Empowering Rural Communities for Human-Wildlife Coexistence

A MINOR PROJECT REPORT

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in partial fulfilment of the requirements

for the degree of

BACHELOR OF TECHNOLOGY

in

COMPUTER SCIENCE ENGINEERING

with specialization in Computer Networking

DEPARTMENT OF NETWORKING AND COMMUNICATIONS

COLLEGE OF ENGINEERING AND TECHNOLOGY

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

KATTANKULATHUR- 603 203

NOVEMBER 2022

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

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ACKNOWLEDGEMENTS

We express our humble gratitude to **Dr C. Muthamizhchelvan**, Vice-Chancellor, SRM Institute of Science and Technology, for the facilities extended for the project work and his continued support. We extend our sincere thanks to Dean-CET, SRM Institute of Science and Technology, **Dr T.V.Gopal**, for his valuable support.

We wish to thank **Dr Revathi Venkataraman**, Professor & Chairperson, School of Computing, SRM Institute of Science and Technology, for her support throughout the project work. We are incredibly grateful to our Head of the Department**,Dr. Annapurani Panaiyappan.K** Professor, Department of Networking and Communications, SRM Institute of Science and Technology, for her suggestions and encouragement at all the stages of the project work.

We want to convey our thanks to our program coordinators , Associate Professor and Panel Head **Dr K Kalaikelvi**, Associate Professor, Department of Networking and Communications, SRM Institute of Science and Technology, for their inputs during the project reviews and support. We register our immeasurable thanks to **Dr M Manickam**, Assistant Professor, Department Networking and Communications, SRM Institute of Science and Technology, for leading and helping us to complete our course.

Our inexpressible respect and thanks to my guide, **Dr K. Deepa Thilak**, Assistant Professor, of Department Networking and Communications, SRM Institute of Science and Technology, for providing me with an opportunity to pursue my project under his/her/their mentorship. She provided me with the freedom and support to explore the research topics of my interest. Her passion for solving problems and making a difference in the world has always been inspiring.

We sincerely thank the Networking and Communications Department staff and students, SRM Institute of Science and Technology, for their help during our project. Finally, we would like to thank parents, family members, and friends for their unconditional love, constant support, and encouragement.

[SHAYAN HORE]
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ABSTARCT

In response to the critical challenge of wild animal incursions in rural areas, we propose an innovative solution aimed at safeguarding rural communities. Our cutting-edge system combines the power of cameras and sound recognition technology to swiftly identify the presence of potentially dangerous wildlife. Simultaneously, it emits a loud sound to deter the animals and immediately alerts villagers.

This professional-grade system is designed to enhance safety and promote economic security in rural areas by effectively mitigating wild animal attacks and minimizing crop damage. Its user-friendly interface and real-time alerting capabilities make it an accessible and reliable tool for rural communities.

By harnessing the capabilities of modern technology, our solution represents a significant stride toward fostering harmonious coexistence between humans and wildlife. It also aligns with the Sustainable Development Goal 15, which focuses on protecting terrestrial ecosystems and promoting the sustainable management of forests and wildlife.

Our innovative approach aims to empower rural communities with the tools and knowledge needed to address the challenges posed by wild animal incursions, ultimately contributing to a safer, more prosperous, and ecologically sustainable future for these regions.

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Chapter 1

Introduction

1.1 Motivation:

The motivation for this system is to reduce human-animal conflict and promote coexistence between humans and wildlife. By alerting villagers to wildlife presence, it can prevent attacks, crop damage, and animal killings. Additionally, it empowers rural communities to take charge of their safety, reducing reliance on external assistance.

A sound-based wildlife detection system offers specific benefits:

1. Enhanced safety: Early warnings enable villagers to protect themselves, shelter, or contact authorities.
2. Reduced crop damage: Alerts mitigate crop damage by notifying villagers about animals like deer, elephants, and monkeys.
3. Conservation support: Data on wildlife behaviour aids effective conservation strategies.
4. Coexistence promotion: Fewer negative interactions foster a sustainable relationship between humans and nature.

1.2 Purpose:

The purpose of this documentation is to provide a comprehensive understanding of the Sound-Based Wildlife Detection System, its objectives, components, and functionalities. It serves as a reference for project stakeholders, developers, and end-users, offering insight into the system's design and utilization.

This documentation aims to:

1. **Inform Stakeholders:** Communicate the system's significance and potential impact on mitigating human-wildlife conflicts, enhancing rural safety, and supporting wildlife conservation efforts.
2. **Guide Development:** Provide technical details on system components, data collection methods, and alert mechanisms for developers and engineers working on system implementation.

3. **Support Users:** Offer clear and concise user instructions for interacting with the system, responding to alerts, and ensuring their safety.
4. **Document Results:** Summarize project outcomes and impact, thereby showcasing the effectiveness of the system in real-world applications.
5. **Facilitate Future Enhancements:** Suggest potential improvements or additional features that could further enhance the system's capabilities.

1.3 Scope:

Widespread Threat: The problem statement revolves around the widespread and escalating threat of wild animal incursions in rural areas.

Human Safety Concerns: This issue is marked by substantial risks to human safety, as rural inhabitants frequently encounter potentially dangerous wild animals.

Wildlife Welfare: Equally concerning are the challenges surrounding the welfare of the wild creatures inhabiting rural landscapes, exposed to habitat disturbances and human interactions.

Agricultural Sustainability: The problem places the very foundation of agriculture in rural regions at risk, where livelihoods are intricately tied to crop production. Addressing this multifaceted challenge is imperative to ensure the well-being of both humans and wildlife, protect rural communities, and sustain the agricultural foundation of these regions.

Chapter 2

Literature Review

In a paper presented at the 2022 IEEE 19th India Council International Conference (INDICON) [1], authored by Joel John Kandathil and team, a solution was proposed to mitigate wild animal attacks on humans and crops. While effective, the YOLO model exhibited more localization inaccuracies than some other state-of-the-art algorithms but demonstrated a lower likelihood of false positives in the background.

In 'Improving weakly-supervised wildlife detection in UAV images' [2], Kellenberger, Marcos, and Tuia of Wageningen University introduce a novel model expertly blending weakly-supervised and fully-supervised methods for precise wildlife detection with minimal annotations. While excelling under weak supervision, it faces challenges with limited full positional ground truth data and may produce false positives with binary annotations. The authors suggest further research into the benefits of increased full supervision.

The paper "Autonomous UAVs Wildlife Detection Using Thermal Imaging, Predictive Navigation and Computer Vision"[3] done by Sean Ward in 2023 presents an innovative system for wildlife detection utilizing low-cost UAVs equipped with thermal cameras. While offering cost-effective solutions, its reliance on low-resolution thermal imaging and environmental factors poses potential limitations requiring further research and development.

Published in 2023, "Deep neural network architectures for cardiac image segmentation" [4] by Jasmine El-Taraboulsi explores the application of deep learning models in cardiac image analysis. It aims to automate and enhance image segmentation, a critical step in diagnosing heart diseases. The article discusses various deep learning techniques and models, such as Convolutional Neural Networks and UNet, highlighting their potential to improve accuracy and efficiency. While not explicitly addressing drawbacks, challenges include data requirements, interpretability, generalization, computational resources, and continual model improvement.

Published in 2023, "A deep learning architecture with an object-detection algorithm and a

convolutional neural network for breast mass detection and visualization"[5] by Steven J. Frank presents a system combining YOLO v5 object detection and a CNN for breast mass identification in mammograms, enhancing efficiency and accuracy in clinical breast cancer screening, although data quality and interpretability challenges may persist.

Published in 2023, "Verification and performance comparison of CNN-based algorithms for two-step helmet-wearing detection" [6] by Ju-Yeon Lee, Woo-Seok Choi, and Sang-Hyun Choi introduces a novel approach for workplace safety by classifying helmet-wearing, head, and hat classes using object detection and classification models. YOLO-Efficient Net outperformed other models with a higher F1-score, potentially aiding in reducing workplace accidents, especially in small-scale settings, though data collection and model generalization challengesremain.

