Reducing Crops Damage Caused By Birds Using AI

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Abstract: Detection and warning systems are crucial for safeguarding agricultural land from the intrusion of large birds, particularly those posing threats to property and human safety. These systems are designed to identify and alert the presence of such birds before they encroach upon farming territories. The deployment of these systems aims to mitigate risks such as bird-related collisions, which can result in significant costs and hazards. However, the effectiveness of these systems may be hindered by the lack of regular monitoring for incidents of bird-related accidents. This paper explores the operational principles of bird detection systems, emphasizing their reliance on machine learning technology to detect patterns indicative of bird presence. Challenges may arise from accurately distinguishing between different bird species and background elements, necessitating the refinement of machine learning algorithms to minimize false positives triggered by environmental factors. Effective deployment of these systems requires comprehensive planning and integration into regional and national agricultural policies. By leveraging advancements in machine learning technology and data analytics, stakeholders can enhance the efficiency of these systems, thereby reducing the incidence of bird-related accidents and protecting agricultural resources. This paper underscores the importance of continuous monitoring and adaptation of bird detection systems to effectively mitigate risks and ensure the sustained protection of farming land and communities.
Keywords: Bird Detection Systems, Agricultural Land Protection, Machine Learning Technology, Environmental Monitoring, Wildlife Management, Risk Mitigation, Farming Safety, Data Analytics, False Positive Reduction, Policy Integration.

I. INTRODUCTION

The protection of agricultural land from the intrusion of large birds is of paramount importance to ensure the safety of property and human activities. Detection and warning systems play a critical role in identifying and alerting the presence of these birds before they pose threats to farming territories. Leveraging advancements in machine learning technology, particularly convolution neural networks (CNNs), these systems have become increasingly sophisticated in discerning patterns indicative of bird activity. This paper explores the operational principles and technological advancements in bird detection systems, emphasizing the application of CNNs in analyzing data collected from various sources to enhance accuracy and efficiency. By integrating machine learning technology into agricultural practices, stakeholders can effectively mitigate risks posed by bird-related incidents and safeguard agricultural resources.

Fig 1 Sample images from the dataset

II. RELATED WORKS

In [1] Md Ataullha; Mushfiqur Rahman; M. Shahidur Rahman Rapid urbanization has threatened bird biodiversity globally, especially in Bangladesh. This study addresses the need for accurate bird detection and classification in urban environments, crucial for conservation efforts. Introducing the PakhiderChobi dataset with 8,670 annotated images of 33 Bangladeshi bird species, it supports real-time recognition and classification. The dataset accommodates various scenarios, including multiple birds of the same species and coexisting species in a frame.

