**A**

**Major Project Report**

**On**

“Revolutionizing Wildlife Conservation through AI-Powered Model Monitoring and Protection”

Submitted in partial fulfillment of the

Requirements for the award of the degree of

**Bachelor of Technology**

**In**

**Computer Science & Engineering -**

**Artificial Intelligence and Machine Learning**

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**2024** 



**Department of CSE-AIML**

**CERTIFICATE**

This is to certify that the project entitled **“Revolutionizing Wildlife Conservation through AI-Powered Model Monitoring and Protection”** has been submitted by **Divakar Mikkilineni, G.Ragasri Harshita, M.Soumya and M.Bhanu Sagar** in partial fulfillment of the requirements for the award of Bachelor of Technology in Computer Science and Engineering - Artificial Intelligence and Machine Learning from MLR Institute of Technology, Hyderabad. The results embodied in this project have not been submitted to any other University or Institution for the award of any degree or diploma.

**Internal Guide** **Head of the Department**

**Project coordinator External Examiner**



**Department of CSE-AIML**

**DECLARATION**

We hereby declare that the project entitled **“Revolutionizing Wildlife Conservation through AI-Powered Model Monitoring and Protection”** is the work done during the periodfrom **January 2024 to May 2024** and is submitted in partial fulfillment of the requirements for the award of degree of Bachelor of Technology in Computer Science and Engineering - Artificial Intelligence and Machine Learning from MLR Institute of Technology, Hyderabad. The results embodied in this project have not been submitted to any other university or Institution for the award of any degree or diploma.

**Divakar Mikkilineni 20R21A6630**

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**ACKNOWLEDGEMENT**

The satisfaction and euphoria that accompany the successful completion of any task would be incomplete without the mention of people who made it possible, whose constant guidance and encouragement crowned our efforts with success. It is a pleasant aspect that we now have the opportunity to express our guidance for all of them.

First of all, we would like to express our deep gratitude towards our internal guide **Mrs. Meena Talari, Assistant Professor, Department of CSE -AIML** for his support in the completion ofour dissertation. We wish to express our sincere thanks to **Dr. K. SAI PRASAD,** HOD, Dept. of CSE-AIML and principal **Dr. K. SRINIVAS RAO** for providing the facilities tocomplete the dissertation.

We would like to thank all our faculty and friends for their help and constructive criticism during the project period. Finally, we are very much indebted to our parents for their moral support and encouragement to achieve goals.

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**ABSTRACT**

Protecting animals and conserving them to maintain the stability of ecosystem balance is the most important role in this world. Protecting wildlife is important. The wildlife sanctuaries that are present now provide shelter to them and protect the wildlife from basic threats like hunger and shelter. We propose a system that protects the wildlife animals in sanctuaries from their major threat, Poaching. The new approach is to construct an AI-based system that detects poaching activity by using suitable CNN (Convolutional Neural Network). The proposed model not only detects the poaching activity in the sanctuaries but also sends alerts to the corresponding monitoring department so that they can take action accordingly.

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# APPENDIX-3

# LIST OF ABBREVIATIONS

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# LIST OF ABBREVIATIONS

| CNN | Convolution Neural Network |
| --- | --- |
| RNN | Recurrent Neural Network |
| YOLO | Yolo Only Look Once |

GPS Global positioning system

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# 

# APPENDIX-4

# REFERENCES

# REFERENCES

[1] Yves Aubry Dominique Chabot Paul Pace André Desrochers, Junior A. Tremblay and David M. Bird. 2018. Estimating Wildlife Tag Location Errors from a VHF Receiver Mounted on a Drone. J. ACM (2018). https://doi.org/10.3390/ drones2040044

[2] Jamal Firmat Banzi. 2014. A Sensor Based Anti-Poaching System in Tanzania National Parks. J. ACM (2014). https://www.researchgate.net/publication/ 281812638\_A\_Sensor\_Based\_Anti-Poaching\_System\_in\_Tanzania\_National\_ Parks

[3] John D Holland Bindi (Thomas) Robertson and Edward Minot. 2012. Wildlife tracking technology options and cost considerations. J. ACM (2012). https: //doi.org/10.1071/WR10211

[4] Youngho Cho Bojana Ivosevic, Yong-Gu Han and Ohseok Kwon. 2015. The use of conservation drones in ecology and wildlife research. J. ACM (2015). https://doi.org/10.5141/ecoenv.2015.012

[5] Aarju; Rajesh Bahuguna; Shweta Pandey; Rajesh Singh; Hardeep Kaur; Gunjan Chhabra. 2023. Enabling Technologies for Wildlife Conservation. Commun. ACM 1 (May 2023). https://doi.org/10.1109/DevIC57758.2023.10134561

[6] Christensen and David R. 2016. A Simple Approach to Collecting Useful Wildlife Data Using Remote Camera-Traps in Undergraduate Biology Courses. J. ACM (May 2016). https://doi.org/EJ1103785

[7] AZA RASKIN SONJA C. VERNES KATHERINE ZACARIAN CHRISTIAN RUTZ, MICHAEL BRONSTEIN and DAMIÁN E. BLASI. 2023. Using machine learning to decode animal communication. J. ACM (2023). https://doi.org/10.1126/science. adg7314

[8] S. Rayamajhi2 D.Mahatara1 and G. Khanal. 2008. Impact of anti-poaching approaches for the success of Rhino conservation in Chitwan National Park, Nepal. J. ACM 28 (2008), 23-31. https://pdfs.semanticscholar.org/8b0a/ dd639b05b160d5b3e899eef0f626e47d0b47.pdf [9] Westerlund and Mika Isabelle, Diane A. 2022. A Review and Categorization of Artificial Intelligence-Based Opportunities in Wildlife, Ocean and Land Conservation. J. ACM (2022). https://doi.org/covidwho-1715676

[10] Sazida B. Islam and Damian Valles. 2020. Identification of Wild Species in Texas from Camera-trap Images using Deep Neural Network for Conservation Monitoring. J. ACM (2020). https://doi.org/10.1109/CCWC47524.2020.9031190

[11] Pascal Mettes Kitso Epema Lian Pin Koh Jan C. van Gemert, Camiel R. Verschoor and Serge Wich. 2015. Nature Conservation Drones for Automatic Localization and Counting of Animals. J. ACM (2015). https://doi.org/10.1007/978-3-319- 16178-5\_17

[12] Hila Shamon Paula J. Castiblanco-Camacho Michael A. Tabak Carl Chalmers Paul Fergus Juliana Vélez, William McShea and John Fieberg. 2022. An evaluation of platforms for processing camera-trap data using artificial intelligence. J. ACM (2022). https://doi.org/10.1111/2041-210X.14044

[13] Yueting Qin Yilei Hou and Yali Wen Kaiwen Su, Jie Ren. 2020. Efforts of Indigenous Knowledge in Forest and Wildlife Conservation: A Case Study on Bulang People in Mangba Village in Yunnan Province, China. J. ACM (2020). https://doi.org/10.3390/f11111178

[14] Shreya Kakhandiki. 2022. Poacher Activity Detection Device for Wildlife Conservation. J. ACM (2022). https://doi.org/10.36838/v4i5.17

[15] Paul Fergus Steve Longmore Alex K. Piel Katie E. Doull, Carl Chalmers and Serge A. Wich. 2021. An Evaluation of the Factors Affecting ‘Poacher’ Detection with Drones and the Efficacy of Machine-Learning for Detection. J. ACM (2021). https://doi.org/10.3390/s21124074

[16] María-José Zurita; Daniel Riofrío; Noel Pérez; David Romo; Diego S. Benítez; Ricardo Flores Moyano. 2023. Towards Automatic Animal Classification in Wildlife Environments for Native Species Monitoring in the Amazon. J. ACM (2023). https://doi.org/10.1109/ColCACI59285.2023.10226093

[17] Wiku B. Adisasmito b Salama Almuhairi c Casey Barton Behravesh d 1 Pépé Bilivogui e Salome A. Bukachi f Natalia Casas g Natalia Cediel Becerra h Dominique F. Charron i Abhishek Chaudhary j Janice R. Ciacci Zanella k Andrew A. Cunningham l Osman Dar m n Nitish Debnath o p Baptiste Dungu q Elmoubasher Farag r George F. Gao s Margaret Khaitsa t and Catherine Machalaba u. . .Marion Koopmans One Health High-Level Expert Panel (OHHLEP), David T.S. Hayman a. 2023. Developing One Health surveillance systems. J. ACM (2023). https://doi.org/10.1016/j.onehlt.2023.100617

[18] Shivani Sisodia; Saurabh Dhyani; Samta Kathuria; Shweta Pandey; Gunjan Chhabra; Rahul Pandey. 2023. AI Technologies, Innovations and Possibilities in Wildlife Conservation. J. ACM (2023). https://doi.org/10.1109/ICIDCA56705. 2023.10099721

[19] Serge A Wich and Lian Pin Koh. 2019. Conservation Drones Mapping and Monitoring Biodiversity. J. ACM (2019), 118. https://www.nhbs.com/conservationdrones-book

[20] Brian G. Dillman Robert K. Swihart Zackary J. Delisle, Patrick G. McGovern. 2022. Imperfect detection and wildlife density estimation using aerial surveys with infrared and visible sensors. J. ACM (2022). <https://doi.org/10.1002/rse2.305>

[21] K. Su, J. Ren, Y. Qin, Y. Hou, and Y. Wen, Efforts of indigenous knowledge in forest and wildlife conservation: A case study on bulang people in mamba village in Yunnan province, china, vol. 11. 2020, pp. 1–16. 8

[22] A. K. Thakur, Rajesh Singh, Anita Gehlot, Ajay Kumar Kaviti, Ronald Aseer, S.KousikSuraparaju, S.K. Natarajan, and V. S.Sikarwar.Advancements in solar technologies for sustainable development of the agricultural sector in India: a comprehensive review on challenges and opportunities. Environmental Science and Pollution Research, vol. 29, no. 29, p. 43635, 2022.

[23] S. Kathuria, P. Rawat, R. Singh, A. Gehlot, A. Kathuria, and S. Pandey, “Technical Intercession of Mixed Reality 4.0: Upholding Senior Citizens Health,” in 2022 5th International Conference on Contemporary Computing and Informatics (IC3I), 2022, pp. 1733– 1737.

[24] D. A. Isabelle and M. Westerlund, A Review and Categorization of Artificial Intelligence-Based Opportunities in Wildlife, Ocean and Land Conservation, vol. 14. 2022. doi: 10.3390/su14041979.

[25] T. Huang, L. Zhou, and M. Zhou, “Key Technologies and Applications of Wild Animal Satellite Tracking,” Journal of Physics: Conference Series, vol. 1757, no. 1, p. 12180, 2021, [26] A. Desrochers, J. A. Tremblay, Y. Aubry, D. Chabot, P. Pace, and D. M. Bird, Estimating wildlife tag location errors from a VHF receiver mounted on a drone, vol. 2. 2018, pp. 1–9. [27] J. J. López and M. Mulero-Pázmány, Drones for conservation in protected areas: Present and future, vol. 3. 2019, pp. 1–23.

[28] K. E. Doull, C. Chalmers, P. Fergus, S. Longmore, A. K. Piel, and S. A. Wich, An evaluation of the factors affecting ‘poacher’ detection with drones and the efficacy of machine-learning for detection, vol. 21. 2021, p. 4074.

[29] B. Ivošević, Y. G. Han, Y. Cho, and O. Kwon, The use of conservation drones in ecology and wildlife research, vol. 38. 2015, pp. 113–118.

[30] J. C. van Gemert, C. R. Verschoor, P. Mettes, K. Epema, L. P. Koh, and S. Wich, “Nature conservation drones for automatic localization and counting of animals,” in Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), 2015, vol. 8925, pp. 255–27

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# CHAPTER 1

# INTRODUCTION

* 1. **OVERVIEW**

The "Revolutionizing Wildlife Conservation through AI-Powered Model Monitoring and Protection” aims to leverage artificial intelligence (AI) technologies to enhance conservation efforts and monitor wildlife populations. By integrating AI algorithms with various data sources such as satellite imagery, camera traps, and acoustic sensors, the project seeks to improve the efficiency and effectiveness of wildlife monitoring and protection. Key objectives include the development of AI models for species identification, habitat mapping, and poaching detection, as well as the establishment of a centralized platform for data analysis and decision-making. Through collaboration with conservation organizations, researchers, and local communities, the project aims to address challenges such as cost, data availability, ethical considerations, and scalability, ultimately contributing to the preservation of biodiversity and the sustainable management of natural resources.

* 1. **PURPOSE OF THE PROJECT**

This project aims to leverage artificial intelligence technologies to address critical challenges in wildlife conservation and monitoring. By integrating AI algorithms with sensor networks and data analytics, the project seeks to enhance the efficiency and effectiveness of conservation efforts. The primary goals include the detection and prevention of poaching activities, monitoring wildlife populations, mitigating human-wildlife conflicts, and facilitating timely responses to environmental threats and emergencies. Through the development and deployment of advanced AI systems, the project strives to safeguard biodiversity, preserve natural habitats, and promote sustainable coexistence between humans and wildlife.

* 1. **MOTIVATION**

The motivation for the project "Revolutionizing Wildlife Conservation through AI-Powered Model Monitoring and Protection" stems from the urgent need to address the escalating threats facing biodiversity worldwide. Rapid habitat loss, illegal poaching, climate change, and human-wildlife conflicts have placed numerous species at risk of extinction. Traditional conservation methods alone are insufficient to tackle these complex challenges effectively. Hence, leveraging advancements in artificial intelligence (AI) offers a promising avenue for enhancing wildlife conservation efforts. By harnessing AI technologies such as machine learning, computer vision, and data analytics, conservationists aim to improve species monitoring, predict and prevent illegal activities, optimize resource allocation, and mitigate human-wildlife conflicts. Ultimately, the project seeks to safeguard biodiversity, restore ecosystems, and promote sustainable coexistence between humans and wildlife for the benefit of present and future generations.

**CHAPTER 2**

**LITERATURE SURVEY**

An extensive literature survey has been conducted by studying existing systems of Revolutionizing Wildlife Conservation through AI-Powered Model Monitoring and Protection. A good number of research papers, journals, and publications have also been referred before formulating this survey.

* 1. **EXISTING SYSTEM**

The existing system of Revolutionizing Wildlife Conservation through AI-Powered Model Monitoring and Protection systems play a crucial role in advancing conservation efforts by providing real-time insights, automating data analysis processes, and enabling proactive conservation measures to protect endangered species and preserve biodiversity.

| **1** |
| --- |
| **Reference in APA format** | | S. V. Viraktamath, J. R, V. A, A. S. Bhat and S. Nayak, "Wildlife Monitoring and Surveillance," 2022 International Conference for Advancement in Technology (ICONAT), Goa, India, 2022, pp. 1-4, doi: 10.1109/ICONAT53423.2022.9725874. | | | | | |
| **URL of the Reference** | | **Authors Names and Emails** | | | | **Keywords in this Reference** | |
| https://ieeexplore.ieee.org/document/9725874 | | Dr S. V. Viraktamath,  Jahnavi R , Vidya,  Abhay S Bhat\*, Sathvik Nayak,  asbhat2107@gmail.com | | | | Animal Detection, object detection, image processing, computer vision, convolutional neural networks. | |
| **The Name of the Current Solution (Technique/ Method/ Scheme/ Algorithm/ Model/ Tool/ Framework/etc)** | | **The Goal (Objective) of this Solution & What is the problem that need to be solved** | | | | **What are the components of it?** | |
| Wildlife Monitoring and Surveillance | | The goal of the solution is to use a CNN algorithm for object detection, automatically extracting, learning, and classifying features of animal images. The aim is to enhance animal classification performance by accurately detecting and classifying animals in digital images. | | | | Author used the Convolutional Neural Network to detect and classify animals in digital images and also Deep learning in computer vision has been built and developed through time. | |
| **The Process (Mechanism) of this Work; Means How the Problem has Solved & Advantage & Disadvantage of Each Step in This Process** | | | | | | | |
| Performance of Detection of spam in email is evaluated based on different algorithms and constraints. Even though this author compared various results upon validating the test data and trained data using machine learning with all supervised and Lazy learning algorithms.   |  | **Process Steps** | **Advantage** | **Disadvantage (Limitation)** | | --- | --- | --- | --- | | **1** | Data Input | It contains a variety of animal images. | Limited types of animal images may make the model biased, making it less reliable across different species. | | **2** | Data Splitting | It divides the dataset into training data and testing data | Unequal distribution between training and testing sets might make the model good at known data but not so good with new, unseen data. | | **3** | Feature Transformation | Converts 1D images in the dataset to 2D images to enhance the feature extraction process. | Converting 1D images to 2D images may introduce information loss if not done carefully. | | **4** | Model Evaluation | This step ensures that the model can generalize its understanding to new, unseen images. | The metrics used for evaluation might not show how well the model works in the real world, causing differences between evaluation and actual use. | | **5** | Model Evaluation | It is expected to predict the presence of animals in new test images. | The model might have trouble with new situations or variations not covered well in the training data, affecting how well it adapts. | | **6** | Predictive capability | It is expected to predict the presence of animals in new test images. | The model might have trouble with new situations or variations not covered well in the training data, affecting how well it adapts. | | **7** | Animal Classification | If the model correctly predicts the presence of animals in test images, it is considered ready for animal classification tasks. | The model might mix up species, especially if animals look similar, impacting how accurate it is. | | **8** | Model Usage | The model processes the image and predicts the type of animal present. | The model might not work as well in real-world situations with changing environments or unexpected challenges not seen during training. | | **9** | Output prediction | The model provides the name of the predicted animal as an output. | The model might make mistakes, especially when dealing with unclear images or species that look very similar, affecting how trustworthy its predictions are. | | | | | | | | |
| **Major Impact Factors in this Work** | | | | | | | |
| | **Dependent Variable** | **Independent Variable** | **Moderating variable** | **Mediating (Intervening) variable** | | --- | --- | --- | --- | | .Camera-traps, acoustic sensors | Natural Ecosystem and Animal Behavior | Image classification, Animal detection, Object Detection | This work does not have any intervening variables. | | | | | | | | |
| | **Relationship Among the Above 4 Variables in This article** | | --- | | The camera traps and acoustic sensors are used to collect image datasets from the ecosystem and using the given technology we classify and detect patterns which give us our output. | | | | | | | | |
| **Input and Output** | | | **Feature of This Solution** | | | | **Contribution & The Value of This Work** |
| | **Input** | **Output** | | --- | --- | | Image Dataset | Predicted Animal | | | | The suggested approach for animal classification and detection relies on deep convolutional neural networks (CNN). The solution integrates crucial computer vision and image processing techniques, which attains a high accuracy rate, capable of automatically extracting, learning, and classifying features from animal images. | | | | The document discusses a research project on animal detection and classification using computer vision systems. The proposed project aims to use a Convolutional Neural Network (CNN) to detect and classify animals in digital images. The algorithm has shown positive results in overall animal classification performance, achieving an accuracy of around 64% with an image size of 50x50. |
| **Positive Impact of this Solution in This Project Domain** | | | | | **Negative Impact of this Solution in This Project Domain** | | |
| The use of CNNs in this project can have a positive impact by improving classification accuracy, reducing manual effort, and enabling the development of an automated animal recognition system. | | | | | The suggested project has advantages in animal detection and classification, but it also has limitations to consider. These include environmental worries, limited scope, accuracy challenges, ethical concerns, and the importance of a balanced approach to wildlife conservation. | | |
| **Analyse This Work by Critical Thinking** | | | | **The Tools That Assessed this Work** | | | **What is the Structure of this Paper** |
| Overall conclusion is that the challenges in animal detection and classification in computer vision, highlights the role of CNNs algorithm-supported object detection method to automatically extract, learn, and classify features from animal images. | | | | Camera based technologies such as camera-taps and acoustic and seismic measures are also used. | | | Abstract   1. Introduction 2. Literature Survey 3. Methodology 4. Result Discussion 5. Conclusion |
| **Diagram/Flowchart** | | | | | | | |
| https://lh7-us.googleusercontent.com/GshcmLhthf_6tbyeyZlO98P3lkqk0XN1U4CT-o1r2YNYN17sFRgyncFlY3HYsexrF-aXdcgZC_1VEjn7vXNAHciovl05QoorkaApAvMtQZyHvvgRu_9_IBu7pLyDPTZOVlH2qtkTWxdIUr8jxEwcgFA | | | | | | | |

