2019	Rajasthan	Wheat,Cereal Crops	3million	5-10 percent loss
2018	California	Vineyards	12million	20 percent reduction In vineyard yield
2017	UnitedKingdom	Apple Orchards	5million	Up to15 percent damage to apples
2016	Philippines	Rice Crops	10million	5-10 percent loss of rice yield
2020	NewZealand	Cherries, Grapes	31million	Upto 50 percent loss
2023	UnitedStates	Rice Crops	20million	Upto 10-30 percent of crop lost

Table2.1: Annual loss of crop due to birds a cross various regions

Scope of the Problem

This project primarily focuses on automated bird detection and alerting for agricultural purposes, though the same principles can be extended to conservation and ecological research. The scope involves developing a software solution that captures live video from a camera. Process the video feed through machine learning to identify birds. An audible alarm (buzzer) should be raised on every detection of a bird.

It's a simple, low-cost, and scalable system for application in many aspects. Though it focuses more on detection in an agricultural environment, there's nothing wrong if one applied this system in protecting wild-life areas or with any other big ecological survey work.

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METHODOLOGY

The bird detection and alert system is a method for real-time detection of birds using a web- cam feed. The system triggers an alarm sound once it detects birds. The steps involved in implementing the methodology are discussed as follows:

Tools and Technologies

- Programming Language:Python
- LibrariesUsed:
- OpenCV: To capture and display the real-time video feed.
- PyTorch: To use a pre-trained YOLOv5 deep learning model for object detection.
- Pygame: Used to play the alarm sound once a bird is detected.
- OS and Time: It is used for file paths and handling the detection timing.
- Hardware: Standard webcam for video input.
- Software: Python IDE for running the code.

System Design

The system comprises of:

- Bird Detection Model: TheYOLOv5 pre-trained model detects objects in the video feed, specifically birds.
- Alert Mechanism: Once a bird Is detected, an alarm sound plays.
- Video Feed Input: The webcam captures the real-time video feed.

Execution

Step1: Import Necessary Libraries

- Importing all the necessary libraries: cv2 for video processing, torch for object detection, pygame for playing the alarm sound, and os and time for system utilities.

Step2: Initialize the Alarm Sound

- pygame.mixer.init() is used to initialize pygame.mixer, and the sound file alert.wav is loaded into the program.If it does not exist, it terminates the system with an error message.

Step3:Load YOLOv5 Model

- A pre-trained YOLOv5s model is loaded from PyTorch’s hub API. This model will be used for real-time object detection.

Step4: Initialize the Webcam

- OpenCV initializes the webcam feed. If the webcam cannot be accessed, the program exists with an error.

Step5: Process Video Frames

- The system reads frames from the webcam in real-time and resizes them for performance optimization.

Step6:ObjectDetection

- YOLOv5 processes each frame to detect objects. Then, the detected objects are further processed to check if any of them belong to the class”bird”.

Step 7: Play Alert Sound

when a bird is detected:

- A flag (bird-detected) is set to True.
- The system checks whether the alarm has been triggered recently, so it doesn’t trigger the alarm again within a short interval (alert-cool down).
- It plays the alarm sound using pygame.

If no bird is detected, the system resets the flag to False.

Step 8: Print Detection Results

The video feed displays the objects detected using bounding boxes and labels. The frames that are annotated are shown in a window using OpenCV.

Step9: Exit Mechanism

The system keeps running the frames unti lthe user exists via the Esc key. At the tim of exit, all resources such as the webcam and pygame are released or closed.

Testing and Validation

- The system was tested using images and videos of different birds to ensure that it would detect the birds correctly and raise the alarm at the right time.
- False alarms were avoided by simulating scenarios where birds were not present.
- Variables like lighting and camera angle were taken into consideration to achieve the best performance possible.

