Revolutionizing Pet Care and Health Monitoring through AI Behaviour Analysis

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Abstract—**The integration of technology into pet care through pet cameras and behaviour analysis systems represents a significant leap forward in monitoring and improving pet health and strengthening the bond between pets and their owners. This report examines the capabilities of these technologies not only in health monitoring but also in enhancing the connection between pets and their owners, despite physical distances.**

I. Introduction

A. Application Domain

New pet care technology, such as pet cameras and behaviour analysis systems, has revolutionized how we care for and connect with our pets. These gadgets offer more than just surveillance - they offer crucial insights into pet health and facilitate virtual interactions that enhance the bond between animals and their human friends. By enabling owners to detect health issues promptly, provide comfort from afar, and preserve precious memories, these advancements are vital for enhancing the quality of life for pets and fostering stronger relationships between humans and their furry companions.

B. Problem Statement

The development of effective pet monitoring systems faces significant challenges, primarily in accurately interpreting pet behaviour without the intervention of human. Additionally, differentiating nuanced behaviours and managing large volumes of data for species-specific analysis add complexity. These systems must adapt to changes in a pet's life, aiming to identify and address irregularities in their routine that could indicate health issues. This report focuses on overcoming these obstacles to improve pet care through advanced monitoring technologies, aiming for a future where pets lead healthier lives with their human companions.

II. Technique on Tackling the Problem

A. Surveys

This survey presents an overview of six papers focused on advancements in using various computer-related methods on analyzing animal behaviour across various environments. These papers demonstrate the interdisciplinary efforts to understand and track animal behaviour through different technologies available, with applications ranging from improving animal welfare to contributing to biological research.

- **Computer Visual Tracking of Poultry** [1]: This paper introduces a method for tracking broiler chickens using computer vision, addressing challenges like human observer influence, difficulty in dark conditions, and the laborious nature of traditional data collection. A novel background extraction technique enables the segmentation of individual birds despite their poor contrast with the background and high density. The method shows high accuracy in tracking, suggesting applications in broader animal behaviour studies and management practices.
- **Quick, Accurate, Smart: 3D Computer Vision Technology Helps Assessing Confined Animals' Behaviour** [2]: Presents B.A.R.K., a software prototype using 3D visual data and machine learning to infer dog behaviours in kennels. B.A.R.K. can recognize dog postures and movements without predefined ethograms, offering a non-invasive and efficient approach to behavioural monitoring. The system's versatility is demonstrated in various settings, promising wider applications in animal welfare studies.

- **JAABA: Interactive Machine Learning for Automatic Annotation of Animal Behaviour** [3]: Introduces the Janelia Automatic Animal Behaviour Annotator (JAABA), a tool that utilizes machine learning to measure animal behaviour from video annotations. JAABA's interactive interface allows biologists to refine behaviour classifiers, enhancing the system's accuracy across different species and behaviours. This system facilitates the generation of detailed behavioural insights, essential for genetic, neurological, and behavioural research.
- **Development of a Real-Time Computer Vision System for Tracking Loose-Housed Pigs** [4]: Discusses a real-time system for tracking pigs without needing physical tags, aiming to reduce farm management workload. The system's design includes enhancements for environmental challenges specific to pig barns and demonstrates robust tracking capabilities. Its application could significantly aid farm management and automation, aligning with new regulations for loose-housed pig breeding systems.
- **Computational Analysis of Behaviour** [5]: A review paper exploring the application of computer science and engineering in animal behaviour analysis. It emphasizes the importance of experiment design, the balance between authenticity and data analysis simplicity, and the challenges in data extraction through computer vision. The review advocates for collaboration between biologists and computer scientists to leverage computational behavioural analysis for uncovering neurobiological behaviour mechanisms.
- **Computerized Video Tracking, Movement Analysis and Behaviour Recognition in Insects** [6]: Introduces EthoVision, a versatile system for automated recording and analysis of insect activity and behaviour. EthoVision stands out for its flexibility in handling diverse experimental setups and its precise quantification of behaviour. The system's development reflects ongoing advancements in video tracking technology, promising enhanced research capabilities in entomology and related fields.

These papers collectively highlight the critical role of technology in advancing our understanding of animal behaviour, offering tools that are non-invasive, accurate, and efficient. Notice that due to the nature of this topic being niche, all of the relevant research belonged to the field of agriculture and computer science, where the availability of new studies are scarce . So, the majority of them were decades old and employed traditional methods like computer vision and video tracking. However, they demonstrated the potential of interdisciplinary approaches to and address complex challenges in animal behaviour studies using computer-aided methods.

B. Description of other techniques

Beyond the techniques highlighted in the six papers, several other innovative approaches are gaining traction in the field of animal behaviour analysis, leveraging advancements in technology and computational methods. These include:

- **Acoustic monitoring and analysis**: This involves using sound recording and analysis tools to study behaviour and communication in animals. The sounds animals make can provide valuable insights into their emotions and physical well-being. However, this can be challenging when the animal is in a group.
- **Wearable Devices for Animals**: Similar to wearable tech in humans, these devices are designed for animals, capable of collecting a wide range of data including physiological signals, activity levels, and even vocalizations. These devices often include RFID and traditional sensors, thus making them able to provide richer, multidimensional data sets, especially when the subjects are too much to be analyzed using acoustic and visuosensory methods.
- **Infrared and Thermal Imaging**: Normal camera can only operate when there is day lights, so operating them during the night is not applicable in most scenario where keeping the location lit at all time is not possible or not cost effective. In these cases, infrared and thermal imaging devices can provide monitoring for the animals with minimum intrusion to the animal's habitat. Also, thermal imaging could help in determining inflammation on animals,

as the inflamed site will be hotter than normal body temperature.