**---End of Paper 1---**

| **2** |
| --- |
| **Reference in APA format** | | S. Sisodia, S. Dhyani, S. Kathuria, S. Pandey, G. Chhabra and R. Pandey, "AI Technologies, Innovations and Possibilities in Wildlife Conservation," 2023 International Conference on Innovative Data Communication Technologies and Application (ICIDCA), Uttarakhand, India, 2023, pp. 1090-1095, doi: 10.1109/ICIDCA56705.2023.10099721. | | | | | |
| **URL of the Reference** | | **Authors Names and Emails** | | | | **Keywords in this Reference** | |
| https://ieeexplore.ieee.org/document/10099721 | | Shivani Sisodia shivanisisodia@uumail.in, Shweta Pandey[shwetapandey2626@gmail.com](mailto:shwetapandey2626@gmail.com), Saurabh Dhyani saurabhdhyani29@gmail.com, Gunjan Chhabra chhgunjan@gmail.com, Samta Kathuria samtakathuria14@gmail.com, Rahul Pandey rahulpandey13062000@gmail.com | | | | Artificial Intelligence, wildlife, SDGs, Machine learning, Deep learning, sensors. | |
| **The Name of the Current Solution (Technique/ Method/ Scheme/ Algorithm/ Model/ Tool/ Framework/etc)** | | **The Goal (Objective) of this Solution & What is the problem that need to be solved** | | | | **What are the components of it?** | |
| https://ieeexplore.ieee.org/document/10099721 | | The goal is to use Artificial Intelligence (AI) to analyze data and create ecological models for safeguarding and reviving wildlife in support of Sustainable Development Goals (SDGs). | | | | Artificial Intelligence, wildlife, SDGs, Machine learning, Deep learning, sensors. | |
| **The Process (Mechanism) of this Work; Means How the Problem has Solved & Advantage & Disadvantage of Each Step in This Process** | | | | | | | |
| Performance of Detection of spam in email is evaluated based on different algorithms and constraints. Even though this author compared various results upon validating the test data and trained data using machine learning with all supervised and Lazy learning algorithms.   |  | **Process Steps** | **Advantage** | **Disadvantage (Limitation)** | | --- | --- | --- | --- | | **1** | Deploying IoT sensors | Provides real-time and accurate data on animal behavior and habitat use. | Initial deployment costs and potential technical challenges in maintaining sensors in remote areas. | | **2** | Data collection | Enables comprehensive and continuous monitoring of wildlife. | Dependence on reliable connectivity for transmitting data and potential data overload. | | **3** | Data processing | Efficient extraction of valuable insights through AI, enhancing data interpretation. | Requires skilled personnel for algorithm development and may face challenges in handling diverse data sets. | | **4** | Analysis and visualization | Facilitates a clearer understanding of ecological patterns for informed decision-making. | Interpretation may be subjective, and visualization tools may require technical expertise. | | **5** | Decision-making | Informed decisions for wildlife conservation based on analyzed and visualized data. | Potential resistance to adopting AI-driven insights and decisions may still require human judgment. | | | | | | | | |
| **Major Impact Factors in this Work** | | | | | | | |
| | **Dependent Variable** | **Independent Variable** | **Moderating variable** | **Mediating (Intervening) variable** | | --- | --- | --- | --- | | Data Collection, Data Processing, Decision Making | Movement of Animals and change in their behavior | Machine Learning, Model Building | Ethical Considerations and Collaborations | | | | | | | | |
| | **Relationship Among the Above 4 Variables in This article** | | --- | | The major impact factors in this work include the collection and processing of data which depends on the behavior of the animals and any other collaborations may change in model building to reach the goal. | | | | | | | | |
| **Input and Output** | | | **Feature of This Solution** | | | | **Contribution & The Value of This Work** |
| | **Input** | **Output** | | --- | --- | | Information on animal behavior | Insights on animal behavior | | | | This project uses AI to address challenges such as deforestation, biodiversity decline, invasive species, and wildlife trafficking. The main objective is to support SDG 15, focusing on land-based life, by using AI to inform effective policies and actions for wildlife conservation. | | | | It reviews existing research works and provides insights into the use of AI and Industry 4.0 in wildlife conservation. Additionally, it discusses challenges and suggestions for future research in this field. |
| **Positive Impact of this Solution in This Project Domain** | | | | | **Negative Impact of this Solution in This Project Domain** | | |
| The Solution highlights that AI can speed up efforts to reach Sustainable Development Goals (SDGs) and safeguard wildlife. By utilizing AI technologies, such as machine learning, deforestation rates can be predicted and poaching activities can be detected and prevented. | | | | | It mentions the need to explore the harmful impacts of certain technologies on the Sustainable Development Goals (SDGs) and the importance of building more responsible AI and industry 4.0. It also acknowledges the challenges of implementing AI models, training data, and data security | | |
| **Analyse This Work by Critical Thinking** | | | | **The Tools That Assessed this Work** | | | **What is the Structure of this Paper** |
| The study highlights the use of AI technologies in wildlife conservation and provides insights into how these technologies can help achieve sustainable development goals. It also discusses the challenges and future prospects of AI in this field. The study aims to provide guidance to researchers and organizations interested in using AI for wildlife conservation. | | | | Drones, Camera-Traps, GPS Collars, IoT, Robot Predators | | | Abstract   1. Introduction 2. Overview of AI 3. AI in Wildlife 4. Challenges 5. Suggestions 6. Conclusions |
| **Diagram/Flowchart** | | | | | | | |
| https://lh7-us.googleusercontent.com/AcfRx_zED9QxgOEfF4ACd_DnO5-r5_GhpAM39xhZwUG6_-i5VFEgOxr8AARt7CewRiwmISY5smJGmG78wYu9pq6Yts3BSnstY8zySID_E5zYSN_YuUywJnjlrS3mLs9G--97zeuBLStOeurnllnAbys | | | | | | | |

| **3** |
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| **Reference in APA format** | | M. Mangaleswaran and M. Azhagiri, "A Comparison of Different Learning Algorithms for Wildlife Detection and Classification in Animal Conservation Applications," 2023 Third International Conference on Artificial Intelligence and Smart Energy (ICAIS), Coimbatore, India, 2023, pp. 920-923, doi: 10.1109/ICAIS56108.2023.10073833. | | | | | |
| **URL of the Reference** | | **Authors Names and Emails** | | | | **Keywords in this Reference** | |
| https://ieeexplore.ieee.org/document/10073833 | | M.Mangaleswaran , Dr.M. Azhagiri mm0103@srmist.edu.in, azhagirm@srmist.edu.in | | | | Deep Learning, Animal Detection, Convolutional Neural Network, Thermal Images, Classification. | |
| **The Name of the Current Solution (Technique/ Method/ Scheme/ Algorithm/ Model/ Tool/ Framework/etc)** | | **The Goal (Objective) of this Solution & What is the problem that need to be solved** | | | | **What are the components of it?** | |
| A Comparison of Different Learning Algorithms for Wildlife Detection and Classification in Animal Conservation Applications | | The goal of this solution is to reduce vehicle-animal accidents on highways by employing computer vision and machine learning algorithms to detect animals, aiming to minimize animal fatalities and improve overall traffic safety. | | | | Deep Learning Methodology, Camera Traps, Image Processing, Classification Methods, Detection of Human-Wildlife Conflict and Animal-Vehicle Collisions, Object Identification and Detection, Thermal Imaging, Video Analysis | |
| **The Process (Mechanism) of this Work; Means How the Problem has Solved & Advantage & Disadvantage of Each Step in This Process** | | | | | | | |
| Performance of Detection of spam in email is evaluated based on different algorithms and constraints. Even though this author compared various results upon validating the test data and trained data using machine learning with all supervised and Lazy learning algorithms.   |  | **Process Steps** | **Advantage** | **Disadvantage (Limitation)** | | --- | --- | --- | --- | | **1** | Image Processing | Deep learning techniques, particularly CNNs, enable efficient detection, classification, and processing of images for various purposes. | complex image processing, demands substantial computational power. | | **2** | Input Image Capture | Camera traps capture images day or night, providing valuable data for analysis. | The use of camera traps may restrict data collection to specific locations or conditions. | | **3** | Convolution and Pooling | Convolution enhances image clarity, and pooling removes noisy data for improved analysis. | Convolution and pooling may result in the loss of fine details, impacting precision in identifying specific features. | | **4** | Dimensionality Reduction | Reducing image size accelerates processing time. | It may lead to the loss of critical information, affecting the accuracy of subsequent analysis. | | **5** | Fully Connected Layer | It accurately forecasts the desired output based on image characteristics. | Use of a fully connected layer may risk overfitting, causing the model to perform well on training data but poorly on new data. | | **6** | Analysis and Results | Analyzing the fully connected layer's output provides insights into wildlife behavior, aiding the prediction of potential conflicts and facilitating proactive conservation strategies. | Analyzing the output may be complex, especially with diverse wildlife populations and behaviors, leading to misinterpretations and misclassifications. | | | | | | | | |
| **Major Impact Factors in this Work** | | | | | | | |
| | **Dependent Variable** | **Independent Variable** | **Moderating variable** | **Mediating (Intervening) variable** | | --- | --- | --- | --- | | Human-Wildlife Conflict and Animal-Vehicle Collisions, Deep Learning and Convolutional Neural Networks (CNNs) | Movement of Animals and change in their behavior | Image Processing and Dataset, Machine Learning and Deep Learning Applications | Accuracy and Performance | | | | | | | | |
| | **Relationship Among the Above 4 Variables in This article** | | --- | | The major impact factors in this work include the application of deep learning and CNNs, addressing human-wildlife conflict and animal-vehicle collisions, image processing and dataset utilization, machine learning and deep learning applications in wildlife monitoring, and the emphasis on accuracy and performance evaluation. | | | | | | | | |
| **Input and Output** | | | **Feature of This Solution** | | | | **Contribution & The Value of This Work** |
| | **Input** | **Output** | | --- | --- | | Image Dataset | Animal Detected | | | | The system employs image processing techniques such as feature extraction, detection, and classification to accurately identify and categorize animals. The goal of the solution is to reduce animal-vehicle accidents and conflicts, protect agriculture and human lives from animal predation, and track and detect animal activities for wildlife management and biodiversity preservation. | | | | The project is focused on addressing the issue of vehicle-animal accidents on the side of the road. They introduce computer vision and machine learning algorithms, specifically convolutional neural networks (CNNs), for detecting animals on highways. The models were trained using donkeys and capybaras respectively. |
| **Positive Impact of this Solution in This Project Domain** | | | | | **Negative Impact of this Solution in This Project Domain** | | |
| The solution provides dependable ways to detect and categorize wildlife, including animal-human conflicts and animal-vehicle collisions. This aids in monitoring animal movements, habitat usage, population details, and human-wildlife conflicts. | | | | | The animal detection system doesn't work with infrared images, which could be a drawback. Infrared images are helpful in low light or nighttime situations, and not being able to process them might make the system less effective in some cases. | | |
| **Analyze This Work by Critical Thinking** | | | | **The Tools That Assessed this Work** | | | **What is the Structure of this Paper** |
| This project aims to reduce human-wildlife conflict and animal-vehicle collisions, ensuring the safety of both humans and animals by monitoring animals. | | | | Computer Vision and Machine Learning Algorithms, Deep Learning Techniques, Raspberry Pi, FLIR Camera, TensorFlow Hub-FasterRCNN+InceptionResNet V2 Network | | | Abstract   1. Introduction 2. Literature Survey 3. Results and Discussion 4. Conclusion |
| **Diagram/Flowchart** | | | | | | | |
| https://lh7-us.googleusercontent.com/bJy7EuFbpygXw_b7YH8oBX8mQkGyLabHoHV6Rty93Nrk1OnlvoXQiCxjwZgnVSexz0B4dLAzFqKL4RixLrYBLDuZ0maW-Y-8ZmFfTBfIpkCmO00oF-_FF5lC9K9lnaL7j5DoNrtq8Ptw2l4Zl_j7v_kwh9y9BQWf | | | | | | | |

| **4** |
| --- |
| **Reference in APA format** | | S. B. Islam and D. Valles, "Identification of Wild Species in Texas from Camera-trap Images using Deep Neural Network for Conservation Monitoring," 2020 10th Annual Computing and Communication Workshop and Conference (CCWC), Las Vegas, NV, USA, 2020, pp. 0537-0542, doi: 10.1109/CCWC47524.2020.9031190. | | | | | |
| **URL of the Reference** | | **Authors Names and Emails** | | | | **Keywords in this Reference** | |
| https://ieeexplore.ieee.org/document/9031190 | | Sazida B  [s\_b608@txstate.edu](mailto:s_b608@txstate.edu), Damian Valles dvalles@txstate.edu | | | | CNN, image classification, species recognition, camera traps, wildlife monitoring. | |
| **The Name of the Current Solution (Technique/ Method/ Scheme/ Algorithm/ Model/ Tool/ Framework/etc)** | | **The Goal (Objective) of this Solution & What is the problem that need to be solved** | | | | **What are the components of it?** | |
| Identification of Wild Species in Texas from Camera-trap Images using Deep Neural Network for Conservation Monitoring | | The goal is to use computer vision and machine learning to make a system that can find and keep track of different animals in a certain place using camera trap pictures. The main plan is to build a setup that can handle, store, and study a lot of camera trap data in an organized way. The ultimate goal is to create software and hardware solutions that can spot and categorize animals like snakes, lizards, and frogs in pictures. | | | | APIs, OpenCV, HiPE Server Environment, Hardware Solution, NVIDIA Jetson Nano Developer Kit, Software Tools, Dataset Collection, Data Pre-processing, Model Architecture, Training and Testing, Species Prediction, Evaluation and Field Application. | |
| **The Process (Mechanism) of this Work; Means How the Problem has Solved & Advantage & Disadvantage of Each Step in This Process** | | | | | | | |
| The proposed project aims to develop a computer vision and machine learning approach to detect species in a camera trap dataset.   |  | **Process Steps** | **Advantage** | **Disadvantage (Limitation)** | | --- | --- | --- | --- | | **1** | Data Collection | This involves being able to gather a rich set of details about how animals look and behave. | Manually analyzing the photographed data can be expensive, time-consuming, and tiresome. | | **2** | Image Analysis | Deep Convolutional Neural Networks enable a quick and accurate identification of species in the images. | Image classification can be hard because things like different looks within a category, unexpected poses, changing light, and busy backgrounds create challenges. | | **3** | Model Design | Customizing the model for each species and combination allows for high prediction probabilities. | Choosing the best model with the highest accuracy can be tricky. | | **4** | Training and Validation | Randomly splitting the dataset and monitoring the network on the validation set helps prevent overfitting. | Uneven numbers of classes in the dataset can impact how well the classification algorithms learn. | | **5** | Model Selection | Selecting the model with the best accuracy ensures the highest performance in the field. | Selecting the right option might need several rounds of training and checking. | | **6** | Field Implementation | Implementing the trained model in the field allows for species detection and monitoring. | Difficulties like uneven class distribution and changes in environmental conditions can influence how well the model works. | | | | | | | | |
| **Major Impact Factors in this Work** | | | | | | | |
| | **Dependent Variable** | **Independent Variable** | **Moderating variable** | **Mediating (Intervening) variable** | | --- | --- | --- | --- | | Camera Traps, Computer Vision and Machine Learning | Environmental Changes | Image Classification and Object Detection | Noise Overlaps and Sound Signal Identification | | | | | | | | |
| | **Relationship Among the Above 4 Variables in This article** | | --- | | As the device collects its input images using camera traps regardless of the changes happening in the environment. By the use of OpenCVs and Machine Learning Techniques we can classify and detect objects or images and the identification of sound signals in addition to image data. | | | | | | | | |
| **Input and Output** | | | **Feature of This Solution** | | | | **Contribution & The Value of This Work** |
| | **Input** | **Output** | | --- | --- | | collection of images | detection and classification of species | | | | The solution aims to automate data analysis in computer vision tasks, particularly in detecting and classifying animal species. Using deep learning methods and CNNs, the solution can manage difficult images and extract important features for precise species identification. | | | | The goal is to precisely identify and track endangered species in specific geographic locations. The research also focuses on improving the network structure and characteristics in order to improve accuracy and efficiency. |
| **Positive Impact of this Solution in This Project Domain** | | | | | **Negative Impact of this Solution in This Project Domain** | | |
| The positive impact of the solution on the project is  by enhancing species detection efficiency, automating image classification, promoting collaborative wildlife monitoring, integrating both hardware and software solutions, and utilizing high-performance computing capabilities. | | | | | One potential negative impact of using camera traps for species detection is the challenge of dealing with highly imbalanced data.When collecting camera trap images at a location that it hasn't been to during training, the model's performance might differ. | | |
| **Analyze This Work by Critical Thinking** | | | | **The Tools That Assessed this Work** | | | **What is the Structure of this Paper** |
| The project aims to develop a computer vision and machine learning approach to detect species in camera trap datasets. The project faces challenges in image classification and object detection, but the use of camera traps provides new opportunities for species detection. The model will be trained using deep CNNs and evaluated for its accuracy in species prediction. | | | | Keras and TensorFlow, OpenCV, HiPE Server Environment, NVIDIA Jetson Nano Developer Kit, Compact T70 Camera | | | Abstract  Introduction  Background  Proposed Design Approach  Initial Results  Future Work |
| **Diagram/Flowchart** | | | | | | | |
| https://lh7-us.googleusercontent.com/OB07JAgbhVxM5jzFBk6b7RFPExNjdIr5gDTHwLCGWVNV15o3VCkHFEJt1LqI2bsuaZpsvw8ZhwbYq3eorFsiCd9k14ldOBIsxq2iSQ5OUCZ-GmkPZ066Og3IMr3IhH7pANnfiTFNBr1rK9Efyb5hstU | | | | | | | |

| **5** |
| --- |
| **Reference in APA format** | | Aarju, R. Bahuguna, S. Pandey, R. Singh, H. Kaur and G. Chhabra, "Enabling Technologies for Wildlife Conservation," 2023 IEEE Devices for Integrated Circuit (DevIC), Kalyani, India, 2023, pp. 217-220, doi: 10.1109/DevIC57758.2023.10134561. | | | | | |
| **URL of the Reference** | | **Authors Names and Emails** | | | | **Keywords in this Reference** | |
| https://ieeexplore.ieee.org/document/10226093 | | Aarju aarjujangra2003@gmail.com, Rajesh drrajeshsingh004@gmail.com, Rajesh  deanlaw@uttaranchaluniversity.ac.in, Hardeep Kaur hardeepjhajj@gmail.com, Shweta Pandey shwetapandey2626@gmail.com, Gunjan Chhabra chhgunjan@gmail.com | | | | convolutional neural networks, deep learning and machine learning algorithms, radio tracking, robotic aircrafts, wildlife conservation | |
| **The Name of the Current Solution (Technique/ Method/ Scheme/ Algorithm/ Model/ Tool/ Framework/etc)** | | **The Goal (Objective) of this Solution & What is the problem that need to be solved** | | | | **What are the components of it?** | |
| Enabling Technologies for Wildlife Conservation | | The goal of the solution is to utilize Artificial Intelligence (AI) and drone technology for the protection and conservation of wildlife. This involves implementing new technologies and innovations, such as cloud computing and IoT, to monitor and track endangered species. | | | | Conservation Drones, Cloud Computing, Artificial Intelligence | |
| **The Process (Mechanism) of this Work; Means How the Problem has Solved & Advantage & Disadvantage of Each Step in This Process** | | | | | | | |
| Performance of Detection of spam in email is evaluated based on different algorithms and constraints. Even though this author compared various results upon validating the test data and trained data using machine learning with all supervised and Lazy learning algorithms.   |  | **Process Steps** | **Advantage** | **Disadvantage (Limitation)** | | --- | --- | --- | --- | | **1** | Data Collection | It helps to gather detailed information about how animals move and migrate in different areas. | Using high-tech sensors and drones can be expensive and complicated, making it challenging to do in some places that don't have many resources. | | **2** | Machine Learning and AI | It divides the dataset into training data and testing data. | It needs a lot of computer power and knowledge, which might be hard for some people or places to get. | | **3** | Animal Detection and Counting | This helps in figuring out where animal groups are and is useful for stopping illegal activities and protecting their homes. | The computer programs for finding and counting animals might not always be perfect, especially if the animals look similar or are in tricky environments. | | **4** | Cloud Computing and IoT | This helps experts identify species that need extra care and come up with practical solutions. | Relying on online technology might not work well in areas with no internet, making it difficult to keep an eye on endangered species in certain places. | | **5** | Automated Monitoring Systems | This helps prevent problems between humans and animals and gives early warnings about illegal activities or natural disasters. | Setting up and maintaining smart systems to watch animals can cost a lot, and if they break or have problems, it might be hard to fix them quickly. | | **6** | Conservation Drones | They're really helpful for keeping track of wildlife. | Using drones with autopilot systems can have rules and restrictions, and people might worry about their privacy. It's also important to make sure the drones don't cause harm or disturbance to wildlife. | | **7** | Artificial Intelligence in Wildlife Conservation | They help experts watch over these animals, guard them from dangers, and create good rules to keep them safe. | It's essential to make sure Artificial Intelligence is fair and accurate. | | | | | | | | |
| **Major Impact Factors in this Work** | | | | | | | |
| | **Dependent Variable** | **Independent Variable** | **Moderating variable** | **Mediating (Intervening) variable** | | --- | --- | --- | --- | | Drone Technology and Artificial Intelligence | Climate Change | Data Processing and Analysis | Emerging technologies, Industrialization and Innovation | | | | | | | | |
| | **Relationship Among the Above 4 Variables in This article** | | --- | | These factors collectively contribute to the implementation of Artificial Intelligence and drone technology in wildlife conservation and shape the limitations, suggestions, and concluding remarks of the work. | | | | | | | | |
| **Input and Output** | | | **Feature of This Solution** | | | | **Contribution & The Value of This Work** |
| | **Input** | **Output** | | --- | --- | | Image Dataset | Analysis of animal patterns | | | | Using cloud computing, drones, and artificial intelligence has changed how we protect wildlife. These technologies help us monitor and understand species accurately. | | | | The paper talks about using AI and drones to protect wildlife. It looks at different methods like radio tracking, GPS, and drones for monitoring animals. |
| **Positive Impact of this Solution in This Project Domain** | | | | | **Negative Impact of this Solution in This Project Domain** | | |
| Using Artificial Intelligence and drones in wildlife conservation has a good effect on the project. It improves wildlife monitoring, helps conservation efforts, brings in new technology, lessens environmental impact, and offers solutions that can be used for bigger conservation goals. | | | | | The problems affecting their effectiveness in this project include issues with network connectivity, data annotation, the weight and durability of batteries, and accurately encoding the position and orientation of objects. | | |
| **Analyse This Work by Critical Thinking** | | | | **The Tools That Assessed this Work** | | | **What is the Structure of this Paper** |
| The use of AI, including Convolutional Neural Networks and machine learning, is discussed. The paper ends by mentioning the limits and suggesting ways to improve wildlife conservation. Overall, it stresses how technology is crucial for saving biodiversity and endangered species. | | | | Cloud Computing, Internet of Things, Connected cameras, Satellite, drone, and lidar pictures, Machine Learning and Deep Learning | | | Abstract   1. Introduction 2. Overview of Technologies in Wildlife Conservation 3. Drones in Wildlife 4. Artificial Intelligence in Wildlife 5. Challenges 6. Discussions 7. Conclusion |
| **Diagram/Flowchart** | | | | | | | |
| https://lh7-us.googleusercontent.com/xgS-dtZBuQOWT3mVJMGt111_FTCwsZvqlmh0L3cPbg7taAOW6AAhFx18HjacQ-CtKdTDqi6Plg_DWu68Q3sZmqbr1FTl9ixTp8Gmw-IAfiyble_xuur4bWy6ad2VQ6lCKGKk1OiBO3KQF6l_IK6UWtHty0x9a-HoTu4qc0AHGSc_gE5hnPDbDmVEqeASuDFzf2iaen0 | | | | | | | |

