Smart Wildlife Security: Fog-Powered Video Compression for Cloud Efficiency

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Abstract

To address the pressing issue of wild animal incursions in rural areas, we propose an inventive solution to safeguard local communities, the project integrates fog computing and smart video compression. The system records continuous 24-hour video footage, employing intelligent algorithms to detect and transmit only relevant segments to the cloud. This reduction in data load enhances efficiency and conserves resources. The process generates a detailed document report, offering comprehensive documentation of wildlife activities for effective monitoring and analysis. The integration of these technologies not only improves security measures but also contributes to sustainable, resource-efficient solutions in wildlife protection.

Keywords— Key Words: **Wildlife security, fog computing, smart video compression, security measures, wildlife activities**

I. INTRODUCTION

In response to the escalating challenges posed by human-wildlife conflicts in rural areas, innovative solutions are imperative for enhanced security and efficient surveillance. One pioneering approach to address these issues involves the integration of cutting-edge technologies such as fog computing and intelligent video compression.

The primary objective of this initiative is to optimize data management by continuously capturing 24-hour video footage. Through the application of intelligent algorithms, the system selectively transmits only pertinent segments to the cloud. This not only ensures the conveyance of relevant information but also alleviates the burden of data overload, leading to more streamlined and efficient operations.

Fog computing plays a crucial role in enhancing the system's architecture. By processing data closer to the source, it minimizes latency and improves overall responsiveness. In the context of human-wildlife conflicts, timely information is of paramount importance for effective intervention and prevention measures.

Comprehensive documentation is another cornerstone of this innovative approach. Intelligent video compression not only conserves bandwidth but also facilitates the creation of detailed PDF reports. These reports serve as invaluable resources for real-time monitoring and post-event analysis, providing crucial insights into wildlife behavior and aiding in the development of effective conservation strategies.Beyond addressing immediate security concerns, this approach aligns with sustainable practices in wildlife protection. The selective transmission of relevant data reduces resource consumption, contributing to an environmentally friendly solution. This underscores the commitment to promoting a harmonious coexistence between human activities and wildlife preservation.

In essence, the integration of fog computing and intelligent video compression represents a paradigm shift in rural security strategies. This approach not only tackles the challenges posed by human-wildlife conflicts but also sets the stage for a more sustainable and technologically advanced method. With a focus on optimized data management, efficient surveillance, and comprehensive documentation, this initiative serves as a beacon for ensuring the safety of rural communities and the preservation of wildlife in an ever-changing landscape

II. LITERATURE REVIEW

In a paper titled "Human-Wildlife Coexistence: Business as Usual Conservation or an Opportunity for Transformative Change" authored by Valentina Fiasco and Kate Massarella in 2022, the conventional approaches to conservation are critically examined. The paper questions the adequacy of current strategies and explores whether there exists untapped potential for transformative change. It delves into the intricacies of human-wildlife coexistence, scrutinizing existing conservation paradigms, and proposes alternative frameworks that could facilitate a more sustainable and harmonious relationship. The study employs face detection techniques and wireless sensors for alerts, introducing innovative technologies to enhance the understanding and management of the dynamics between humans and wildlife.

The paper titled "Participatory Scenario Planning to Facilitate Human–Wildlife Coexistence," Maraja Riechers, Ruth Kansky, and Joern Fischer challenge conventional conservation approaches. They question the sufficiency of current strategies and explore the potential for transformative change, examining the dynamics of coexistence between humans and wildlife. The paper critically analyzes existing conservation paradigms and proposes alternative frameworks to foster a more sustainable and harmonious relationship. Key techniques employed in the study include Geographic Information Systems (GIS), modeling software, and data visualization tools.

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In a paper titled "Rural Livelihoods, Community-Based Conservation, and Human–Wildlife Conflict: Scope for Synergies," authored by Maximilian Meyer and Jan Borner, the study explores innovative strategies to address conflicts, aiming to align conservation efforts with the economic needs of local communities. Employing a multidisciplinary approach, the project analyzes social, economic, and ecological dimensions to identify synergies benefiting both wildlife preservation and sustainable rural livelihoods. Utilizing techniques such as Social Media Analysis, Remote Sensing, and Community-Based Monitoring Platforms, this research is poised to offer valuable insights for policymakers, conservationists, and community leaders dedicated to fostering a harmonious coexistence between humans and wildlife.