Evaluation using the YOLOv8 object detection model yielded a mean average precision of 95.3% with efficient inference times of 6.6 milliseconds per image.
In[2] Moein Shakeri; Hong Zhang This paper presents a real-time bird detection system designed for detecting birds in flight using a single fixed camera. The system employs background subtraction and tracking through point correspondence techniques. Zivkovic's background subtraction method, incorporating a non-parametric model and a Gaussian mixture model extension, forms the basis of the system. Additionally, a correspondence component based on point-tracking is integrated into the background subtraction algorithm to enhance bird detection reliability. Experimental evaluations were conducted to assess the system's performance across objects of varying size, color, and velocity. The results demonstrate the system's efficiency and accuracy in detecting fast-moving objects such as birds.
In [3] Prathamesh Datar; Kashish Jain; Bhavin Dhedhi Object detection and localization is one of the prominent applications of the computer vision. The paper presents a comparative study of state of the art deep learning methods-YOLOv2, YOLOv3 and Mask R-CNN, for detection of birds in the wild. Detection of birds is an important problem across multiple applications including the aviation safety, avian protection and ecological science of migrant bird species. Deep learning based methods are very pre-eminent at detecting and localizing the birds in the image as it can tackle the conditions wherein the birds shown are diverse in shapes and sizes and most importantly the complex backgrounds they are in. We used the training and testing dataset provided by the NCVPRIG (BROID) conference which contained 325 and 275 images respectively. For training, we used the pre-trained models on the VOC 2012 and COCO dataset and trained them on the 325 images. We used F-score as one of the performance metrics, and F-Scores were 0.8140, 0.8721, 0.8688 for the YOLOv2, YOLOv3 and Mask R-CNN respectively. The results show that YOLOv3 outperforms YOLOv2 and is a marginal improvement over Mask R-CNN.
In[4] Babacar Diop; Dame Diongue; Ousmane Thiare This paper presents an innovative method for creating an automated surveillance system designed to monitor rice fields for pest and grain-eating birds. The primary objective is to accurately detect bird sounds, particularly those of harmonic nature, by utilizing normalized power sequences. The proposed detection system is straightforward and suitable for implementation using sensors. It involves refining audio frame blocks to preserve pertinent peaks, calculating the normalized power of recorded audio files, and inferring bird presence through the analysis of critical variances within the input files. Experimental findings confirm the efficacy of the proposed scheme, achieving a 91.07% accuracy rate in correctly identifying bird calls from the dataset. This underscores the system's potential in effectively detecting birds for agricultural surveillance purposes.
In[5] Akito Takeki; Tu Tuan Trinh; Ryota Yoshihashi; Rei Kawakami; Makoto Iida; Takeshi Naemura This paper addresses the challenge of detecting birds in large landscape images, particularly for applications in the wind energy industry. Despite advancements in image recognition through deep convolutional neural networks (CNNs), detecting small objects remains problematic. To overcome this, the paper proposes a hybrid approach combining CNN-based detection, fully convolutional networks, and a superpixel-based semantic segmentation method. These methods are integrated using support vector machines to enhance detection performance. Experimental results using a bird image dataset demonstrate the effectiveness and high precision of the proposed approach in bird detection within large landscape images.
In[6] Ce Li; Hanwen Hu; Baochang Zhang Recent advances in image super-resolution and object detection algorithms have offered unprecedented potential for reconstructing low-resolution images and detecting various objects. In this paper, we aim to analyze reliability of bird detection from Low-Resolution (LR) images. We collect a dataset named BIRD-50 1 and a public dataset named CUB-200 of real bird images with different scale low-resolutions, then conduct a study to quantify the performance of several state-of-the-art Super-Resolution (SR) reconstruction algorithms using deep convolutional networks.
In[7] Tyrol Chiang; Qizhong Li; Miaohua Huang This paper presents a novel target detection and segmentation algorithm designed for peripheral vision cameras, a key area in autonomous driving perception research. The proposed algorithm operates within a bird's-eye view perspective, combining the Cross-view Transformer with road segmentation and target detection functions. By employing a single network, the algorithm simultaneously addresses both tasks. To overcome inaccuracies in angle regression inherent in bird's-eye view object detection, the paper introduces a coding form based on direction vectors and a loss function utilizing cosine similarity.
In[8] Deqi Dong; Zhijie Xiao; Lulian Liu; Xiaodong Li This paper explores an enhanced object detection network based on the YOLOv3 network, a widely used algorithm in computer vision. While supervised learning methods dominate the field, they often require large amounts of labeled data, resulting in time-consuming manual labeling and training. Leveraging YOLOv3's fast inference speed, cost-effectiveness, and versatility, the improved network can accurately identify and locate specific class objects by extracting features through algorithms.

EXISTING SYSTEM

In the field of computer vision, YOLO v3 is recognized as a significant breakthrough in object detection technology. YOLO v3 introduces novel techniques such as residual skip connections and up-sampling to detect objects across different scales, resulting in a substantial improvement in accuracy compared to previous versions. By integrating more anchor boxes and refining the loss function to predict an "objectness" score, YOLO v3 achieves remarkable advancements in object detection accuracy. This represents a significant leap forward in computer vision, offering more precise and effective solutions for detecting objects in images. YOLO v3's capability to identify objects accurately at various scales addresses fundamental challenges in object detection, making it an invaluable tool for a wide range of applications. The implementation of advanced techniques like residual skip connections underscores a dedication to pushing the boundaries of object detection capabilities. With YOLO v3, researchers and developers gain access to a potent tool capable of revolutionizing tasks such as image recognition, autonomous driving, and surveillance. Its impact transcends academia, with practical implications for industries spanning healthcare to transportation. By harnessing YOLO v3's state-of-the-art features, developers can design more robust and efficient computer vision systems to meet the demands of modern environments. As YOLO v3 continues to advance, it holds the promise of further enhancing object detection capabilities and fostering innovation in computer vision.

