Machine Learning and Conservation: An Animal Tracking and Monitoring Algorithm for Sanctuaries and Conservationists

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ABSTRACT
There is a notable gap in the availability of continuous, unobtrusive animal tracking systems that can operate through live camera feeds despite the existence of many camera feeds. I propose utilizing a modified object identification algorithm to identify and track animals to monitor their habits and better care for their health. The algorithm will be able to process live camera feeds to identify and monitor the movements, activities, and habits of animals in captivity, eliminating the need for physical tagging and human observation. The results of this proposed solution will showcase how effectively such an algorithm can provide accurate data with a significant reduction in effort needed. Future work should focus on improving the algorithm's utility across various conditions and expanding its applications to a more diverse range of species and habitats as well as targeting issues such as low-light settings.

1. INTRODUCTION

Tracking and monitoring of animals, especially those in captivity, is important to understanding their behaviors, ensuring their activities are not irregular, and caring for their overall health. As animal live-cams have become readily available, an opportunity to revolutionize animal monitoring has risen. Despite this, current tracking methods are still largely dependent on physical tagging and direct human observation. Tagging is extremely invasive and is often only useful for tracking general movements of an animal in the wilderness while falling short for those in captivity.

Direct human observation is the most commonly-used strategy for animals in captivity which is often labor intensive. In more recent years, Alveus Sanctuary has begun live streaming animal cams 24/7, allowing the general public to watch them, which resulted in the public noticing and informing staff members almost immediately when one of their wolfdogs was injured. While the animal was unable to be saved, it was saved from much suffering because of the quick action of the general public watching the cams when the staff could not. Almost all sanctuaries lack this kind of public engagement which is precisely the gap in animal care a monitoring algorithm aims to solve.

2. RELATED WORKS

Applications for machine learning in wildlife conservation, particularly for monitoring, have slowly gained attention in recent years as image processing and real time data analysis software have both improved. A large part of this is due to how much data on animal behaviors modern sanctuaries are able to create, mainly through live camera feeds of enclosures. Despite the availability of this data,

processing has remained largely but not entirely unaddressed. Machine learning *has* been used for analyzing large wildlife datasets to get some insights on behaviors and habits and studies show integrating machine learning and wildlife expertise to effectively analyze data can both improve informed decision making and reduce necessary human intervention (Nature Communications, 2022). My proposal builds on their demonstration of the potential for automated tracking systems for wildlife, specifically citing issues with conventional tracking such as the high rate of plane crashes for wildlife biologists conducting observations from the air and the physical limitations of a human when it comes to tracking large numbers of animals in the wild.

Object tracking, one of the key components for automated animal monitoring, has been developed dramatically in recent years. Advances in computer vision enabling real-time tracking of many objects in dynamic environments is a type of technology that conservation efforts could not fathom in years past. Tracking and object ID models like DeepSORT and CenterTrack are two examples of models using deep learning to improve object tracking in crowded environments (Viso AI, 2023). Understanding algorithms like these is vital to designing an efficient system able to recognize and track distinct animals through live-cam feeds.

Beyond the existing generic object trackers, many machine learning algorithms have been developed to identify individual animals. Such open source tools provide a vital foundation for sanctuary tracking systems. Models like these have already been applied to many wild animal populations as well as some in captivity. (BES Journals, 2023). Frameworks like this are essential to understand before building an algorithm tailored to sanctuary environments since they provide a perfect set of building blocks that can be improved to account for specific layouts of an enclosure, lighting conditions, and diverse species.

These are just a few examples of modern advances in machine learning, object tracking, and animal identification that serve to provide a good foundation for an animal tracking system to be used by sanctuaries. In utilizing these technologies, sanctuaries will be able to increase their efficiency, improve standards of care for animals, and allow for quick information and intervention in case of emergencies.

3. PROPOSAL DESIGN

This proposed machine learning solution involves adapting advanced object tracking algorithms specifically tailored for animal tracking in sanctuaries using existing live camera feeds. This project aims to leverage popular deep learning frameworks, primarily YOLO (You Only Look Once) for object detection and DeepSORT for continuous tracking, which together allow real-time monitoring of animals within enclosed environments. This combination of algorithms was selected due to YOLO's ability to efficiently identify animals in diverse and cluttered backgrounds and DeepSORT’s ability to maintain consistent tracking even when objects briefly disappear from view or cross paths.