| **6** |
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| **Reference in APA format** | | Christensen, David R.”A Simple Approach to Collecting Useful Wildlife Data Using Remote Camera-Traps in Undergraduate Biology Courses” Bioscene: Journal of College Biology Teaching, v42 n1 p25-31 May 2016, *Association of College and Biology Educators. Web site: http://acube.org* | | | | | |
| **URL of the Reference** | | **Authors Names and Emails** | | | | **Keywords in this Reference** | |
| https://eric.ed.gov/?q=species+identification+of+wildlife+using+camera+traps+&id=EJ1103785 | | David R Christensen | | | | Remote camera-traps, wildlife, inquiry based , biological corridor, undergraduate students | |
| **The Name of the Current Solution (Technique/ Method/ Scheme/ Algorithm/ Model/ Tool/ Framework/etc)** | | **The Goal (Objective) of this Solution & What is the problem that need to be solved** | | | | **What are the components of it?** | |
| Camera-Trap methodology | | Aim is to teach students about real-world skills using remote camera technology and provide realistic experience | | | | By performing 3-step lab activity which includes camera-trap setup, camera retrieval and data analysis | |
| **The Process (Mechanism) of this Work; Means How the Problem has Solved & Advantage & Disadvantage of Each Step in This Process** | | | | | | | |
| Performance of Detection of spam in email is evaluated based on different algorithms and constraints. Even though this author compared various results upon validating the test data and trained data using machine learning with all supervised and Lazy learning algorithms.   |  | **Process Steps** | **Advantage** | **Disadvantage (Limitation)** | | --- | --- | --- | --- | | **1** | Literature Review : Students are allocated relevant literature to review about biological corridor theory and camera-trap case studies. | Helps in better understanding of previous studies of camera-trap and helps in formulating research questions and objectives | To avoid potential bias further sampling is needed | | **2** | Data Collection: Collection data from remote cameras and using relative abundance index to compare data across temporal and spatial scales. | This allows students to real-world skills as this uses inquiry based approach | Each remote-camera methodology has strengths and weaknesses, so clear objectives are needed for a study to be successful | | **3** | Data analysis: analyze collected data to identify diversity and behavior to develop more analysis of them. | Remote cameras have been effective in capturing nocturnal and cryptic species, other than felines, reducing the amount of sampling time required | longer and strategic camera placement may be necessary to improve encounters with these species. | | | | | | | | |
| **Major Impact Factors in this Work** | | | | | | | |
| | **Dependent Variable** | **Independent Variable** | **Moderating variable** | **Mediating (Intervening) variable** | | --- | --- | --- | --- | | Wildlife diversity ,Data analysis ,Genetic analysis | Data collection | Relative Abundance Index | The paper does not mention any mediating variables. | | | | | | | | |
| | **Relationship Among the Above 4 Variables in This article** | | --- | | After collecting the required data , moderating variable relative abundance index is calculated for camera encounter rate considering different time periods. | | | | | | | | |
| **Input and Output** | | | **Feature of This Solution** | | | | **Contribution & The Value of This Work** |
| | **Input** | **Output** | | --- | --- | | Data gathered in camera traps | Deil behavior ,Encounter rate calculation Trapping effort calculation | | | | Measuring wildlife diversity, deil behavior | | | | This paper talks about how remote-camera technology contributes to the field of biology and helps students to develop skills in study design , data analysis and scientific communication. |
| **Positive Impact of this Solution in This Project Domain** | | | | | **Negative Impact of this Solution in This Project Domain** | | |
| It allows increased sampling, which can capture and expose trends in wildlife abundance and behavior , also helps students utilize these data sets | | | | | Biated cameras can generate biased relative abundance estimates. So, some species are attracted to baited cameras leading to repeated observations and overestimation of their abundance | | |
| **Analyze This Work by Critical Thinking** | | | | **The Tools That Assessed this Work** | | | **What is the Structure of this Paper** |
| Remote-cameras are used for capturing mammal species , identified according to the time periods. Calculating trapping effort and camera-encounter rates to estimate deil activity and relative abundance of wildlife. | | | | Camera-traps | | | Abstract   1. Introduction 2. Methods 3. Results and discussions 4. Conclusions and Suggestions |
| **Diagram/Flowchart** | | | | | | | |
|  | | | | | | | |

| **7** |
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| **Reference in APA formats** | | shreya Kakhandiki “Poacher Activity Detection Device for Wildlife Conservation” 2022 Terra Science and Education, DOI: 10.36838/v4i5.17 | | | | | |
| **URL of the Reference** | | **Authors Names and Emails** | | | | **Keywords in this Reference** | |
| https://terra-docs.s3.us-east-2.amazonaws.com/IJHSR/Articles/volume4-issue5/2022\_45\_p102\_Kakhandiki.pdf | | Shreya Kakhandiki | | | | Ecology, Camera Trap , Poacher Detection, Wildlife Conservation , Artificial Intelligence , Machine Learning, Facial Recognition , Raspberry pi | |
| **The Name of the Current Solution (Technique/ Method/ Scheme/ Algorithm/ Model/ Tool/ Framework/etc)** | | **The Goal (Objective) of this Solution & What is the problem that need to be solved** | | | | **What are the components of it?** | |
| To provide a device which is low-cost ,open platform for wildlife conservation | | The main goal is to develop a low-cost and scalable wildlife monitoring device to prevent poaching which poses a threat to both animals and park rangers. | | | | Raspberry pi Computer, s small solar power bank, a camera , infrared motion sensor, a GPRS modem | |
| **The Process (Mechanism) of this Work; Means How the Problem has Solved & Advantage & Disadvantage of Each Step in This Process** | | | | | | | |
| Performance of Detection of spam in email is evaluated based on different algorithms and constraints. Even though this author compared various results upon validating the test data and trained data using machine learning with all supervised and Lazy learning algorithms.   |  | **Process Steps** | **Advantage** | **Disadvantage (Limitation)** | | --- | --- | --- | --- | | **1** | Taking a photo using camera when motion sensor is triggered | The device is equipped with a GSM/GPRS/GNSS modem, providing connectivity options | Significant cost associated with traditional methods of patrolling and monitoring wilderness areas | | **2** | Analyzing it to detect the presence of animals, humans and weapons. | Raspberry pi offers optimized performance and functionality | Human patrolling in wilder areas is high risk factor | | **3** | Further analyze to classify animal species and determine if human is park ranger or unknown | Low cost ,small size , low power consumption | Lack of modular and replaceable components adds to high maintenance expenses. | | **4** | Setting up alert level on detected threats | The device has the ability to run on natural renewable power sources such as solar panels | The emergency alert systems in India are not able to provide accurate and timely information on the location, magnitude, intensity, and impact of the disasters | | | | | | | | |
| **Major Impact Factors in this Work** | | | | | | | |
| | **Dependent Variable** | **Independent Variable** | **Moderating variable** | **Mediating (Intervening) variable** | | --- | --- | --- | --- | | Classification of animals, humans, weapons in the photos taken by the camera | Raspberry pi as a device’s computer , motion infrared sensor, GPRS modem | There is no specific moderating variable. | There is no specific mediating variable. | | | | | | | | |
| | **Relationship Among the Above 4 Variables in This article** | | --- | | As inputs are taken from the device which further helps for the detection and classification | | | | | | | | |
| **Input and Output** | | | **Feature of This Solution** | | | | **Contribution & The Value of This Work** |
| | **Input** | **Output** | | --- | --- | | Infrared camera, GPRS modem ,motion sensor | Detection and classification | | | | The main feature of this solution is algorithm design, alert rules and performance testing. | | | | The main aim is to address wildlife poaching through development of a low-cost device that can detect and alert officials which are also deployed in many geographical regions, allowing for increased monitoring and protection of wildlife. |
| **Positive Impact of this Solution in This Project Domain** | | | | | **Negative Impact of this Solution in This Project Domain** | | |
| By developing a low-cost, scalable device that can detect and alert authorities which is over 90% accurate in recognising humans, weapons, animals and generated notifications. | | | | | There is no specific negative impact because it highlights challenges and risks associated with poaching, endangerment of animal species, safety of rangers. | | |
| **Analyze This Work by Critical Thinking** | | | | **The Tools That Assessed this Work** | | | **What is the Structure of this Paper** |
| This gives an idea that a successful development of a wildlife monitoring device with potential for future deployment in high risks has been made. | | | | Raspberry pi, camera , motion sensor , GPRS modem , AI-based image classification algorithms | | | Abstract   1. Introduction 2. Related work 3. Design and Prototype Development 4. Conclusion and Future work 5. Acknowledgements and References |
| **Diagram/Flowchart** | | | | | | | |
|  | | | | | | | |