Chapter 3

Problem definition and Objective

3.1 Problem Statement:

The pressing issue at hand revolves around the widespread and escalating threat of wild animal incursions in rural areas, impacting various facets of life in these regions.

Human Safety Concerns: This challenge poses significant risks to human safety as rural inhabitants frequently encounter potentially dangerous wild animals. These encounters can lead to injuries, fatalities, and psychological distress, particularly in communities that coexist with such wildlife.

Wildlife Welfare: Simultaneously, there are considerable concerns surrounding the welfare of the wild creatures inhabiting these rural landscapes. The habitat disturbances and increased human interactions have a profound impact on their well-being. This includes disruptions in migration patterns, changes in feeding and breeding behaviors, and increased stress, all of which can lead to a decline in the overall health and population of these animals.

Agricultural Sustainability: Furthermore, the problem jeopardizes the very foundation of agriculture in rural regions, where livelihoods are intimately connected to crop production. Wild animals often raid and damage crops, leading to economic losses and food insecurity for rural communities. The resulting financial strain can significantly impact the agricultural sustainability of these regions.

Addressing this multifaceted challenge is imperative to ensure the well-being of both humans and wildlife, protect rural communities, and sustain the agricultural foundation of these regions. Finding effective solutions that balance human safety, wildlife conservation, and agricultural sustainability is essential for achieving harmonious coexistence in these areas.

3.2 Objective:

Our project encompasses several fundamental objectives aimed at addressing the multifaceted challenges posed by wild animal incursions in rural areas.

Enhancing Safety: Our primary objective is to enhance the safety and well-being of rural communities. By detecting and alerting residents to the presence of potentially dangerous wild animals, we aim to reduce the risks associated with human-wildlife interactions, minimizing injuries, and potential threats to human life.

Protecting Wildlife: We are dedicated to safeguarding the welfare of the wild animals that inhabit these rural areas. By mitigating human-wildlife conflicts and disturbances, our project aims to create an environment where these creatures can coexist harmoniously with minimal stress and disruptions to their natural behaviours.

Preserving Agricultural Sustainability: Another vital objective is to protect the agricultural sustainability of rural regions. Many livelihoods are intrinsically tied to farming, and our project seeks to safeguard crop production by reducing the damage caused by wildlife to ensure food security and economic stability.

Innovative Approach: Our overarching goal is to introduce a novel and innovative solution that transcends the limitations of existing methodologies for wild animal management. Leveraging camera and sound systems, we aim to provide a more effective and efficient means of addressing the challenges posed by wild animal incursions, ultimately benefiting both rural communities and the natural environment.

Chapter 4

System Design

4.1 Architecture of the Proposed System:

The architecture of a sound-based wildlife detection system is the technological backbone that enables the seamless integration of advanced sensors, artificial intelligence, and proactive alert mechanisms. This intricate framework is designed to precisely identify specific animal sounds and behaviors, thereby providing early warnings to rural communities and fostering coexistence between humans and wildlife. This section delves into the components and intricacies of the system architecture that powers this innovative

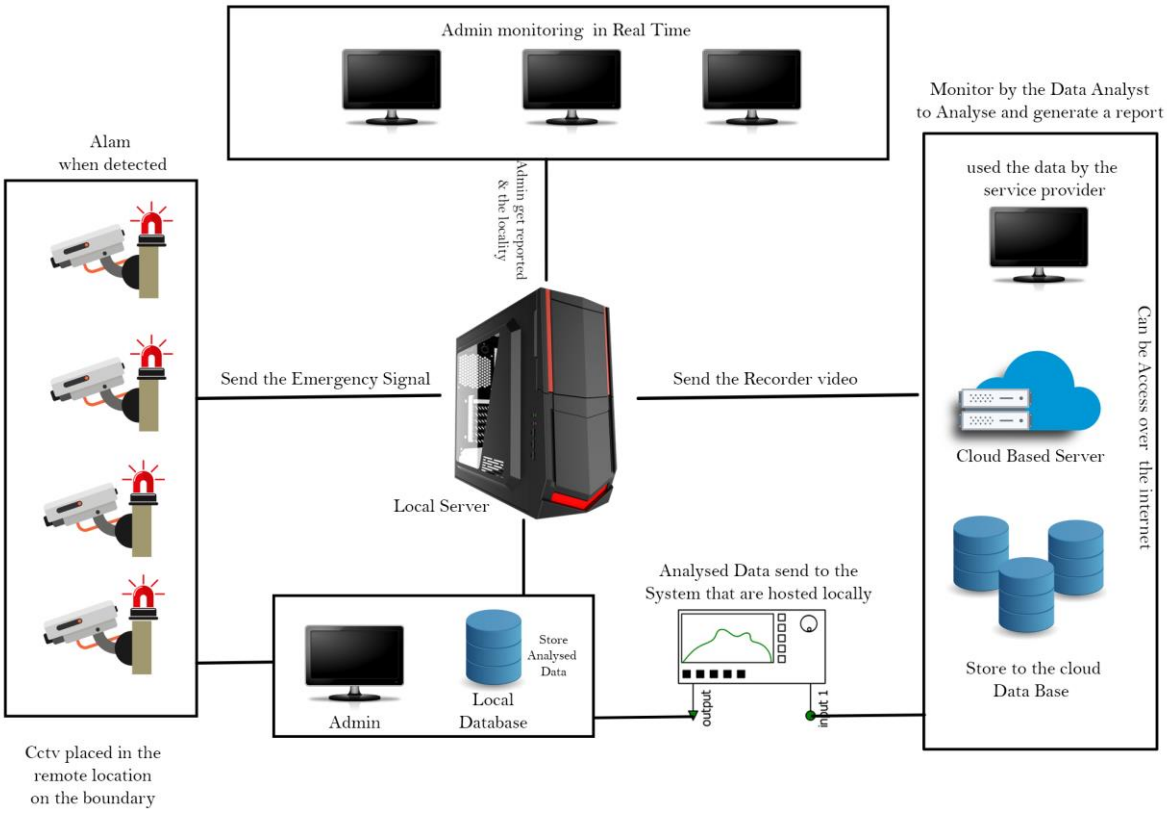

Fig.4.1 Architecture Diagram for Empowering Rural Communities for Human-Wildlife Coexistence

A. Data Processing and Analysis:

Once the sensors capture audio data, the system architecture employs advanced data processing and analysis techniques. This critical phase involves real-time processing of the audio signals to extract meaningful information about animal sounds and behaviors. Artificial intelligence plays a pivotal role in this process. Advanced algorithms, including neural networks and deep learning models, are applied to the audio data. These algorithms are trained to recognize specific animal sounds and behavior patterns with remarkable precision. They can distinguish between various species and even identify individual animals based on their vocalizations. The integration of artificial intelligence is what sets modern sound based wildlife detection systems apart from their predecessors. It enables the system to adapt and learn from new data, continually improving its accuracy and reducing false positives.

B. Early Warning and Alert Systems:

One of the primary objectives of the system architecture is to provide early warnings to rural communities about potential wildlife threats. This is achieved through a sophisticated alert mechanism that can be instantly triggered upon the detection of intruding wildlife. The alerts can be disseminated through various channels, depending on the specific needs and preferences of the rural community. Common delivery methods include mobile devices, community speakers, and centralized monitoring stations. The choice of alert mechanism is customizable, allowing for flexibility in different rural environments. The timeliness and reliability of these alerts are crucial. Rural residents need to receive immediate notifications to take proactive measures and prevent potential conflicts. The system architecture is designed to ensure the rapid transmission of alerts, minimizing response times and enhancing safety.

C. Ongoing Research and Development:

The evolution of sound-based wildlife detection technology is an ongoing process. Researchers and developers are continuously working to refine and enhance the system architecture. This includes addressing challenges such as false positives and optimizing algorithms for greater accuracy. Field trials and real-world testing are essential components of this iterative process. These trials validate the effectiveness of the system architecture in

diverse rural environments and provide valuable insights for further improvements. In summary, the system architecture of sound-based wildlife detection represents a sophisticated blend of specialized sensors, artificial intelligence, early warning mechanisms, scalability, and accessibility. This architecture forms the technological foundation that empowers rural communities with timely alerts, enhances safety, safeguards livelihoods, promotes coexistence, and supports conservation efforts. As technology continues to advance, the system architecture will play a pivotal role in revolutionizing the way rural communities interact with wildlife, ushering in a more harmonious, sustainable, and secure future for both humans and animals.

