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Smart Wildlife Intrusion Detection and Field Protection System

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Abstract: ***Human wildlife conflict poses a significant problem in areas close to forests and farmlands, where wild animals frequently enter human settlements or agricultural fields, leading to property damage and safety threats. To address this, the project introduces an Advanced Wildlife and Field Protection Framework that can identify the presence of specific animals such as elephants, tigers, lions/leopards, and wild boars using an Arduino-based embedded setup. The framework employs easily available components like ultrasonic sensors, PIR (Passive Infrared) sensors, LED indicators, and potentiometers to mimic animal-specific temperature signals. By combining motion detection with animal-type simulation, the system enables real-time responses through visual alerts. This solution strengthens early warning capabilities while offering a cost-effective and flexible method to reduce crop losses and safeguard human lives in high-risk areas.***

Keywords: Smart system; Wildlife intrusion; Detection system; Field protection; Embedded system; IoT-based monitoring; Early warning system

1. Introduction

Human–wildlife conflict is an increasing concern in areas where agricultural lands lie close to forests. Wild animals frequently invade farmlands in search of food and water, causing crop losses and creating risks to human safety. Conventional measures such as electric fencing, watchtowers, and manual patrolling are costly, labor-intensive, and often insufficient in preventing such intrusions. However, with recent advancements in embedded systems and sensor technologies, it is now possible to design intelligent systems capable of automatically detecting and responding to animal movements in real time. The enhanced wildlife protection system is built on an Arduino Uno and combines ultrasonic and PIR sensors to monitor both motion and distance. To replicate animal-specific characteristics, four potentiometers are employed, each representing an animal — elephant, tiger, lion/leopard, and wild boar. These potentiometers generate simulated temperature values that act as stand-ins for real sensor inputs. When movement is detected within the designated range, the system reads the potentiometer values to identify which animal is being represented. Once recognized, a visual alert, such as an LED indicator, is triggered to signal potential danger. By incorporating multiple potentiometers, the framework is able to differentiate between various wild animals and respond appropriately. Designed as a modular and scalable prototype, the system can later be enhanced with real- world detection technologies, including thermal imaging or specialized animal sensors.

2. Related Study

This study introduces a deep learning–based surveillance system tailored for wildlife protection during both day and night. By employing advanced neural network techniques, it is capable of recognizing and tracking wildlife movements under varying illumination, offering an automated, 24/7 monitoring solution to enhance conservation efforts. [1] Focused on practical wildlife conservation, this paper details the implementation of Faster R-CNN, a state-of-the-art object detection algorithm, for monitoring tigers in real time. Using camera traps, the system provides robust detection and density estimation of tigers, aiding ongoing conservation initiatives. [2] This work proposes a specialized deep learning framework for detecting the "Big-4" snakes—India's most medically significant species. Leveraging convolutional neural networks, it aims to enhance real- time detection in both field environments and healthcare contexts, improving snakebite response and species monitoring. [3] This paper presents a novel observation system combining tethered balloon platforms with high-resolution imaging to monitor marine wildlife in offshore renewable energy zones. The method ensures minimal ecological disturbance while enabling continuous, real-time data collection crucial for sustainable marine development. [4] The study describes a CNN-based deep learning model designed to detect animal intrusions in farmlands, protecting crops from wildlife. The methodology includes training on field imagery to accurately identify and alert for potential threats, offering an automated, data-driven alternative to conventional farm security. [5] This research introduces an IoT-enabled system that uses advanced lighting detection sensors to identify early signs of fire in forest areas. By integrating automated alerts with rapid response protocols, the framework enhances forest and wildlife safety through real-time monitoring and intervention. [6] The authors propose a real-time, IoT-enabled object detection framework aimed at safeguarding agricultural fields from intrusion whether by animals or unauthorized human presence. The system leverages edge processing and sensor networks to trigger timely alerts, improving field security and crop preservation. [7] This empirical study evaluates the viability of drone-captured imagery combined with object detection algorithms for automatic wildlife monitoring. The paper assesses detection accuracy and operational efficiency across species and environments, offering data-driven insights into scalable wildlife surveillance. [8] A comprehensive review of

