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Knee-Jerk Reaction for Protecting Agricultural Farms from the Invasion of Wild Animals

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Abstract: "Agriculture is backbone of our country." Threats to agriculture can be considered as threats to economy as well. Crops are reducing because of the major attack of animals, which causes crop damage. Crop damage by animals, resulting in lower yields, in turn affects farmers' mental health too. The most commonly practised methods which are followed by farmers are not feasible and it will not be able to shoo the wild animals. So, this project mainly detects animals and, upon detection, generates corresponding sounds for different animals like monkeys, elephants, and boars. The expansion of cultivated land into former wildlife habitats poses a major threat to crop yields in India. Human-wildlife conflict intensifies as animal attacks, particularly crop raiding, become a significant challenge for farmers. In addition to pests and natural calamities, animals cause substantial damage, which results in lower yields. The methods followed by farmers to mitigate these issues prove ineffective, and hiring guards for continuous crop surveillance is economically unfeasible. Striking a balance between protecting crops and ensuring the safety and security of both humans and animals is imperative. Developing non-harmful strategies to divert animals from crops becomes essential in addressing this multifaceted challenge.

Keywords: YOLO Algorithm, HOG Algorithm, Librosa, ESP32, Internet of Things

I. INTRODUCTION

Agriculture, often termed the backbone of a nation's economy, encounters multifaceted challenges, with threats to its productivity presenting substantial ramifications. Among these threats, the Operennial issues of damaged crops resulting from animal approaches prominently. Such encroachments by wildlife pose a substantial menace to agricultural output, directly impacting the nation's economic stability.

However, the repercussions extend beyond financial implications, deeply affecting the mental and emotional well-being of farmers whose livelihood hinge on the success of their harvests. The conventional methods employed by farmers to mitigate these challenges have proven inadequate and inefficient. The impracticality of hiring personnel to continuously monitor vast agricultural expanses further compounds this issue. In response to this imperative, a pioneering project has been initiated to tackle this predicament.

The project centers around the development and deployment of a sophisticated system adept at animal detection within agricultural landscapes. This system harnesses cutting-edge technology to discern the existence of various wildlife species—ranging from the mischievous monkeys to the colossal elephants and the foraging boars. The crux of the system's functionality lies in its ability to not merely detect these animals but also to emit targeted and species-specific sounds upon detection. By leveraging an understanding of the distinct auditory repertoires that resonate uniquely with each wildlife species, the system generates tailored sounds capable of deterring the specific animals identified. For instance, upon detecting monkeys, the system could emit sounds mimicking predatory calls or signals associated with a threat, prompting these creatures to retreat. Similarly, different sounds would be generated for elephants and boars, attuned to dissuade their presence without causing harm.

This creative approach holds significant promise in mitigating wildlife-induced crop damage. By providing an automated, non-invasive, and humane means of discouraging animal intrusion, it aims to curtail crop losses substantially. Beyond preserving agricultural yields, the endeavor aspires to alleviate the mental strain and anxiety that farmers endure due to persistent threat of wildlife intrusion. By offering effective and sustainable method of protecting crops, this project endeavors not only to fortify agricultural sustainability and economic stability but also to foster the well-being of those toiling on the frontline of agricultural production—the farmers.

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II. PROBLEM STATEMENT

Threats to agriculture can be considered as threats to economy as well. Crops are reducing because of the major attack of animals, which causes crop damage. Crop damage by animals, resulting in lower yields, in turn affects farmers' mental health too. The most commonly practiced methods followed by farmers are not feasible and will not be able to deter wild animals. We are working on a project that detects animals and, upon detection, generates corresponding sounds for different animals like monkeys, elephants, and boars. Hence, we are introducing 'Knee-Jerk Reaction for Protecting Agricultural Farms from Invasion of Wild Animals'.

The issues of animal- induced crop damage present a multifaceted challenge. When wild animals intrude upon agricultural land, they not only jeopardize crop yield but also disrupt the economic stability of farmers. Conventional methods lack efficiency in warding off these animals, while employing human guards is often impractical due to cost constraints and the vastness of agricultural areas. Our project aims to revolutionize this scenario by leveraging advanced technology. Through an innovative animal detection system, we can identify specific threats like monkeys, elephants, and boars.