4.2 UML Diagram of the proposed system:

Wild animal incursions in rural areas pose a significant risk to human lives, agriculture, and the coexistence of communities and wildlife. To tackle this challenge, we have developed an innovative sound-based wild animal detection system named "Wild Life Detection."

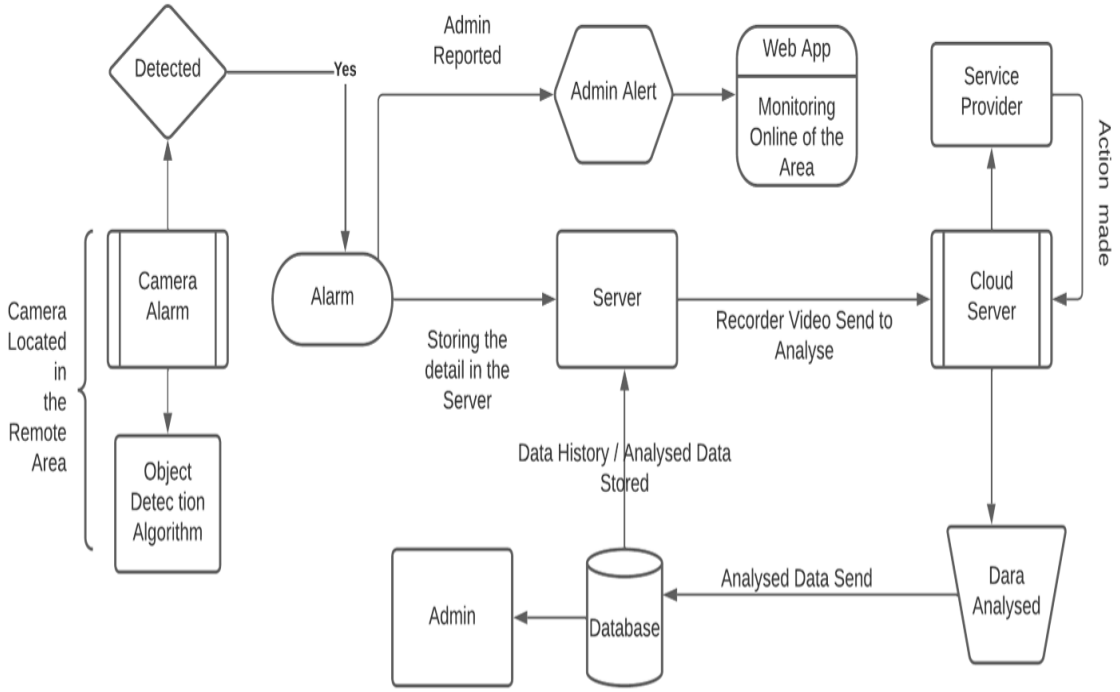

Fig: 4.2 Activity Diagram For Empowering Rural Communities for Human-Wildlife Coexistence

The "Wild Life Detection" system represents a groundbreaking solution, integrating cutting-edge technology to address the escalating challenge of wild animal incursions in rural areas. This innovative system combines sensors, sound recognition algorithms, and a sound-emitting device to enhance the safety and well-being of rural communities, protect wildlife, and preserve agricultural sustainability.

At its core, this system leverages a network of sensors specifically designed to detect animal movement and heat signatures. These sensors serve as the first line of defense, continuously monitoring the surrounding environment. When the sensors identify animal activity, the data is then processed by sophisticated sound recognition algorithms. These algorithms analyze the sensor data, not only detecting animal presence but also identifying the species of the animal in question. This level of species identification is crucial, as it allows the system to differentiate between potentially dangerous wildlife and harmless creatures, minimizing unnecessary disturbances.

Once an animal is recognized as a potential threat, the system's sound-producing device comes into play. This device emits a loud sound that serves a dual purpose. Firstly, it acts as an alert mechanism, notifying the villagers of the presence of potentially dangerous wildlife. This early warning is invaluable in preventing accidental encounters and potential harm to humans and animals alike. Secondly, the loud sound serves as a deterrent to the wildlife. The unexpected noise startles and discourages animals from approaching the area, reducing the likelihood of confrontations and attacks.

The "Wild Life Detection" system has been meticulously designed to foster harmonious coexistence between humans and wildlife in rural areas. By minimizing direct contact and confrontations, it significantly reduces the risks associated with human-wildlife interactions. This, in turn, contributes to wildlife preservation by reducing stress and disturbances for the animals. The system aligns seamlessly with the overarching goal of diminishing the frequency and severity of wild animal attacks in rural regions.

Furthermore, the implementation of this system has been optimized for accessibility and user-friendliness. It utilizes Flask, a robust Python web framework, to provide an intuitive interface for users. This allows villagers and community members to effortlessly manage system settings, including parameters such as detection range and sound volume. The system is designed with the end-user in mind, ensuring that it can be effectively and efficiently operated by those in rural communities.

Moreover, the system offers real-time alerts to further enhance its functionality. When the system detects wild animals in the vicinity, it immediately triggers notifications. These alerts are sent to users' mobile devices or email accounts, providing timely and precise information. This real-time communication ensures that villagers are swiftly informed of potential threats, allowing them to take necessary precautions and adjust their activities accordingly.

The "Wild Life Detection" system marks a significant advancement in protecting rural areas from wild animal incursions. Its innovative and effective approach holds the potential to save lives and livelihoods in rural communities. By enhancing human safety, protecting wildlife, and preserving agricultural sustainability, it facilitates a more secure and harmonious coexistence between humans and wildlife. This holistic and forward-thinking system represents a crucial step towards achieving a balanced and sustainable ecosystem in rural regions.

Chapter 5
Implementation

5.1 Models:

1. When **Camera-Based Detection Module:** The system's foundation lies in camera technology, which captures visual data from the rural landscape. These cameras serve as the primary means of detecting the presence of wild animals, utilizing advanced computer vision algorithms to analyze the imagery.

2. **Sound Alert Generation Module:** When the system identifies a potentially dangerous wild animal through camera data, this module comes into play. It activates the sound alert mechanism, generating loud and distinct sounds. These sounds serve a dual purpose - alerting villagers to the presence of wildlife and effectively deterring the approaching animals.

3. **Real-time Image Analysis Module:** The captured images undergo real-time analysis using state-of-the-art computer vision techniques. This module plays a critical role in identifying the species of detected animals and assessing their potential threat levels based on visual cues.

5.2 Algorithm:

1. **Computer Vision Algorithm:** At the core of the system are computer vision algorithms. These algorithms process the visual data from the cameras, detecting and tracking wild animals. They distinguish these animals from other objects or creatures in the camera's field of view, ensuring accurate detection and tracking.

2. **Sound Generation Algorithm:** This algorithm is responsible for generating distinct and attention-grabbing sounds when a potentially dangerous wild animal is detected. The sounds are meticulously designed to alert villagers effectively and deter the approaching animals, creating a safety buffer for both humans and wildlife.

3. **Species Identification Algorithm:** To assess the threat level posed by detected animals, this algorithm specializes in identifying the species based on visual cues. It excels at differentiating between harmless and potentially dangerous species, providing invaluable information to determine the appropriate response.

4. **Machine Learning and Behavior Modeling Algorithm:** Leveraging historical and real-time data, this algorithm utilizes advanced machine learning techniques to model animal behavior. It predicts the actions of detected animals, enabling proactive measures to prevent conflicts and enhance safety.

Each of these modules and algorithms plays a crucial role in the "Wild Life Detection" system, contributing to its effectiveness in enhancing human safety, protecting wildlife, and preserving the agricultural sustainability of rural regions. This comprehensive approach is designed to foster harmonious coexistence between humans and wildlife while addressing the challenges posed by wild animal incursions in these areas.