India's forest policies, legal frameworks, and governance mechanisms as they relate to wildlife conservation. The chapter highlights regulatory strengths and gaps, advocating policy reforms to preserve fading wildlife heritage. [9] Examining the interplay between wildlife resource management and sustainable development in China, this work evaluates institutional, economic, and environmental barriers. It provides strategic recommendations to optimize conservation efforts in alignment with national sustainability goals. [10] This paper presents WildSaver, a system combining UAV-based monitoring with block chain for secure, transparent wildlife data recording. It enhances anti-poaching initiatives and ecological oversight through decentralized and tamper-proof mechanisms. [11] A deep learning–based system using YOLOv5 architecture for detecting and classifying lions. The approach focuses on precision and speed to facilitate real-time wildlife surveillance, contributing significantly to lion conservation efforts. [12] This study employs geospatial tools to assess elephant habitat suitability and movement patterns within Dalma Wildlife Sanctuary. Insights are utilized to delineate viable corridors, aiming to reduce human-elephant conflict and guide habitat management. [13]

3. Methodology

This project presents an Advanced Field and Wildlife Protection Framework designed to detect and prevent intrusions in agricultural and forest border areas. The system integrates an Arduino Uno with a PIR sensor for motion detection and an ultrasonic sensor for distance measurement, enabling real-time monitoring of animals or humans. When thresholds are met, a visual alert via LED is activated, with scope for future upgrades such as buzzers or GSM modules for remote notifications. Implemented using Arduino IDE and built on a modular breadboard setup, the system is cost-effective, portable, and scalable. It offers a practical solution to reduce human effort and crop damage, with potential enhancements including wireless communication, solar power, and IoT integration.

3.1 Flow Chart

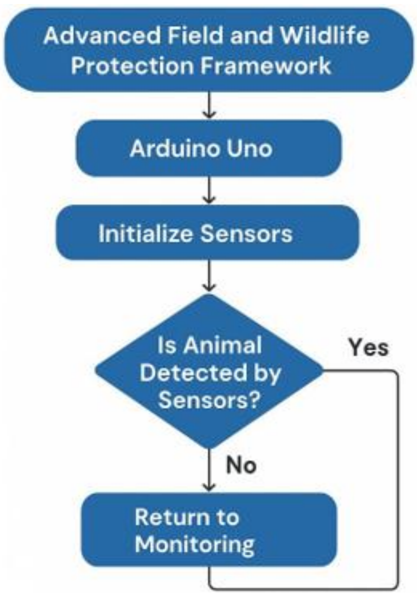

Figure 3.1: Flow chart

Figure 3.1 depicts the sequential workflow of the Advanced Field and Wildlife Protection Framework. The process starts when the system is powered on and managed by the Arduino Uno microcontroller. Upon activation, the Arduino initializes all connected sensors, primarily the PIR and Ultrasonic sensors, which are vital for detecting motion and monitoring proximity around the protected field or forest boundary. Once initialization is complete, the system enters a continuous monitoring cycle, where the sensors constantly scan the environment to identify movement or the presence of objects, such as humans or animals. The Arduino evaluates these sensor readings to determine if an intrusion has occurred. If motion or a notable distance variation is detected, the system recognizes the intrusion and can activate alert mechanisms like LEDs or buzzers (though not explicitly shown in the flowchart). Whether detection occurs or not, the system loops back to its monitoring mode. This continuous cycle ensures uninterrupted surveillance, making the framework efficient and reliable for protecting farmlands and wildlife zones.