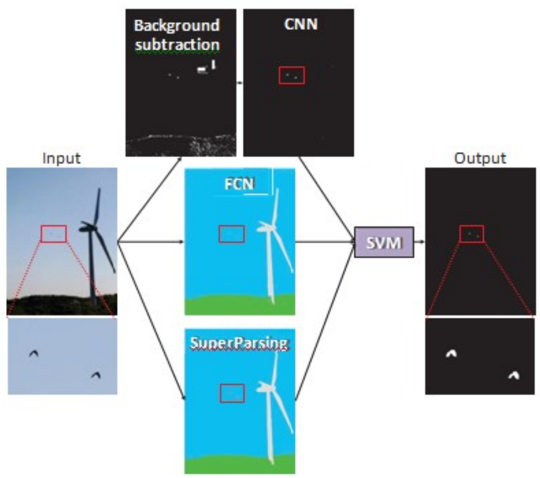

Fig 2 Existing system architecture

III. PROPOSED SYSTEM

This proposal seeks to establish a bird detection system tailored for farmland utilization, employing convolution Neural Network (CNN) algorithms within machine learning. The core objective is to precisely discern and categorize bird species by analyzing their unique sounds, furnishing timely alerts to farmers for mitigating bird-related threats in agricultural settings. The methodology encompasses diverse bird sound dataset acquisition, preprocessing steps for signal refinement, CNN model formulation targeting bird sound pattern comprehension, alongside model training and validation processes. Subsequent steps include system implementation for real-time detection and rigorous evaluation to assess its efficacy in bird presence detection. The anticipated outcome is the provision of a dependable tool enabling farmers to monitor bird activities efficiently, thereby reducing crop damage and bolstering agricultural output. This research holds significance in the realm of precision agriculture, presenting sustainable measures to mitigate bird-related risks and fortify agricultural sustainability.

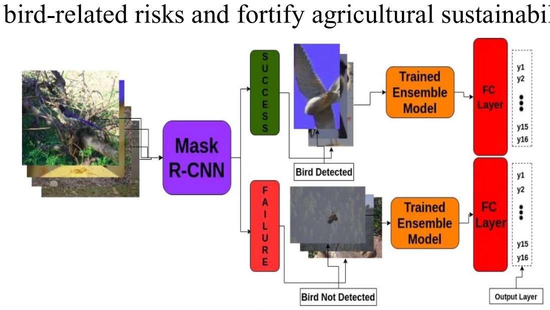

Fig 3 Proposed Architecture

IV. I MPLEMENTATION METHODOLOGY

CCTV Surveillance

Closed-Circuit Television (CCTV) surveillance, commonly known as CCTV, is a technology utilized for monitoring and surveillance purposes by transmitting video signals from cameras to specific monitors or recording devices. These systems find extensive use in various environments, including public spaces, residential areas, commercial establishments, and industrial facilities, for ensuring security, safety, and monitoring. CCTV surveillance facilitates continuous observation of activities and events, aiding in crime prevention, incident investigation, and general monitoring tasks. Typically, CCTV systems involve strategically installing cameras equipped with lenses to capture video footage of designated areas. This footage is then transmitted via wired or wireless connections to a centralized control center or recording device, where authorized personnel can view, store, and analyze it. Advanced functionalities such as motion detection, facial recognition, and remote access are often incorporated into CCTV surveillance systems, enhancing their effectiveness in monitoring and securing premises.

Video Processing

The Video processing encompasses the comprehensive manipulation and analysis of digital video data. Within our project scope, video processing involves capturing visual information from various sources such as CCTV cameras or other imaging devices deployed in surveillance setups. This process entails the conversion of optical signals into digital data, enabling subsequent analysis and processing by the system. Crucially, video acquisition lays the groundwork by providing raw visual data necessary for subsequent tasks. Factors such as image resolution, color depth, and frame rate are carefully considered to ensure the quality and fidelity of captured video footage. These acquired videos serve as the backbone for detecting and identifying objects or events of interest within the surveillance footage. Moreover, adjustments to video acquisition parameters may be made based on environmental conditions or specific application needs to optimize system performance and enhance overall video quality.

Frame Conversion

Frame conversion constitutes a pivotal process within our project, involving the conversion of individual frames of video footage obtained from CCTV surveillance cameras into a standardized format conducive to further processing and analysis. This conversion entails adjusting parameters such as resolution, frame rate, color depth, and encoding format to ensure compatibility with subsequent image processing algorithms. By performing frame conversion, we prepare the video data for efficient storage, transmission, and manipulation within the surveillance system, thereby facilitating seamless integration of diverse video sources. Moreover, frame conversion may encompass preprocessing steps such as noise reduction or image enhancement to enhance the quality and usability of the video frames. Once optimized, these frames are primed for subsequent analysis tasks, including object detection, tracking, and event recognition, thereby enhancing the overall surveillance capabilities of the system.