| **8** |
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| **Reference in APA format** | | D. Mahatara1\*, S. Rayamajhi2 and G. Khanal3  “Impact of anti-poaching approaches for the success of Rhino conservation in Chitwan National Park, Nepal” Banko Janakari, Vol 28 No. 2, 2018 | | | | | |
| **URL of the Reference** | | **Authors Names and Emails** | | | | **Keywords in this Reference** | |
| https://pdfs.semanticscholar.org/8b0a/dd639b05b160d5b3e899eef0f626e47d0b47.pdf | | D.Mahatara , S.Rayamajhi and G. Khanal | | | | Anti-poaching , one-horned rhino patrol efforts , patrol frequency, SMART patrolling | |
| **The Name of the Current Solution (Technique/ Method/ Scheme/ Algorithm/ Model/ Tool/ Framework/etc)** | | **The Goal (Objective) of this Solution & What is the problem that need to be solved** | | | | **What are the components of it?** | |
| SMART patrolling | | The mail goal is to reduce the occurrence of illegal activities | | | | Patrol frequency, patrol framework, detection of illegal activities, occupancy framework, GIS tools | |
| **The Process (Mechanism) of this Work; Means How the Problem has Solved & Advantage & Disadvantage of Each Step in This Process** | | | | | | | |
| Performance of Detection of spam in email is evaluated based on different algorithms and constraints. Even though this author compared various results upon validating the test data and trained data using machine learning with all supervised and Lazy learning algorithms.   |  | **Process Steps** | **Advantage** | **Disadvantage (Limitation)** | | --- | --- | --- | --- | | **1** | Literature review: Authors conducted various published and unpublished documents to gather information on the current strategies used to combat illegal activities in the park | This paper provides valuable insights for smart patrolling in reducing illegal activities. | Limited scope as it only focused on conservation areas. | | **2** | Data collection: Collected information from 53 anti-poaching units which included distance patrolled per year, number of patrols conducted per year | Authors used rigorous methodology to collect and analyze data, including literature review | This study did not include a comparison group of areas where anti-poaching strategies were not implemented. | | **3** | Database creation: Authors used GIS tools to create a database | This provides evidence-based recommendations for improving anti-poaching strategies | This study relied on anti-poaching units, which may be subject to bias or insecurities. | | **4** | Statistical Analysis: Used logistic regression models to analyze | It can help you determine the monthly, quarterly, yearly figures of sales profits, and costs making it easier to make your decisions | The statistical data can lead to misuse. There are chances of errors becomes easy when the statistical methods are not done by the experts. | | | | | | | | |
| **Major Impact Factors in this Work** | | | | | | | |
| | **Dependent Variable** | **Independent Variable** | **Moderating variable** | **Mediating (Intervening) variable** | | --- | --- | --- | --- | | Occurrences of illegal activities, such as poaching | Patrol effect and Patrol Frequency | Security posts, community-based anti-poaching unit formation ,conservation education and seeping/camping operations | There is no mediating variable in this paper. | | | | | | | | |
| | **Relationship Among the Above 4 Variables in This article** | | --- | | There is a stronger negative relationship with the occurrences of illegal activities than patrol effort, indicating the patrol frequency is highly significant compared to patrol efforts. | | | | | | | | |
| **Input and Output** | | | **Feature of This Solution** | | | | **Contribution & The Value of This Work** |
| | **Input** | **Output** | | --- | --- | | Data collected from patrolling logbooks, records of illegal cases, annual reports of different stakeholders, journals, articles | Findings of study which include relationship between patrol frequency and patrol effort | | | | This includes use of logistic regression models, also highlights importance of community involvement and the need for effective law enforcement capability | | | | The findings of this study can be used to inform policy decisions and improve the effectiveness of anti-poaching efforts in other rhino conservation areas. The value of this solution is that it provides a scientific basis for anti-poaching efforts in Chitwan National Park and its buffer zone. |
| **Positive Impact of this Solution in This Project Domain** | | | | | **Negative Impact of this Solution in This Project Domain** | | |
| This includes potential for improved conservation outcomes for rhinos and provides evidence-based recommendations for improving the effectiveness of anti-poaching efforts. | | | | | Increased conflict between anti-poaching units and local communities. This study has limited generalizability to other conservation areas. | | |
| **Analyze This Work by Critical Thinking** | | | | **The Tools That Assessed this Work** | | | **What is the Structure of this Paper** |
| It is important to develop a comprehensive anti-poaching strategy which also involves the community. | | | | GIS tools | | | 1. Introduction 2. Materials and methods 3. Results 4. Discussion 5. Conclusion and Acknowledgements |
| **Diagram/Flowchart** | | | | | | | |
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| **9** |
| --- |
| **Reference in APA format** | | Jamali Firmat Banzi “A Sensor Based Anti-Poaching   System in Tanzania National Parks” International Journal of Scientific and Research Publications, Volume 4, Issue 4, April 2014 | | | | | |
| **URL of the Reference** | | **Authors Names and Emails** | | | | **Keywords in this Reference** | |
| https://www.researchgate.net/publication/281812638\_A\_Sensor\_Based\_Anti-Poaching\_System\_in\_Tanzania\_National\_Parks | | https://www.researchgate.net/publication/281812638\_A\_Sensor\_Based\_Anti-Poaching\_System\_in\_Tanzania\_National\_Parks | | | | https://www.researchgate.net/publication/281812638\_A\_Sensor\_Based\_Anti-Poaching\_System\_in\_Tanzania\_National\_Parks | |
| **The Name of the Current Solution (Technique/ Method/ Scheme/ Algorithm/ Model/ Tool/ Framework/etc)** | | **The Goal (Objective) of this Solution & What is the problem that need to be solved** | | | | **What are the components of it?** | |
| Sensor-based Anti-Poaching System | | The Goal is to provide early detection and to solve the problem of increasing threat of poaching. | | | | Collar type sensors, Central computer system , a database for storing data. | |
| **The Process (Mechanism) of this Work; Means How the Problem has Solved & Advantage & Disadvantage of Each Step in This Process** | | | | | | | |
| Performance of Detection of spam in email is evaluated based on different algorithms and constraints. Even though this author compared various results upon validating the test data and trained data using machine learning with all supervised and Lazy learning algorithms.   |  | **Process Steps** | **Advantage** | **Disadvantage (Limitation)** | | --- | --- | --- | --- | | **1** | Data Collection: uses access points to continuously receive and store location of the data of MBS in central computer database | Very easily adaptable to the present anti-poaching systems. | Difficult to capture dangerous animals like elephants and attach sensors without trained personnel | | **2** | Panic and Abnormalities Detection: checks sudden animal panics and abnormalities in the actions of the MBS. | Cost-effective | Use of batteries can cause pollution and extra radiation | | **3** | Alarm and Location Display: it first raises the alarm and then displays the exact location of the incident using GPS. | Provides more Knowledge about animal behavior and comprehensive animal death | Batteries need to be changed periodically, which can be challenging | | **4** | Image Processing : processes received image using edge detection, thresholding and filtering to provide a clear image of what is happening | Can be applied to any species in danger at a particular time | Incorrect battery operation can result in wrong data being sent | | **5** | Alerting game rangers: sends a short message to the game rangers through GSM network further taking required measures. | Can prevent serious poaching activities an ecological imbalance | Additional unforseen disadvantages may occur as the system has not yet been implemented | | | | | | | | |
| **Major Impact Factors in this Work** | | | | | | | |
| | **Dependent Variable** | **Independent Variable** | **Moderating variable** | **Mediating (Intervening) variable** | | --- | --- | --- | --- | | Reduction of Poaching activities , protection of endangered species like elephants | Employment of sensor fusion technology , establishment of IAPF(International Anti-Poaching Foundation) | Financial resources allocated by governments, Level implementation. | Environmental considerations such as the impact of batteries on pollution and radiation | | | | | | | | |
| | **Relationship Among the Above 4 Variables in This article** | | --- | | The anti-poaching initiatives help in reduction poaching while being moderated by external factors like financial resources, communication effectiveness and mediated by environmental considerations. | | | | | | | | |
| **Input and Output** | | | **Feature of This Solution** | | | | **Contribution & The Value of This Work** |
| | **Input** | **Output** | | --- | --- | | Location data from sensors, Images from sensors | Animal Behaviour , Real-time visualization of animal’s surroundings | | | | New system for anti-poaching involves sensor fusion and computer vision techniques. | | | | Developing a sophisticated technology system for anti-poaching and protecting endangered species. The value lies in addressing the issue leading to the preservation of wildlife and prevention of ecological balance. |
| **Positive Impact of this Solution in This Project Domain** | | | | | **Negative Impact of this Solution in This Project Domain** | | |
| Improved poaching prevention, Cost-Effective , Real-time Visualization and Observation | | | | | Challenges faced in capturing Dangerous animals, Battery related issues | | |
| **Analyze This Work by Critical Thinking** | | | | **The Tools That Assessed this Work** | | | **What is the Structure of this Paper** |
| This gives the idea of using animals as mobile biological sensors to combat poaching. By attaching sensors to animals, system can detect abnormal behavior and alert game reserve officers. | | | | Sensor Fusion, Artificial Intelligence, Image Processing Techniques, Wireless Communication, SMS Alerts. | | | Abstract   1. Introduction 2. Related Work and Motivation 3. Proposed System Infrastructure 4. Methodology and Discussion 5. Conclusion and Future Work 6. References |
| **Diagram/Flowchart** | | | | | | | |
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| **10** |
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| **Reference in APA format** | | Sachini Kuruppu “AI System to Protect Endangered Animal Population and Prevent Poaching Threats using Weapon Detection” Volume 8, Issue 9, September 2023, International Journal of Innovative Science and Research Technology ISSN No:-2456-2165 | | | | | |
| **URL of the Reference** | | **Authors Names and Emails** | | | | **Keywords in this Reference** | |
| https://scholar.google.co.in/scholar?q=poaching+detection+in+forest+using+deep+learning+2023&hl=en&as\_sdt=0&as\_vis=1&oi=scholart | | Sachini Kuruppu | | | | Illegal Wildlife Trade, Yolo v5, Camera Traps , Long Range(LoRa ) Technology, Raspberry, detecting weapons | |
| **The Name of the Current Solution (Technique/ Method/ Scheme/ Algorithm/ Model/ Tool/ Framework/etc)** | | **The Goal (Objective) of this Solution & What is the problem that need to be solved** | | | | **What are the components of it?** | |
| Automated weapon detection system | | Protect endangered animals from poaching which includes illegal exploitation | | | | Camera Traps, LoRa technology, Raspberry Pi 4 , YOLOv5 object | |
| **The Process (Mechanism) of this Work; Means How the Problem has Solved & Advantage & Disadvantage of Each Step in This Process** | | | | | | | |
| Performance of Detection of spam in email is evaluated based on different algorithms and constraints. Even though this author compared various results upon validating the test data and trained data using machine learning with all supervised and Lazy learning algorithms.   |  | **Process Steps** | **Advantage** | **Disadvantage (Limitation)** | | --- | --- | --- | --- | | **1** | Data Collection: camera traps are used to collect real-time videos from forest areas. | Enhanced Wildlife Protection as it includes endangered species | LoRa technology is used which is suitable for remote forest areas with low internet connection. | | **2** | Weapon Detection: using YOLOv5 weapons are detected specifically guns used by poachers | Sends alerts to park-rangers in real-time when suspicious activity detected | Totally dependent on cameras, so they should functions properly | | **3** | Data Pre-processing: Retrieves Date, Time , Location from the videos | Efficient Resource Allocation is possible by monitoring unexplorable geographical areas. | As it uses ai technology there may be some changes in the accuracy of the data | | **4** | Alert Generation and Transmission: When weapon is detected then alert is generated and transmitted to the park rangers | you can detect and resolve issues more quickly before they impact users or cause downtime | Lack of Accuracy and Timeliness: | | **5** | Ranger Response : After receiving the signal ranger takes immediate action and prevents poaching threats. | Immediate action should be taken at particular area | if there is any network issue in communication the action get delay | | | | | | | | |
| **Major Impact Factors in this Work** | | | | | | | |
| | **Dependent Variable** | **Independent Variable** | **Moderating variable** | **Mediating (Intervening) variable** | | --- | --- | --- | --- | | Alerting park rangers about presence of poachers based on detection of weapons | Camera traps, LoRa technology ,Raspberry Pi | YOLOv5 used to detect weapons and poachers | Geographic terrain | | | | | | | | |
| | **Relationship Among the Above 4 Variables in This article** | | --- | | The effectiveness of the anti-poaching system, influenced by various independent variables like YOLOv5, serves as a mediating variable ,explaining how the detection system affects the ability to prevent illegal poaching activities. | | | | | | | | |
| **Input and Output** | | | **Feature of This Solution** | | | | **Contribution & The Value of This Work** |
| | **Input** | **Output** | | --- | --- | | Camera Traps, YOLOv5 object detection Algorithm, LoRa Technology with Raspberry Pi 4 | Real-time alerts (such as presence of weapon, fire or gunshot) | | | | Implementation of an automated weapon detection system in forest areas with high population density of endangered species. | | | | Using AI the system can monitor the presence of endangered animals and give alerts to the rangers.  The value of the work lies in its potential to significantly enhance wildlife protection and safeguard park rangers. Saves wasted time and energy spent in inefficient patrols and contributed to the conservation of endangered species. |
| **Positive Impact of this Solution in This Project Domain** | | | | | **Negative Impact of this Solution in This Project Domain** | | |
| Enhanced wildlife protection, efficient resource utilization , Real-time Alerts. | | | | | Limited Data Accuracy, Limited Awareness, Challenges in Remote Areas | | |
| **Analyze This Work by Critical Thinking** | | | | **The Tools That Assessed this Work** | | | **What is the Structure of this Paper** |
| It discusses issue of poaching and automated system to detect and prevent poaching | | | | Camera units, Raspberry pi | | | Abstract   1. Introduction 2. Research Gap 3. Methodology 4. Results 5. Conclusion and Acknowledgment 6. References |
| **Diagram/Flowchart** | | | | | | | |
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| **11** |
| --- |
| **Reference in APA format** | | An evaluation of platforms for processing camera-trap data using artificial intelligence | | | | | |
| **URL of the Reference** | | **Authors Names and Emails** | | | | **Keywords in this Reference** | |
| https://besjournals.onlinelibrary.wiley.co | | Juliana Vélez, William McShea, Hila Shamon, Paula J. Castiblanco-Camacho, Michael A. Tabak, Carl Chalmers, Paul Fergus, John Fieberg | | | | Camera Traps ,Artificial Intelligence (AI), MegaDetector, | |
| **The Name of the Current Solution (Technique/ Method/ Scheme/ Algorithm/ Model/ Tool/ Framework/etc)** | | **The Goal (Objective) of this Solution & What is the problem that need to be solved** | | | | **What are the components of it?** | |
| Deeplearning  convolutional neural networks  camera-trap  Camelot and Timelapse   |  |  | The goal of this solution is to enhance the | The components of the solution are camera traps, AI | | --- | --- | --- | --- | |  |  | efficiency of camera-trap surveys in ecology | algorithms (e.g., CNNs), AI platforms (e.g., Conservation AI), | |  |  | by leveraging artificial intelligence, particularly | and data management tools, all aimed at automating wildlife | |  | deep learning, to automate the identification | species identification and improving the efficiency of | |  |  | and classification of objects and species in | camera-trap data processing. | | camera-trap images. The problem being |  | |  |  |  | |  |  |  | | | The goal of this solution is to enhance the efficiency of camera-trap surveys in ecology by leveraging artificial intelligence, particularly deep learning, to automate the identification and classification of objects and species in camera-trap images. The problem being  addressed is the time-consuming data processing associated with camera-trap surveys, and the solution aims to improve the speed and accuracy of data analysis. | | | | The components of the solution are camera traps, AI algorithms (e.g., CNNs), AI platforms (e.g., Conservation AI), and data management tools, all aimed at automating wildlife species identification and improving the efficiency of  camera-trap data processing. | |
| **The Process (Mechanism) of this Work; Means How the Problem has Solved & Advantage & Disadvantage of Each Step in This Process** | | | | | | | |
| Performance of Detection of spam in email is evaluated based on different algorithms and constraints. Even though this author compared various results upon validating the test data and trained data using machine learning with all supervised and Lazy learning algorithms.   |  | **Process Steps** | **Advantage** | **Disadvantage (Limitation)** | | --- | --- | --- | --- | | **1** | Data Collection with Camera Traps: | Camera traps offer non-invasive, continuous, and remote wildlife monitoring, allowing for natural behavior observation. | They have limited coverage and can be triggered by non-target subjects, requiring careful data management. | | **2** | AI-Based Image Processing: | AI-based image processing offers numerous advantages in ecological research. It stands out for its exceptional efficiency, swiftly handling extensive image datasets, thus saving valuable time and human effort. | AI-based image processing does come with certain challenges. Firstly, it necessitates extensive and diverse training data to ensure robust performance, a requirement that may be resource-intensive. | | **3** | AI-Powered Platforms: | AI-Powered Platforms can be beneficial in making AI-based image processing more accessible to a broader range of users. One significant advantage lies in their provision of user-friendly interfaces. .Platforms that facilitate the use of AI via user-friendly interfaces.Examples of such platforms include Camelot, Conservation AI, MegaDetector, MLWIC2, Timelapse, and Wildlife Insights | AI-Powered Platforms can be beneficial in making AI-based image processing more accessible to a broader range of users. One significant advantage lies in their provision of user-friendly interfaces. These platforms are designed with simplicity in mind, allowing both experienced researchers and those with limited technical expertise to utilize AI for their projects | | **4** | Integrating AI Output with Standard Workflows | Integrating AI Output with Standard Work flows provides a valuable bridge between AI and traditional camera-trap data processing. | Integrating AI Output with Standard Work flows presents challenges in terms of the need for human input to record additional information beyond AI capabilities | | | | | | | | |
| **Major Impact Factors in this Work** | | | | | | | |
| | **Dependent Variable** | **Independent Variable** | **Moderating variable** | **Mediating (Intervening) variable** | | --- | --- | --- | --- | | Observing wildlife behavior and estimating population parameters  Limited camera trap placement and coverage, missing rare species  Extensive and diverse training data for accurate results. | Camera trap deployment  AI-based image processing  Training data augmentation  AI-powered platforms Integrating AI output with standard work flows  Quality control and human verification | The paper does not explicitly mention a moderating variable. However, one can argue that the "Mega detector" might act as a moderating variable. | The paper does not explicitly mention a mediating variable. However, one could consider the "MLWIC2" process as a potential mediating variable. |  |  | | | | | | | | |
| | **Relationship Among the Above 4 Variables in This article** | | --- | | The independent variables include Camera trap deployment, AI-based image processing ,Training data augmentation A potential mediating variable in this context could be the "Mega detector," as an AI model for classification of animals, people and vehicles in camera trap images. Its output can be integrated with different platforms (e.g. Camelot, Timelapse or Zooniverse) to facilitate camera-trap image processing | | | | | | | | |
| **Input and Output** | | | **Feature of This Solution** | | | | **Contribution & The Value of This Work** |
| | **Input** | **Output** | | --- | --- | | camera trap image | processed and | | | | Offering the application of artificial intelligence (AI) and deep learning algorithms for processing camera trap image data. This solution involves using AI to perform tasks such as image classification, object detection, species identification, and data processing in ecological research. | | | | From the paper, we've gained knowledge about Mega detector, MLWIC2 ,artificial intelligence (AI) as well as their pros and cons. |
| **Positive Impact of this Solution in This Project Domain** | | | | | **Negative Impact of this Solution in This Project Domain** | | |
| Data Processing and classification are big challenges in the current research and eyeing this area makes sense in the right direction. | | | | | Since this is a performance evaluation of various algorithms, not much to project on the negative side as all the things used are defined in advance. | | |
| **Analyse This Work by Critical Thinking** | | | | **The Tools That Assessed this Work** | | | **What is the Structure of this Paper** |
| This paper has truly enhanced our understanding of how the camera trap data is processed and classified using Ai powered platforms evaluation and on the fly structure that detects spam. | | | | GitBook ,collab | | | Abstract   1. Introduction 2. workflow 3. platform selection 4. Model evaluation 5. Results 6. Discussions |
| **Diagram/Flowchart** | | | | | | | |
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| **12** |
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| **Reference in APA format** | | Automatically identifying, counting, and describing wild animals in camera-trap images with deep learning | | | | | |
| **URL of the Reference** | | **Authors Names and Emails** | | | | **Keywords in this Reference** | |
| https://[www.pnas.org/doi/epdf/10.1073/](http://www.pnas.org/doi/epdf/10.1073/) pnas.1719367115 | | Mohammad Sadegh Norouzzadeha, Anh Nguyenb, Margaret Kosmalac, Alexandra Swansond, Meredith S. Palmere,Craig Packere, and Jeff Clunea | | | | deep learning|deep neural networks|artificial intelligence|camera-trap images|wildlife ecology | |
| **The Name of the Current Solution (Technique/ Method/ Scheme/ Algorithm/ Model/ Tool/ Framework/etc)** | | **The Goal (Objective) of this Solution & What is the problem that need to be solved** | | | | **What are the components of it?** | |
| The current solution involves using deep learning, specifically deep convolutional neural networks, to automatically identify, count, and describe the behaviors of wildlife species captured in motion-sensor "camera trap" images. | | The goal is to use deep learning to automatically identify, count, and describe wildlife species and behaviors in camera trap images, enhancing ecological and conservation research. | | | | Data Collection, Data Processing, Data Analysis | |
| **The Process (Mechanism) of this Work; Means How the Problem has Solved & Advantage & Disadvantage of Each Step in This Process** | | | | | | | |
| Performance of Detection of spam in email is evaluated based on different algorithms and constraints. Even though this author compared various results upon validating the test data and trained data using machine learning with all supervised and Lazy learning algorithms.   |  | **Process Steps** | **Advantage** | **Disadvantage (Limitation)** | | --- | --- | --- | --- | | **1** | Literature Review | Identify trends in the usage of aerial thermal sensors for wildlife sampling. | Limited to the information available in the reviewed articles, which may not cover all research in the field. | | **2** | Data Collection for Case Study | Collect real-world data to assess the impact of | Data collection can be resource-intensive | | **3** | Single Viewer Analysis | Estimate population density using data from a single viewer to assess the impact of viewer- induced errors. | May not fully account for all sources of detection error. | | **4** | Double Viewer Analysis | Can provide more robust estimates of detection probabilities. | Double-observer methods can be more complex to analyze | | **5** | Evaluate the Use of RGB Cameras | Determine the value of RGB cameras in reducing false positives. | Additional equipment and data processing may be needed. | | **6** | Statistical Analysis and Estimation | Obtain quantitative results that can inform wildlife management decisions | Complex statistical analyses may require advanced expertise. | | **7** | Recommendations and Future Research | Provide recommendations based on the findings to improve the accuracy of wildlife population estimates. | Recommendations may need to be validated through further research. | | | | | | | | |
| **Major Impact Factors in this Work** | | | | | | | |
| | **Dependent Variable** | **Independent Variable** | **Moderating variable** | **Mediating (Intervening) variable** | | --- | --- | --- | --- | | Wildlife Population Density This is the variable we are trying to estimate and understand. It represents the density of white- tailed deer in the study areas. | Altitude at which the aerial surveys were conducted. Ground condition, which is categorized as either snow cover or no snow cove | There is no specific moderating variable mentioned in the case study text. A moderating variable typically affects the strength or direction of the relationship between an independent variable  and a dependent variable | There is no explicit mention of a mediating variable in the case study text either. A mediating variable comes into play when it helps to explain the process or mechanism by which an independent variable  influences a dependent variable | | | | | | | | |
| | **Relationship Among the Above 4 Variables in This article** | | --- | | variations in altitude and ground conditions affect the accuracy of wildlife population density estimates, with the use of RGB cameras as a potential moderating variable. The primary aim is to understand how these factors influence population density estimations of white-tailed deer during aerial surveys. | | | | | | | | |
| **Input and Output** | | | **Feature of This Solution** | | | | **Contribution & The Value of This Work** |
| | **Input** | **Output** | | --- | --- | | Altitude, ground | Population density | | | | factors influencing detection errors in aerial wildlife surveys using infrared thermography and offers recommendations to improve accuracy and reduce error. | | | | The contribution of this work is an extensive review of error sources in aerial wildlife surveys using infrared thermography, coupled with a case study illustrating the importance of addressing viewer- induced false negatives and confirming thermal signatures using RGB video. |
| **Positive Impact of this Solution in This Project Domain** | | | | | **Negative Impact of this Solution in This Project Domain** | | |
| improving the accuracy of wildlife density estimates from aerial surveys, which enhances wildlife management and conservation efforts.. | | | | | could include increased costs and potential challenges in implementing double- observer methods and using additional equipment like red-green-blue cameras, which may be resource-intensive. | | |
| **Analyze This Work by Critical Thinking** | | | | **The Tools That Assessed this Work** | | | **What is the Structure of this Paper** |
| This work presents valuable insights into addressing error sources in wildlife sampling using aerial infrared thermography | | | | Data Analytics  Deep learning | | | Abstract  1.Introduction  2.Materials and Methods  3.Data collection  4.Single viewer  5.Double viewer  6.results |
| **Diagram/Flowchart** | | | | | | | |
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| **13** |
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| **Reference in APA format** | | Optimizing the automated recognition of individual animals to support population monitoring | | | | | |
| **URL of the Reference** | | **Authors Names and Emails** | | | | **Keywords in this Reference** | |
| https://[www.authorea.com/doi/full/10.22](http://www.authorea.com/doi/full/10.22) 541/au.167845477.77416758 | | Tijmen de Lorm,Catharine Horswill,Daniella Rabaiotti,Robert Ewers,Rosemary Groom,Jessica Watermeyer,Rosie Woodroffe | | | | automated individual recognition, Hotspotter, I3S-pattern, Lycaon pictus, photographic identification, Wild-ID | |
| **The Name of the Current Solution (Technique/ Method/ Scheme/ Algorithm/ Model/ Tool/ Framework/etc)** | | **The Goal (Objective) of this Solution & What is the problem that need to be solved** | | | | **What are the components of it?** | |
| developing a framework that automates the selection of suitable images for individual identification and comparing the performance of three identification software packages i.e Hotspotter, I3S- Pattern, and WildID | | enhance cost-effective large-scale monitoring and conservation efforts . | | | | individual-based demographic data from photographic records for monitoring threatened species. | |
| **The Process (Mechanism) of this Work; Means How the Problem has Solved & Advantage & Disadvantage of Each Step in This Process** | | | | | | | |
| Performance of Detection of spam in email is evaluated based on different algorithms and constraints. Even though this author compared various results upon validating the test data and trained data using machine learning with all supervised and Lazy learning algorithms.   |  | **Process Steps** | **Advantage** | **Disadvantage (Limitation)** | | --- | --- | --- | --- | | **1** | Image Datasets: | ensuring a substantial and diverse dataset. | Potential bias in image selection or quality due to the nature of long-term monitoring. | | **2** | Pre-processing Steps | Enhances data quality for more accurate analysis | Time and resource-intensive,potentially introducing subjectivity. | | | | | | | | |
| **Major Impact Factors in this Work** | | | | | | | |
| | **Dependent Variable** | **Independent Variable** | **Moderating variable** | **Mediating (Intervening) variable** | | --- | --- | --- | --- | | Image-matching accuracy. | Image pre-processing techniques. | Population of African wild dogs | Removal of image backgrounds. | | | | | | | | |
| | **Relationship Among the Above 4 Variables in This article** | | --- | |  | | | | | | | | |
| **Input and Output** | | | **Feature of This Solution** | | | | **Contribution & The Value of This Work** |
| | **Input** | **Output** | | --- | --- | | Image datasets of African wild dogs with various pre- processing steps. | Image-matching accuracy results, identifying the best software package. | | | | An automated image processing pipeline for wild dog | | | | Advances in efficient, large-scale species monitoring with applications in wildlife conservation and research |
| **Positive Impact of this Solution in This Project Domain** | | | | | **Negative Impact of this Solution in This Project Domain** | | |
| Enhanced efficiency and accuracy in wild dog population monitoring. | | | | | Dependency on specific image-matching software, potentially limiting generalizability to other species or populations. | | |
| **Analyze This Work by Critical Thinking** | | | | **The Tools That Assessed this Work** | | | **What is the Structure of this Paper** |
| The paper employs automated image pre- processing and image-matching tools to optimize wild dog monitoring. | | | | Microsoft AI for Earth MegaDetector, Convolutional Neural Networks, image-matching software. | | | Abstract   1. Introduction 2. Methods 3. Results 4. references |
| **Diagram/Flowchart** | | | | | | | |
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| **14** |
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| **Reference in APA format** | | A First Step Towards Automated Species Recognition from Camera Trap Images of Mammals Using AI in a European Temperate Forest | | | | | |
| **URL of the Reference** | | **Authors Names and Emails** | | | | **Keywords in this Reference** | |
| https://link.springer.com/chapter/10.1007  /978-3-030-84340-3\_24 | | Mateusz Choiński, Mateusz Rogowski, Piotr Tynecki, Dries P. J. Kuijper, Marcin Churski & Jakub W. Bubnicki | | | | Computer vision ,Deep learning,YOLOv5,Camera trap,TRAPPER ,Wildlife | |
| **The Name of the Current Solution (Technique/ Method/ Scheme/ Algorithm/ Model/ Tool/ Framework/etc)** | | **The Goal (Objective) of this Solution & What is the problem that need to be solved** | | | | **What are the components of it?** | |
| The current solution is an AI model based on YOLOv5 architecture for automatic object detection | | Developing a system for malicious email spam detection. | | | | The goal of this solution is to automate the object detection and species-level classification in camera trapping data to improve wildlife monitoring and conservation efforts,  addressing the challenge of efficiently processing vast | |
| **The Process (Mechanism) of this Work; Means How the Problem has Solved & Advantage & Disadvantage of Each Step in This Process** | | | | | | | |
| Performance of Detection of spam in email is evaluated based on different algorithms and constraints. Even though this author compared various results upon validating the test data and trained data using machine learning with all supervised and Lazy learning algorithms.   |  | **Process Steps** | **Advantage** | **Disadvantage (Limitation)** | | --- | --- | --- | --- | | **1** | System architecture is a bit complicated having two modules Pre-processing and RAN-LSH classifier is adopted. | Incremental learning for monitoring malicious spam mails is conducted quickly and accuracy is also high on this aspect. | Performance is not yet compared with other algorithms. Need to confirm whether this incremental learning is available in a quick access system to avoid the latency of mail delivery. | | **2** | Classifier separates the spam emails including online cyber security. Incremental learning feature enables reliable spam detection. | The algorithm that would be most appropriate for segregating spam emails from good emails is binary classification | There is always a risk of false positives and negatives. False positives can cause you to miss important messages, while false negatives can expose you to unwanted or harmful messages. | | **3** | Incremental Outlier detection separates the odd malicious mails. | it helps to identify unusual behavior or events that can lead to significant losses or failures. | It is not always the same LOF score that determines whether a point is an outlier or not | | | | | | | | |
| **Major Impact Factors in this Work** | | | | | | | |
| | **Dependent Variable** | **Independent Variable** | **Moderating variable** | **Mediating (Intervening) variable** | | --- | --- | --- | --- | | Species-level classification accuracy in camera trapping data. | YOLOv5-based AI model. | Sample size of training data. | Hyperparameter tuning and model  training process. | | | | | | | | |
| | **Relationship Among the Above 4 Variables in This article** | | --- | | The independent variable (YOLOv5-based AI model) directly affects the dependent variable (species-level classification accuracy), with the moderating variable (sample size of training data) influencing this relationship, and the mediating variable (hyperparameter tuning and model training) acting as an intermediary in determining classification accuracy. | | | | | | | | |
| **Input and Output** | | | **Feature of This Solution** | | | | **Contribution & The Value of This Work** |
| | **Input** | **Output** | | --- | --- | | Camera trap images | Species-level | | | | Implementation of a YOLOv5-based AI model for automated mammal species recognition in camera trap images. | | | | This work provides a cost-effective and efficient solution for automating wildlife monitoring and conservation efforts, with the potential to enhance the management of mammalian populations. |
| **Positive Impact of this Solution in This Project Domain** | | | | | **Negative Impact of this Solution in This Project Domain** | | |
| Enhanced efficiency in wildlife monitoring, potentially leading to better conservation and population management outcomes. | | | | | Potential misclassification or inaccuracies in species recognition, especially for species with limited training data, which may affect the reliability of monitoring results. | | |
| **Analyze This Work by Critical Thinking** | | | | **The Tools That Assessed this Work** | | | **What is the Structure of this Paper** |
| Addressing the need for efficient wildlife monitoring using AI technology. It showcases the | | | | tools used to assess it likely involve image recognition accuracy metrics and evaluation of | | | 1. Introduction 2. Materials and Methods 3. Results and Discussion 4. Materials and Methods 5. Results and Discussion 6. Conclusions, and supplementary information |
| **Diagram/Flowchart** | | | | | | | |
|  | | | | | | | |