3.2 Block Diagram

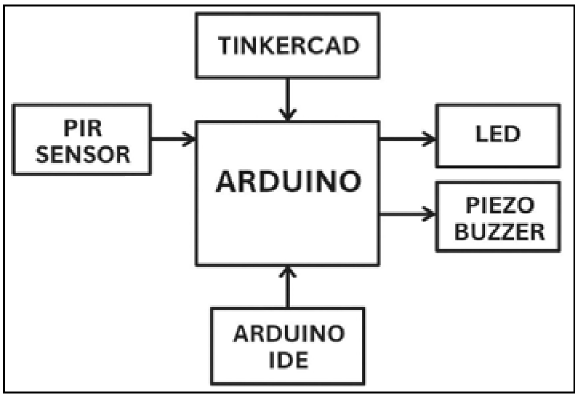

Figure 3.2: Block Diagram

Figure 3.2 presents the block diagram of the Advanced Field and Wildlife Protection Framework**,** developed to detect motion in agricultural lands and forest boundaries to prevent intrusions by humans or animals. At the center of the system is the Arduino Uno microcontroller, which manages both input and output functions. The primary input device is the PIR (Passive Infrared) sensor, which identifies infrared radiation emitted by moving objects such as humans or wildlife. Upon detecting motion, the sensor transmits a digital signal to the Arduino. This process is particularly valuable in remote or sensitive regions where continuous human surveillance is impractical. The Arduino interprets the input and triggers an alert mechanism. In this case, an LED acts as the output device, illuminating when motion is detected to provide a clear visual warning. Although the block diagram also features a buzzer, it was excluded from the final hardware version, leaving the LED as the sole alert system. The circuit was modeled and tested virtually in Tinker cad, ensuring proper functionality before physical implementation. Programming and code uploading were carried out using the Arduino IDE. This system thus offers a practical and low-cost solution to improve field safety and minimize risks of wildlife intrusion or crop damage.

3.3 Arduino Uno

Figure 3.3: Arduino Uno

Figure 3.3 depicts the Arduino Uno, a widely used microcontroller board built around the ATmega328P. It is an open-source platform, easy to use, and suitable for both beginners and experienced developers in electronics and embedded systems. As the most popular model in the Arduino family, the Uno often serves as the core controller in automation and embedded applications. The board features 14 digital input/output pins (6 of which can function as PWM outputs) and 6 analog inputs. Operating at 5V with a 16 MHz quartz crystal oscillator, it also includes a USB port, power jack, ICSP header, and a reset button. The USB connection allows for both programming and serial communication with a computer. Programming is done through the Arduino IDE, which uses a C/C++-based environment and provides a simple interface for uploading code. With its ability to connect to multiple sensors and actuators, the Arduino Uno is ideal for real-time monitoring and control tasks. In this project, it is used to process signals from the PIR sensor and control the LED based on motion detection, enabling fast and efficient responses in the field protection system.

3.4 PIR Sensor

Figure 3.4: PIR Sensor

Figure 3.4 shows a PIR (Passive Infrared) sensor, an electronic device designed to detect motion by sensing the infrared radiation naturally emitted by objects, particularly living beings such as humans and animals. Since all warm objects give off infrared energy, the PIR sensor monitors variations in these radiation levels within its field of view. At its core, it uses a pyroelectric element that produces a small voltage when exposed to infrared rays. When a person or animal moves across its range, the change in detected energy generates a voltage variation, which the sensor interprets as motion. Typically, the sensor has two infrared elements arranged to recognize differences in radiation as objects enter or leave the detection zone. Upon detecting movement, it produces an output signal that can be used to activate lights, alarms, or other systems. Due to its low power use, cost-effectiveness, and reliability, the PIR sensor is widely applied in security, lighting automation, and smart home systems.