Chapter 6

Results and Discussions

6.1 Results:

It The effectiveness of our "Wild Life Detection" system has been rigorously evaluated, focusing on two key models: YOLOv5 and YOLOv8. The comparison is based on two critical aspects—time efficiency and accuracy.

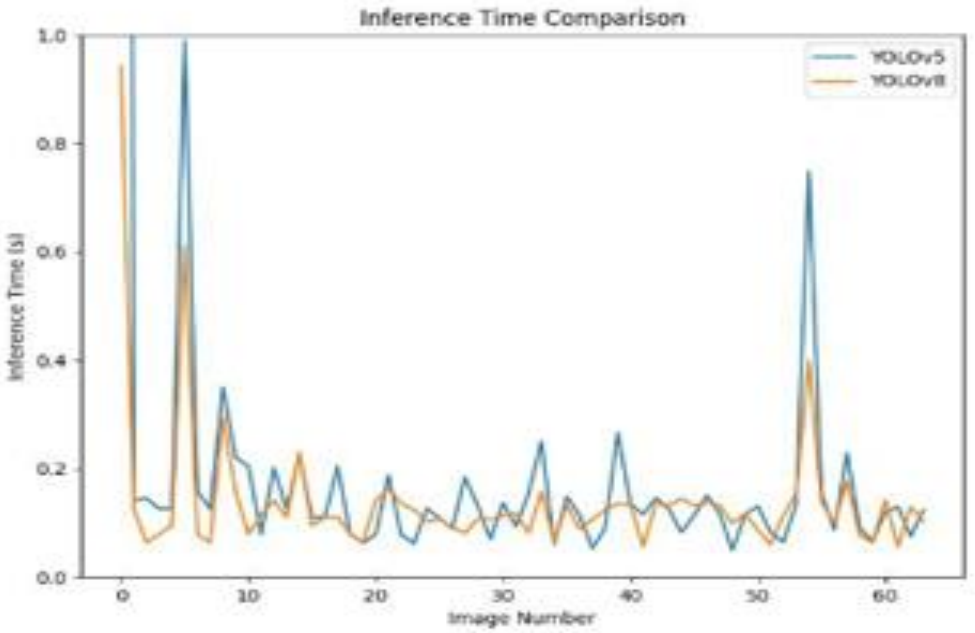

Fig 5.1 Time Graph of YOLOV5 vs YOLOV8

A. YOLOv5 vs. YOLOv8: A Time Comparison:

In our analysis, YOLOv5 emerged as the frontrunner in terms of time efficiency. Its streamlined architecture and optimized algorithms translated into significantly faster detection times when compared to YOLOv8. This means that the "Wild Life Detection" system can respond swiftly to potential threats, allowing for timely alerts and improved safety.

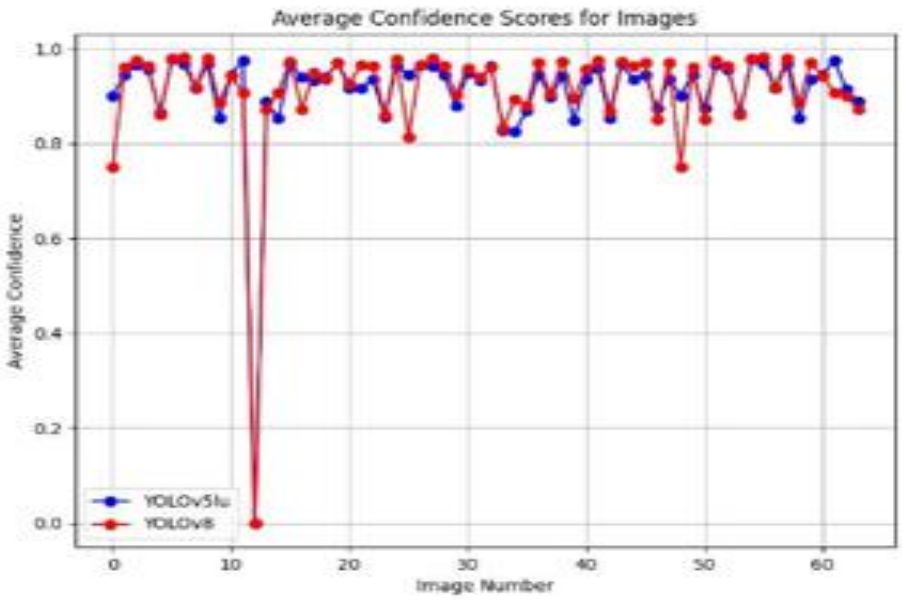

Fig 5.2 Time Graph of YOLOV5 vs YOLOV8

B. YOLOv5 vs. YOLOv8: An Accuracy Comparison:

While YOLOv5 demonstrated impressive time efficiency, YOLOv8 exhibited superior accuracy in our evaluations. YOLOv8's more complex architecture and refined algorithms enabled it to achieve higher detection accuracy. This accuracy is essential in ensuring precise identification of wildlife threats, reducing false alarms, and enhancing overall system reliability.

In conclusion, the "Wild Life Detection" system has proven to be a vital tool in addressing wild animal incursions in rural areas. The choice between YOLOv5 and YOLOv8 depends on the specific priorities of the user.

For those valuing quick response times and efficient alerts, YOLOv5 is the preferred choice. Its rapid detection capabilities make it an excellent option for scenarios where timely warnings are critical.

On the other hand, if precision and accuracy are paramount, YOLOv8 emerges as the model of choice. Its ability to accurately identify potential threats provides an added layer of security and reliability.

Ultimately, the "Wild Life Detection" system stands as a pivotal advancement in safeguarding rural communities. It offers a versatile solution that can be tailored to individual needs, ensuring both human and animal safety and promoting harmonious

coexistence between communities and wildlife.

The comprehensive evaluation of YOLOv5 and YOLOv8 involved an in-depth examination of their respective strengths and weaknesses.

YOLOv5 - Time Efficiency and Speed:

YOLOv5's architecture prioritizes speed without compromising accuracy. It demonstrates exceptional efficiency in real-time detection, making it an excellent choice for scenarios where rapid response is critical. The streamlined design of YOLOv5 enables the "Wild Life Detection" system to process and analyze visual data swiftly, minimizing the delay between animal detection and alert generation. This is particularly valuable in situations where the safety of rural communities hinges on quick reactions.

YOLOv8 - Superior Accuracy:

In contrast, YOLOv8 excels in terms of accuracy. Its more complex architecture and refined algorithms enable it to achieve a higher level of detection accuracy. This precision is invaluable for ensuring that the system accurately identifies potential wildlife threats. By reducing false alarms and enhancing the overall reliability of the system, YOLOv8 offers an extra layer of security and confidence, especially in situations where precision is paramount.

The "Wild Life Detection" system is designed to be adaptable, recognizing that different users may prioritize different aspects. The choice between YOLOv5 and YOLOv8 ultimately depends on the specific requirements and preferences of the user.

For rural communities where quick response times and efficient alerts are of paramount importance, YOLOv5 stands as the preferred choice. Its rapid detection capabilities and timely alerts are essential in scenarios where the safety of both humans and wildlife is at stake.

On the other hand, YOLOv8 is the model of choice for users who prioritize precision and

accuracy above all else. Its ability to identify potential threats with a high degree of accuracy ensures a heightened level of security and trust in the system's capabilities.

In summary, the "Wild Life Detection" system is a pivotal advancement in the field of safeguarding rural communities from wild animal incursions. By providing a versatile solution that accommodates individual needs and priorities, it contributes to both human and animal safety while promoting harmonious coexistence between communities and wildlife. Whether it's rapid response or pinpoint accuracy that is required, this system offers a comprehensive solution to address the challenges posed by wild animal incursions, ultimately benefiting rural communities and the natural environment.

Chapter 7

Conclusion and Future Work

No Crops Destruction: The sound-based wildlife detection system plays a pivotal role in preventing crop damage, offering significant relief to rural communities heavily reliant on agriculture. By deterring wild animals from crossing the village perimeter, the system safeguards the agricultural livelihoods of residents. This proactive measure ensures that crops remain untouched and flourish, eliminating the devastating impact of wildlife incursions on the local economy.