In the paper titled "Wild Animals Intrusion Detection for Safe Commuting in Forest Corridors using AI Techniques," authored by J. Joshua Daniel Ra, Sangeetha.C.NSArthak Ghori, and presented in 2023, the research delves into strategies to mitigate fatalities resulting from wild animal attacks through the implementation of early detection systems. The investigation focuses on the application of face detection technology, template matching algorithms, and computer vision techniques to identify animal movements. Additionally, the study introduces the utilization of wireless sensor networks equipped with detection nodes to promptly alert drivers to nearby animal activity.

In their paper titled "Design and Development of a Fog-Assisted Elephant Corridor over a Railway Track," authors Manash Kumar, Riman Mandal, Sourav Banerjee, Monali Sanyal, Uttam Ghosh, and Utpal Biswas, published in 2023, the focus is on object counting within the domain of computer vision. The research delves into three distinct model types: detection-based, regression-based, and density-based, providing a meticulous analysis of their individual strengths and weaknesses, thereby offering a comprehensive perspective on their applicability. The paper extensively discusses related work, elucidates the methodology employed in experiments, and presents the findings and results obtained from the research. In conclusion, the paper identifies potential avenues for future exploration and development within the field of object counting, highlighting areas that warrant further research. The chosen technique for this investigation is Object Counting, with specific emphasis on Computer Vision using Detection-based Models, Regression-based Models, and Density-based Models.

III. SYSTEM DESIGN OF SMART WILDLIFE SECURITY

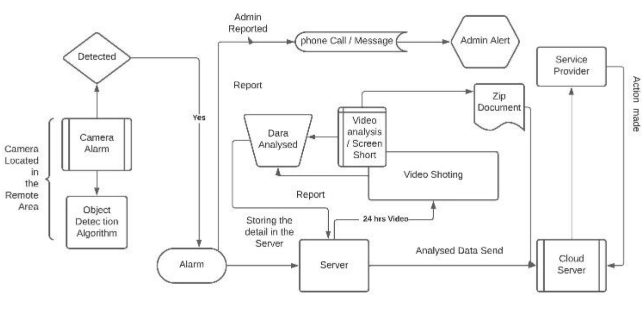

Fig 3.1 UML Diagram of Smart Wildlife Security: Fog Powered Video Compression for Cloud Efficiency

IV. SYSTEM ARCHITECTURE AND DESIGN

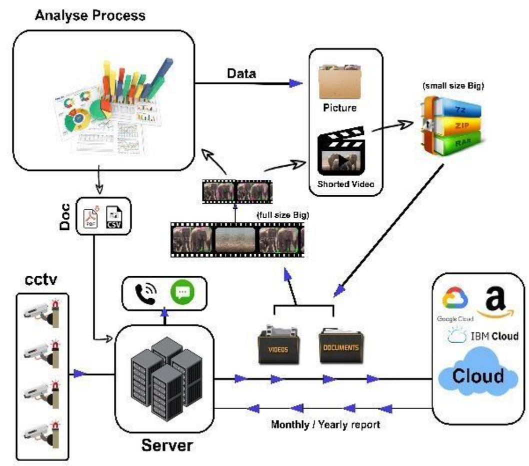

Fig 4.1 System Architecture of Smart Wildlife Security:Fog-Powered Video Compression for Cloud Efficiency

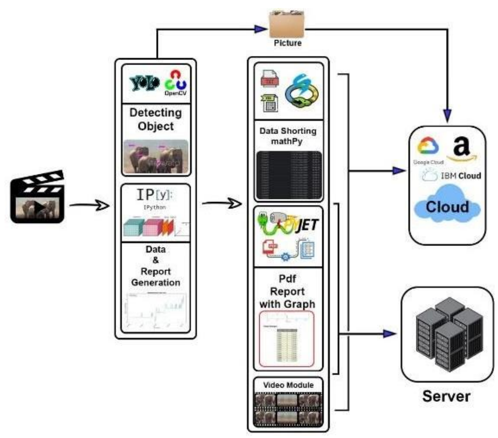

Fig 4.2 Software Architecture of Smart Wildlife Security:Fog-Powered Video Compression for Cloud Efficiency

A. Video Capture and Frame Extraction with smart video compression Algorithm

The Video Capture Module stands as a foundational element in the system, employing the sophisticated Frame Extraction algorithm. Positioned strategically in the monitored area, cameras continuously capture video footage. The algorithm isolates individual frames from the video stream, laying the groundwork for subsequent processing.