Birds Feature Extraction

In Birds Feature Extraction is a critical component of our project, focusing on identifying and isolating distinctive characteristics specific to avian species within surveillance footage. Utilizing advanced image processing and computer vision techniques, this module extracts key features such as shapes, textures, colors, and patterns associated with birds from captured video frames. These extracted features serve as discriminative cues for distinguishing birds from other objects or background elements present in the surveillance imagery. By accurately extracting and representing these avian features, our system enhances the efficiency and accuracy of bird detection, classification, and tracking tasks This module enables the system to concentrate on relevant regions of interest containing birds while filtering out irrelevant information, thereby optimizing surveillance efforts. Moreover, to improve computational efficiency, feature extraction may involve dimensionality reduction techniques, streamlining data representation. The extracted bird features serve as valuable inputs for machine learning algorithms utilized in bird detection and recognition tasks, ultimately enhancing the overall effectiveness of the surveillance system.

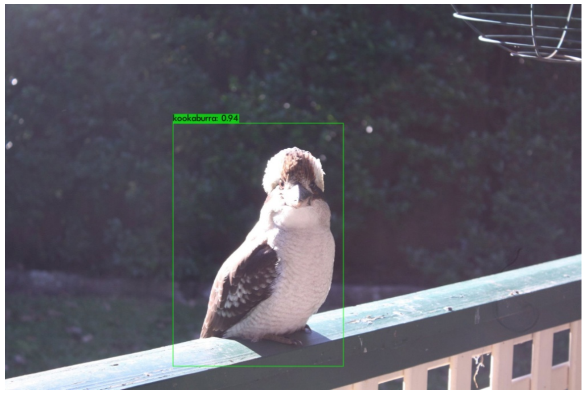

Fig 5 Birds Feature Extraction

CNN Classification

The Bird Classification using Convolutional Neural Networks (CNNs) is a pivotal aspect of our project, aimed at automatically categorizing avian species detected within surveillance footage. CNNs, specialized deep learning architectures designed for image processing tasks, are employed within this module. These networks leverage convolutional layers to autonomously learn and extract hierarchical features from input images, enabling accurate classification of birds based on learned patterns and characteristics.This module serves a crucial role in our avian surveillance system by facilitating automated identification and categorization of birds captured in CCTV footage. By harnessing CNN classification, our system can efficiently analyze large volumes of visual data and accurately classify birds into predefined categories or classes. This capability enables rapid decision-making and response to potential threats or incidents involving avian wildlife. Furthermore, CNN classification may entail fine-tuning pre-trained CNN models on specific bird datasets to enhance classification performance and adaptability to diverse environmental conditions. Leveraging CNNs for classification tasks significantly improves the effectiveness and efficiency of our avian surveillance system, thereby contributing to enhanced wildlife monitoring and conservation efforts.