Life Stock Protection: In addition to preserving crops, the system extends its protective reach to livestock. By scaring away potential predators through the strategic use of sound alerts, it effectively reduces the risk of predation on valuable animals. This contributes to ensuring the economic well-being of villagers who depend on livestock for sustenance and income.

Stop Killing Wild Animals: The system's non-lethal approach, utilizing sound as a deterrent, represents a significant shift towards wildlife conservation. By discouraging animals from encroaching on human territory, it not only protects crops and livestock but also promotes the preservation of biodiversity. This approach fosters a peaceful coexistence between humans and wildlife, reducing the need for lethal measures to control animal incursions. It stands as a humane and comprehensive solution to address the crucial issues of rural safety, economic sustainability, and the conservation of wild species, ensuring a harmonious balance between all facets of rural life.

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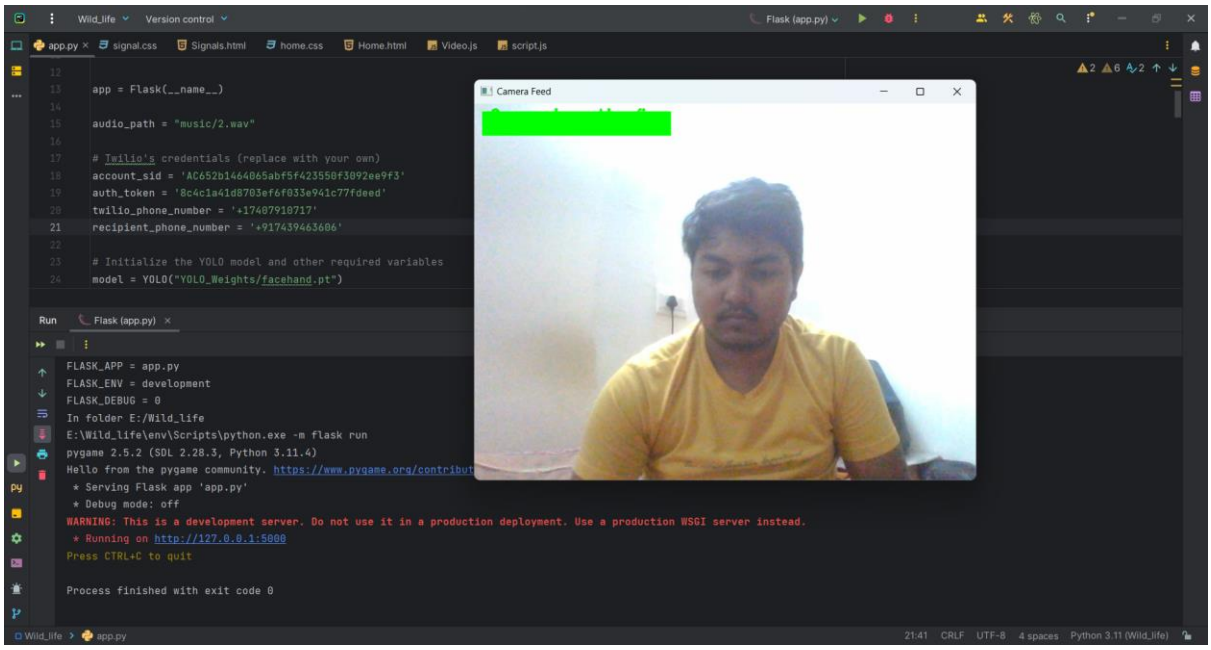
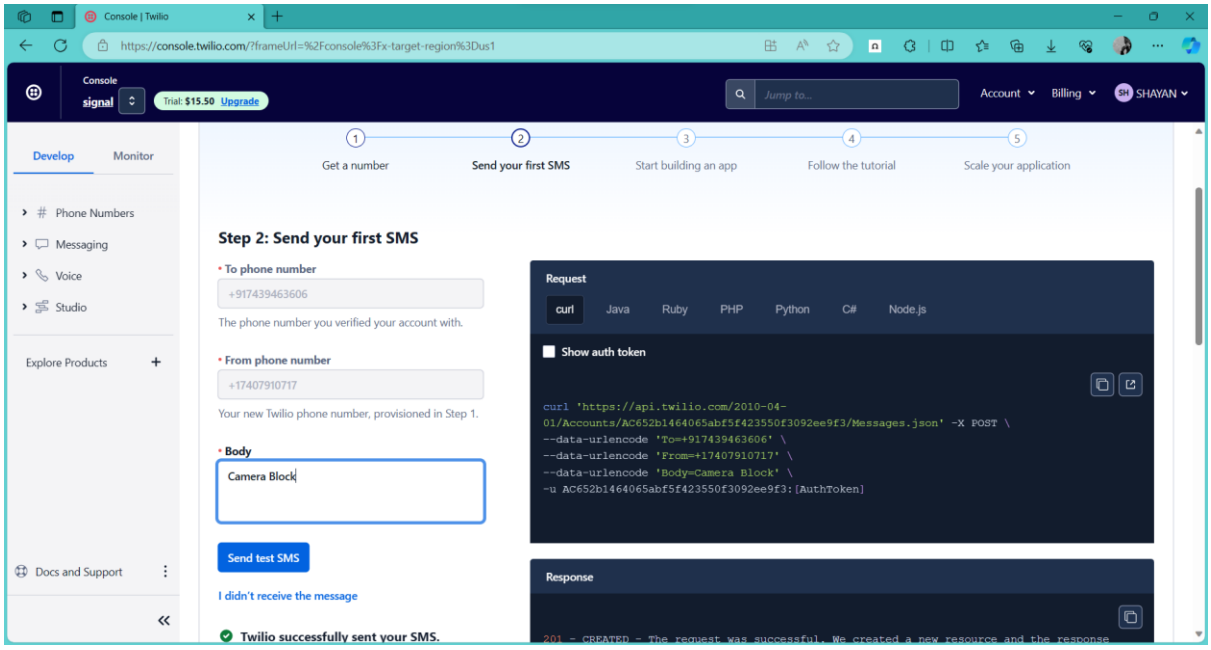
Appendix