| **15** |
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| **Reference in APA format** | | AI System to Protect Endangered Animal Population and Prevent Poaching Threats using Weapon Detection | | | | | |
| **URL of the Reference** | | **Authors Names and Emails** | | | | **Keywords in this Reference** | |
| https://[www.researchgate.net/profile/Sac](http://www.researchgate.net/profile/Sac) hini- Kuruppu/publication/374328611\_AI\_Syste m\_to\_Protect\_Endangered\_Animal\_Popul ation\_and\_Prevent\_Poaching\_Threats\_usi ng\_Weapon\_Detection/links/65184f791e2  386049debeab3/AI-System-to-Protect- | | Sachini Kuruppu ,Sri Lanka Institute of Information Technology | | | | Illegal Wildlife Trade, Yolov5, Camera Traps,Long Range (LoRa) technology, Raspberry, detecting weapons. | |
| **The Name of the Current Solution (Technique/ Method/ Scheme/ Algorithm/ Model/ Tool/ Framework/etc)** | | **The Goal (Objective) of this Solution & What is the problem that need to be solved** | | | | **What are the components of it?** | |
| The current solution proposed is an AI- based anti-poaching system utilizing camera traps, YOLOv5 object detection, and LoRa technology with Raspberry Pi 4 to detect poachers carrying concealed weapons in real-time, enhancing wildlife protection efforts. | | The goal of this solution is to protect endangered animal populations and prevent poaching threats by using an AI-based system to detect concealed weapons carried by poachers in high-density forest areas. | | | | The components of the solution include camera traps, the YOLOv5 object detection algorithm, Long Range (LoRa) technology, and Raspberry Pi 4 for real-time detection of concealed weapons used by poachers in forest areas. | |
| **The Process (Mechanism) of this Work; Means How the Problem has Solved & Advantage & Disadvantage of Each Step in This Process** | | | | | | | |
| Performance of Detection of spam in email is evaluated based on different algorithms and constraints. Even though this author compared various results upon validating the test data and trained data using machine learning with all supervised and Lazy learning algorithms.   |  | **Process Steps** | **Advantage** | **Disadvantage (Limitation)** | | --- | --- | --- | --- | | **1** | Camera Traps | Camera traps provide continuous monitoring and data collection. | Initial setup and maintenance of camera traps can be resource-intensive. | | **2** | Data Collection | Real-time data collection enables prompt analysis. | Limited internet connectivity in remote areas may lead to data transfer delays. | | **3** | YOLOv5 Object Detection | YOLOv5 is efficient and lightweight, making it | Accuracy can be affected by challenging | | **4** | Alert Generation | Park rangers can respond promptly to potential poaching incidents. | Park rangers can respond promptly to potential poaching incidents. | | **5** | Alert Transmission | LoRa technology ensures long-range communication in areas with limited internet connectivity. | Interference or signal loss can occur in challenging terrains. | | **6** | Park Ranger Response | Rapid response can deter poachers and protect endangered species. | The effectiveness of the response depends on the proximity and availability of park rangers. | | | | | | | | |
| **Major Impact Factors in this Work** | | | | | | | |
| | **Dependent Variable** | **Independent Variable** | **Moderating variable** | **Mediating (Intervening) variable** | | --- | --- | --- | --- | | Poaching incidents (frequency and impact). | Implementation of the AI-based anti-poaching system. | Geographical location and environmental conditions affecting system performance. | Prompt response time by park rangers to detect threats. | | | | | | | | |
| **Input and Output** | | | **Feature of This Solution** | | | | **Contribution & The Value of This Work** |
| | **Input** | **Output** | | --- | --- | | Real-time video data from camera traps. | Alerts to park rangers regarding potential poaching threats, including the date, time, and location of the detected incidents. | | | | Real-time weapon detection, low-cost hardware (Raspberry Pi), LoRa technology for remote areas, and YOLOv5 object detection for efficiency. | | | | This work contributes to wildlife conservation by providing an innovative, cost-effective, and real- time solution to combat poaching, protecting endangered species and the lives of park rangers. |
| **Positive Impact of this Solution in This Project Domain** | | | | | **Negative Impact of this Solution in This Project Domain** | | |
| Enhanced wildlife protection, reduced poaching incidents, and increased biodiversity conservation. | | | | | Possible false alarms or delayed responses that may undermine system trustworthiness and effectiveness. | | |
| **Analyse This Work by Critical Thinking** | | | | **The Tools That Assessed this Work** | | | **What is the Structure of this Paper** |
| The work addresses a critical issue with innovative technology but may face challenges in real-world implementation, including potential false alarms and the need for reliable internet connectivity in remote areas. | | | | The paper utilizes AI-based technology, camera traps, YOLOv5, Raspberry Pi, and LoRa technology to address the problem of poaching. | | | The paper follows a structured format, including an abstract, literature review, problem identification, proposed solution, research gap, methodology, and the potential positive impact on wildlife conservation. |
| **Diagram/Flowchart** | | | | | | | |
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| **16** |
| --- |
| **Reference in APA format** | | Shreya Kakhandiki “Poacher Activity Detection Device for Wildlife Conservation” 2022 Terra Science and Education, DOI: 10.36838/v4i5.17 | | | | | |
| **URL of the Reference** | | **Authors Names and Emails** | | | | **Keywords in this Reference** | |
| https://terra-docs.s3.us-east-2.amazonaws.com/IJHSR/Articles/volume4-issue5/2022\_45\_p102\_Kakhandiki.pdf | | Shreya Kakhandiki | | | | Ecology, Camera Trap , Poacher Detection, Wildlife Conservation , Artificial Intelligence , Machine Learning, Facial Recognition , Raspberry pi | |
| **The Name of the Current Solution (Technique/ Method/ Scheme/ Algorithm/ Model/ Tool/ Framework/etc)** | | **The Goal (Objective) of this Solution & What is the problem that need to be solved** | | | | **What are the components of it?** | |
| To provide a device which is low-cost ,open platform for wildlife conservation | | The main goal is to develop a low-cost and scalable wildlife monitoring device to prevent poaching which poses a threat to both animals and park rangers. | | | | Raspberry pi Computer, s small solar power bank, a camera , infrared motion sensor, a GPRS modem | |
| **The Process (Mechanism) of this Work; Means How the Problem has Solved & Advantage & Disadvantage of Each Step in This Process** | | | | | | | |
| Performance of Detection of spam in email is evaluated based on different algorithms and constraints. Even though this author compared various results upon validating the test data and trained data using machine learning with all supervised and Lazy learning algorithms.   |  | **Process Steps** | **Advantage** | **Disadvantage (Limitation)** | | --- | --- | --- | --- | | **1** | Taking a photo using camera when motion sensor is triggered | The device is equipped with a GSM/GPRS/GNSS modem, providing connectivity options | Significant cost associated with traditional methods of patrolling and monitoring wilderness areas | | **2** | Analysing it to detect the presence of animals, humans and weapons. | Raspberry pi offers optimized performance and functionality | Human patrolling in wilder areas is high risk factor | | **3** | Further analyze to classify animal species and determine if human is park ranger or unknown | Low cost ,small size , low power consumption | Lack of modular and replaceable components adds to high maintenance expenses. | | **4** | Setting up alert level on detected threats | The device has the ability to run on natural renewable power sources such as solar panels | The emergency alert systems in India are not able to provide accurate and timely information on the location, magnitude, intensity, and impact of the disasters | | | | | | | | |
| **Major Impact Factors in this Work** | | | | | | | |
| | **Dependent Variable** | **Independent Variable** | **Moderating variable** | **Mediating (Intervening) variable** | | --- | --- | --- | --- | | Classification of animals, humans, weapons in the photos taken by the camera | Raspberry pi as a device’s computer , motion infrared sensor, GPRS modem | There is no specific moderating variable. | There is no specific mediating variable. | | | | | | | | |
| | **Relationship Among the Above 4 Variables in This article** | | --- | | As inputs are taken from the device which further helps for the detection and classification | | | | | | | | |
| **Input and Output** | | | **Feature of This Solution** | | | | **Contribution & The Value of This Work** |
| | **Input** | **Output** | | --- | --- | | Infrared camera, GPRS modem ,motion sensor | Detection and classification | | | | The main feature of this solution is algorithm design, alert rules and performance testing. | | | | The main aim is to address wildlife poaching through development of a low-cost device that can detect and alert officials which are also deployed in many geographical regions, allowing for increased monitoring and protection of wildlife. |
| **Positive Impact of this Solution in This Project Domain** | | | | | **Negative Impact of this Solution in This Project Domain** | | |
| By developing a low-cost, scalable device that can detect and alert authorities which is over 90% accurate in recognising humans, weapons, animals and generated notifications. | | | | | There is no specific negative impact because it highlights challenges and risks associated with poaching, endangerment of animal species, safety of rangers. | | |
| **Analyse This Work by Critical Thinking** | | | | **The Tools That Assessed this Work** | | | **What is the Structure of this Paper** |
| **Diagram/Flowchart** | | | | | | | |
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| **17** |
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| **Reference in APA format** | | Sachini Kuruppu “AI System to Protect Endangered Animal Population and Prevent Poaching Threats using Weapon Detection” Volume 8, Issue 9, September 2023, International Journal of Innovative Science and Research Technology ISSN No:-2456-2165 | | | | | |
| **URL of the Reference** | | **Authors Names and Emails** | | | | **Keywords in this Reference** | |
| https://scholar.google.co.in/scholar?q=poaching+detection+in+forest+using+deep+learning+2023&hl=en&as\_sdt=0&as\_vis=1&oi=scholart | | Sachini Kuruppu | | | | Illegal Wildlife Trade, Yolo v5, Camera Traps , Long Range(LoRa ) Technology, Raspberry, detecting weapons | |
| **The Name of the Current Solution (Technique/ Method/ Scheme/ Algorithm/ Model/ Tool/ Framework/etc)** | | **The Goal (Objective) of this Solution & What is the problem that need to be solved** | | | | **What are the components of it?** | |
| Automated weapon detection system | | Protect endangered animals from poaching which includes illegal exploitation | | | | Camera Traps, LoRa technology, Raspberry Pi 4 , YOLOv5 object | |
| **The Process (Mechanism) of this Work; Means How the Problem has Solved & Advantage & Disadvantage of Each Step in This Process** | | | | | | | |
| Performance of Detection of spam in email is evaluated based on different algorithms and constraints. Even though this author compared various results upon validating the test data and trained data using machine learning with all supervised and Lazy learning algorithms.   |  | **Process Steps** | **Advantage** | **Disadvantage (Limitation)** | | --- | --- | --- | --- | | **1** | Data Collection: camera traps are used to collect real-time videos from forest areas. | Enhanced Wildlife Protection as it includes endangered species | LoRa technology is used which is suitable for remote forest areas with low internet connection. | | **2** | Weapon Detection: using YOLOv5 weapons are detected specifically guns used by poachers | Sends alerts to park-rangers in real-time when suspicious activity detected | Totally dependent on cameras, so they should functions properly | | **3** | Data Pre-processing: Retrieves Date, Time , Location from the videos | Efficient Resource Allocation is possible by monitoring unexplorable geographical areas. | As it uses ai technology there may be some changes in the accuracy of the data | | **4** | Alert Generation and Transmission: When weapon is detected then alert is generated and transmitted to the park rangers | It can help to deter crime. If would-be criminals know that there is a chance they will be caught before they even have a chance to commit a crime, they may be less likely to attempt one in the first place. | These technologies are not perfect and can produce false positives or negatives | | **5** | Ranger Response : After receiving the signal ranger takes immediate action and prevents poaching threats. | immediate action takes place | if there is network issue the ranger might not receive communication | | | | | | | | |
| **Major Impact Factors in this Work** | | | | | | | |
| | **Dependent Variable** | **Independent Variable** | **Moderating variable** | **Mediating (Intervening) variable** | | --- | --- | --- | --- | | Alerting park rangers about presence of poachers based on detection of weapons | Camera traps, LoRa technology ,Raspberry Pi | YOLOv5 used to detect weapons and poachers | Geographic terrain | | | | | | | | |
| | **Relationship Among the Above 4 Variables in This article** | | --- | | The effectiveness of the anti-poaching system, influenced by various independent variables like YOLOv5, serves as a mediating variable ,explaning how the detection system affects the ability to prevent illegal poaching activities. | | | | | | | | |
| **Input and Output** | | | **Feature of This Solution** | | | | **Contribution & The Value of This Work** |
| | **Input** | **Output** | | --- | --- | | Camera Traps, YOLOv5 object detection Algorithm, LoRa Technology with Raspberri Pi 4 | Real-time alerts (such as presence of weapon, fire or gunshot) | | | | Implementation of an automated weapon detection system in forest areas with high population density of endangered species. | | | | Using AI the system can monitor the presence of endangered animals and give alerts to the rangers.  The value of the work lies in its potential to significantly enhance wildlife protection and safeguard park rangers. Saves wasted time and energy spent in inefficient patrols and contributed to the conservation of endangered species. |
| **Positive Impact of this Solution in This Project Domain** | | | | | **Negative Impact of this Solution in This Project Domain** | | |
| Enhanced wildlife protection, efficient resource utilization , Real-time Alerts. | | | | | Limited Data Accuracy, Limited Awareness, Challenges in Remote Areas | | |
| **Analyze This Work by Critical Thinking** | | | | **The Tools That Assessed this Work** | | | **What is the Structure of this Paper** |
| It discusses issue of poaching and automated system to detect and prevent poaching | | | | Camera units, Raspberry pi | | | Abstract   1. Introduction 2. Research Gap 3. Methodology 4. Results 5. Conclusion and Acknowledgment 6. References |
| **Diagram/Flowchart** | | | | | | | |
|  | | | | | | | |

| **18** |
| --- |
| **Reference in APA format** | | S. Sisodia, S. Dhyani, S. Kathuria, S. Pandey, G. Chhabra and R. Pandey, "AI Technologies, Innovations and Possibilities in Wildlife Conservation," 2023 International Conference on Innovative Data Communication Technologies and Application (ICIDCA), Uttarakhand, India, 2023, pp. 1090-1095, doi: 10.1109/ICIDCA56705.2023.10099721. | | | | | |
| **URL of the Reference** | | **Authors Names and Emails** | | | | **Keywords in this Reference** | |
| https://ieeexplore.ieee.org/document/10099721 | | Shivani Sisodia shivanisisodia@uumail.in, Shweta Pandey[shwetapandey2626@gmail.com](mailto:shwetapandey2626@gmail.com), Saurabh Dhyani saurabhdhyani29@gmail.com, Gunjan Chhabra chhgunjan@gmail.com, Samta Kathuria samtakathuria14@gmail.com, Rahul Pandey rahulpandey13062000@gmail.com | | | | Artificial Intelligence, wildlife, SDGs, Machine learning, Deep learning, sensors. | |
| **The Name of the Current Solution (Technique/ Method/ Scheme/ Algorithm/ Model/ Tool/ Framework/etc)** | | **The Goal (Objective) of this Solution & What is the problem that need to be solved** | | | | **What are the components of it?** | |
| AI Technologies, Innovations and Possibilities in Wildlife Conservation | | The goal of the solution is to use Artificial Intelligence (AI) to safeguard and revive wildlife. Through AI, researchers and organizations can analyze extensive data, create ecological models, and enhance decision-making for Sustainable Development Goals (SDGs). | | | | Trends.Earth, Wildbook, Conservation Metrics, Wildlife Protection Solutions (WPS), Protection Assistant for Wildlife Security (PAWS), Archangel Imaging, Robot Predators, AI Technologies and Innovations. | |
| **The Process (Mechanism) of this Work; Means How the Problem has Solved & Advantage & Disadvantage of Each Step in This Process** | | | | | | | |
| Performance of Detection of spam in email is evaluated based on different algorithms and constraints. Even though this author compared various results upon validating the test data and trained data using machine learning with all supervised and Lazy learning algorithms.   |  | **Process Steps** | **Advantage** | **Disadvantage (Limitation)** | | --- | --- | --- | --- | | **1** | Deploying IoT sensors | Provides real-time and accurate data on animal behavior and habitat use. | Initial deployment costs and potential technical challenges in maintaining sensors in remote areas. | | **2** | Data collection | Enables comprehensive and continuous monitoring of wildlife. | Dependence on reliable connectivity for transmitting data and potential data overload. | | **3** | Data processing | Efficient extraction of valuable insights through AI, enhancing data interpretation. | Requires skilled personnel for algorithm development and may face challenges in handling diverse data sets. | | **4** | Analysis and visualization | Facilitates a clearer understanding of ecological patterns for informed decision-making. | Interpretation may be subjective, and visualization tools may require technical expertise. | | **5** | Decision-making | Informed decisions for wildlife conservation based on analyzed and visualized data. | Potential resistance to adopting AI-driven insights and decisions may still require human judgment. | | | | | | | | |
| **Major Impact Factors in this Work** | | | | | | | |
| | **Dependent Variable** | **Independent Variable** | **Moderating variable** | **Mediating (Intervening) variable** | | --- | --- | --- | --- | | Data Collection, Data Processing, Decision Making | Movement of Animals and change in their behavior | Machine Learning, Model Building | Ethical Considerations and Collaborations | | | | | | | | |
| | **Relationship Among the Above 4 Variables in This article** | | --- | | The major impact factors in this work include the collection and processing of data which depends on the behavior of the animals and any other collaborations may change in model building to reach the goal. | | | | | | | | |
| **Input and Output** | | | **Feature of This Solution** | | | | **Contribution & The Value of This Work** |
| | **Input** | **Output** | | --- | --- | | Information on animal behavior | Insights on animal behavior | | | | This project uses AI to address challenges such as deforestation, biodiversity decline, invasive species, and wildlife trafficking. The main objective is to support SDG 15, focusing on land-based life, by using AI to inform effective policies and actions for wildlife conservation. | | | | It reviews existing research works and provides insights into the use of AI and Industry 4.0 in wildlife conservation. Additionally, it discusses challenges and suggestions for future research in this field. |
| **Positive Impact of this Solution in This Project Domain** | | | | | **Negative Impact of this Solution in This Project Domain** | | |
| The Solution highlights that AI can speed up efforts to reach Sustainable Development Goals (SDGs) and safeguard wildlife. By utilizing AI technologies, such as machine learning, deforestation rates can be predicted and poaching activities can be detected and prevented. | | | | | It mentions the need to explore the harmful impacts of certain technologies on the Sustainable Development Goals (SDGs) and the importance of building more responsible AI and industry 4.0. It also acknowledges the challenges of implementing AI models, training data, and data security | | |
| **Analyse This Work by Critical Thinking** | | | | **The Tools That Assessed this Work** | | | **What is the Structure of this Paper** |
| The study highlights the use of AI technologies in wildlife conservation and provides insights into how these technologies can help achieve sustainable development goals. It also discusses the challenges and future prospects of AI in this field. The study aims to provide guidance to researchers and organizations interested in using AI for wildlife conservation. | | | | Drones, Camera-Traps, GPS Collars, IoT, Robot Predators | | | Abstract   1. Introduction 2. Overview of AI 3. AI in Wildlife 4. Challenges 5. Suggestions 6. Conclusions |
| **Diagram/Flowchart** | | | | | | | |
| https://lh7-us.googleusercontent.com/AcfRx_zED9QxgOEfF4ACd_DnO5-r5_GhpAM39xhZwUG6_-i5VFEgOxr8AARt7CewRiwmISY5smJGmG78wYu9pq6Yts3BSnstY8zySID_E5zYSN_YuUywJnjlrS3mLs9G--97zeuBLStOeurnllnAbys | | | | | | | |

| **19** |
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| **Reference in APA format** | | Aarju, R. Bahuguna, S. Pandey, R. Singh, H. Kaur and G. Chhabra, "Enabling Technologies for Wildlife Conservation," 2023 IEEE Devices for Integrated Circuit (DevIC), Kalyani, India, 2023, pp. 217-220, doi: 10.1109/DevIC57758.2023.10134561 | | | | | |
| **URL of the Reference** | | **Authors Names and Emails** | | | | **Keywords in this Reference** | |
| https://ieeexplore.ieee.org/document/10226093 | | Aarju aarjujangra2003@gmail.com, Rajesh drrajeshsingh004@gmail.com, Rajesh  deanlaw@uttaranchaluniversity.ac.in, Hardeep Kaur hardeepjhajj@gmail.com, Shweta Pandey shwetapandey2626@gmail.com, Gunjan Chhabra chhgunjan@gmail.com | | | | convolutional neural networks, deep learning and machine learning algorithms, radio tracking, robotic aircrafts, wildlife conservation | |
| **The Name of the Current Solution (Technique/ Method/ Scheme/ Algorithm/ Model/ Tool/ Framework/etc)** | | **The Goal (Objective) of this Solution & What is the problem that need to be solved** | | | | **What are the components of it?** | |
| Enabling Technologies for Wildlife Conservation | | The goal of the solution is to utilize Artificial Intelligence (AI) and drone technology for the protection and conservation of wildlife. This involves implementing new technologies and innovations, such as cloud computing and IoT, to monitor and track endangered species. | | | | Conservation Drones, Cloud Computing, Artificial Intelligence | |
| **The Process (Mechanism) of this Work; Means How the Problem has Solved & Advantage & Disadvantage of Each Step in This Process** | | | | | | | |
| Performance of Detection of spam in email is evaluated based on different algorithms and constraints. Even though this author compared various results upon validating the test data and trained data using machine learning with all supervised and Lazy learning algorithms.   |  | **Process Steps** | **Advantage** | **Disadvantage (Limitation)** | | --- | --- | --- | --- | | **1** | Data Collection | It helps to gather detailed information about how animals move and migrate in different areas. | Using high-tech sensors and drones can be expensive and complicated, making it challenging to do in some places that don't have many resources. | | **2** | Machine Learning and AI | It divides the dataset into training data and testing data. | It needs a lot of computer power and knowledge, which might be hard for some people or places to get. | | **3** | Animal Detection and Counting | This helps in figuring out where animal groups are and is useful for stopping illegal activities and protecting their homes. | The computer programs for finding and counting animals might not always be perfect, especially if the animals look similar or are in tricky environments. | | **4** | Cloud Computing and IoT | This helps experts identify species that need extra care and come up with practical solutions. | Relying on online technology might not work well in areas with no internet, making it difficult to keep an eye on endangered species in certain places. | | **5** | Automated Monitoring Systems | This helps prevent problems between humans and animals and gives early warnings about illegal activities or natural disasters. | Setting up and maintaining smart systems to watch animals can cost a lot, and if they break or have problems, it might be hard to fix them quickly. | | **6** | Conservation Drones | They're really helpful for keeping track of wildlife. | Using drones with autopilot systems can have rules and restrictions, and people might worry about their privacy. It's also important to make sure the drones don't cause harm or disturbance to wildlife. | | **7** | Artificial Intelligence in Wildlife Conservation | They help experts watch over these animals, guard them from dangers, and create good rules to keep them safe. | It's essential to make sure Artificial Intelligence is fair and accurate. | | | | | | | | |
| **Major Impact Factors in this Work** | | | | | | | |
| | **Dependent Variable** | **Independent Variable** | **Moderating variable** | **Mediating (Intervening) variable** | | --- | --- | --- | --- | | Drone Technology and Artificial Intelligence | Climate Change | Data Processing and Analysis | Emerging technologies, Industrialization and Innovation | | | | | | | | |
| | **Relationship Among the Above 4 Variables in This article** | | --- | | These factors collectively contribute to the implementation of Artificial Intelligence and drone technology in wildlife conservation and shape the limitations, suggestions, and concluding remarks of the work. | | | | | | | | |
| **Input and Output** | | | **Feature of This Solution** | | | | **Contribution & The Value of This Work** |
| | **Input** | **Output** | | --- | --- | | Image Dataset | Analysis of animal patterns | | | | Using cloud computing, drones, and artificial intelligence has changed how we protect wildlife. These technologies help us monitor and understand species accurately. | | | | The paper talks about using AI and drones to protect wildlife. It looks at different methods like radio tracking, GPS, and drones for monitoring animals. |
| **Positive Impact of this Solution in This Project Domain** | | | | | **Negative Impact of this Solution in This Project Domain** | | |
| Enhanced wildlife protection, reduced poaching incidents, and increased biodiversity conservation. | | | | | Possible false alarms or delayed responses that may undermine system trustworthiness and effectiveness. | | |
| **Analyse This Work by Critical Thinking** | | | | **The Tools That Assessed this Work** | | | **What is the Structure of this Paper** |
| The work addresses a critical issue with innovative technology but may face challenges in real-world implementation, including potential false alarms and the need for reliable internet connectivity in remote areas. | | | | The paper utilizes AI-based technology, camera traps, YOLOv5, Raspberry Pi, and LoRa technology to address the problem of poaching. | | | The paper follows a structured format, including an abstract, literature review, problem identification, proposed solution, research gap, methodology, and the potential positive impact on wildlife conservation. |
| **Diagram/Flowchart** | | | | | | | |
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| **20** |
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| **Reference in APA format** | | A First Step Towards Automated Species Recognition from Camera Trap Images of Mammals Using AI in a European Temperate Fores | | | | | |
| **URL of the Reference** | | **Authors Names and Emails** | | | | **Keywords in this Reference** | |
| https://link.springer.com/chapter/10.1007  /978-3-030-84340-3\_24 | | Mateusz Choiński, Mateusz Rogowski, Piotr Tynecki, Dries P. J. Kuijper, Marcin Churski & Jakub W. Bubnicki | | | | Computer vision ,Deep learning,YOLOv5,Camera trap,TRAPPER ,Wildlife | |
| **The Name of the Current Solution (Technique/ Method/ Scheme/ Algorithm/ Model/ Tool/ Framework/etc)** | | **The Goal (Objective) of this Solution & What is the problem that need to be solved** | | | | **What are the components of it?** | |
| System architecture is a bit complicated having two modules Pre-processing and RAN-LSH classifier is adopted. | | Incremental learning for monitoring malicious spam mails is conducted quickly and accuracy is also high on this aspect. | | | | Performance is not yet compared with other algorithms. Need to confirm whether this incremental learning is available in a quick access system to avoid the latency of mail delivery. | |
| **The Process (Mechanism) of this Work; Means How the Problem has Solved & Advantage & Disadvantage of Each Step in This Process** | | | | | | | |
| Performance of Detection of spam in email is evaluated based on different algorithms and constraints. Even though this author compared various results upon validating the test data and trained data using machine learning with all supervised and Lazy learning algorithms.   |  | **Process Steps** | **Advantage** | **Disadvantage (Limitation)** | | --- | --- | --- | --- | | **1** | System architecture is a bit complicated having two modules Pre-processing and RAN-LSH classifier is adopted. | System architecture is a bit complicated having two modules Pre-processing and RAN-LSH classifier is adopted. | System architecture is a bit complicated having two modules Pre-processing and RAN-LSH classifier is adopted. | | **2** | Classifier separates the spam emails including online cyber security. Incremental learning feature enables reliable spam detection. | Classifier separates the spam emails including online cyber security. Incremental learning feature enables reliable spam detection. | Classifier separates the spam emails including online cyber security. Incremental learning feature enables reliable spam detection. | | **3** | Incremental Outlier detection separates the odd malicious mails. | Incremental Outlier detection separates the odd malicious mails. | Incremental Outlier detection separates the odd malicious mails. | | | | | | | | |
| **Major Impact Factors in this Work** | | | | | | | |
| | **Dependent Variable** | **Independent Variable** | **Moderating variable** | **Mediating (Intervening) variable** | | --- | --- | --- | --- | | Species-level classification accuracy  in camera trapping data. | YOLOv5-based AI model. | Sample size of training data. | Hyperparameter tuning and model  training process. | | | | | | | | |
| | **Relationship Among the Above 4 Variables in This article** | | --- | | The independent variable (YOLOv5-based AI model) directly affects the dependent variable (species-level classification accuracy), with the moderating variable (sample size of training data) influencing this relationship, and the mediating variable (hyperparameter tuning and model training) acting as an intermediary in determining classification accuracy. | | | | | | | | |
| **Input and Output** | | | **Feature of This Solution** | | | | **Contribution & The Value of This Work** |
| | **Input** | **Output** | | --- | --- | | Camera trap images | Species-level | | | | Using cloud computing, drones, and artificial intelligence has changed how we protect wildlife. These technologies help us monitor and understand species accurately. | | | | The paper talks about using AI and drones to protect wildlife. It looks at different methods like radio tracking, GPS, and drones for monitoring animals. |
| **Positive Impact of this Solution in This Project Domain** | | | | | **Negative Impact of this Solution in This Project Domain** | | |
| Enhanced efficiency in wildlife monitoring, potentially leading to better conservation and population management outcomes. | | | | | Potential misclassification or inaccuracies in species recognition, especially for species with limited training data, which may affect the reliability of monitoring results. | | |
| **Analyse This Work by Critical Thinking** | | | | **The Tools That Assessed this Work** | | | **What is the Structure of this Paper** |
| Addressing the need for efficient wildlife monitoring using AI technology. It showcases the authors' scientific rigor in data collection, model selection, and methodology, while also acknowledging limitations and suggesting areas for future improvement, indicating a thoughtful approach to ecological research and conservation. | | | | tools used to assess it likely involve image recognition accuracy metrics and evaluation of | | | 1. Introduction 2. Materials and Methods 3. Results and Discussion 4. Conclusions, and supplementary information. |
| **Diagram/Flowchart** | | | | | | | |
|  | | | | | | | |