III. OBJECTIVES

1. The main objective of the project is to safeguard the agricultural field from wild animals and also to protect them by driving them away instead of killing them.

2. The project also aims to protect human lives from animal attacks. We are using an integrative approach in the field of Deep Learning to provide a monitoring and repelling system for crop protection against animal attacks.

3. This project will be able to protect the crops from damage caused by animals as well as divert the animals without any harm.

4. Crops on farms are many times ravaged by local animals like buffaloes, cows, goats, birds, etc. This leads to huge losses for the farmers. Farmers can't barricade entire fields or stay on a field 24 hours and guard it.

IV. EXPECTED OUTCOMES

1.The system is designed to capture and detect the presence of animals entering the crop yard. Upon detection, it initiates a response by producing specific sounds through a speaker, serving as a deterrent to shoo away the animals. This automated process aims to protect crops from potential damage caused by wildlife intrusion.

2. The system is equipped to detect sounds produced by animals. This auditory detection serves as an additional layer of defense, allowing the system to identify potential animal invasion by recognizing specific sounds associated with wildlife presence. Once detected, the system responds by implementing measures to shoo away the animals.

3. The system stores relevant data, including information about detected objects, sounds, and responses. This data is then transmitted to the farmer through a mobile application. The farmer receives real-time alerts and information about the ongoing status of the crop protection system, providing them with valuable insights into potential threats and system performance.

4. The smart crop protection system operates on dual nodes, combining both automatic and manual functionalities. While the automated processes continuously monitor and respond to potential threats, there is also a manual control option. This dual operation provides flexibility and allows farmers to intervene if necessary, providing them with the ability to actively manage and control the system.

V. LITERATURE SURVEY

[1] **K Balakrishna | Fazil Mohammed | C.R. Ullas "Application of IOT and machine learning in crop protection against animal intrusion using Internet of Things"** Published in keai publishing and global transition proceedings - Crop protection from animal intrusion is important for the successful cultivation of the crops and this can be done with the IoT and Machine learning. The various techniques used in this paper are Raspberry Pi processor, Wi-Fi module, R- CNN, SSD, and Twilio. SSD algorithm performance better compared to the R-CNN algorithm with computation time, accuracy and efficiency. In future work, an App-based model can be developed to make it more mobility and user friendly.

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[2] **Aibin Abraham | Bibin Mathew | Devika Panikkar | Jaya John "Wild Animal Intrusion Detection System using YOLO"** This project, detailed in the International Journal of Innovative Science and Research Technology, employs strategically placed cameras on farms to capture clear animal images. By utilizing pre-processing, feature extraction, and the YOLO algorithm, the system achieves high-accuracy classification, providing a cost-effective and energy- efficient smart embedded farmland security solution. Its primary objective is to mitigate crop losses and safeguard farmland from intruders and wild animals, addressing crucial threats to agricultural areas.

[3] **Mohaimenul Azam Khan Raiaan | Nur Mohammad Fahad | Shovan Chowdhury | Debopom Sutradhar "IoT-Based Object-Detection System to Safeguard Endangered Animals and Bolster Agricultural Farm Security using object detection model and YOLOv8"** Published in future internet - The ESP32-CAM and YOLOv8 model in a sophisticated object-detection system achieves remarkable real-time detection and classification of endangered and harmful animals in farming, boasting an impressive mean average precision of 92.44% and a sensitivity rate of 96.65% on unseen test data. This approach not only helps in crop protection by providing farmers with timely warnings but also promotes a humane coexistence between farming communities and wildlife, contributing significantly to sustainable agriculture and wildlife conservation amidst the challenges of human settlement encroachment into natural habitats.

[4] **Mr. Jayesh Redij | Mr. Pranav Shitap | Mr. Shikhar Singh | Mr. Durvesh Zagade "Smart Crop Protection System from Animals Using Raspberry pi and PIR sensor"** Published in (IJCRT) that is International Journal of Creative Research Thoughts - The primary objective is to mitigate crop losses caused by intruders and wild animals, a prevalent issue faced by Indian farmers. The devised system employs sound production to deter animals, ensuring their safe departure, and utilizes a GSM module to alert farmers via a call. This affordable and farmer-friendly solution aims to address the significant losses farmers encounter due to animal intrusion. Importantly, the system prioritizes non-harmful methods, both for animals and individuals, effectively safeguarding agricultural areas day and night through IoT monitoring. In essence, this system not only provides an accessible and humane means of protection but also offers real-time communication, empowering farmers in safeguarding their crops.