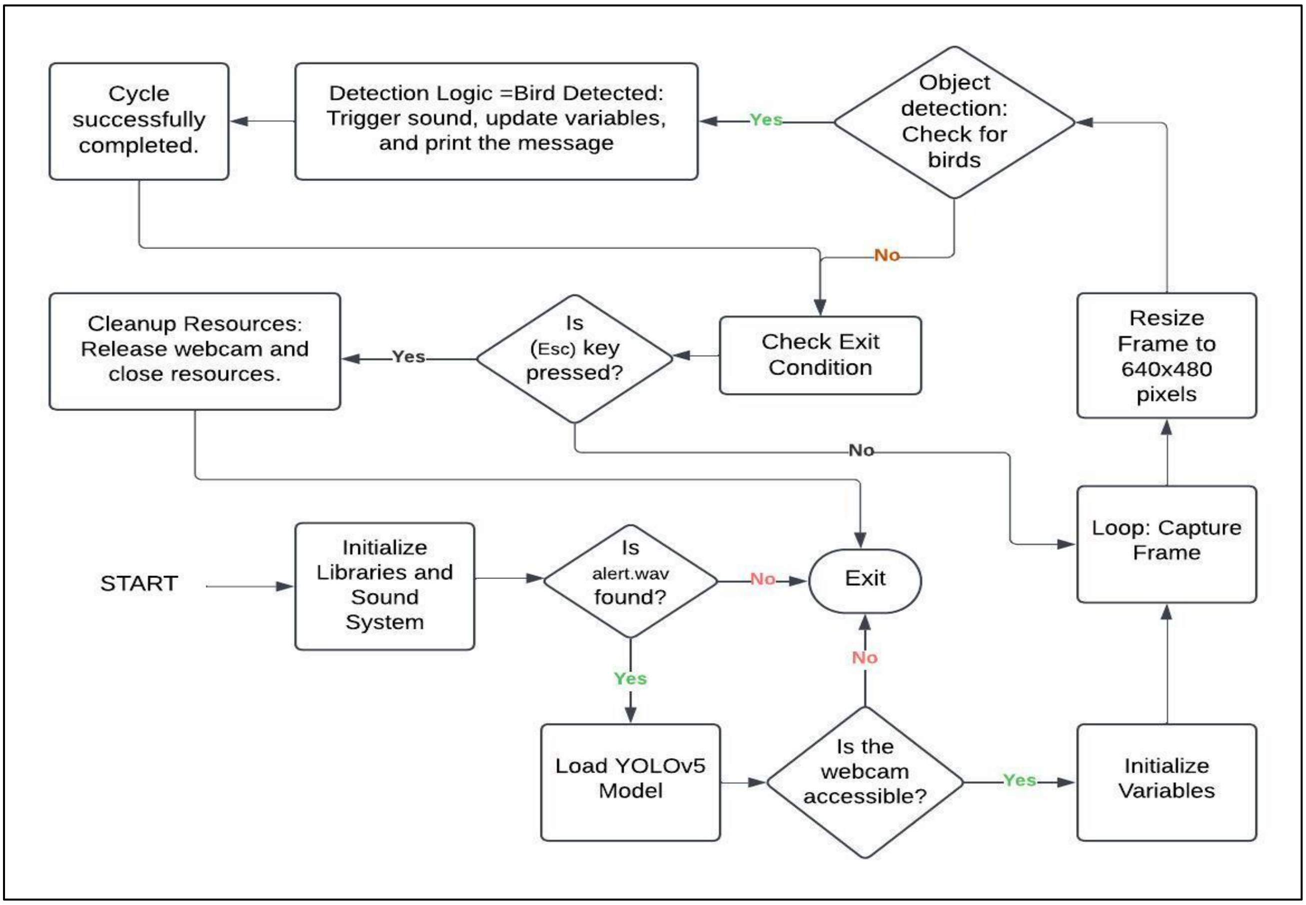

Figure3.1: Simplified Block Diagram

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HARDWARE AND SOFTWARE REQUIREMENTS

Hardware Requirements

- Computer Specifications:
  - Processor: Inteli5 or equivalent (minimum recommended).
  - RAM: 4GB or higher (8GB recommended for better performance).
  - Storage: Atleast 500MB of free disk space.
  - Operating System: Windows 10/11 , macOS, or Linux.
- Webcam:
  - Standard USB Webcam with a minimum resolution of 720p.
  - Integrated webcams in laptops can also beused but may have limited resolution.
- Audio Output:
  - Speakersystemorheadphonesforalarmsoundplayback.
- PowerSupply:
  - Reliable power source for the computer and webcam.