**2.2 Comparison Table**

| **Author** | ***Year*** | ***Approach*** | ***Description*** |
| --- | --- | --- | --- |
| Jamali.F Banzi | 2014 | Sensor-based anti-poaching System | Developing a sophisticated technology system for anti-poaching and protecting endangered species. |
| T. A. S. Achala Perera and J. Collins | 2015 | Eigenface technique | Commonly used in human face recognition and applied in research papers for species recognition. Creating a set of animal images and normalizing them by subtracting the mean from the animal faces to obtain mean-shifted images. |
| T. Sarma and V. Baruah | 2015 | Digital Signal Processing | The system is designed to determine the distance between sensor position, and the sound source, aiding in the capture of poachers and providing medical aid to injured animals. |
| Christensen, David R | 2016 | Camera-Trap Methodology | It allows increased sampling, which can capture and expose trends in wildlife abundance and behavior. |
| H. Nguyen et al | 2017 | Deep learning, convolutional neural networks, large-scale image classification, animal recognition and wildlife monitoring. | We created an automated wildlife monitoring system using a dataset from the Wildlife Spotter project, contributed by citizen scientists. Using advanced neural networks, our system filters and identifies animal species in the wild. |
| Mohammad Sadegh Norouzzadeha, Anh Nguyenb, Margaret Kosmalac, Alexandra Swansond, Meredith S. Palmere,Craig Packere, and Jeff Clunea,f,1 | 2018 | Artificial intelligence and camera-trap images and deep learning neural networks. | The solution utilizes deep neural networks (DNNs) to automatically extract features from raw data, such as images taken from camera traps. |
| D.Mahatara1\*, S. Rayamajhi2 andG. Khanal3 | 2018 | SMART patrolling | The Findings of this study can be used to inform policy decisions and improve the effectiveness of anti-poaching efforts in other rhino conservation areas. |
| S. B. Islam and D. Valles | 2020 | CNN, image classification, species recognition, camera traps, and wildlife monitoring. | The solution aims to automate data analysis in computer vision tasks, particularly in detecting and classifying animal species. Using deep learning methods and CNNs, the solution can manage difficult images and extract important features for precise species identification. |
| [Mateusz Choiński](https://link.springer.com/chapter/10.1007/978-3-030-84340-3_24#auth-Mateusz-Choi_ski), [Mateusz Rogowski](https://link.springer.com/chapter/10.1007/978-3-030-84340-3_24#auth-Mateusz-Rogowski), [Piotr Tynecki](https://link.springer.com/chapter/10.1007/978-3-030-84340-3_24#auth-Piotr-Tynecki), [DriesP.J.Kuijper](https://link.springer.com/chapter/10.1007/978-3-030-84340-3_24#auth-Dries_P__J_-Kuijper),[Marcin Churski & Jakub](https://link.springer.com/chapter/10.1007/978-3-030-84340-3_24#auth-Marcin-Churski)[. Bubnicki](https://link.springer.com/chapter/10.1007/978-3-030-84340-3_24#auth-Jakub_W_-Bubnicki) | 2021 | Computer vision, Deep learning, YOLOv5, Camera trap, TRAPPER , Wildlife | The goal of this solution is to automate the object detection and species-level classification in camera trapping data to improve wildlife monitoring and conservation efforts, addressing the challenge of efficiently processing vast 20 amounts of multimedia data to secure mammal populations and minimize conflicts with humans. |
| S.V.Viraktamath, J. R, V. A, A. S. Bhat and S. Nayak | 2022 | Animal Detection, object detection, image processing, computer vision, convolutional neural networks. | The suggested approach for animal classification and detection relies on deep convolutional neural networks (CNN). The solution integrates crucial computer vision and image processing techniques, which attain a high accuracy rate, capable of automatically extracting, learning, and classifying features from animal images. |
| Shreya Kakhandiki | 2022 | Image classification algorithms | To address wildlife poaching through the development of a low-cost device that can detect and alert officials which is also deployed in many geographical regions, allowing for increased monitoring and protection of wildlife |
| S. Minaee, Y. Boykov, F. Porikli, A. Plaza, N. Kehtarnavaz and D. Terzopoulos | 2022 | Image segmentation, Computer architecture, Semantics, Deep Learning, Computational modeling, Generative adversarial networks, Logic gates. | Image segmentation, vital in computer vision and processing, has diverse applications including scene understanding, medical analysis, robotics, surveillance, augmented reality, and compression. Various segmentation algorithms exist in the literature. |
| [Juliana Vélez](https://besjournals.onlinelibrary.wiley.com/authored-by/V%C3%A9lez/Juliana), [William McShea](https://besjournals.onlinelibrary.wiley.com/authored-by/McShea/William), [Hila Shamon](https://besjournals.onlinelibrary.wiley.com/authored-by/Shamon/Hila), [Paula J. Castiblanco-Camacho](https://besjournals.onlinelibrary.wiley.com/authored-by/Castiblanco%E2%80%90Camacho/Paula+J.), [Michael A. Tabak](https://besjournals.onlinelibrary.wiley.com/authored-by/Tabak/Michael+A.), [Carl Chalmers](https://besjournals.onlinelibrary.wiley.com/authored-by/Chalmers/Carl), [Paul Fergus](https://besjournals.onlinelibrary.wiley.com/authored-by/Fergus/Paul), [John Fieberg](https://besjournals.onlinelibrary.wiley.com/authored-by/Fieberg/John) | 2022 | Camera Traps, Artificial Intelligence (AI), MegaDetector, MLWIC2: Machine Learning | Offering the application of artificial intelligence (AI) and deep learning algorithms for processing camera trap image data. This solution involves using AI to perform tasks such as image classification, object detection, species identification, and data processing in ecological research. |
| T.A. de Lorm1, C. Horswill2,3,4, D. Rabaiotti2,3, R.M. Ewers1, R. J. Groom2,5, J. Watermeyer5, R. Woodroffe2,3 | 2023 | automated individual recognition, Hotspotter, I3S-pattern, Lycaon pictus, photographic identification, Wild-ID | Developing a framework that automates the selection of suitable images for individual identification and comparing the performance of three identification software packages i.e Hotspotter, I3SPattern, and WildID |
| S. Sisodia, S. Dhyani, S. Kathuria, S. Pandey, G. Chhabra and R. Pandey | 2023 | Artificial Intelligence, wildlife, SDGs, Machine learning, Deep learning, sensors. | This project uses artificial intelligence to address issues such as deforestation, biodiversity loss, invasive species, and wildlife trafficking. The major goal is to assist SDG 15, which focuses on land-based life, by applying AI to inform successful wildlife conservation policies and initiatives. |
| Sachini Kuruppu | 2023 | Object Detection Algorithm, LoRa Technology | Using AI the system can monitor the presence of endangered animals and give alerts to the rangers. |
| M. Mangaleswaran and M. Azhagiri | 2023 | Deep Learning, Animal Detection, Convolutional Neural Network, Thermal Images, Classification. | The system employs image processing techniques such as feature extraction, detection, and classification to accurately identify and categorize animals. The goal of the solution is to reduce animal-vehicle accidents and conflicts, protect agriculture and human lives from animal predation, and track and detect animal activities for wildlife management and biodiversity preservation. |
| Aarju, R. Bahuguna, S. Pandey, R. Singh, H. Kaur and G. Chhabra | 2023 | convolutional neural networks, deep learning, and machine learning algorithms, radio tracking, robotic aircraft, wildlife conservation | Using cloud computing, drones, and artificial intelligence has changed how we protect wildlife. These technologies help us monitor and understand species accurately. |

**2.3 Work Evaluation Table**

| **Author Name and Year** | **Work Goal** | **System's Components** | **System's Mechanism** | **Features /Characteristics** | **Advantages** | **Limitations /Disadvantages** | **Results** |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Dr S. V. Viraktamath,  Jahnavi R , Vidya,  Abhay S Bhat\*, Sathvik Nayak** | The goal is to employ a CNN algorithm for precise animal detection and classification in digital images, thereby improving animal classification accuracy. | The Convolutional Neural Network to detect and classify animals in digital images and also Deep learning in computer vision has been built and developed through time. | The camera traps and acoustic sensors are used to collect image datasets from the ecosystem and using the given technology we classify and detect patterns which give us our output. | The proposed animal classification and detection method employs deep CNNs, integrating computer vision and image processing techniques to achieve high accuracy in automatically extracting, learning, and classifying features from animal images. | Utilizing CNNs in this project enhances classification accuracy, streamlines manual efforts, and facilitates the creation of an automated animal recognition system. | The proposed project offers benefits in animal detection and classification but faces limitations such as environmental concerns, scope constraints, accuracy issues, ethical dilemmas, and the necessity for a balanced wildlife conservation approach. | The document outlines a research project utilizing Convolutional Neural Networks for animal detection and classification in digital images, achieving a 64% accuracy with 50x50 image sizes. |
| **S. Sisodia, S. Dhyani, S. Kathuria, S. Pandey, G. Chhabra and R. Pandey** | The goal is to use Artificial Intelligence (AI) to analyze data and create ecological models for safeguarding and reviving wildlife in support of Sustainable Development Goals (SDGs). | Trends.Earth, Wildbook, Conservation Metrics, Wildlife Protection Solutions (WPS), Protection Assistant for Wildlife Security (PAWS), Archangel Imaging, Robot Predators, AI Technologies and Innovations | The major impact factors in this work include the collection and processing of data which depends on the behavior of the animals and any other collaborations may change in model building to reach the goal. | This AI project aims to combat deforestation, biodiversity loss, invasive species, and wildlife trafficking to support Sustainable Development Goal 15 by informing conservation policies and actions. | AI technologies like machine learning accelerate progress towards Sustainable Development Goals (SDGs) by predicting deforestation rates and detecting/preventing poaching activities to safeguard wildlife. | The document emphasizes investigating tech's negative effects on SDGs, promoting responsible AI/Industry 4.0, and addressing challenges in AI implementation and data security. | The paper synthesizes AI and Industry 4.0 applications in wildlife conservation, addressing challenges and proposing future research directions. |
| **M. Mangaleswaran and M. Azhagiri,** | The goal is to develop  a computer vision and machine learning-based solution to mitigate vehicle-animal accidents on highways by detecting animals, thereby reducing fatalities and enhancing traffic safety. | Deep Learning Methodology, Camera Traps, Image Processing, Classification Methods, Detection of Human-Wildlife Conflict and Animal-Vehicle Collisions, Object Identification and Detection, Thermal Imaging, Video Analysis | The major impact factors in this work include the application of deep learning and CNNs, addressing human-wildlife conflict and animal-vehicle collisions, image processing and dataset utilization, machine learning and deep learning applications in wildlife monitoring, and the emphasis on accuracy and performance evaluation. | The system utilizes image processing for accurate animal identification, aiming to mitigate animal-vehicle accidents, protect agriculture, and monitor wildlife for biodiversity conservation. | The solution facilitates reliable detection and categorization of wildlife, aiding in monitoring animal movements, habitat usage, population details, and mitigating human-wildlife conflicts, including animal-human conflicts and animal-vehicle collisions. | The animal detection system's inability to process infrared images could limit its effectiveness in low light or nighttime conditions, potentially impacting its overall performance. | The project employs computer vision and CNNs trained on donkeys and capybaras to detect animals and reduce vehicle-animal accidents on highways. |
| **S. B. Islam and D. Valles** | The goal is to develop a computer vision and machine learning system for analyzing camera trap images to detect, categorize, and track various animals such as snakes, lizards, and frogs. | APIs, OpenCV, HiPE Server Environment, Hardware Solution, NVIDIA Jetson Nano Developer Kit, Software Tools, Dataset Collection, Data Pre-processing, Model Architecture, Training and Testing, Species Prediction, Evaluation and Field Application. | As the device collects its input images using camera traps regardless of the changes happening in the environment. By the use of OpenCVs and Machine Learning Techniques we can classify and detect objects or images and the identification of sound signals in addition to image data. | The solution utilizes deep learning and CNNs to automate animal species detection and classification in computer vision tasks with precision. | The solution enhances species detection, automated image classification, promotes collaborative wildlife monitoring, integrates hardware and software, and utilizes high-performance computing. | The potential negative impact of using camera traps for species detection includes dealing with highly imbalanced data, which can lead to variations in model performance when applied to new locations not encountered during training. | Research aims to accurately identify and monitor endangered species while enhancing network structures for increased precision and efficiency. |
| **Aarju, R. Bahuguna, S. Pandey, R. Singh, H. Kaur and G. Chhabra** | The goal is to leverage AI, drone technology, cloud computing, and IoT for wildlife protection and conservation, focusing on monitoring and tracking endangered species. | Conservation Drones, Cloud Computing, Artificial Intelligence | These factors collectively contribute to the implementation of Artificial Intelligence and drone technology in wildlife conservation and shape the limitations, suggestions, and concluding remarks of the work. | Advancements in cloud computing, drones, and artificial intelligence are revolutionizing wildlife protection by enhancing species monitoring and understanding. | Integrating AI and drones in wildlife conservation enhances monitoring, aids conservation, introduces advanced technology, reduces environmental footprint, and provides scalable solutions for broader conservation objectives. | Challenges in the project's efficacy encompass network connectivity, data annotation, battery weight/durability, and precise object position/orientation encoding. | The paper explores the utilization of AI and drones, alongside technologies such as radio tracking and GPS, for wildlife conservation and monitoring |
| **David Christensen** | The goal is to introduce undergraduate biology students to the use of remote camera-traps in wildlife studies and provide them with meaningful examples. | Camera traps to capture wildlife data | Photographs are analyzed to measure diversity. | Allows students to learn about research design, local wildlife abundance, diversity, behavior | Allows students to gain hands-on experience with remote camera-traps. System generates meaningful data that can be used to study wildlife populations and behavior | Mainly relies on assumption , encounter rate may not accurately represent the true abundance of species. | This paper discusses how remote-camera technology enhances biology research and fosters students' development in study design, data analysis, and scientific communication. |
| **Shreya Kakhandiki** | The goal is to build a low-cost device that can be installed in wilderness areas and send real-time alerts to park officials | Raspberri Pi computer with a power bank,camera, antenna | Image Classification to detect the presence of humans, weapons,animals in photos. | The device takes about 5 minutes to run per image, is over 90% accurate in recognizing humans, weapons, animals and in text images | The device may help rangers monitor large areas and decrease poaching activity. | Highlighting challenges and risks associated with poaching, endangerment of animal species, and safety of rangers mitigates specific negative impacts. | The device successfully meets all engineering goals. |
| **D.Mahatara , S. Rayamajhi, G.Khanal** | Goal of the study was to assess the impact of anti-poaching approaches on the success of rhino conservation in Chitwan National Park, Nepal | Utilized a unified database management system called MIST | Used real-time SMART monitoring system designed by the Wildlife Conservation Society. | Patrol frequency and patrol efforts were found to be significant factors reducing the occurrence of illegal activities | It showed that the capture and jailing of Nepal’s most wanted poacher demonstrated the government’s seriousness in tackling wildlife crime. | Increased conflict between anti-poaching units and local communities highlights limited generalizability to other conservation areas. | Increasing usage of patrol frequency and patrol efforts were significant in reducing the occurrence of illegal activities |
| **Jamali Firmat Banzi** | The main goal is to develop a sensor-based anti-poaching system in Tanzania National Parks to combat poaching activities | Is consists of MBS and sensor fusion technology (visual , infrared camera and GPS | The system works continuously collecting data about location of animal groups using GPS | Cost-effective , easily adoptable to current anti-poaching systems | Cost-effective , easily adoptable to current anti-poaching systems | Wide-range of poacher detection, ability to reveal more knowledge about animal behavior | Creating a cutting-edge anti-poaching technology system to safeguard endangered species, promoting wildlife preservation and ecological balance. |
| **Sachini Kuruppu** | The goal is to protect endangered animal populations and prevent poaching threats | Camera traps, YOLOv5 object detection algorithm and LoRa technology with Raspberry pi | Detects presence of weapons from camera footage, retrives date, time and location alerts park rangers | Raspberry pi 4 is used due to its faster processor , larger RAM , more USB ports | Saves energy and time spent by wildlife rangers | Limited Data Accuracy, Limited Awareness, Challenges in Remote Areas | AI-driven systems enhance wildlife protection by monitoring endangered animal presence, alerting rangers, and conserving resources, ultimately safeguarding both wildlife and park personnel. |
| **Juliana Vélez, William McShea, Hila Shamon, Paula J. Castiblanco-Camacho, Michael A. Tabak, Carl Chalmers, Paul Fergus, John Fieberg** | The goal of this solution is to enhance the  efficiency of camera-trap surveys in ecology  by leveraging artificial intelligence, particularly  deep learning, to automate the identification  and classification of objects and species in  camera-trap images. The problem being  addressed is the time-consuming data processing associated with camera-trap  surveys, and the solution aims to improve the  speed and accuracy of data analysis. | The components of the solution are camera traps, AI algorithms (e.g., CNNs), AI platforms (e.g., Conservation AI), and data management tools, all aimed at automating wildlife species identification and improving the efficiency of  camera-trap data processing | A fully automated recognition workflow requires a trained model capable of identifying all classes of interest and providing highly accurate classifications. Users that desire a fully automated work-flow will likely need to leverage data collected from their specific area, which may require training their own models, or using similar area- specific models trained by others. | Data Collection Data Processing Data Analysis | Identify trends in the usage of aerial thermal sensors for wildlife sampling. | Limited to the information available in the reviewed articles, which may not cover all research in the field | The performance of MegaDetector and the MLWIC2 ‘empty\_ani-mal’ model was dependent on the dataset, with the Orinoquía Camera Traps dataset having the highest F1 score (0.96 and 0.89 for MegaDetector and MLWIC2, respectively) and the Snapshot Kgalagadi dataset having the lowest F1 score (0.87 and 0.53 for MegaDetector and MLWIC2, respectively) when evaluated using a confidence threshold of 0.65 (Table 5) |
| **Mohammad Sadegh Norouzzadeha, Anh Nguyenb, Margaret Kosmalac, Alexandra Swansond, Meredith S. Palmere,Craig Packere, and Jeff Clunea** | The goal is to use deep learning to automatically identify, count, and describe wildlife species and behaviors in camera trap images, enhancing ecological and conservation research. | Data Collection Data Processing Data Analysi | The current solution involves using deep learning, specifically deep convolutional neural networks, to automatically identify, count, and describe the behaviors of wildlife species captured in motion-sensor "camera trap" images. | variations in altitude and ground conditions affect the accuracy of wildlife population density estimates, with the use of RGB cameras as a potential moderating variable. The primary aim is to understand how these factors influence population density estimations of white-tailed deer during aerial surveys. | improving the accuracy of wildlife density estimates from aerial surveys, which enhances wildlife management and conservation efforts. | could include increased costs and potential challenges in implementing double- observer methods and using additional equipment like red-green-blue cameras, which may be resource-intensive. | The factors influencing detection errors in aerial wildlife surveys using infrared thermography and offers recommendations to improve accuracy and reduce error. |
| **Tijmen de Lorm,Catharine Horswill,Daniella Rabaiotti,Robert Ewers,Rosemary Groom,Jessica Watermeyer,Rosie Woodroffe** | enhance cost-effective large-scale monitoring and conservation efforts . | individual-based demographic data from photographic records for monitoring threatened species. | developing a framework that automates the selection of suitable images for individual identification and comparing the performance of three identification software packages i.e Hotspotter, I3S- Pattern, and WildID | The image-matching accuracy (dependent variable) is influenced by the image pre-processing techniques (independent variable), with the population of African wild dogs acting as a moderating variable, and the removal of image backgrounds as a mediating variable, affecting the overall performance. | Enhanced efficiency and accuracy in wild dog population monitoring. | Dependency on specific image-matching software, potentially limiting generalizability to other species or populations | An automated image processing pipeline for wild dog |
| **Mateusz Choiński, Mateusz Rogowski, Piotr Tynecki, Dries P. J. Kuijper, Marcin Churski & Jakub W. Bubnicki** | Developing a system for malicious email spam detection. | the object detection and species-level classification in camera trapping data to improve wildlife monitoring and conservation efforts,  addressing the challenge of efficiently processing vast | The current solution is an AI model based on YOLOv5 architecture for automatic object detection | he independent variable (YOLOv5-based AI model) directly affects the dependent variable (species-level classification accuracy), with the moderating variable (sample size of training data) influencing this relationship, and the mediating variable (hyperparameter tuning and model training) acting as an intermediary in determining classification accuracy. | Enhanced efficiency in wildlife monitoring, potentially leading to better conservation and population management outcomes. | Potential misclassification or inaccuracies in species recognition, especially for species with limited training data, which may affect the reliability of monitoring results. | Implementation of a YOLOv5-based AI model for automated mammal species recognition in camera trap images. |
| **Sachini Kuruppu ,Sri Lanka Institute of Information Technology** | The goal of this solution is to protect endangered animal populations and prevent poaching threats by using an AI-based system to detect concealed weapons carried by poachers in high-density forest areas. | The components of the solution include camera traps, the YOLOv5 object detection algorithm, Long Range (LoRa) technology, and Raspberry Pi 4 for real-time detection of concealed weapons used by poachers in forest areas. | The current solution proposed is an AI- based anti-poaching system utilizing camera traps, YOLOv5 object detection, and LoRa technology with Raspberry Pi 4 to detect poachers carrying concealed weapons in real-time, enhancing wildlife protection efforts. | The implementation of the AI-based anti-poaching system is expected to have a direct positive relationship with the dependent variable, reducing poaching incidents. Geographical location and environmental conditions may moderate the system's effectiveness, while the mediating variable, prompt park ranger response, enhances the impact of the anti-poaching system on reducing poaching incidents. | Enhanced wildlife protection, reduced poaching incidents, and increased biodiversity conservation. | Possible false alarms or delayed responses that may undermine system trustworthiness and effectiveness. | Real-time weapon detection, low-cost hardware (Raspberry Pi), LoRa technology for remote areas, and YOLOv5 object detection for efficiency. |
| **S. Sisodia, S. Dhyani, S. Kathuria, S. Pandey, G. Chhabra and R. Pandey** | The goal is to use Artificial Intelligence (AI) to analyze data and create ecological models for safeguarding and reviving wildlife in support of Sustainable Development Goals (SDGs). | Trends.Earth, Wildbook, Conservation Metrics, Wildlife Protection Solutions (WPS), Protection Assistant for Wildlife Security (PAWS), Archangel Imaging, Robot Predators, AI Technologies and Innovations | The major impact factors in this work include the collection and processing of data which depends on the behavior of the animals and any other collaborations may change in model building to reach the goal. | This AI project aims to combat deforestation, biodiversity loss, invasive species, and wildlife trafficking to support Sustainable Development Goal 15 by informing conservation policies and actions. | AI technologies like machine learning accelerate progress towards Sustainable Development Goals (SDGs) by predicting deforestation rates and detecting/preventing poaching activities to safeguard wildlife. | The document emphasizes investigating tech's negative effects on SDGs, promoting responsible AI/Industry 4.0, and addressing challenges in AI implementation and data security. | The paper synthesizes AI and Industry 4.0 applications in wildlife conservation, addressing challenges and proposing future research directions. |
| **S. B. Islam and D. Valles** | The goal is to develop a computer vision and machine learning system for analyzing camera trap images to detect, categorize, and track various animals such as snakes, lizards, and frogs. | APIs, OpenCV, HiPE Server Environment, Hardware Solution, NVIDIA Jetson Nano Developer Kit, Software Tools, Dataset Collection, Data Pre-processing, Model Architecture, Training and Testing, Species Prediction, Evaluation and Field Application. | As the device collects its input images using camera traps regardless of the changes happening in the environment. By the use of OpenCVs and Machine Learning Techniques we can classify and detect objects or images and the identification of sound signals in addition to image data. | The solution utilizes deep learning and CNNs to automate animal species detection and classification in computer vision tasks with precision. | The solution enhances species detection, automated image classification, promotes collaborative wildlife monitoring, integrates hardware and software, and utilizes high-performance computing. | The potential negative impact of using camera traps for species detection includes dealing with highly imbalanced data, which can lead to variations in model performance when applied to new locations not encountered during training. | Research aims to accurately identify and monitor endangered species while enhancing network structures for increased precision and efficiency. |
| **Shreya Kakhandiki** | The goal is to build a low-cost device that can be installed in wilderness areas and send real-time alerts to park officials | Raspberri Pi computer with a power bank,camera, antenna | Image Classification to detect the presence of humans, weapons,animals in photos. | The device takes about 5 minutes to run per image, is over 90% accurate in recognizing humans, weapons, animals and in text images | The device may help rangers monitor large areas and decrease poaching activity. | Highlighting challenges and risks associated with poaching, endangerment of animal species, and safety of rangers mitigates specific negative impacts. | The device successfully meets all engineering goals. |
| **Jamali Firmat Banzi** | The main goal is to develop a sensor-based anti-poaching system in Tanzania National Parks to combat poaching activities | Is consists of MBS and sensor fusion technology (visual , infrared camera and GPS | The system works continuously collecting data about location of animal groups using GPS | Cost-effective , easily adoptable to current anti-poaching systems | Cost-effective , easily adoptable to current anti-poaching systems | Wide-range of poacher detection, ability to reveal more knowledge about animal behavior | Creating a cutting-edge anti-poaching technology system to safeguard endangered species, promoting wildlife preservation and ecological balance. |
| **Mateusz Choiński, Mateusz Rogowski, Piotr Tynecki, Dries P. J. Kuijper, Marcin Churski & Jakub W. Bubnicki** | Developing a system for malicious email spam detection. | the object detection and species-level classification in camera trapping data to improve wildlife monitoring and conservation efforts,  addressing the challenge of efficiently processing vast | The current solution is an AI model based on YOLOv5 architecture for automatic object detection | The independent variable (YOLOv5-based AI model) directly affects the dependent variable with the moderating variable influencing this relationship, and the mediating variable acting as an intermediary in determining classification accuracy. | Enhanced efficiency in wildlife monitoring, potentially leading to better conservation and population management outcomes. | Potential misclassification or inaccuracies in species recognition, especially for species with limited training data, which may affect the reliability of monitoring results. | Implementation of a YOLOv5-based AI model for automated mammal species recognition in camera trap images. |