C. Comparison of techniques

For the following section, we will base our comparison on visual means only, since we will be implementing the visual analysis using the aid of artificial intelligence. For techniques like acoustic monitoring and wearable devices, it could be easily integrated into the monitoring system as another component running parallel to the visual analyzer, and serving as a complementary data source for the user. ”Table I” on the next page provides a detailed comparison of each technique by comparing their advantages and disadvantages.

III. Developing Ai Technique

For our project, we decided to build a monitoring system for a guinea pig we raised. This system will monitor the behaviour of the guinea pig, and inform the user if any irregularity occurred. For example, if it spend less time on eating.

For this task, we decided to use a combination of the above-mentioned techniques, namely using computer vision to determine the object’s location and employing machine learning to determine its category. The best open-source tool to achieve this goal is YOLOv8, as it’s highly efficient and has lots of pre-trained models for object detection.

A. Methodology

We employs the YOLOv8 model for its robust real-time object detection and image segmentation capabilities. The model was trained on a dataset comprising images of different animals including dogs and cats in various states such as resting and eating. This dataset was augmented to include various lighting conditions, angles. However, this dataset didn’t include guinea pig, In our use case, since the only fluffy animal that will be appearing is the guinea pig, we just categorizing guinea pig with the classification animal as a whole.

B. Implementation

The system was implemented using Python 3.10 and PyTorch 1.8.0. A custom dataset was created and annotated manually to mark the guinea pigs and their actions. YOLOv8 was [7] chosen for its efficiency and accuracy in detecting objects in real-time. The system processes live video feed from a camera monitoring the guinea pig’s habitat, segmenting each frame to detect the specified eating actions.

1) **Argument Dataset**: Each data in the dataset is an image. Each image is augmented by squaring out each object in it and providing the class name for each square. The tool we used is called YOLO-Label [8], which is a repository available on Git Hub. In this case, each guinea pig and bowl in the picture is augmented.
2) **Train the model**: The model was trained with a split of 80% training and 20% validation data. Early stopping and real-time data augmentation techniques were employed to prevent overfitting and improve model generalizability.
3) **Action detection**: Trained model is proficient in identifying the locations of both the bowl and the guinea pig within an image. An illustration of this capability is provided in figure 1, showcasing effective object detection.

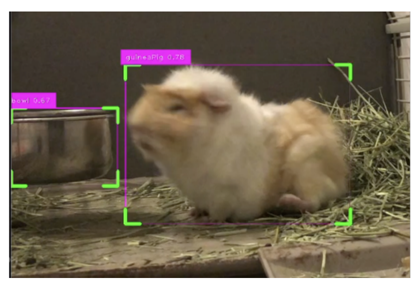

Fig. 1: Example of object detection

The system extends its functionality to monitor the feeding behaviour of guinea pigs by recognizing instances where the guinea pig and the bowl significantly overlap. Such an event is depicted in figure 2, indicating the action of feeding.

Technique	Advantages	Disadvantages	Scalability	Ease of Use
Background Subtraction and Segmentation	- Efficient in differentiating subjects from background - Good in controlled environments	- Struggles with dynamic backgrounds - Overlapping subjects issue	Medium	Moderate
3D Computer Vision	- Depth information for better analysis - More accurate interpretation	- Requires depth sensors - Data-intensive	Medium to High	Moderate to Difficult
Unsupervised Machine Learning	- High accuracy in classification - Adapts to species and behaviors	- Needs large datasets - Computationally intensive	High	Difficult
Interactive Machine Learning	- Expert knowledge and efficiency - Iterative improvement	- Time-consuming annotation - Quality of input critical	Medium	Moderate
Real-Time Tracking Algorithms	- Monitoring in dynamic environments - Instant data analysis	- Significant computational resources - Struggles with dense populations	High	Moderate to Difficult

TABLE I: Comparison of Different Techniques for Visual Behavioural Analysis

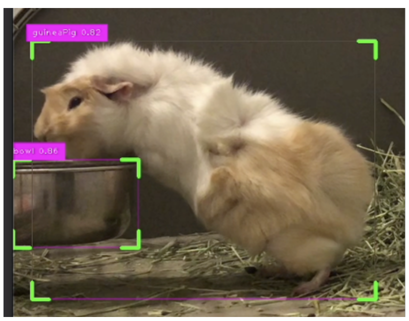

Fig. 2: Detection of Feeding Action

Upon detecting the ending of feeding activities, which was evidenced by the absence of overlap between the two objects-the program ceases its timer and subsequently calculates and reports the total duration of the feeding session.

C. Results

The implementation of YOLOv8 for detecting guinea pig eating behaviours achieved an accuracy of 98% on the validation dataset. The system was able to detect the start and stop of eating actions in real-time with a latency of less than 200 milliseconds, making it suitable for live monitoring.

D. Discussion

The application of YOLOv8 for pet health monitoring, particularly in observing guinea pig eating habits, demonstrates a significant advancement in enhancing pet-owner connections across distances. Real-time monitoring allows for irregularity detection in living habit for pets, also allows immediate interventions by pet owners or veterinarians in case of health concerns. It's also very easy to setup in the sense that YOLOv8 is an open-sourced platform with plenty of trained dataset provided by the user. So, we should expect to see more applications like this become more available to normal pet owners and hospitals.

E. Future Works

Further research will focus on expanding the dataset to include more diverse behaviours and exploring the integration of additional sensors for comprehensive health monitoring. Enhancements in model efficiency and the development of a user-friendly interface for pet owners are also planned.

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