Software Requirements

- Operating System:
  - Windows, macOS, or Linux.
- Python Environment:
  - PythonVersion: 3.8 or above.
- Required Libraries:
  - OpenCV (opencv-python) for video processing.
  - PyTorch for loading the YOLOv5 pre-trained model.
  - Pygame for handling the alert sound.

- Library Installation Commands:

  Pip install opencv-python

  Pip install torch torchvision orchaudio

  pip install pygame

- Integrated Development Environment (IDE):
  - Any Python-supported IDE, such as:
    - ∗PyCharm
    - ∗Visual Studio Code
    - ∗Jupyter Notebook
    - ∗Spyder
- Alert Sound File:
  - File format: .wav
  - File location: Place the alert .wav file in the same directory as the Python script.

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ADVANTAGES AND APPLICATIONS

Advantages

- Real-Time Detection: The system works on a live video feed from a webcam to detect birds in real-time, thus enabling immediate response and action, which is an important requirement of applications that need to be intervened quickly.
- Automation:This project does away with constant human monitoring as the system automates the process of detection and alerting, thus making it a very practical and efficient solution for large-scale environments.
- Cost-Effective: Since this system makes use of affordable and widely available hardware such as webcams and personal computers, and free open source software libraries such as YOLOv5, this system is very economical.
- Scalability and Flexibility: The system can easily be adapted to detect other animals, objects, or specific conditions through training or integration of further machine learning models, so it’s versatile for any future needs.
- User-Friendly Implementation: The project has been developed to be relatively easy to implement and use, even by those who are not experts in the technical field, just with some basic Python programming knowledge.
- Eco-Friendly: Prevents harm to wildlife by using non-lethal deterrence methods, such as sound alarms, instead of physical barriers or harmful substances.

Applications

- Agricultural Protection: The system helps farmers safeguard crops by detecting birds and triggering alarms to deter them from causing damage to seeds, fruits, and plants.
- Wildlife Monitoring: Enables researchers and conservationists to observe bird activity in their natural habitat for studies about migration, behavior, and species conservation without disturbing the ecosystem.
- Aviation Safety: The system can be installed close to airports to monitor birds in real time and thereby reduce the threat of bird strikes while ensuring the safety of wildlife and aircraft.
- Smart Farming and IoT Integration: It can be integrated into a larger networked solution involving the Internet of Things to create a smart farm capable of managing multiple tasks such as pest control, weather monitoring, and irrigation management.
- Educational and Research Applications: This acts as a practical demonstration of computer vision and artificial intelligence techniques, which allows it to be suitable for educational purposes within academic institutions and workshops.
- Urban and Suburban Use: It can also be used in urban gardens, parks, and rooftops to monitor bird activities in residential or recreational spaces.

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RESULTS AND DISCUSSION

Results

The real-time bird detection and alert system successfully achieved the desired functionality. The system was able to:

- Detect birds in the webcam feed with high accuracy using the YOLOv5 pre-trained model.
- Trigger an alert sound upon detecting a bird, providing immediate feedback.
- Stop the alert sound once the bird was no longer detected, ensuring the system operates efficiently without unnecessary noise.

The following image demonstrates the system in action, capturing the web cam feed with object detection results overlayed, and the detection of a bird triggering the alarm:

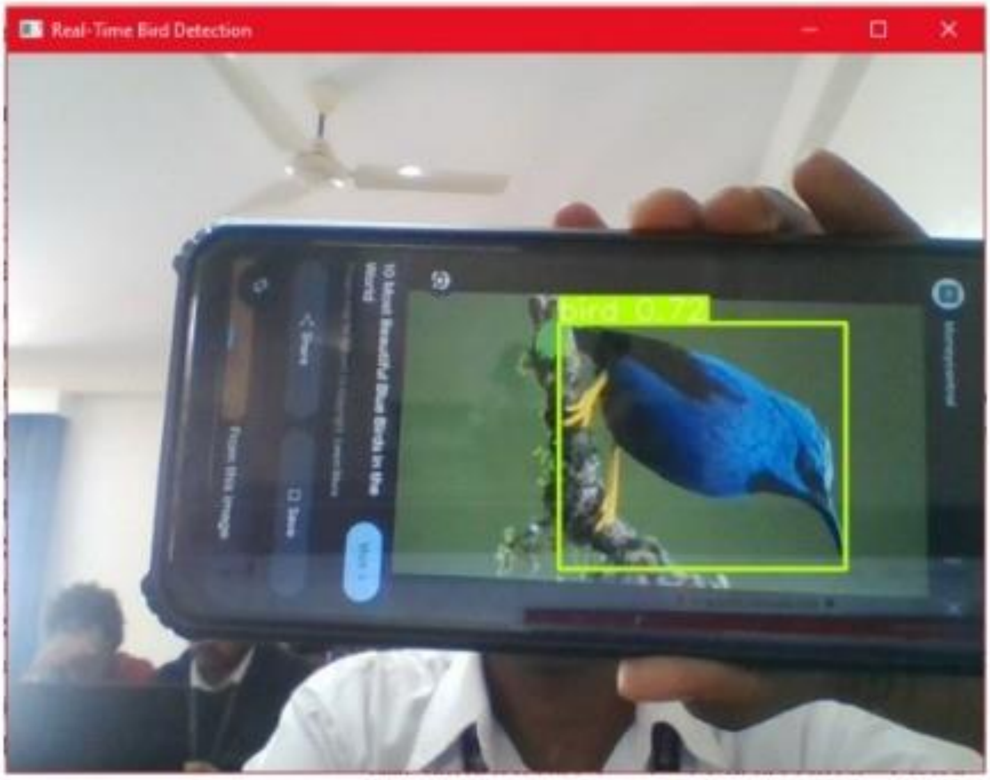

Figure6.1: Real time bird image detection by the software

Discussion

The project effectively demonstrated the use of computer vision and deep learning for real- world applications.The following points highlight the observations and insights gained during implementation:

- Accuracy: The YOLOv5 model was accurate in detecting birds under various lighting conditions. However, detection performance may vary with the webcam's quality and resolution.
- Performance: The system performed well in real-time scenarios with minimal latency. Performance could be further enhanced by utilizing a dedicated GPU or optimizing the model for edge devices.
- Sound Alert: The use of a sound alert ensured an immediate and effective response to bird detection. Additional alert methods, such as visual signals, can be explored for noiseless environments.

Challenges Faced and Overcome Methods Implemented

During the implementation of the project, several challenges were encountered. This subsection discusses these challenges and the methods employed to overcome them:

- Challenge: Webcam Access Issues
  - Problem: Initially, the webcam feed could not be accessed due to compatibility issues with the system's drivers.
  - Solution: Updated the webcam drivers and ensured that the Python 'cv2.VideoCapture' function was correctly initialized.
- Challenge: False Positives in Bird Detection
  - Problem: Objects with similar features to birds, such as small animals or bird-shaped decorations, were sometimes incorrectly identified as birds.
  - Solution: Used confidence threshold tuning in the YOLOv5 model to filter out Low-confidence detections, improving the accuracy.

- Challenge: Alert Sound Repetition
  - Problem: The alert sound played repeatedly in rapid succession, making it over whelming.
  - Solution: Implemented an alert cool down mechanism to ensure the sound plays only once within a defined time interval.
- Challenge: Performance Bottlenecks
  - Problem: The system experienced occasional delays when processing high-resolution frames.
  - Solution: Resized the webcam frames to alow erresolution befor eprocessing, reducing computational overhead and improving response time.