**2.4 DISADVANTAGES OF EXISTING SYSTEM**:

* It's expensive to set up AI systems due to technology, infrastructure, and skilled staff, especially for organizations in developing countries.
* AI systems are complex and need specialized knowledge for development, deployment, and maintenance. This complexity can hinder their use, especially where technical expertise is scarce.
* AI relies on high-quality data, which can be hard to get in remote wildlife habitats. Limited data availability can reduce the accuracy of AI models.
* AI monitoring systems raise privacy and security issues. Balancing conservation goals with individual rights is difficult.
* Over-reliance on AI can sideline traditional conservation methods and local knowledge, ignoring indigenous perspectives.
* The production and use of AI hardware can harm the environment through energy use and electronic waste. Sustainable strategies are needed to minimize this impact.
* Expanding AI-based conservation projects to cover larger areas faces challenges like interoperability and coordination among stakeholders.

**CHAPTER 3**

**PROPOSED SYSTEM**

**3.1 PROPOSED SYSTEM**

The proposed approach is to maintain the balance in the ecosystem and thus to protect the wildlife from the fear of being hunted, data that is collected from the camera traps or live streams of a camera is provided to the proposed model as input after the application of pre-processing steps on the data and then the model continues with its job i.e. object detection, classification and then alert creation. So, the alert is then sent to the corresponding wildlife protection department. Various improvements and modifications to the proposed model such as training the model to even detect gunshot sounds to improve its detection capacity will be worked on in the future paper.

**3.2 OBJECTIVES OF PROPOSED SYSTEM**

The objectives of the proposed system include the following:

* Automated poaching aims to exploit advanced technology to maximize efficiency illegally hunting and harvesting wildlife.
* Alert creation is to develop systems that promptly notify relevant parties about specific events or conditions, enabling timely response and decision-making.
* After the occurrence of the specific events, alerts should be sent to concerned departments.

**3.3 ADVANTAGES OF PROPOSED SYSTEM**

The proposed system has the following advantages:

* Efficient Monitoring: The use of camera traps or live streams allows for continuous monitoring of wildlife habitats, providing a wealth of data for analysis.
* Timely Alert Generation: By processing the data through a model for object detection and classification, potential threats to wildlife can be identified promptly, allowing for timely intervention.
* Automated Detection: Utilizing an automated model for object detection and classification reduces the need for manual monitoring, saving time and resources.
* Enhanced Accuracy: With advancements in machine learning and computer vision, the model can potentially offer more accurate detection and classification of objects, including identifying specific threats such as gunshot sounds.
* Streamlined Communication: Sending alerts directly to wildlife protection departments streamlines communication and ensures that relevant authorities are informed promptly, enabling swift action to protect wildlife.
* Scalability: Once developed and deployed, this approach can be scaled up to cover larger areas or multiple locations simultaneously, improving overall conservation efforts.
* Continuous Improvement: Mention of future improvements, such as training the model to detect gunshot sounds, indicates a commitment to enhancing the system's capabilities over time, adapting to evolving threats and technological advancements.
* Holistic Approach to Conservation: By focusing on maintaining ecosystem balance and protecting wildlife from hunting, the approach aligns with broader conservation goals aimed at preserving biodiversity and ecosystem health.

**3.4 SYSTEM REQUIREMENTS**

The system requirements for the development and deployment of the project as an application are specified in this section. These requirements are not to be confused with the end-user system requirements. There are no specific, end-user requirements as the intended application is cross-platform and is supposed to work on devices of all form-factors and configurations.

**3.4.1 SOFTWARE REQUIREMENTS**

Below are the software requirements for application development:

1. Editor for python : vsCode, Jupyter
2. vsCode with extension support
3. Python 3.8 installed in local system

**3.4.2 HARDWARE REQUIREMENTS**

Hardware requirements for application development are as follows:

* 1. CPU - intel i3 or higher
  2. RAM - 4 GB or higher

**3.4.3 IMPLEMENTATION TECHNOLOGIES**

**Deep Learning:**

Deep learning has transformed object detection, with popular models like Faster R-CNN and YOLO. These models employ a two-stage or one-stage approach to detect objects in images. They propose regions containing objects and classify them using convolutional neural networks (CNNs). Backbone networks like ResNet and EfficientNet are crucial for feature extraction. Attention mechanisms, like those in DETR, enhance accuracy by focusing on relevant regions. Data augmentation and pre-training on large datasets improve generalization. Object detection methods are constantly evolving with advancements in architectures and training strategies. They find applications in various real-world scenarios due to their effectiveness. Deep learning has led to significant improvements in speed and accuracy in object detection tasks. Overall, deep learning-based object detection continues to advance, driven by research and practical need

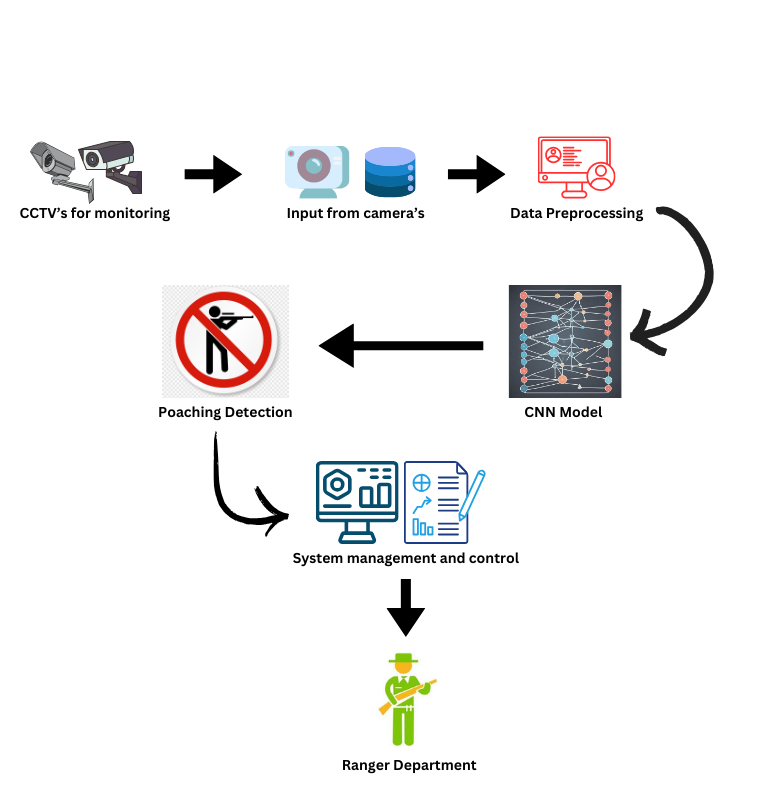
**CNN:**

Convolutional Neural Networks (CNNs) are pivotal in object detection, serving to extract meaningful features from input images. These networks, often deployed as backbone architectures like ResNet or MobileNet, learn hierarchical representations of visual patterns through convolutional layers. In two-stage object detection frameworks such as Faster R-CNN, CNNs also facilitate region proposal generation, identifying potential object locations via region proposal networks (RPNs). Subsequently, CNNs contribute to both object classification and localization tasks, predicting object categories and refining bounding box coordinates. With pre-training on large datasets followed by fine-tuning on detection-specific data, CNNs adapt to diverse object detection tasks. Their ability to automatically learn discriminative features enables the accurate detection and localization of objects within images, making CNNs indispensable in modern object detection systems.

**CHAPTER 4**

**SYSTEM DESIGN**

**4.1 PROPOSED SYSTEM ARCHITECTURE**

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**Fig 1: Architecture of the proposed system**

To maintain the balance in the ecosystem and thus to protect the wildlife from the fear of being hunted, data that is collected from the camera traps or live streams of a camera is provided to the proposed model as input after the application of pre-processing steps on the data and then the model continues with its job i.e. object detection, classification and then alert creation. So, the alert is then sent to the corresponding wildlife protection department. Various improvements and modifications to the proposed model such as training the model to even detect gunshot sounds to improve its detection capacity will be worked on in the future paper.

**4.2 APPLICATION MODULES**

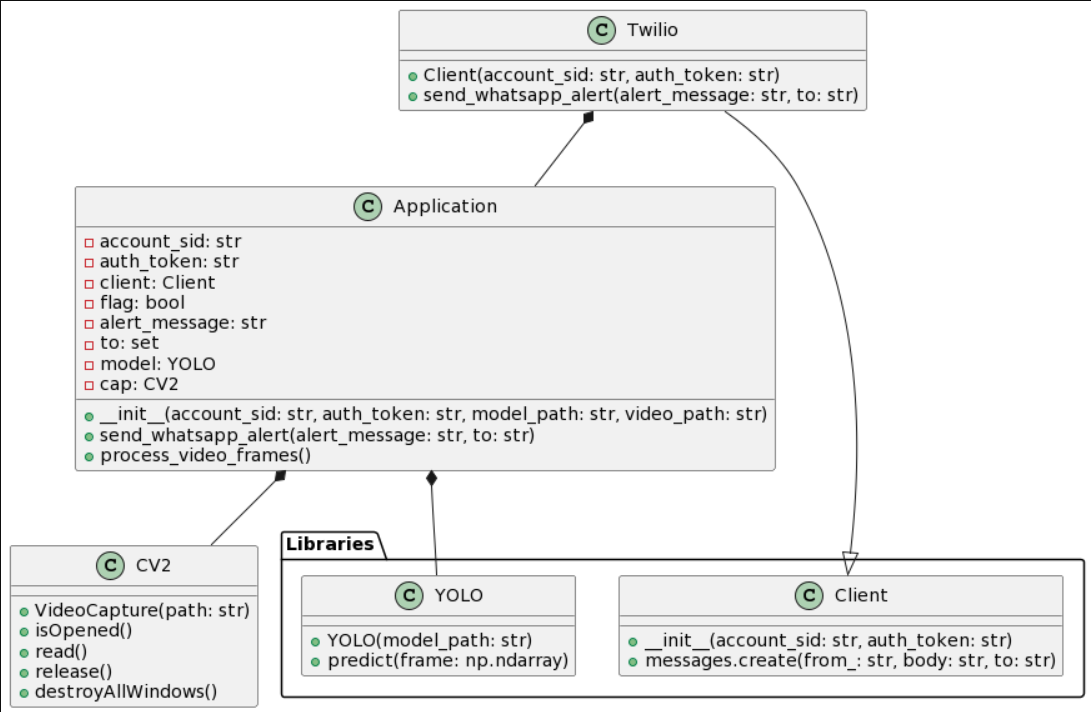
The application overall involves five main modules.

**4.2.1 Tensorflow**

This module involves TensorFlow which is an open-source machine learning framework developed by Google Brain, designed to facilitate the creation, training, and deployment of deep learning models. At its core, TensorFlow operates on a computational graph paradigm, where mathematical operations are represented as nodes and data flow through the edges. This graph-based approach enables efficient execution across multiple devices, including CPUs, GPUs, and TPUs, making TensorFlow suitable for a wide range of applications, from research prototypes to large-scale production systems. With its flexible architecture and extensive library of pre-built components, TensorFlow supports various machine learning tasks, including image recognition, natural language processing, and reinforcement learning.

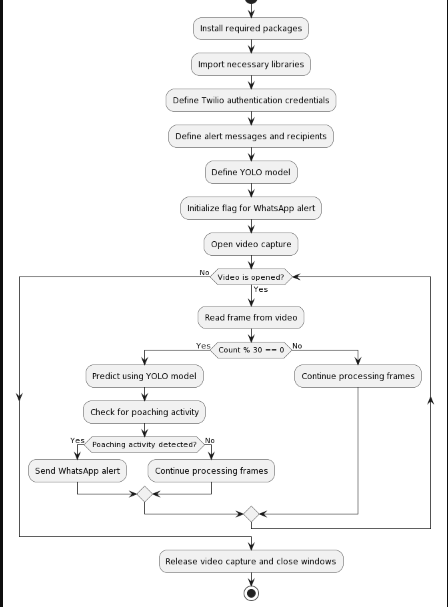
One of the key features of TensorFlow is its scalability and distributed computing capabilities, allowing users to train complex models on large datasets distributed across multiple machines. TensorFlow also provides high-level APIs like Keras, which simplifies the process of building and training neural networks, making it accessible to both beginners and experienced developers. Additionally, TensorFlow's ecosystem includes tools for model debugging, visualization, and deployment, such as TensorFlow Serving and TensorFlow Lite, enabling seamless integration into production environments and edge devices.

Furthermore, TensorFlow fosters a vibrant community of researchers, developers, and practitioners, who contribute to its continuous improvement and expansion. Through initiatives like TensorFlow Research Cloud and TensorFlow Hub, users can access pre-trained models, datasets, and computational resources, accelerating the development and deployment of AI solutions. Overall, TensorFlow has emerged as a leading framework in the field of machine learning, empowering individuals and organizations worldwide to harness the power of deep learning for diverse applications, ranging from healthcare and finance to robotics and autonomous vehicles.

**Fig 2: Use Case diagram of the proposed system**

**4.2.2 Ultralytics:**

Ultralytics is a prominent company specializing in computer vision and deep learning solutions, particularly renowned for its development and open-source contributions to state-of-the-art object detection algorithms. Led by a team of expert researchers and engineers, Ultralytics has gained recognition for its cutting-edge work in the field of artificial intelligence (AI), focusing on empowering organizations across various industries with advanced visual recognition capabilities. The company's flagship product, the PyTorch-based YOLOv5 framework, stands out for its exceptional speed, accuracy, and ease of use, making it a popular choice for real-time object detection tasks. Furthermore, Ultralytics is committed to fostering collaboration and knowledge sharing within the AI community, evidenced by its extensive documentation, tutorials, and active participation in academic conferences and workshops. With a dedication to innovation and accessibility, Ultralytics continues to push the boundaries of computer vision technology, driving advancements that have profound implications for diverse applications, including autonomous vehicles, surveillance systems, and wildlife conservation efforts.



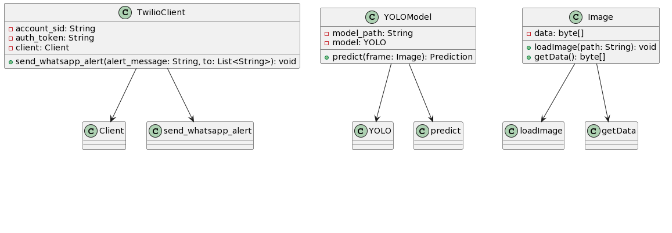
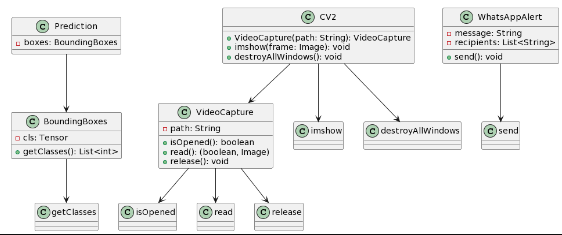
**Fig 3: Activity diagram of the proposed system**

**4.2.3 Importing YOLO from Ultralytics:**

Importing YOLO (You Only Look Once) from Ultralytics involves leveraging cutting-edge object detection capabilities for various applications. Ultralytics offers an open-source implementation of YOLO, a state-of-the-art deep-learning algorithm renowned for its speed and accuracy in detecting objects within images and videos. By integrating YOLO into projects, users can efficiently identify and track objects of interest in real time, making it invaluable for tasks such as surveillance, autonomous vehicles, and wildlife monitoring. Importing YOLO from Ultralytics provides access to pre-trained models trained on large-scale datasets, enabling rapid deployment without the need for extensive training data or computational resources. This accessibility democratizes the use of advanced computer vision technologies, empowering developers and researchers to tackle diverse challenges with ease.

Moreover, importing YOLO from Ultralytics offers seamless integration with popular deep-learning frameworks like PyTorch, facilitating flexible customization and extension for specific use cases. With its user-friendly interface and comprehensive documentation, Ultralytics' implementation of YOLO simplifies the development process, allowing users to focus on application-specific tasks rather than grappling with complex technical details. Additionally, Ultralytics provides ongoing support and updates, ensuring that users have access to the latest advancements and improvements in object detection technology. This commitment to continuous innovation enhances the reliability and performance of YOLO-based solutions, fostering confidence in its capabilities across diverse industries and domains.

Furthermore, importing YOLO from Ultralytics opens up possibilities for collaborative research and development initiatives, as the open-source nature of the project encourages knowledge sharing and community engagement. Developers and researchers can leverage the extensive ecosystem surrounding YOLO to exchange ideas, share best practices, and collaborate on addressing common challenges. By fostering a vibrant and inclusive community, Ultralytics promotes innovation and progress in the field of computer vision, ultimately driving advancements in object detection and related applications. In summary, importing YOLO from Ultralytics offers a powerful and accessible solution for harnessing the capabilities of deep learning in object detection, paving the way for transformative applications across diverse industries and domains.

