Interdisciplinary Project

CS 579

Artificial Intelligence for Arid Land Agriculture

Steven Williams

Arath Ramos Coronado

*Introduction*

Arid land agriculture demands a virtuous understanding of animal behavior and crop conditions. This allows farmers to optimize resource usage and enhance their productivity. Monitoring cattle behavior such as their water consumption and movement can help manage herds effectively.

This project uses YOLOv8 to detect and analyze animal behavior from specific videos. By annotating video frames and training a model, we can get insights on livestock activity patterns such as grazing, resting and drinking. Detecting these patterns is crucial to get more sustainable farming practices in arid land agriculture.

*Project Overview*

We have chosen to work on project (p2): Utilizing Videos to Understand Animal Behavior. The objectives for this project are to train a model to detect behaviors using animal videos as the dataset and to evaluate the model’s performance on testing of the data. Although, dog videos were used in this implementation, the work and tools are transferable to cattle behavior.

*Tasks and Milestones*

For the preparation of the dataset we built a labeled dataset of animal behaviors. We annotated frames from dog videos to label behaviors like running, sitting and jumping. This can be adapted to a cattle environment by replacing the dog videos with cattle footage.

During this process we extracted frames from the videos using OpenCV. We then proceeded to annotate frames with bounding boxes using CVAT.

The model was trained using YOLOv8 and the annotated dataset. The train\_yolo.py script was used to load the dataset and being the training. Furthermore, the parameters were optimized to achieve a high accuracy for behavior detection.

We tested the model by evaluating the trained model. This model was tested on new dog videos to evaluate its ability to detect annotated behaviors. This model can be used to detect grazing patterns and therefor optimize the use of land.

Moreover, the model performance data includes the following:

Precision: 0.50

mAP@0.5: 0.34

mAP@0.5-0.95: 0.20

Class 0: mAP = 0.16

The performance metrics indicate the model has a precision of 0.50, meaning 50% of detections are correct, while the mAP@0.5 is 0.34, showing the model achieves 34% accuracy in localizing objects at a reasonable IoU threshold. The stricter mAP@0.5-0.95 is 0.20, highlighting the need for better localization and confidence calibration. For Class 0, the mAP is 0.16, suggesting significant room for improvement in detecting objects of this class. Overall, the model performs moderately but needs further optimization to improve detection accuracy and bounding box quality.

This model has different applications to arid land agriculture. This project is an efficient artificial intelligence tool to monitor animal behavior. These are potential applications of the model:  
  
Cattle Management

This model is capable of detecting grazing patterns to prevent overgrazing in arid land agriculture environments. Additionally, this model can optimize water resources in this environment.

Crop Monitoring

Similar AI techniques used in this model can be used to detect crop stress or pest infestations in arid land agriculture. This model can me modified and trained to properly serve as an effective tool in crop management.

Automating animal behavior detection can reduce labor costs, improve resource management and increase productivity in arid land agriculture.

This interdisciplinary project combines artificial intelligence and agriculture to solve challenges in arid land agriculture. The current implementation uses dog videos, nevertheless the anatomy of these animals is similar to the one in cattle. This methodology can be transferred to cattle behavior easily.

By applying this methodology to cattle, farmers can monitor essential behaviors such as grazing, resting, drinking and other types of movements. This model can help to ensure an efficient water usage and prevent overgrazing. Moreover, this model can me complimented with other farming tools to increase its efficiency and optimization.