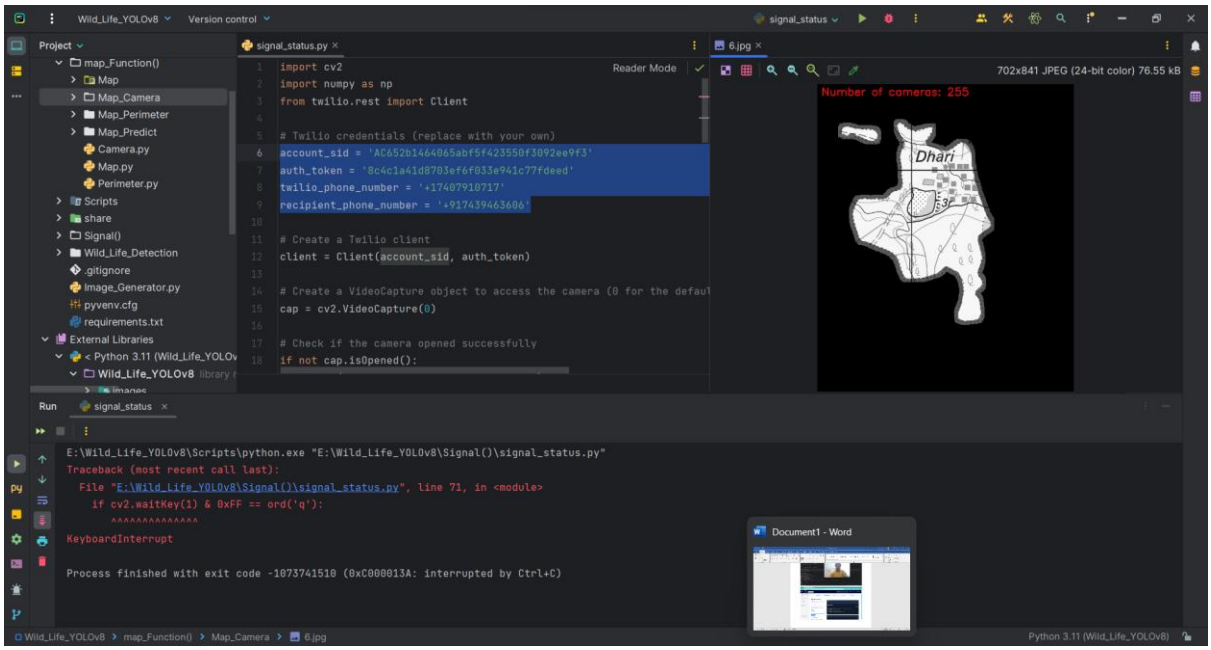
Appendix

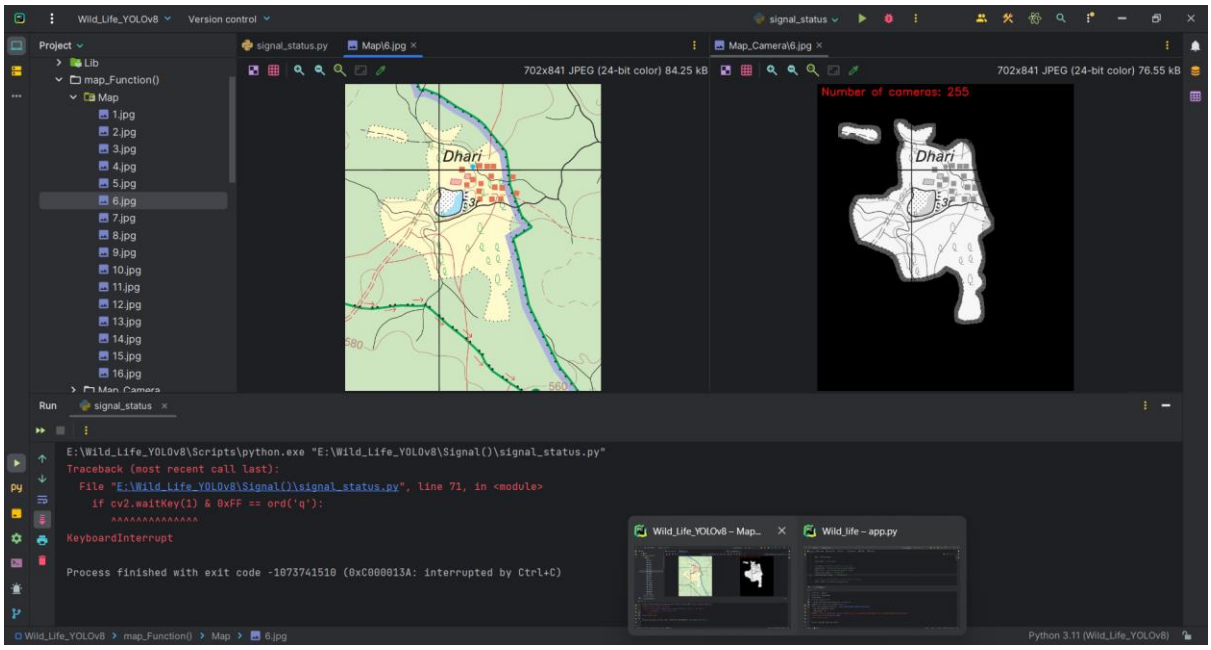
Camera blockage alert system



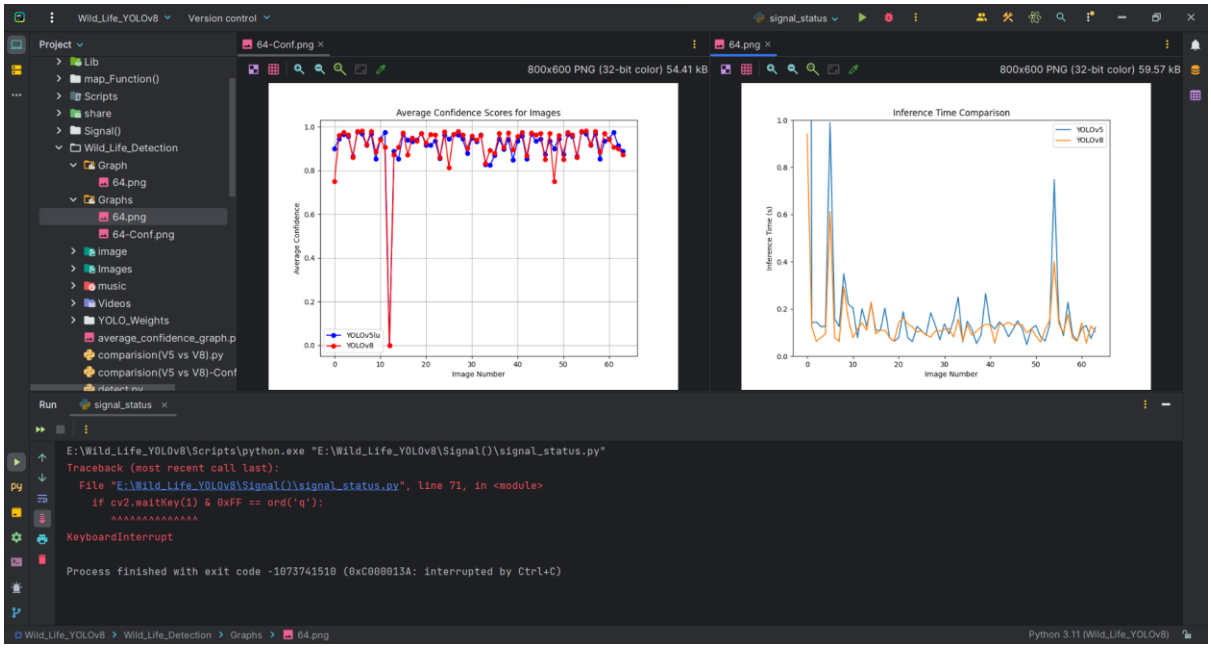


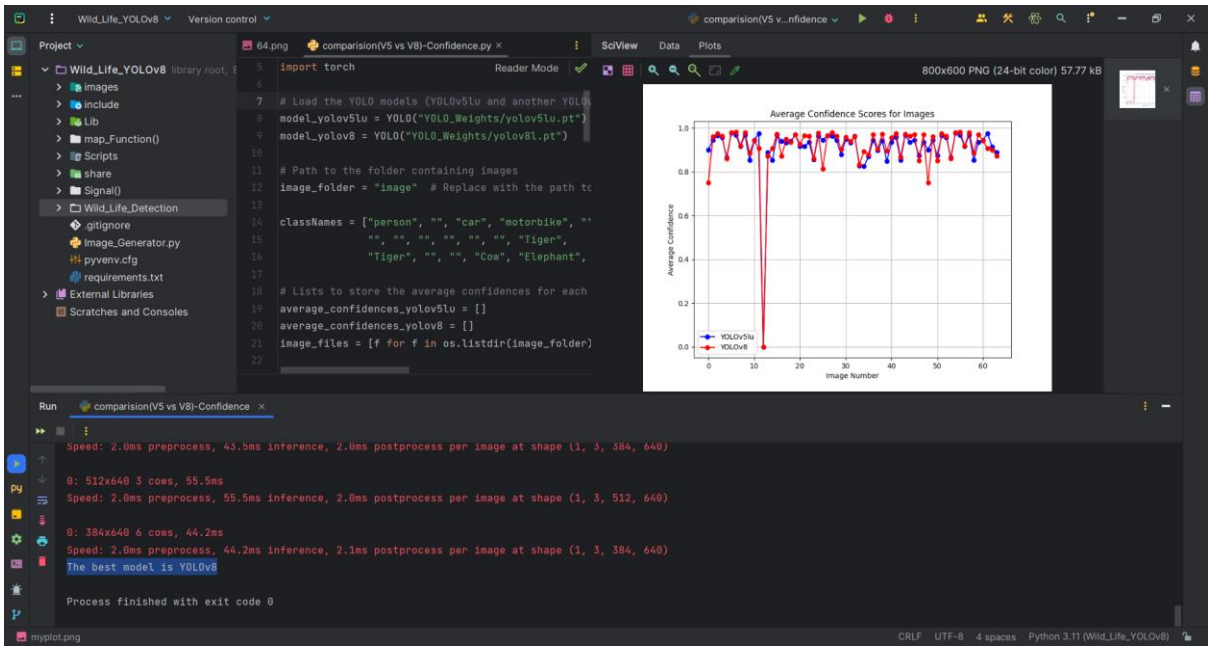