3.5 Ultrasonic Sensor

Figure 3.5: Ultrasonic Sensor

Figure 3.5 shows an ultrasonic sensor, an electronic component that detects objects and measures distance using high- frequency sound waves, usually above 20 kHz. The sensor operates by transmitting a burst of ultrasonic waves, which travel through the air and bounce back when they strike an object. The receiver then captures these reflected waves and calculates the time taken for the round trip. Using this time delay, the sensor determines the distance of the object. Ultrasonic sensors are widely applied in robotics for obstacle detection, automotive parking systems, and liquid level monitoring in tanks**.** They are valued for their high accuracy, contactless operation, and adaptability to different environmental conditions.

3.6 LED Indicator

Figure 3.6: LED Indicator

Figure 3.6 highlights the role of LED indicators in providing clear visual signals about the system's operational status. LEDs are used to show different conditions; such as motion detection or alert activation. For instance, an LED may glow to indicate the presence of wildlife or unauthorized human entry in the monitored area. Multiple colors can represent various states— green for normal operation, red for a detected threat, and blinking yellow for standby mode. These visual cues enable operators to quickly understand the system's condition and take timely action, thereby improving monitoring efficiency and wildlife protection.

Figure 3.7: Potentiometer

Figure 3.7 shows a three-terminal variable resistor (potentiometer), widely used in electronic circuits to adjust parameters such as volume, brightness, or sensor values. It consists of a resistive strip and a movable wiper connected to the middle terminal. Rotating the knob changes the wiper's position along the resistive track, thereby varying the resistance between the center and outer terminals. This enables smooth control of voltage output. In this project, the potentiometer is employed to simulate the body temperature of different wild animals (such as elephants or tigers), providing variable analog input to the Arduino to test system responses under different conditions. Its simplicity and precision make it highly suitable for simulation and prototyping in embedded applications.

4. Results and Discussion

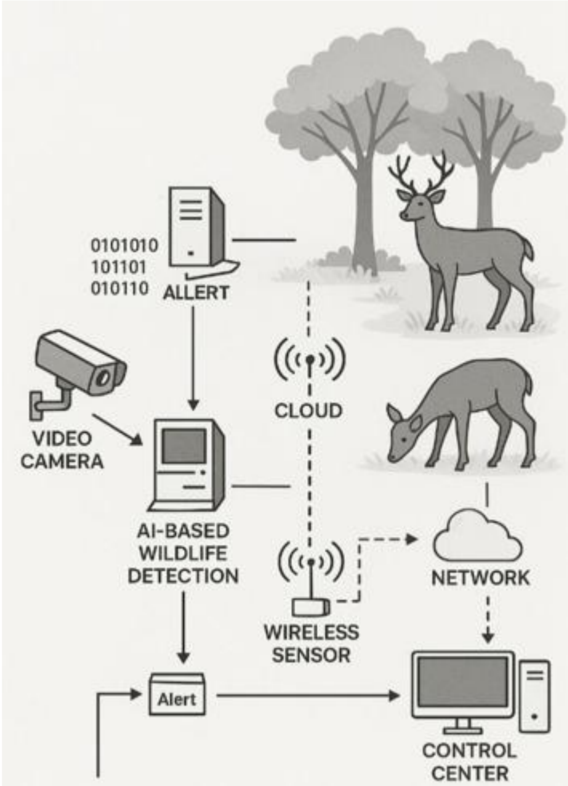

Figure 4.1: Smart Wildlife Detection and Protection Setup

Figure 4.1 presents the circuit layout of the Smart Wildlife Protection System designed in the Tinker cad environment. The configuration integrates an Arduino Uno microcontroller with key components such as the HC-SR04 ultrasonic sensor for distance measurement, a PIR sensor for motion detection, and a fire LED serving as a warning mechanism. To replicate animal- specific inputs, four potentiometers are employed to represent elephant, tiger, lion/leopard, and wild boar by producing variable analog signals that simulate temperature values. These inputs are analyzed by the system to identify the simulated animal and initiate the corresponding protection measures. The connections between the Arduino and breadboards are organized to ensure accurate communication between sensors and actuators, facilitating reliable monitoring and control of the system.