[5] **Vaishakh Bhasme | Shrutika Patil | Aditya Pimple | Prof. S.A. Koti "Smart Farming and Crop Monitoring Technology Using Crop Monitoring and ESP32"** Published in International Research Journal of Modernization in Engineering Technology and Science (IJRMETS) – By utilizing Crop Monitoring and ESP32, these systems enable farmers to address issues related to irrigation, temperature, humidity, and other factors through the continuous monitoring of soil conditions and crop growth. A more efficient communication path for the transfer of useful data between various nodes can be established. Consequently, farmers can use a smartphone or computer to monitor their crops and manage various agricultural equipment. These devices offer a broad range of applications, aiding users in advancing both their expertise and crop productivity. With the help of the Internet of Things, it becomes possible to monitor soil quality, temperature, humidity, yield, and other factors influencing growing conditions.

[6] **Dr. M.V. Subramanyam | Shaik Safiya Thasleem | Yenigela Sravani "IoT Based Farm Protection from Animals and Human Theft Using ESP32 With Camera Module"** Published in International Research Journal of Modernization in Engineering Technology and Science (IJRMETS) – Here ESP32 with camera module acts as bot for alerting the farm owner whenever intruder is detected. This system identifies movement of living beings and captures the image. Arduino IDE is mainly used to write and dump the code to the microcontroller board. The Blynk application is employed to send alert messages and images to farmers. By utilizing these devices and technologies, we have developed a system to detect wild animals, providing farmers with a tool to reduce crop damage and achieve **better yields.**

[7] **Dr. R.S. Sabeenian | N. Deivanai | B. Mythili "Wild Animals Intrusion Detection using Deep Learning Techniques"** Published in International Journal of Pharmaceutical Research - Addressing the contemporary social issue of crop damage by wild animals, this project emphasizes the importance for farmers to consider the welfare of these living beings during crop production. Urgent attention is required to find an effective solution to this problem. The proposed smart embedded farmland protection system holds significant social relevance, aiming to assist farmers in safeguarding their fields. By doing so, it not only prevents substantial financial losses but also alleviates the unproductive efforts that farmers invest in field protection. This project aligns with the ethical consideration of protecting animals while promoting sustainable and responsible farming practices, making it a crucial initiative for the well- being of both farmers and wildlife.

[8] **Vikas Bavane | Arti Raut | Swapnil Sonune "Protection of Crops from Wild Animals Using Intelligent Surveillance System"** Published in International Journal of Research in Advent Technology (IJRAT) -This impactful project endeavors to address pressing agricultural challenges through the development of a smart embedded farmland protection and surveillance-based system. With a primary focus on affordability and energy efficiency, the system aims

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to curb crop losses by safeguarding fields against threats posed by intruders and wild animals. This solution not only offers a cost- effective means of protection but also alleviates the burden on farmers, sparing them from labor-intensive efforts. The anticipated outcome extends beyond financial preservation, as the system is poised to enhance overall crop yields. By empowering farmers to secure their orchards and fields, the project contributes significantly to the economic well-being of agricultural communities. The amalgamation of technology and agriculture in this venture signifies a crucial step toward sustainable and prosperous farming practices.

[9] **K. Saravanan | V. Sharanya | S. V. Lakshmi "Smart Crop Protection System from Wild Animals Using Arm"** Published in Journal of Critical Reviews – With the assistance of PIR and ultrasonic sensors, the primary function of this system is to detect the presence of wild animals, preventing their entry into farmland and mitigating potential threats to crops. This eliminates the need for electric fences and other traditional methods that can cause harm to the animals searching for food in the farmland. The owners of the farmland can easily detect any unwanted trespassing of wild animals into their fields. Additionally, these animals are deterred by the ultrasonic sensors. This technique is highly useful, considering social responsibility towards farmers, as the GSM module sends messages alerting them to potential issues.

[10] **Jitesh Kumar "Agricultural Field Protection from Wild Animal using Surveillance and Safety precautions"** Published in Journal of Emerging Technologies and Innovative Research (JETIR) - This paper presents an integrative approach in the field of IoT for smart agriculture, with a focus on low- power devices and open-source platforms. The main purpose of this work is to develop a system for repelling and monitoring against animal attacks and adverse weather conditions to enhance crop protection. The term 'animal attack security' in this paper refers to the functionality of the system and suggests potential areas for future work, exploring the possibility of integrating these features into various other sectors.