**Fig 4: Class diagram of the proposed system**

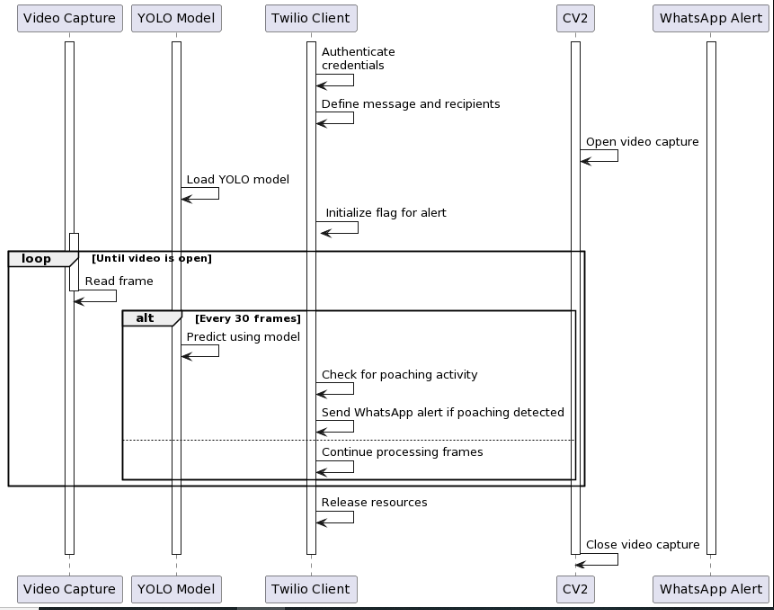
**4.2.4 Twilio:**

Twilio is a cloud communications platform that enables developers to integrate various communication channels, such as voice, messaging, and video, into their applications through simple APIs (Application Programming Interfaces). Founded in 2008, Twilio has become a leading provider of communication tools for businesses worldwide. Its platform offers scalable and reliable solutions that empower developers to build custom communication experiences tailored to their specific needs.

One of Twilio's core offerings is its Programmable Communications Cloud, which provides a suite of APIs for voice calls, SMS messaging, video conferencing, and more. Developers can easily embed these communication capabilities into their applications, allowing for seamless interactions with users across multiple channels. Twilio's APIs abstract away the complexities of telecom infrastructure, enabling developers to focus on building innovative communication features without having to manage the underlying infrastructure themselves.

In addition to its communication APIs, Twilio offers a range of other products and services to enhance the customer experience and streamline business operations. These include Twilio Flex, a fully programmable contact center platform; Twilio SendGrid, a cloud-based email delivery service; and Twilio Segment, a customer data platform for gathering, analyzing, and acting on user data.

Twilio's platform is highly flexible and customizable, making it suitable for businesses of all sizes and industries. Whether it's enabling real-time customer support, automating marketing campaigns, or enhancing collaboration among team members, Twilio provides the tools and infrastructure needed to create engaging and personalized communication experiences. With its commitment to innovation and customer success, Twilio continues to shape the future of communication technology and drive digital transformation across industries.

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**Fig 5: Sequence diagram of the proposed system**

**4.2.5 OpenCV:**

OpenCV, short for Open Source Computer Vision Library, is a widely used open-source computer vision and machine learning software library. Originally developed by Intel, it now boasts a large community of contributors and users. OpenCV provides a comprehensive suite of functionalities for tasks such as image and video analysis, object detection and recognition, facial recognition, motion tracking, and augmented reality. It supports multiple programming languages including C++, Python, Java, and MATLAB, making it accessible to a broad range of developers and researchers.

One of the key strengths of OpenCV lies in its extensive collection of pre-trained models and algorithms, which enable rapid development and deployment of computer vision applications. These models cover a wide range of tasks, from basic image processing operations like filtering and thresholding to more advanced tasks like feature extraction and deep learning-based object detection. Additionally, OpenCV integrates seamlessly with other popular libraries and frameworks such as TensorFlow and PyTorch, allowing for interoperability and flexibility in building complex machine-learning pipelines.

Another notable feature of OpenCV is its platform independence, with support for various operating systems including Windows, Linux, macOS, Android, and iOS. This versatility enables developers to deploy their applications across different devices and environments, from desktop computers to mobile devices and embedded systems. Furthermore, OpenCV provides optimized implementations of its algorithms for different hardware architectures, leveraging parallel processing capabilities to achieve high performance and efficiency.

In recent years, OpenCV has become an indispensable tool in numerous domains including robotics, autonomous vehicles, medical imaging, security and surveillance, and augmented reality. Its ease of use, extensive documentation, and active community support have contributed to its widespread adoption and continued evolution. As computer vision continues to play an increasingly important role in various industries and applications, OpenCV remains at the forefront, driving innovation and empowering developers to turn their ideas into reality.

**CHAPTER 5**

**IMPLEMENTATION**

**5.1 AI-BASED IMPLEMENTATION**

The existing problem can be solved by designing an artificial intelligence-based wildlife conservation system i.e. an artificial intelligence model that detects poaching activity through gun detection and immediately alerts the corresponding action-taking department.

(1) Data collection and Data preprocessing

(2) Implementing the YOLOv8 Model

(3) Developing and training the model

(4) Testing the model

**5.1.1 Data Preparation and preprocessing**

Data collection and preprocessing are foundational steps in developing any AI or ML model. In this scenario, the dataset consists of images depicting people (poachers) and guns, crucial for training a detection system. Preprocessing begins with auto orientation, ensuring all images are uniformly aligned for consistency. Following this, resizing standardizes image dimensions to 640x640 pixels, optimizing them for subsequent analysis. Annotation and labeling are essential to provide the model with ground truth information, accomplished by marking bounding boxes around people and guns within the images. Finally, data augmentation techniques, such as duplicating data with slight variations or adding noise, are employed to enhance dataset size and diversity, ultimately improving the model's robustness and generalization capabilities. These preprocessing steps lay the groundwork for training a reliable AI model capable of detecting poaching activity effectively.

**5.1.2 Implementing the YOLOv8 Model**

Implementing the YOLOv8 model involves several key steps to ensure the effective detection of guns and poachers. Firstly, the training data is organized and prepared by creating a .yaml file. This file includes the addresses of the training, testing, and validation data, along with information about the classes present in the dataset. Once the data is set up, the YOLO model is imported from the Ultralytics package, leveraging its powerful capabilities for object detection tasks. With the model imported, training begins using the collected dataset. During training, the YOLOv8 model learns to identify and localize guns and poachers within the images, optimizing its detection performance through iterative adjustments. By meticulously following these steps, the YOLOv8 model can be effectively trained to detect poaching activity, contributing to wildlife conservation efforts.

**5.1.3 Training and developing the model**

Training and developing the model is a critical phase that significantly influences its performance. Several key considerations are vital throughout this process. Firstly, selecting an appropriate number of epochs is crucial to strike a balance between effective training and avoiding overfitting. Epoch selection involves iteratively training the model on the dataset, with each epoch representing a complete pass through the entire dataset. Additionally, model configuration plays a pivotal role in optimizing performance. Parameters such as batch size and image size are adjusted to fine-tune the model's behavior and improve its ability to detect guns and poachers accurately. Lastly, model evaluation is essential to assess its performance objectively. By evaluating the trained model on separate validation and test datasets, its ability to generalize and accurately detect poaching activity can be thoroughly assessed. These considerations collectively ensure that the trained model is robust, effective, and reliable in addressing the conservation challenges posed by poaching.

**5.2 SOURCE CODE**

# Install required packages !pip install ultralytics

# Import necessary libraries

import ultralytics from ultralytics

import YOLO import twilio from twilio.rest

import Client import cv2

# Define Twilio authentication credentials account\_sid = 'your\_account\_sid' auth\_token = 'your\_auth\_token' client = Client(account\_sid, auth\_token)

# Function to send WhatsApp alert

def send\_whatsapp\_alert(alert\_message, to):

global flag

if flag:

return

message = client.messages.create( from\_='whatsapp:+14155\*\*\*\*\*\*', body=alert\_message, to=to )

flag = True

print(message.sid)

# Define alert messages and recipients

alert\_message = "Poaching activity Detected,

Check the cameras immediately!"

to = {'whatsapp:+919\*\*\*\*\*\*\*03', 'whatsapp:+918\*\*\*\*\*\*097'}

# Define YOLO model

model\_path = "/path/to/your/model/weights/best.pt"

model = YOLO(model\_path)

# Initialize flag for WhatsApp alert

flag = False

# Open video capture

cap = cv2.VideoCapture("/path/to/your/video.mp4")

if not cap.isOpened():

print("Error: Could not open camera.")

exit()

# Process video frames

count = 0

while cap.isOpened():

count += 1

ret, frame = cap.read()

if not ret:

print("Error: Failed to grab a frame.")

break

if count % 30 == 0:

#Process every 30 frames & Predict using YOLO model

res = model.predict(frame)

res = res[0]

res\_tensor = res.boxes.cls

res\_numpy = res\_tensor.numpy()

print(res\_numpy)

# Check for poaching activity and send alert

for i in res\_numpy:

if i == 9:

send\_whatsapp\_alert(alert\_message, to)

else:

continue

# Release video capture and close windows

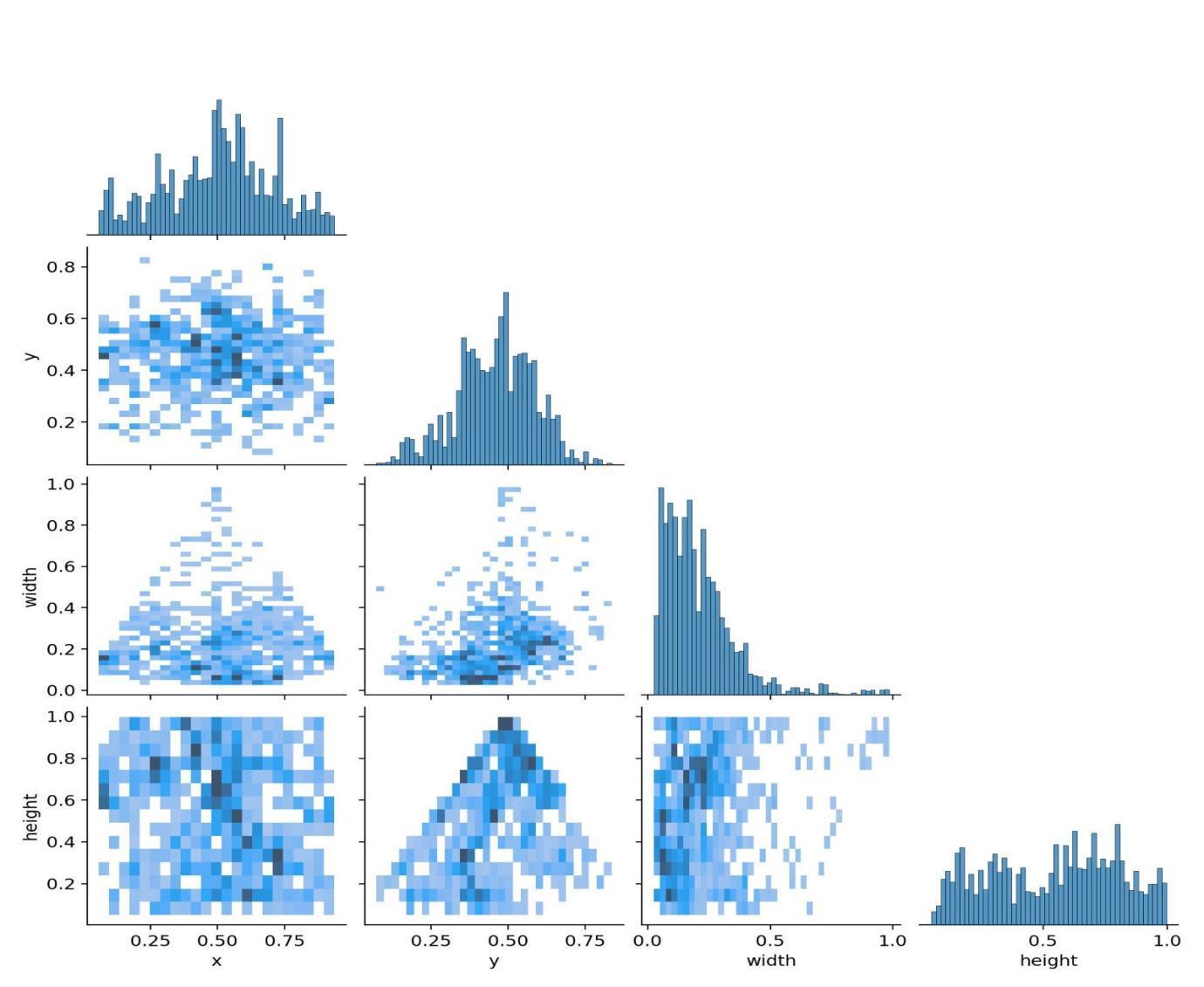
cap.release()

cv2.destroyAllWindows()

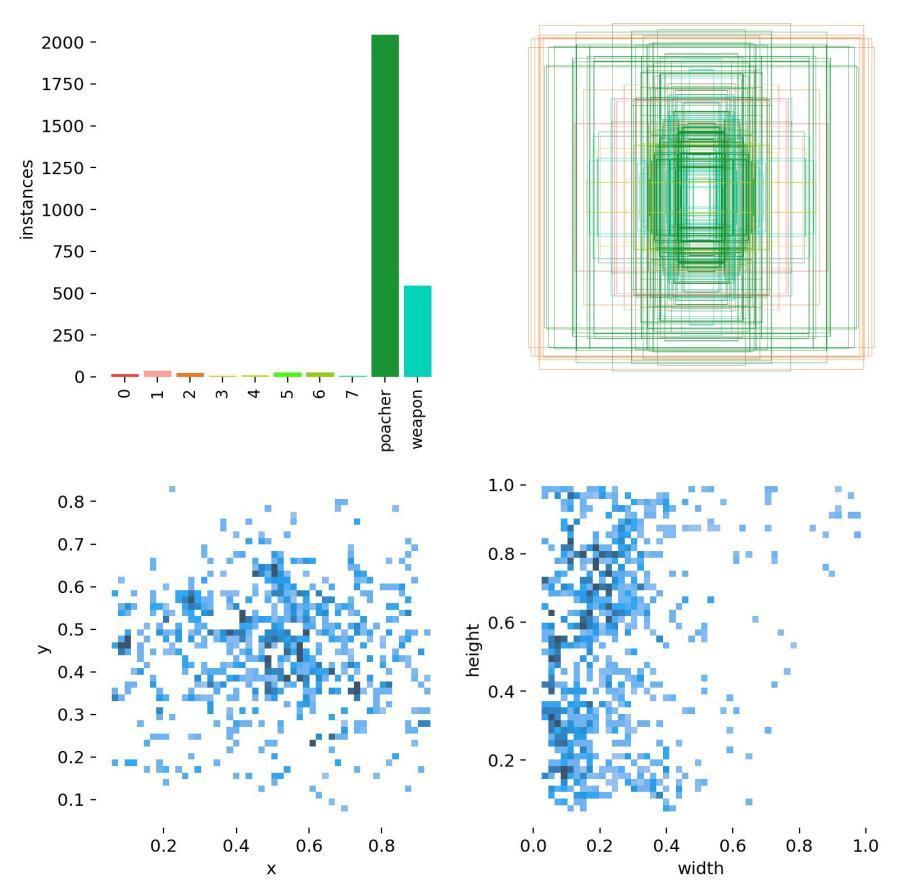
**CHAPTER 6**

**RESULTS**

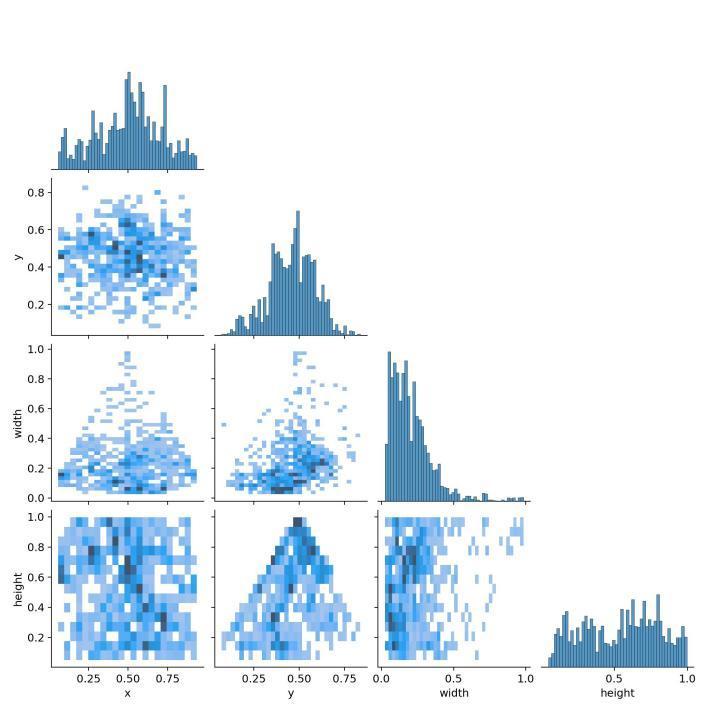
To evaluate the proposed model we are using a metric named, PrecisionConfidence Curve which is also known as PC Curve and shows how precision changes with the different confidence intervals. We are also interpreting the Precision-Recall Curve (PR Curve) that displays the tradeoff between precision and recall at different threshold levels.

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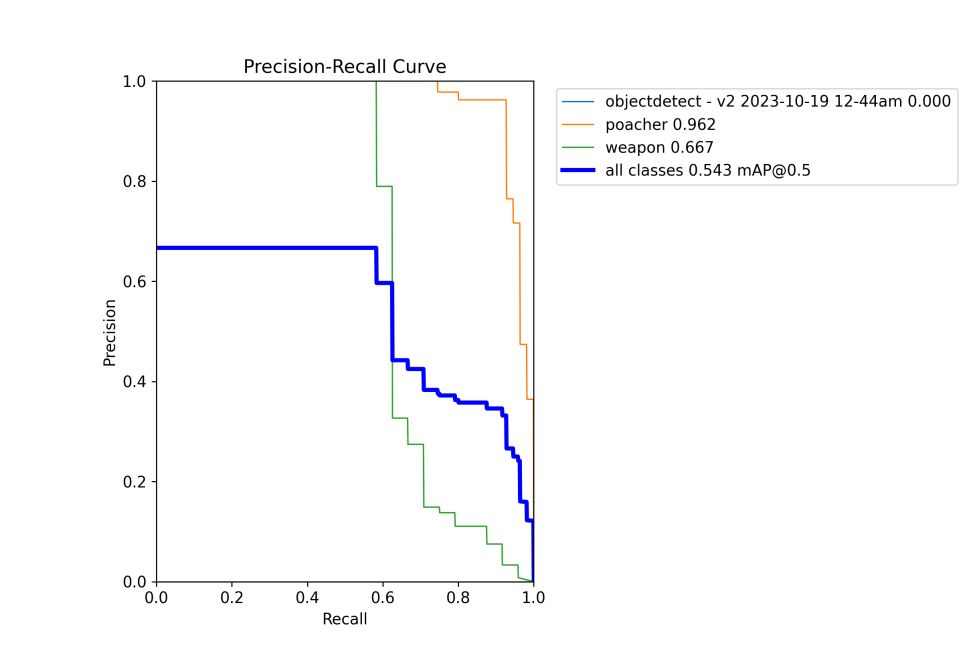
**Fig 6 : Diagram representing correlationship (correlation matrix)**

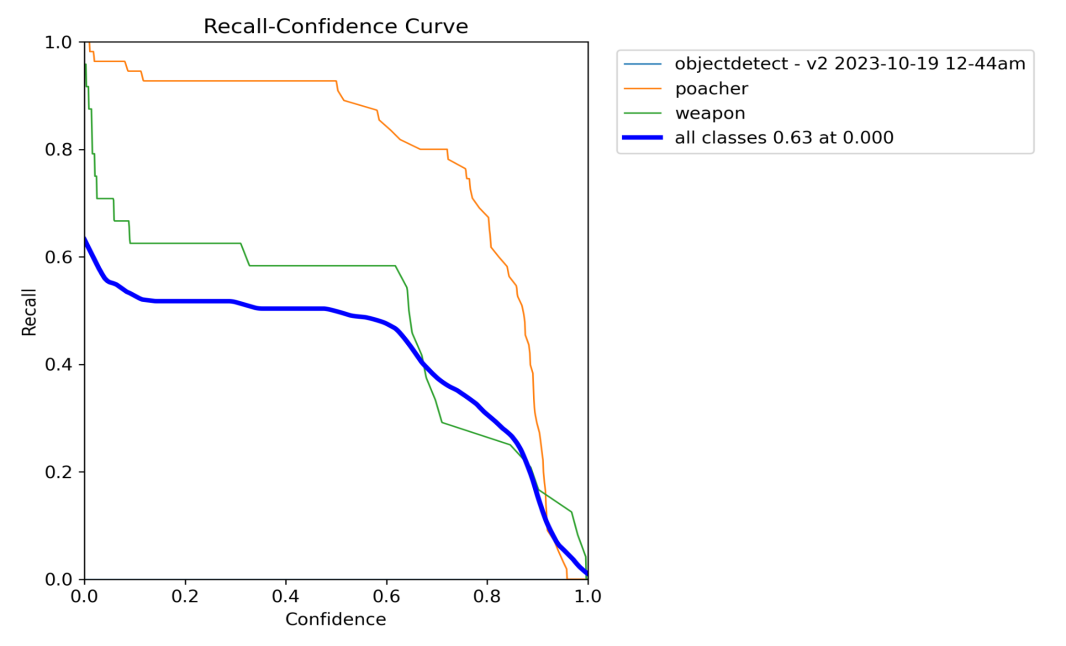
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**Fig 7 : Diagram representing labels after training**

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**Fig 8 : Train batch**



**Fig 9 : Precision -recall curve**

**Fig 10 : Recall-Confidence curve**

**Fig 10 : Recall-Confidence curve**

**CHAPTER 7**

**CONCLUSION**

In Conclusion, the incorporation of advanced technological methods, particularly in the realm of wildlife conservation and monitoring, represents a crucial stride towards implementing more effective and enduring strategies. Innovative technologies, such as enhanced monitoring and surveillance techniques, exhibit immense promise in curtailing poaching activities, bolstering the well-being of wildlife, and steering initiatives aimed at safeguarding and rejuvenating habitats. The data-centric approach facilitated by these technological advancements not only aids in steering conservation decisions but also lays the groundwork for sustainable practices, fostering a harmonious coexistence between human endeavors and the preservation of our planet’s diverse ecosystems. Confronting contemporary challenges, the integrating of advanced technology into wildlife conservation emerges as a potent asset, offering inventive resolution to uphold the fragile equilibrium for our ecosystem for the benefit of future generations..

**FUTURE ENHANCEMENTS AND DISCUSSIONS**

To maintain the balance in the ecosystem and thus to protect the wildlife from the fear of being hunted, data that is collected from the camera traps or live streams of a camera is provided to the proposed model as input after the application of preprocessing steps on the data and then the model continues with its job i.e. object detection, classification and then alert creation. So, the alert is then sent to the corresponding wildlife protection department. Various improvements and modifications to the proposed model such as training the model to even detect gunshot sounds to improve its detection capacity will be worked on in the future paper.