Rapid Animal Detection and Driver Warning System to Mitigate Animal Vehicle Collisions Using Artificial Intelligence

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Introduction

Ecological and Economic Impact

As an economy, we continue to be more dependent on our roadways than ever before. According to the Federal Highway Administration, over 148,000 miles of roadway in the United States are National Highway System. The roadway is considered to be the backbone of our 4 trillion-dollar public road network. Highway construction and transportation have a significant impact on the environment and economic development. The environmental impact of highway construction is substantial, with significant habitat fragmentation, loss of species, and increased pollution. The economic impact of highway construction is also significant, with costs for land acquisition, construction, and maintenance. Therefore, it is crucial to consider the ecological and economic impact of highway construction and transportation when designing and implementing infrastructure projects.

The Solution

Project in Numbers

- 4+ Months of Hardware Development
- 4 Hardware Revisions
- 4000+ Lines of Code
- 2 Computer Vision Algorithms
- 2 different GPU Implementations (RTX 3080, Jetson Nano)
- 40 Hours of annotations
- 20+ Hours of model training
- 2 Model Architectures
- 3 Trips to Reno, Nevada
- 4 Days of On-Site Installation

Computer Vision

Data Augmentation

The optical computer vision model was trained from scratch using 200K images from the COCO dataset (Lin et al., 2014) with an additional 2000 images of animals, including horses, cows, and deer. Data augmentation techniques were used to augment the dataset.

Transfer Learning

The YOLO V3 base model has three layers: the backbone, which extracts major features from the image; the neck, which normalizes images through three scales; and the head, which classifies the objects of interest inside the images based on the features extracted by the backbone. I used transfer learning to retrain the head layer parameters and freeze the backbone and neck layers. I used 2450 images as a dataset to retrain the head layer because I didn’t want certain characteristics of the object, like color, to become limiting factors in the classification of the objects. After training the models for about 4000 epochs, I achieved 98% accuracy on the test images.

System Design

Highway Hypnosis

Highway 439 in Nevada (Figure 1), is a classic example of highway fragmentation due to the new highway construction (439 opened in 2016). This area is home to a wildlife corridor where animals have historically crossed the road. However, due to the construction of the new highway, the animals have become more reliant on predictability, familiarity, and muscle memory to execute the activity of driving rather than real-time stimuli. This leads to worsened reaction times and higher muscle memory to execute the activity of driving rather than real-time stimuli. Since animal third most often involved in animal-related crashes, with an average of 34.8 fatalities annually (Coffin, 2007).

Detector Image: http://www.trafficorp.com/category/safety-resources/

Field Deployment in Reno, Nevada

The system was benchmarked by collecting baseline data images of the current traffic and wildlife conditions. This will entail using GAN based machine learning and image morphing techniques to create a virtual environment that simulates the effect of different lighting conditions. This will be useful for testing the model’s performance across all seasons with no variances in detection recall and classification precision. This system will be used to analyze driver behavior compared to existing solutions (fences and bridges) makes it highly scalable. To expand to multiple states and geographic locations is critical. For example, if the system in support of a wider range of animal in both day and nighttime animal movements. The system was developed using a backend server, Python, and a front-end dashboard.

Discussion & Future Work

The EgoSens system has been deployed in Reno, Nevada. The system is equipped with various sensors like camera, GPS, and an accelerometer. The system is able to identify and track animals in real-time. The system is able to detect animals in real-time. The system is able to detect animals in real-time.

References


Hardware Engineering

Power Consumption vs Processing Capacity

The first deployment of the device in July of 2021 was with the Acer Predator Helios 300 gaming laptop which contained an i7-10700 processor and 16GB of RAM. The GPU gave a high performance as the system was able to run the model in real-time at a high frame rate with little latency and the CPU was able to run the model with a minimum of 20W of power, meaning the creation of more efficient algorithms and models.

Although the NANO has less CUDA cores and was only able to process 12-18 frames per second, the greater level of calculation produced the better outcomes.

Camera Replacement (Hardware/Software): By upgrading the camera to a higher performance model with better outcomes.

GPU Swap (Hardware/Replacement): After getting a new laptop with more memory and faster performance, the system ran much better.

Startup Launch (URL Link): https://trafficorp.com/category/safety-resources/