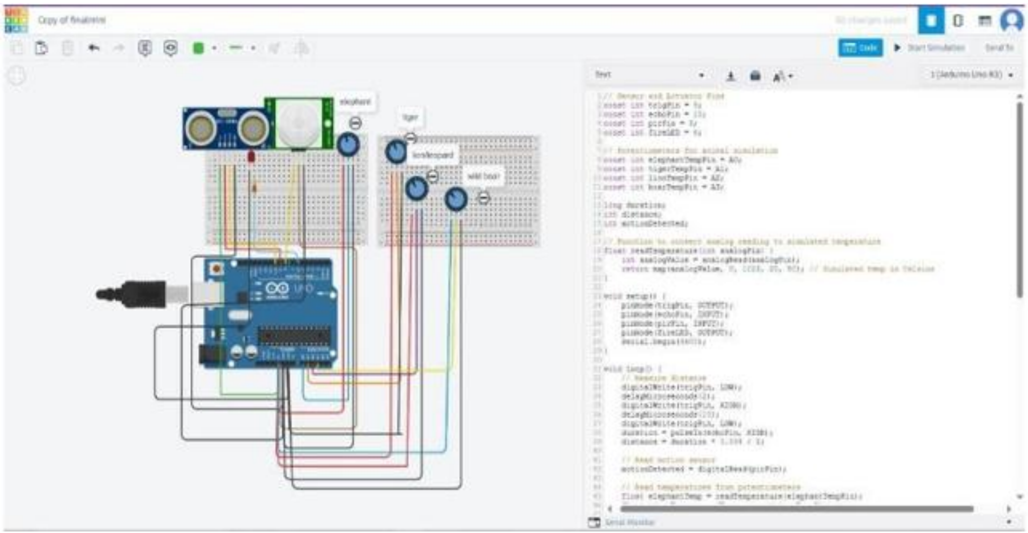

Figure 4.2: System Execution in Tinker cad

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Figure. 4.2 illustrates the execution stage of the Smart Wildlife Protection System in Tinker cad. In this setup, the Arduino UNO is connected to an ultrasonic sensor, a PIR sensor, a fire LED, and several potentiometers representing animals such as elephants, tigers, lions/leopards, and wild boars. The ultrasonic sensor monitors distance to identify nearby movement, while the PIR sensor captures motion within the surveillance zone. The potentiometers emulate animal-specific temperature values to simulate their presence. When predefined conditions—motion detection and corresponding simulated temperature readings— are met, the system activates the fire LED as a deterrent to repel the animal and safeguard the field.