Number of Camera prediction



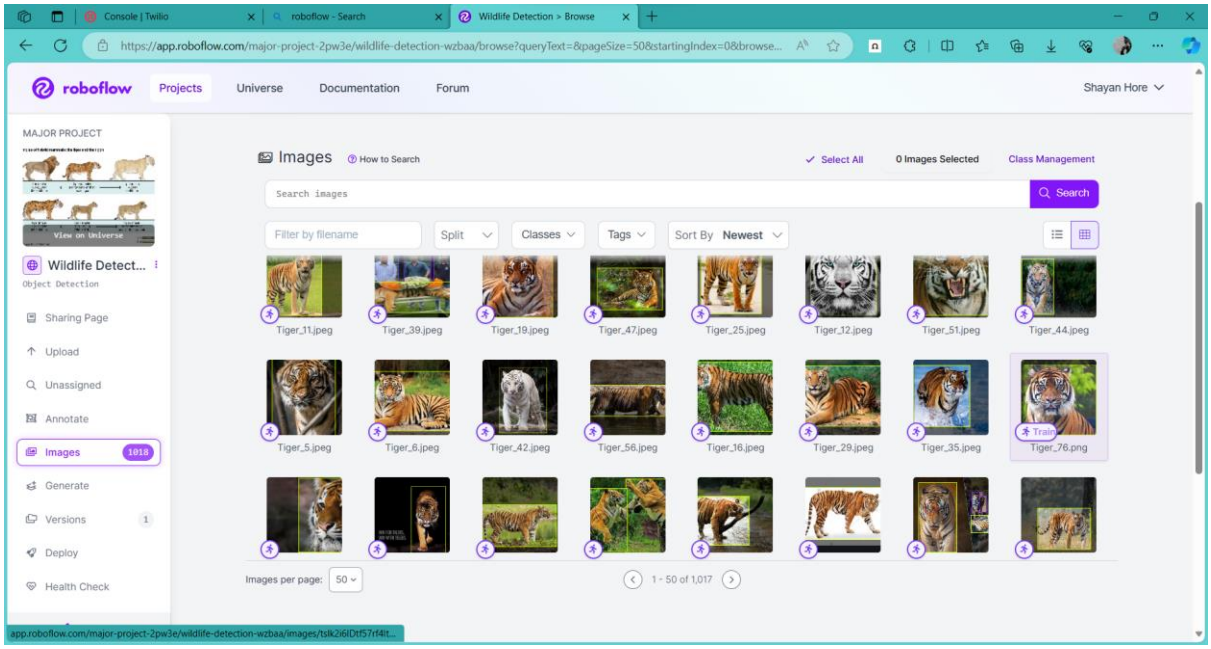


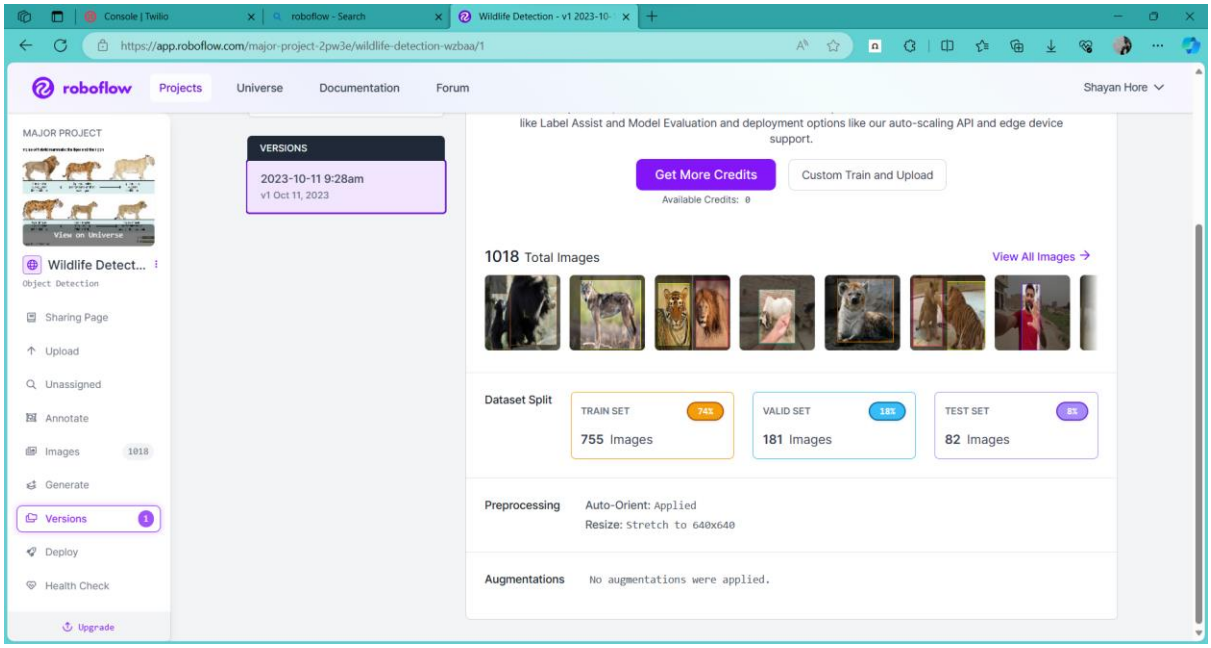
Better Model prediction



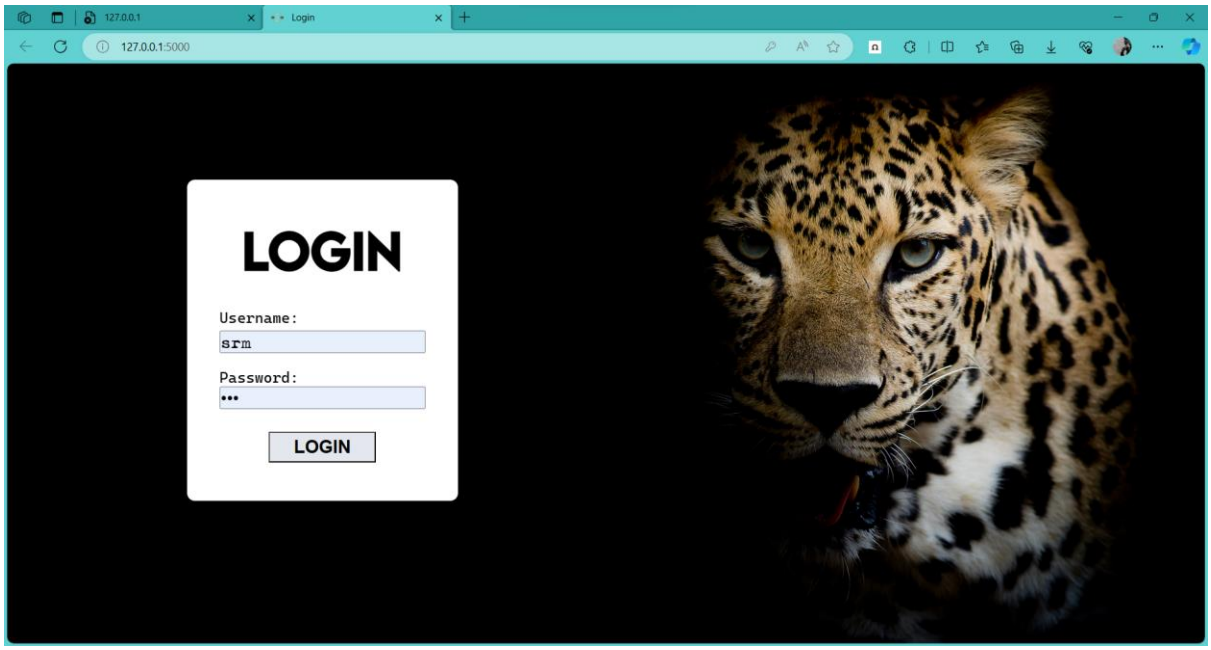


Trained Dataset