VI. PROPOSED WORK

The main objective of this project is to safeguard agricultural fields from local and wild animals, emphasizing a non-lethal approach to drive them away. With a focus on protecting both crops and human lives from animal attacks, the project utilizes an integrative Deep Learning approach for a monitoring and repelling system. This initiative seeks to prevent crop damage by animals and divert them harmlessly. Many farms experience significant losses due to animal interference, making it impractical for farmers to manually guard their fields 24/7. Hence, the proposed automatic crop protection system employs intelligent detection to warn and deter animals, offering a practical solution to safeguard crops effectively. It comprises several components, including the ESP32, a central control unit, a controller for system coordination, cameras for image capture, a microphone for sound recording, a speaker for producing deterrent sounds, and a servo motor for potential actions such as adjusting camera angles. The detection process involves continuous image and sound capture in the yard. Images are converted to JPG or PNG format, while sounds are converted to MP3 format. Both data types are sent to Firebase storage for further processing. In the machine learning processing phase, a Jupyter Notebook or Anaconda software tool utilizes the HOG (Histogram of Oriented Gradients) algorithm for object detection in images. Simultaneously, the Librosa library is employed for sound analysis, aiding in understanding the characteristics of recorded animal sounds. Firebase facilitates communication between components, serving as a conduit for transmitting data between storage and the ESP32. Detected animal names are sent back to Firebase from the Jupyter Notebook or Anaconda tool and then relayed to the ESP32. In automatic mode, the ESP32 triggers the speaker to produce sounds that deter animals based on their detected names. Additionally, the animal names are sent as notifications to the farmer's mobile application through Firebase, keeping the farmer informed about potential threats to the crops.

The system operates in two modes: automated and manual. In automated mode, the entire process runs autonomously, while in manual mode, the farmer can intervene after receiving notifications. This dual- mode operation provides flexibility and empowers the farmer to make decisions based on real-time information. Overall, the system integrates advanced technologies, machine learning algorithms, and real- time communication to create an efficient and adaptive crop protection solution.

In this project, we primarily utilize three types of flowcharts. The first illustrates the overall working of the system, incorporating Firebase storage. The second flowchart details the hardware process, were the ESP cam and microphone are employed to detect animals based on data visualization and sounds, respectively. The third flowchart outlines the software flow, depicting communication between Firebase, the processor, and the mobile app. It also illustrates the two modes in the system flow.

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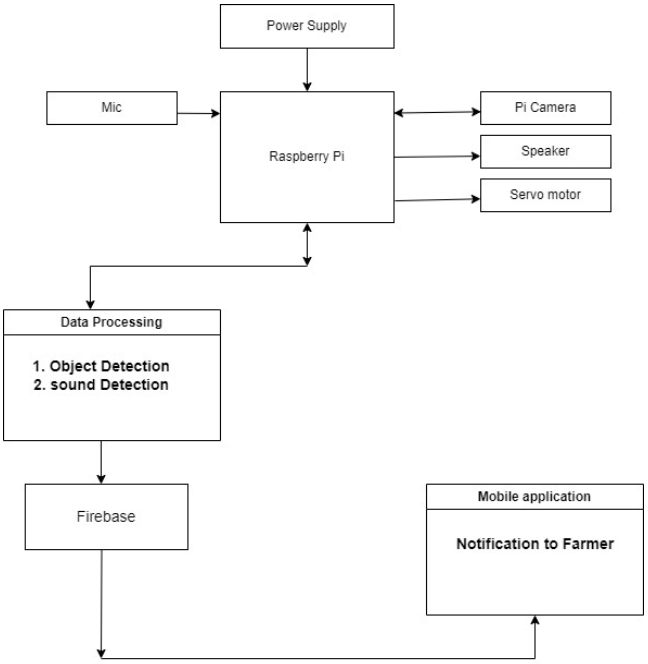

Figure 1 Block Diagram of the system

The above Figure 1 illustrates the Block Diagram of the System. In this system, there's a special computer called a Raspberry Pi, it's linked to a camera and a speaker. There's also a microphone, a power supply, and even a mobile app involved. This system is smart—it can detect objects with the camera, recognize sounds with the microphone, and send alerts to farmers through something called Firebase.