3.1 Algorithm Selection and Modification

The initial step in the design involves selecting YOLOv8, a powerful yet lightweight object detection algorithm known for its accuracy, speed, and ease of deployment. YOLOv8 can be fine-tuned on existing publicly available animal datasets, supplemented with specific images from

sanctuary camera feeds to enhance accuracy in species-specific contexts. Concurrently, the DeepSORT algorithm will be modified to better handle occlusions—instances where animals may temporarily obstruct each other or leave and re-enter the camera's view.

3.2 Dataset Preparation

To optimize the accuracy and reliability of the tracking model, datasets from platforms like data.gov (2025) will be combined with data directly collected from sanctuary camera feeds, specifically from Alveus Sanctuary due to its extensive public live-streaming archives. These datasets will be labeled manually to ensure accuracy, focusing on species-specific identifiers and distinct behavioral cues that can indicate health or stress conditions. Data augmentation techniques, including rotation, scaling, and color variation, will be utilized to further enhance model robustness.

3.3 Real-Time Monitoring Interface

An interactive monitoring interface will be designed to display real-time data from the tracking algorithm. This interface will be developed using Python's Flask web framework for accessibility across multiple devices. It will provide caregivers with immediate insights into animal behaviors, health indicators, and notifications regarding any irregular activity detected by the algorithm, significantly improving response times to potential emergencies.

3.4 Performance Metrics

The efficacy of the algorithm will be assessed using performance metrics such as precision, recall, F1-score, and tracking consistency across different camera setups and environmental conditions. Additionally, the system will be tested for performance in varied lighting conditions, including night vision scenarios, to ensure robust, around-the-clock tracking capabilities.

4. ANTICIPATED RESULTS

The anticipated outcomes of this project include the successful implementation of a functioning animal tracking and monitoring algorithm able to operate efficiently in real-time using camera feeds from sanctuaries. Preliminary expectations based on similar applications such as YOLO and DeepSORT in the field of object tracking suggest the algorithm will achieve high accuracy in correctly identifying and tracking animals continuously over extended periods. Additionally, the algorithm is expected to handle common tracking challenges, such as occlusions in the camera feeds and brief disappearances of animals from feeds, more effectively than current manual observation practices.

In addition, the integration of real-time alerts and an interactive interface for sanctuary staff will likely lead to significantly improved animal welfare due to quicker detection and intervention in emergency situations, reducing the potential for animal suffering. This implementation will also enable caregivers to dedicate more of their attention and resources to direct animal care rather than monitoring, resulting in improved overall sanctuary efficiency. Finally, the successful demonstration of this technology may encourage broader adoption across various conservation environments, fundamentally changing how animal sanctuaries manage and care for animals in their charge.

5. CONCLUSION

Machine learning provides a compelling alternative for animal tracking by enabling the development of automated monitoring systems through existing live camera feeds. These systems can continuously track

animal movements, identify abnormal behaviors and ensure caretakers receive a constant and reliable stream of data regarding animal welfare. Recent advancements in machine learning and increased availability of public datasets, such as those hosted on data.gov (2025), significantly streamline the process of training sophisticated algorithms. Leveraging these extensive existing datasets eliminates the need for developers to create datasets from scratch, greatly reducing the resources and effort required for this project.

The successful deployment of an algorithm like this would have a profound impact on the health and welfare of animals in captivity by providing alerts and insights into animal behavior, reducing the reliance on invasive tagging and monitoring methods. Ultimately, wider adoption of such technologies across sanctuaries, zoos and conservation environments has the potential to enhance both animal care standards and efficiency.

6. FUTURE WORK

Future work should initially focus on thorough, real-world testing of the proposed tracking algorithm in diverse sanctuary and zoo settings to validate its robustness across environmental and lighting conditions, particularly low-light and night-time scenarios. Refinements based on feedback will be essential, specifically targeting enhancements to handle tracking challenges such as persistent occlusions, multiple animals overlapping and irregular animal movements.

Additionally, expanding the algorithm's capability to identify and monitor more diverse species, including those with subtle differences or limited distinguishing features, will greatly extend the technology's applicability. Exploring the integration of behavioral analysis algorithms that can predict potential health issues or stress conditions based on movement patterns could further enhance the utility and impact of this solution. Ultimately, extending the system to broader ecological monitoring applications, such as tracking wildlife in natural habitats, presents an avenue for contributing to global conservation efforts.

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