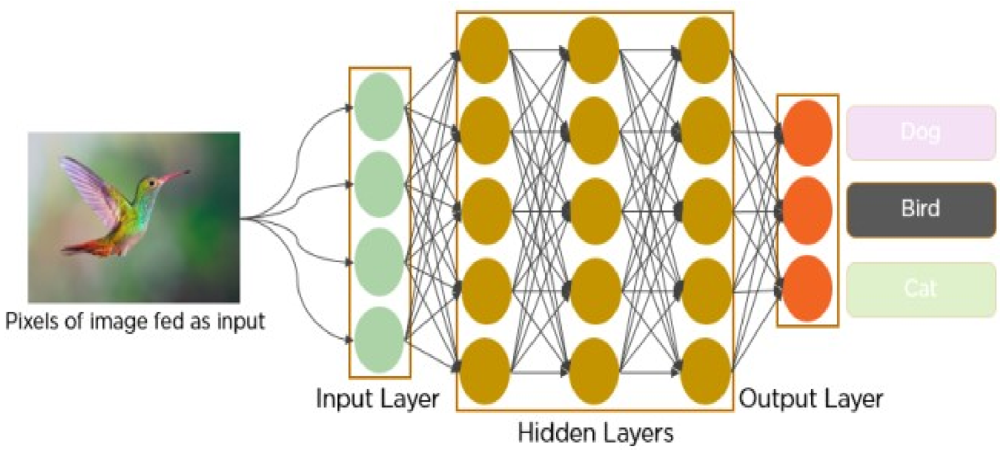

Fig 6 CNN classification

V. R

ESULT AND DISCUSSION

In this study, we implemented and evaluated a comprehensive surveillance system tailored for agricultural environments, focusing on the detection and mitigation of potential threats to crops and property. The system comprised several modules, including CCTV surveillance, image acquisition, frame conversion, bird feature extraction, CNN classification, bird detection, and crackers sound detection. The results of our study demonstrate the effectiveness of the surveillance system in detecting and responding to various threats in agricultural fields. The CCTV surveillance module provided continuous monitoring of the farm premises, enabling real-time observation and retrospective analysis of activities. This facilitated the early detection of potential threats and incidents, contributing to enhanced farm security.Image acquisition and frame conversion modules played crucial roles in processing visual data obtained from CCTV cameras. These modules ensured the seamless integration of diverse video sources and prepared the video data for efficient storage, transmission, and manipulation within the surveillance system. The bird feature extraction module successfully identified and isolated relevant characteristics specific to avian species within surveillance footage. By extracting distinctive features such as shapes, textures, colors, and patterns associated with birds, the system facilitated accurate classification and tracking of avian wildlife. The CNN classification module employed deep learning techniques to categorize animals detected within surveillance footage. Leveraging convolutional neural networks, the system efficiently analyzed large volumes of visual data and accurately classified birds into predefined categories or classes. This automated classification process contributed to rapid decision-making and response to potential threats involving wildlife.The bird detection module utilized computer vision algorithms and machine learning techniques to automate the identification and localization of birds within surveillance footage. By analyzing visual features such as shapes, textures, and colors, the system identified regions of interest containing birds, thereby enhancing surveillance capabilities and facilitating timely responses to potential threats or incidents involving avian wildlife.Furthermore, the crackers sound detection module provided an additional layer of monitoring and early warning against potential animal intrusion or disturbances in agricultural fields. By detecting specific acoustic signatures indicative of threats, such as the sound of crackers, the system alerted farmers or relevant authorities promptly, enabling immediate action to safeguard crops and property.In conclusion, the results of our study demonstrate the effectiveness of the comprehensive surveillance system in enhancing farm security and mitigating risks to agricultural resources. By integrating advanced technologies such as CCTV surveillance, image processing, machine learning, and auditory detection, the system offers a robust solution for monitoring and protecting agricultural environments against potential threats and disturbances.

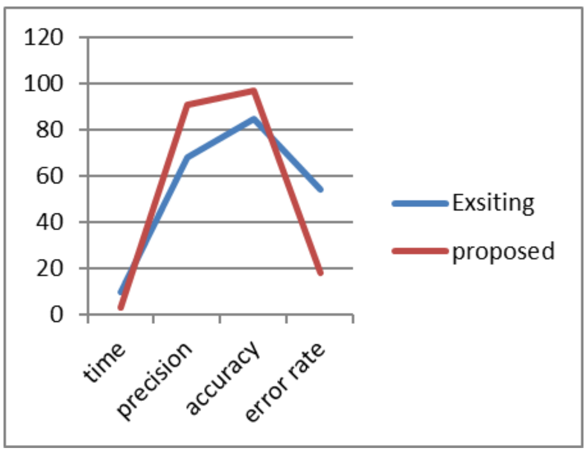

Fig 8 Simple Average Comparison

	time	precision	accuracy	error rate
Exsiting	10	68	85	54
proposed	3	91	97	18

Fig 9 Real time data analysis of comparison system

VI. CONCLUSION

In this study, we have presented a comprehensive surveillance system tailored for agricultural environments, designed to detect and mitigate potential threats to crops and property effectively. Through the integration of advanced technologies such as CCTV surveillance, image processing, machine learning, and auditory detection, our system offers a robust solution for enhancing farm security and safeguarding agricultural resources.The results of our study demonstrate the efficacy of each module within the surveillance system. The CCTV surveillance module provided continuous monitoring of farm premises, enabling real-time observation and retrospective analysis of activities. Image acquisition and frame conversion modules ensured the seamless integration of diverse video sources and prepared visual data for efficient processing and analysis. The implementation of bird feature extraction and CNN classification modules enabled the accurate identification and categorization of avian wildlife within surveillance footage. Leveraging advanced image processing techniques and deep learning algorithms, our system facilitated the automated detection and classification of birds, contributing to rapid decision-making and response to potential threats involving wildlife. Additionally, the bird detection module utilized computer vision algorithms to automate the identification and localization of birds within surveillance footage. This module enhanced surveillance capabilities by analyzing visual features and identifying regions of interest containing birds, thereby facilitating timely responses to potential threats or incidents involving avian wildlife. Furthermore, the integration of the crackers sound detection module provided an additional layer of monitoring and early warning against potential animal intrusion or disturbances in agricultural fields. By detecting specific acoustic signatures indicative of threats, such as the sound of crackers, the system alerted farmers or relevant authorities promptly, enabling immediate action to safeguard crops and property. Overall, our study demonstrates the effectiveness of the surveillance system in enhancing farm security and mitigating risks to agricultural resources. By leveraging advanced technologies and automation, our system offers a proactive approach to monitoring and protecting agricultural environments, contributing to the sustainability and productivity of farming operations.

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