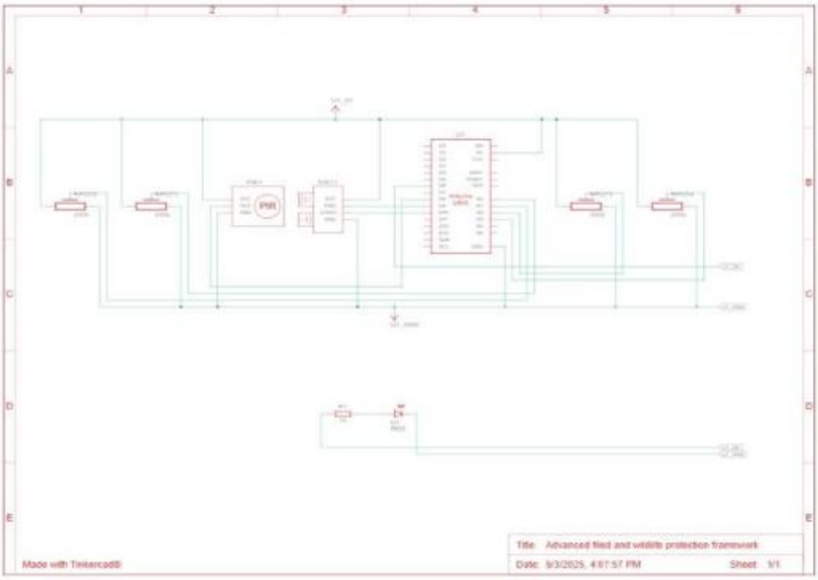

Figure 4.3: Schematic view

Figure. 4.3 shows the schematic diagram of the Smart Wildlife Protection System created in Tinker cad. At the center of the design is the Arduino Uno (U1), interfaced with an ultrasonic sensor (DIST1) for distance measurement, a PIR sensor (PIR1) for motion detection, and four potentiometers (RPOT1–RPOT4) that generate simulated temperature values representing different wild animals. The ultrasonic sensor is linked to digital pins, while the potentiometers are connected to analog pins (A0–A3) to provide animal-specific inputs. A fire LED (D1), driven through a current-limiting resistor (R1), functions as a scare device upon detection of wildlife. Power is supplied consistently to all components via the 5V and GND lines. The schematic illustrates the structured wiring and component connections required to implement the field protection system effectively.

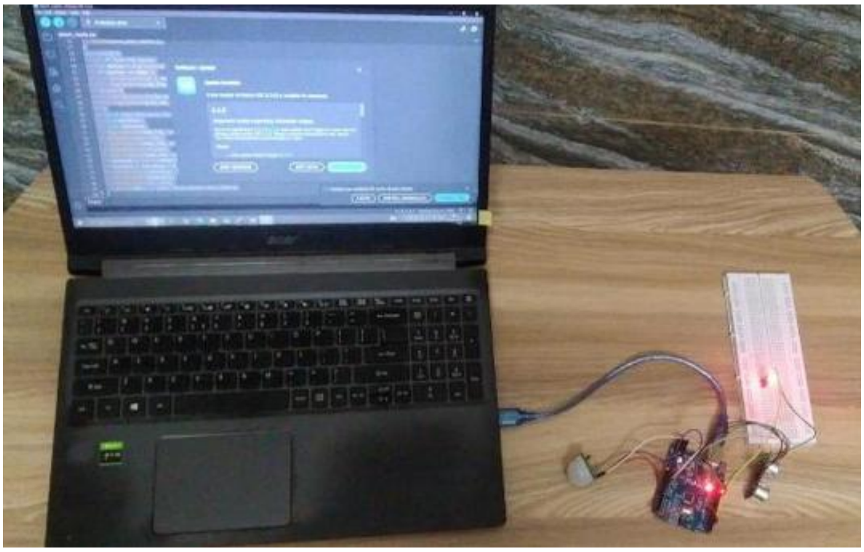

Figure 4.4: Real time work with hardware component

Figure. 4.4 illustrates the hardware configuration where an Arduino Uno is connected to a laptop through a USB cable for both programming and power. An ultrasonic sensor (HC-SR04) and an LED are linked to the Arduino via a breadboard and jumper wires. The ultrasonic sensor detects the distance of approaching objects, and based on this input, the Arduino controls the LED. If the object is within a preset threshold, the LED switches ON; otherwise, it stays OFF. The breadboard facilitates connections for the LED along with its series resistor, which prevents excess current flow. The Arduino IDE on the laptop is used to upload the program, enabling live interaction between sensor data and LED response.

5. Conclusion

The proposed Advanced Field and Wildlife Protection Framework demonstrates a scalable, cost-effective solution for real-time monitoring of protected areas. By leveraging sensor integration and Arduino-based control, it strengthens conservation strategies while promoting biodiversity preservation. With future enhancements such as wireless connectivity, advanced analytics, and renewable energy support, the system has the potential to become a sustainable tool for long-term wildlife protection.

