Boosting ADAS Camera Robustness

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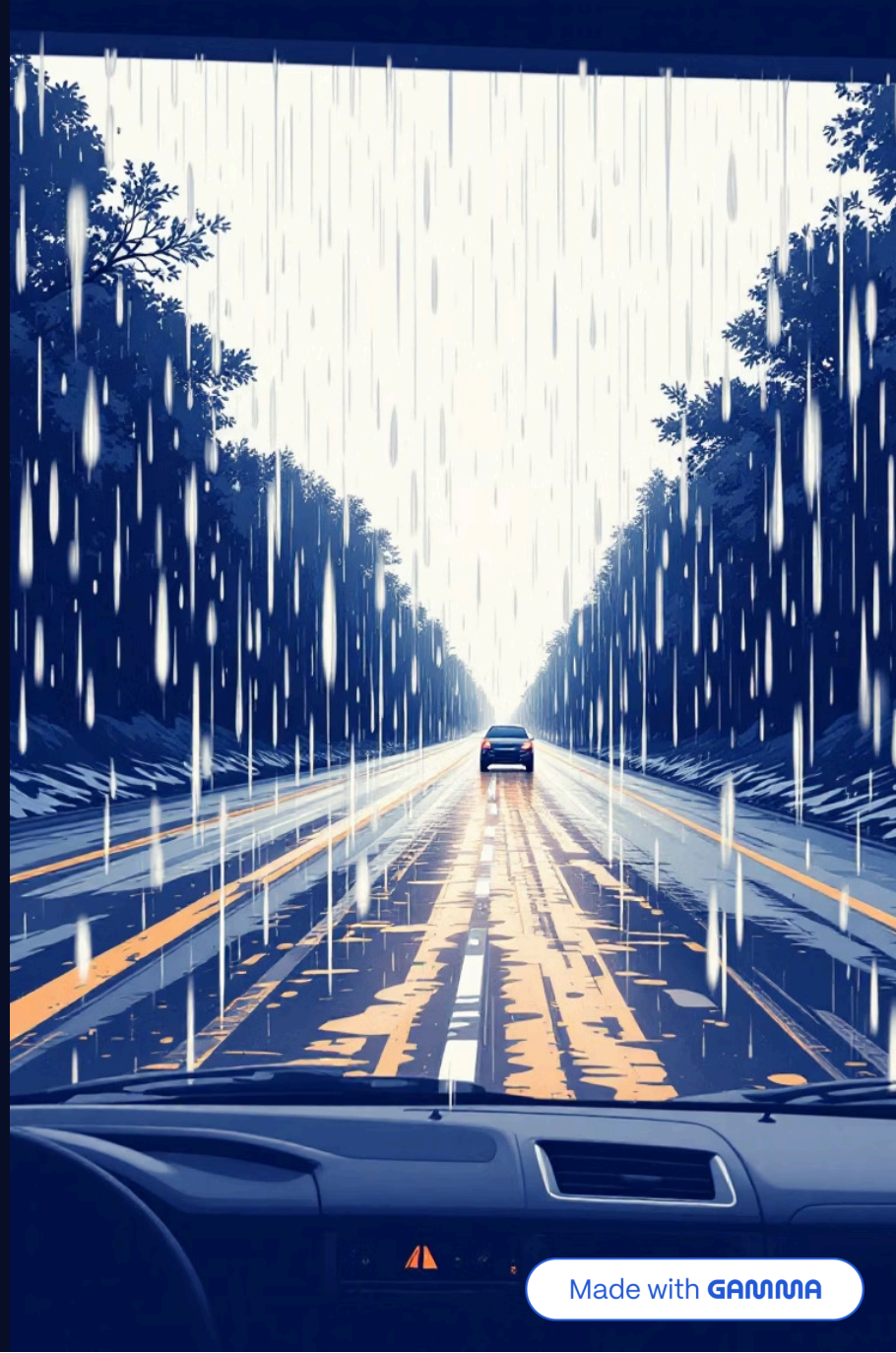
Novel Approach: Simulating Real-World Obstacles

Motivation & Specifications

Improve ADAS camera robustness by simulating lens contamination (mud, droplets, dirt) to train object detection models under adverse conditions.

Key Contributions

- Application of KITTI dataset with realistic multi-type lens contamination.
- Data augmentation simulating real-world environmental conditions.
- Establishing a benchmark for ADAS performance under lens contamination.



Title / Year	Task	Methods	Data	Results	Relation to Your Project
Effect of Droplet Contamination on Camera Lens Surfaces: Degradation of Image Quality and Object Detection Performance (2025)	Quantitatively analyze how droplet contamination affects image quality and detection	Image quality metrics (MTF); object detection performance evaluation across detectors	Controlled images with varying droplet volumes/number on lens surfaces	Small object detection drops up to ~90% mAP due to droplets; MTF50 drops up to ~80%	Provides **quantitative evidence of how droplets hurt detection**, informing why robust models and training on contaminated data are necessary

Building the Contaminated Dataset

1

Dataset Creation

- **Base:** KITTI object detection images.
- **Contaminations:** mud, dirt, water droplets.
- **Labels:** same as KITTI (bounding boxes).

2

Generation Techniques

- Alpha-blended contamination textures.
- Randomized contamination levels and placement for realism.

3

Exploratory Data Analysis (EDA)

- Class distribution consistent with original KITTI.
- Balanced contamination distribution across types.

Visualizing the impact of contamination:

Baseline Performance & Analysis

Baseline Model: Pretrained YOLOv8

Utilized a pretrained YOLOv8 model on KITTI, with minimal adaptation to contaminated images initially.

Observation: Significant Accuracy Drop

Performance reduced with heavy contamination, highlighting the need for specialized training.

Error Analysis: False Negatives

Mostly on objects partially occluded by contamination, confirming the necessity for data augmentation.

Project Roadmap & Next Steps

1

Dataset Generation

Description: Create full contaminated KITTI dataset (mud, droplets, mixed).

Outcome: Complete labeled dataset for training.

2

Model Training

Description: Fine-tune YOLOv8 on the newly contaminated dataset.

Outcome: Improved detection under various contamination scenarios.

3

Evaluation

Description: Evaluate model on both contaminated and clean images.

Outcome: Quantitative performance analysis and benchmark.

4

Optimization

Description: Adjust data augmentation and hyperparameters.

Outcome: Maximized accuracy under all contamination types.

5

Final Presentation

Description: Prepare comprehensive slides & visualizations.

Outcome: Showcase results and future implications.