Car detection using YOLO and Faster R-CNN

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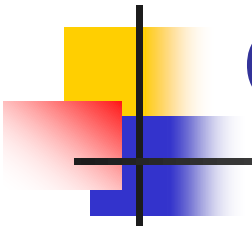


Overview

- Problem
  - About the problem
  - Existing methods
  - Our approach to the problem
  - Eksperimental results of methods
- Conclusion
  - Future improvements

About

- Used two state-of-the-art deep models
  - YOLO (You only look once)
  - Faster R-CNN (Region based Convolutional network)
- Implementation and evaluation
- Comparing the results of models

Why car detection matters and why is it challenging

- Autonomous driving
- Surveillance and traffic analysis

- Varying object sizes and angles
- Lightning Conditions
- Speed vs. accuraccy trade-off

Existing methods overview

- YOLO
  - Single stage detector
  - Entire image in a single pass
  - Real-time perfomance
  - Fast
  - Less accurate for small objects

Existing methods overview

- Faster R-CNN
  - Two stage detector
  - Region proposal network (RPN)
  - High precision
  - Better bounding boxes
  - Slower and more expensive

Our approach

- YOLOv8
  - pre-trained
  - Detection and counting with bounding boxes and confidence scores

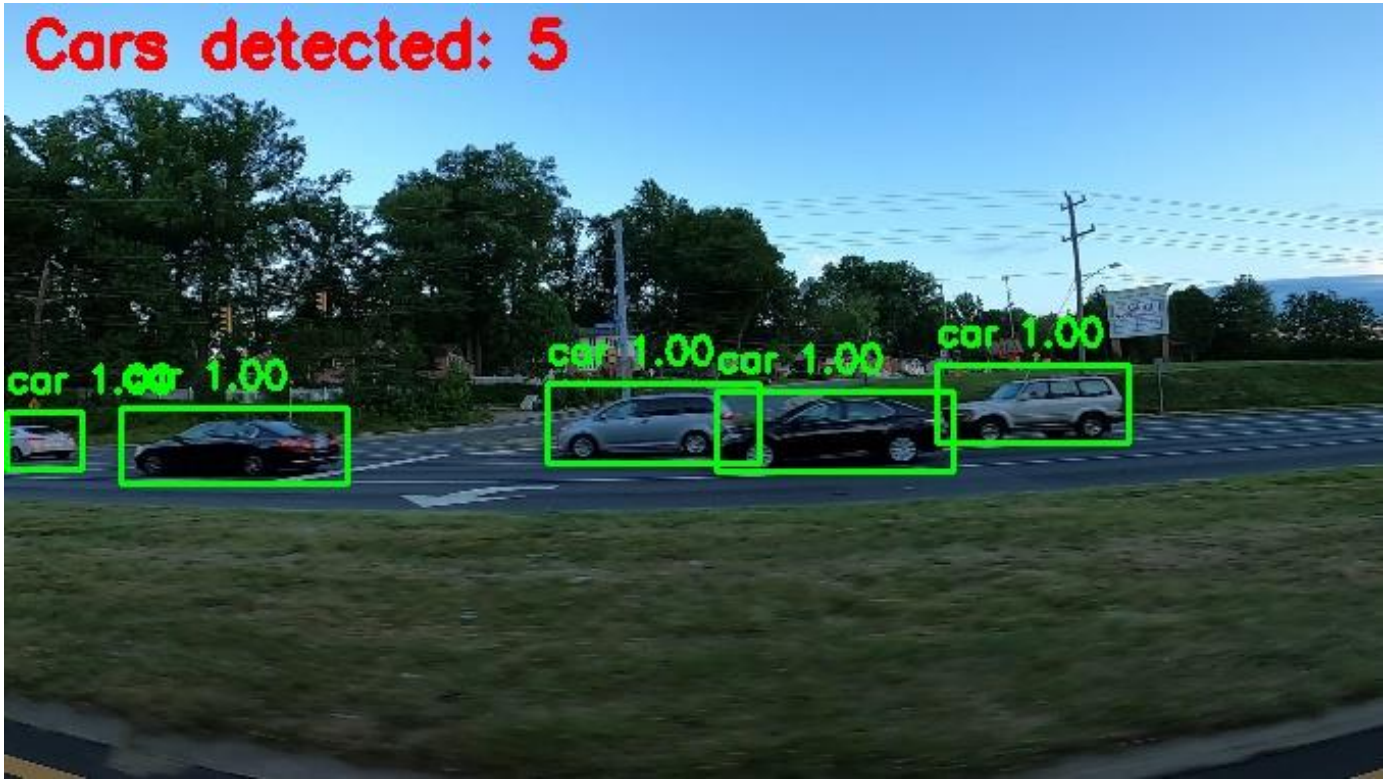
Yolo model – test output example

Our approach

- Faster R-CNN
  - Pre-trained model – COCO
  - Fine tuned model
    - Classification head for cars only
    - Trained with annotated car dataset
    - Improved precision

Pre-trained Faster R-CNN – test output example

Fine-tuned Faster R-CNN – test output example



Our approach

- Our own custom model
- Bad results
- Challenges:
  - Structure of the network
  - Small dataset
  - Custom loss function
  - Connecting postprocessing with training process

Experiment results

- YOLOv8 results
  - Precision - 0.919
  - Recall – 0.857
  - mAP@50 – 0.904
  - mAP50-95 – 0.360
- Fast and accurate
- Low precision at IoU thresholds

Experiment results

- Faster R-CNN pre-trained
  - mAP@50 – 0.7768
  - mAP@75 – 0.0645
- Bad localization and detection of small object
- Weak performance without tuning

Experiment results

- Faster R-CNN Fine-tuned:
  - mAP@50 – 0.9987
  - mAP@75 – 0.7541
- High precision after fine-tuning
- Still weak on small objects
- Fine-tuning is an effective strategy

Video of GUI:

- https://drive.google.com/file/d/19FnDuNmnvrjnNum3ipGIGDVimcg3iWXY/view?usp=sharing

Conclusion

- YOLOv8 – ideal for fast real-time identification of an object
  - Highly efficient for car detection
  - Not precise
- Faster R-CNN – ideal when accuracy is critical
  - superior precision

Future improvements

- Edge deployment
- Robustness to challenging conditions
- Improvements in detection
- Different datasets