Step 1 -Capture the video and convert it into frames.
Step 2 -Employ an object detection algorithm to identify objects in each frame. When an object is detected, track the object and store the current frame as well as the last frame where the object was detected.
Step 3 -In frames where the object is not detected, use the previous frame and extend it throughout that time period.
Step 4 -Merge the processed frames to generate a video sequence.
Step 5 -Multiple videos may be generated from different object detections. Merge all the videos to create a consolidated video and execute the final trimmed video.

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Step 6 -Enhance security by applying salt and a key to the video for encryption purposes.
Step 7 -Implement a client-server architecture using socket techniques. Send the video from the client to the server for further processing.
Step 8 -Decrypt the final input on the server side for analysis or storage

B. Data Transmission Module: Dynamic Data Transmission Algorithm

The Data Transmission Module introduces the Dynamic Data Transmission algorithm. This intelligent algorithm ensures that only compressed, relevant video segments are transmitted to the cloud for storage. The system dynamically manages transmission based on detected wildlife activities, effectively addressing the challenge of data overload. This adaptive approach conserves resources and judiciously utilizes cloud storage.
Step 1 - Encrypt the data using salt.
Step 2 - Compress the image file to decrease its size.
Step 3 - Combine the compressed files into a zip archive and encrypt both the key and salt used for generating the file.
Step 4 - Send the encrypted and compressed zip file to the server.
Step 5 - Unzip or decrypt the received file on the server using the saved salt key and extract the data.
Step 6 - Conclude the process by generating a comprehensive report summarizing key details and outcomes achieved through the data transmission system.

In conclusion, the integration of the Frame Extraction, Selective Video Compression, and Dynamic Data Transmission algorithms establishes a sophisticated technological foundation. This architecture efficiently captures and processes continuous video footage while optimizing data transmission, conserving resources, and enhancing overall system performance. The iterative refinement of these algorithms ensures the system's continued effectiveness in wildlife monitoring and protection amidst evolving technological landscapes.

V. RESULTS AND CONCLUSION

YOLOv8 stands out as more efficient than the sliding window technique in our wildlife detection system. With its streamlined architecture and optimized algorithms, YOLOv8 ensures swift detection times, allowing for timely alerts and improved safety. Its superior time efficiency stems from its ability to quickly process large amounts of data, making it the preferred choice for scenarios where rapid response times are critical.

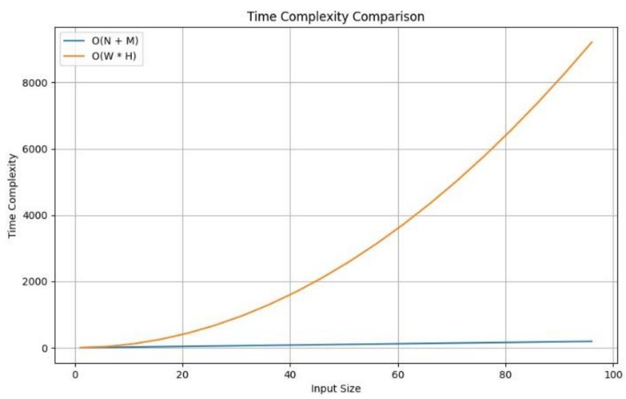

Fig 5.1 Time complexity graph of Video Trimming between Object Detection and Sliding Window Technique

In contrast, while the sliding window approach exhibits satisfactory performance, it lacks the efficiency and speed offered by YOLOv8. The sliding window technique involves processing each window of the image separately, resulting in slower detection times compared to YOLOv8's holistic approach.

Furthermore, YOLOv8's efficiency does not compromise on accuracy. Its complex architecture and refined algorithms enable it to achieve higher detection accuracy compared to the sliding window technique. This accuracy is essential for precise identification of wildlife threats, reducing false alarms, and enhancing overall system reliability.

In conclusion, YOLOv8 emerges as the preferred model for efficient and accurate wildlife detection in our system. Its ability to swiftly and accurately identify potential threats underscores its importance in safeguarding rural communities against human-wildlife conflicts. As we continue to refine our system, YOLOv8 will remain integral to ensuring both human and animal safety and promoting harmonious coexistence between communities and wildlife.

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