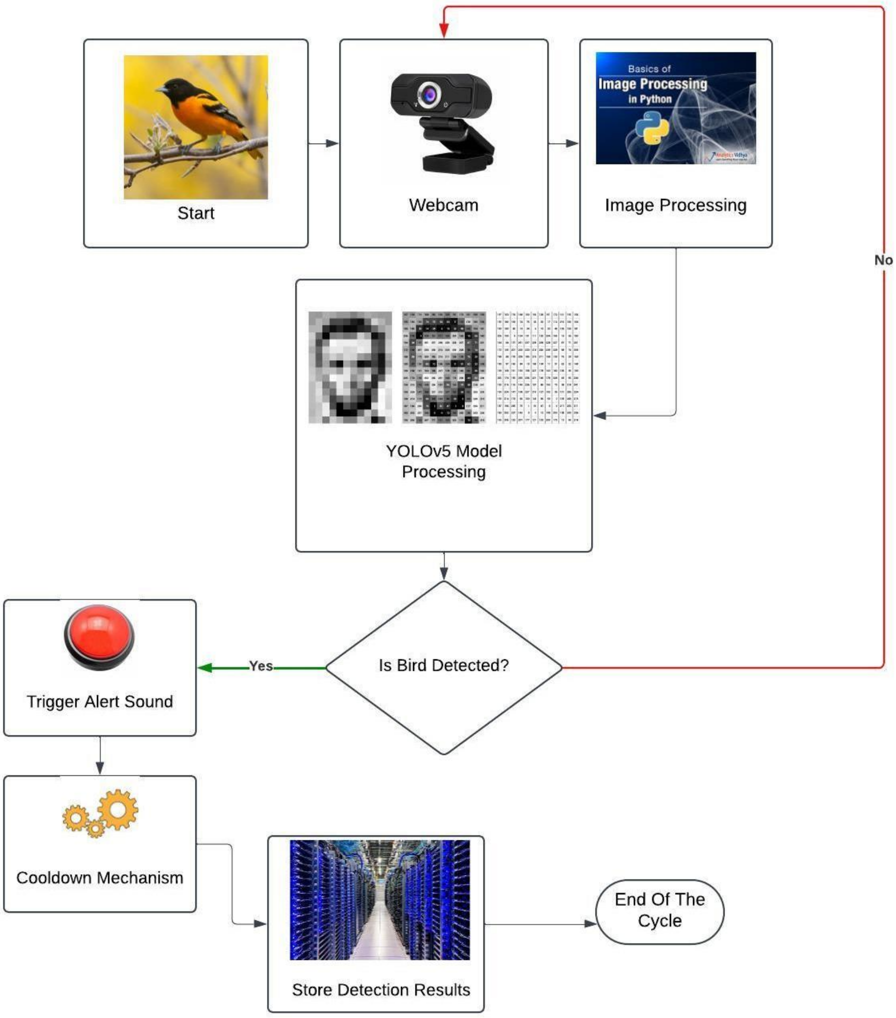

Figure6.2: Working Mechanism

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CONCLUSION

The real- time raspberry discovery and alert system represents a successful integration of computer vision and artificial intelligence to break practical challenges.By exercising the YOLOv5 pre-trained model and Python programming, the design demonstrated the eventuality of using deep literacy technologies for real- world operations.

The system was designed to descry catcalls in a live videotape feed and spark an alert sound, achieving its intended functionality with high delicacy and effectiveness. The crucial advantages of the design include its real-time operation, cost-effectiveness, and ease of perpetration. also, the design provides a scalable andeco-friendly result, suitable for different operations in husbandry, wildlife monitoring, aeronautics safety, and civic operation.

While the design achieved its primary objects, it also stressed areas for enhancement, similar as minimizing false cons and optimizing integrationwith IoT platforms, and deployment in more complex surroundings. Performance for low- power bias.This perceptivity paves the way for unborn advancements, including the use of custom-trained models,

In conclusion, this design not only addresses a specific problem of raspberry operationing ranges and other areas but also serves as a stepping gravestone for farther disquisition and invention in computer vision- grounded results. The knowledge and experience gained through this bid accentuate the significance of interdisciplinary approaches in working ultramodern challenges, showcasing the transformative eventuality of technology in everyday life.

Chapter - 08

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