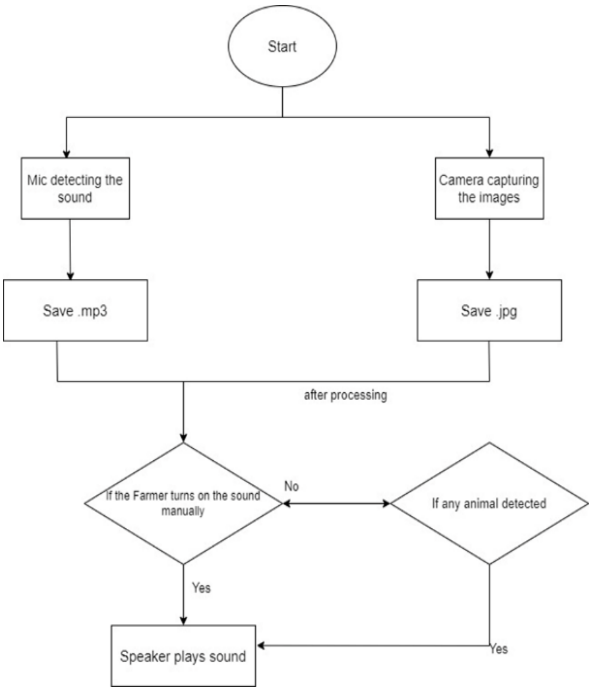

Figure 2 Flowchart of Embedded System

The above Figure 2 shows the Flowchart of the embedded system. This system is mainly designed for farms, and starts by listening for sounds and looking for animals through a microphone and camera respectively. If it detects anything, it saves the sounds as .mp3 files and the images as .jpg files. After processing, it checks if the farmer has manually turned on the sound; if not, it ends there. However, if the sound is off and an animal is detected, it plays sound through a speaker.

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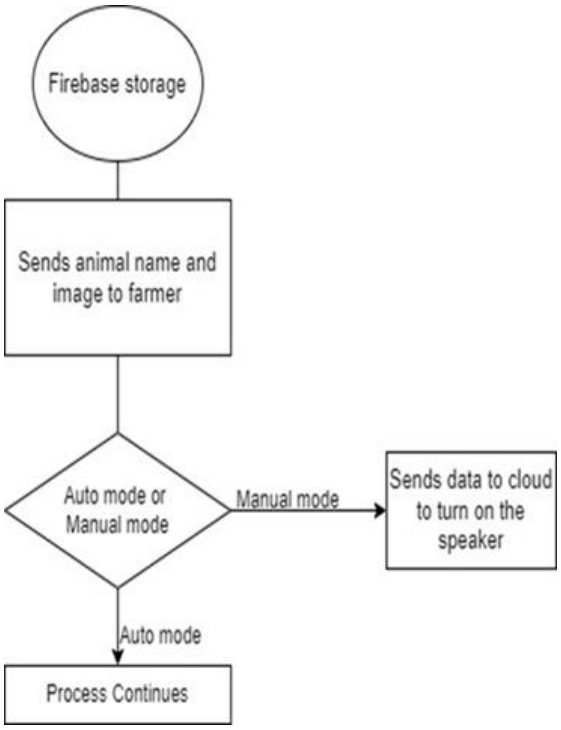

Figure 3 Flowchart of Mobile Application

The above Figure 3 shows the flowchart of the Mobile Application where from the Firebase storage the animal name and image will be sent to the Farmer. It operates in two modes: Auto and Manual mode. In auto mode, the process continues while in manual mode it sends data to the cloud to turn on the speaker.

VII. CONCLUSION

Crop damage by wild animals is a serious issue, and a new project is addressing it to assist farmers. The project aims to protect fields, preventing financial losses and saving farmers from fruitless efforts. Using warning sounds, it scares animals away without causing harm, providing a humane solution. This not only resolves immediate problems but also enhances crop yields, fostering long-term benefits for farmers. The approach is practical, offering a sustainable and successful farming environment. By tackling the root of the issue, this initiative contributes to a more secure and prosperous future for farmers dealing with the challenges of wild animal interference in agriculture.

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