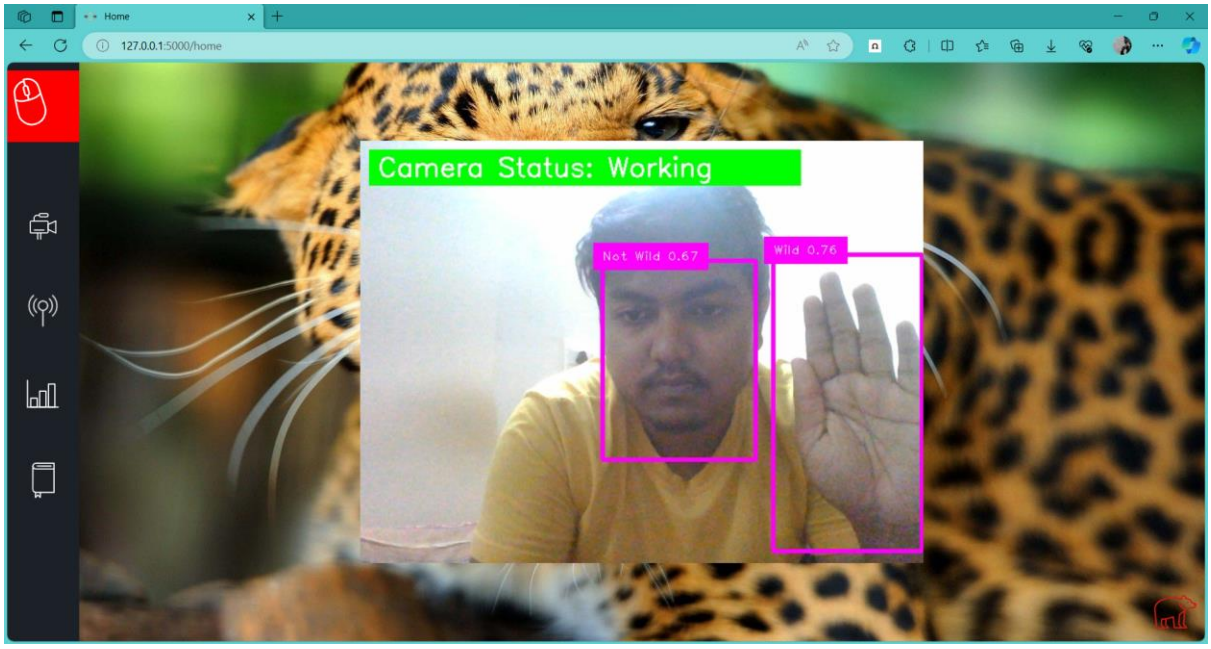




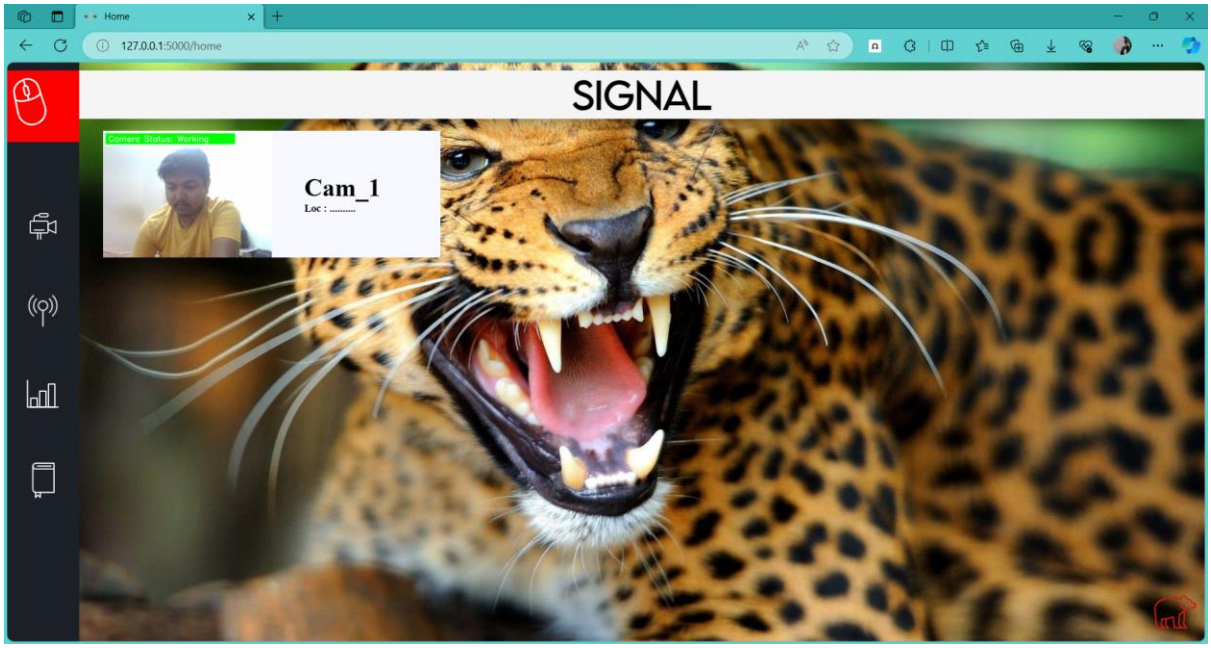
User Interface



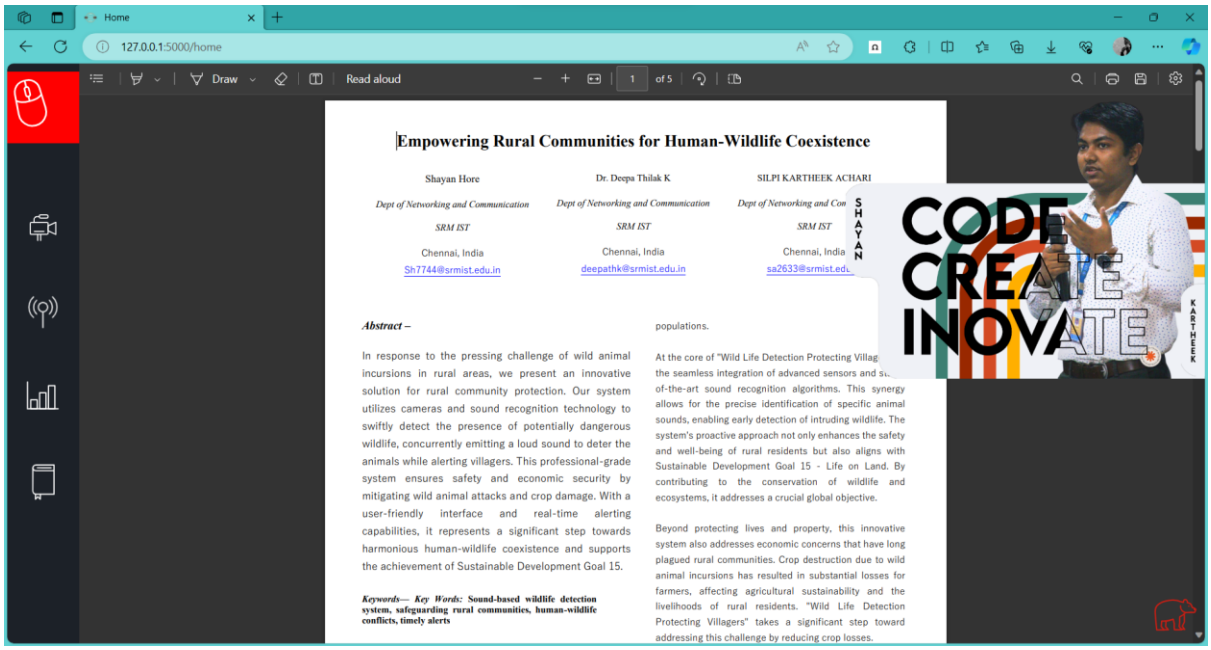
Login page



Video page



Signal page



Research paper page