References

[1] N. Madhasu and S. D. Pande, "Revolutionizing wildlife protection: a novel approach combining deep learning and night-time surveillance," Multimedia Tools and Applications, Aug. 10, 2024. https://link.springer.com/article/10.1007/s11042-024-19876-4

[2] S. Saravanan, J. R. F. Raj, G. V. Rajkumar, C. A. V. Kumar, N. Soundiraraj, and K. Bharathi, "Deploying Faster R- CNN for real-time tiger monitoring in wildlife conservation," *IEEE*, 2024. https://ieeexplore.ieee.org/document/10841726

[3] N. J. Ahuja, N. Pasi, and H. Naz, "A deep learning-based framework for the detection of Big-4 snakes," *IEEE*, 2024. https://ieeexplore.ieee.org/document/10830347

[4] Amerson and D. Dexheimer, "Enhancing marine wildlife observations: the application of tethered balloon systems and advanced imaging sensors for sustainable marine energy development," *Marine Biology*, vol. 172, no. 68, Apr. 2025. https://link.springer.com/article/10.1007/s00227-025-04618-3

[5] R. R. Pavitra, K. Panimalar, D. Rajalakshmi, and A. Chinnasamy, "A contemporary CNN implanted deep learning framework for crop protection from animal intrusion in farming environment," *IEEE*, 2024. https://ieeexplore.ieee.org/document/10533193

[6] M. T. I. Sheam and E. T. Arpa, "IoT-driven advanced lighting detection and fire response system for forest and wildlife protection," in *Real-World Applications and Implementations of IoT, Studies in Smart Technologies (SST)*, pp. 195–212, Feb. 12, 2025. https://link.springer.com/chapter/10.1007/978-981-97-8627-5_13

[7] P. Singh and R. Krishnamurthi, "IoT-based real-time object detection system for crop protection and agriculture field security," *Journal of Real-Time Image Processing*, vol. 21, no. 106, Jun. 2024. https://link.springer.com/article/10.1007/s11554-024-01488-8

[8] T. Vuong, M. Chang, M. Palaparthi, L. G. Howell, A. Bonti, M. Abdelrazek, and D. T. Nguyen, "An empirical study of automatic wildlife detection using drone-derived imagery and object detection," *Multimedia Tools and Applications*, Feb. 15, 2025. https://link.springer.com/article/10.1007/s11042-024-20522-2

[9] T. Sekar and A. Srivastav, "Conserving wildlife: a vanishing asset," in *Forest Policies, Laws, and Governance in India*, pp. 281–353, Jul. 17, 2024. https://link.springer.com/chapter/10.1007/978-981-97-3862-5_7

[10] N. Du, A. M. Fathollahi-Fard, and K. Y. Wong, "Wildlife resource conservation and utilization for achieving sustainable development in China: main barriers and problem identification," *Environmental Science and Pollution Research*, Apr. 22, 2023. https://link.springer.com/article/10.1007/s11356-023-269827

[11] Ananna, M. H. Rifat, S. Akter, T. I. A. Rain, and N. Mansoor, "WildSaver: advancing wildlife conservation with UAVs and blockchain technology," in *Proceedings of World Conference on Information Systems for Business Management (ISBM 2023), Lecture Notes in Networks and Systems*, vol. 833, pp. 475–483, Mar. 1, 2024. https://link.springer.com/chapter/10.1007/978-981-99-8346-9_39

[12] Tandon, A. Saranya, R. Shah, and C. Tandon, "LionSense: redefining wildlife monitoring and AI-powered YOLOv5 lion detection and classification," in *Advanced Engineering Optimization Through Intelligent Techniques (AEOTIT 2023), Lecture Notes in Electrical Engineering*, vol. 1226, pp. 55–67, Oct. 15, 2024. https://link.springer.com/chapter/10.1007/978-981-97-4654-5_6

[13] S. K. Chaudhary, A. C. Pandey, and B. R. Parida, "Geospatial analysis of elephant habitat suitability and movement for mapping the elephant corridor in Dalma Wildlife Sanctuary (India)," *Environmental Monitoring and Assessment*, vol. 196, no. 936, Sep. 16, 2024. https://link.springer.com/article/10.1007/s10661-024-01820-3