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Computing Innovation for Technology Entrepreneurship

Østfold University College

COMPUTER VISION FOR SELF DRIVING CARS

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AGENDA

1. Introduction
2. Object Detection with OpenCV
3. Model with OpenCV and Cascade Classifier
4. Convolutional Neural Networks
5. Object detection with YOLO
6. Model with YOLO
7. Conclusions
8. Q&A

1. INTRODUCTION

COMPUTER VISION FOR ROAD SAFETY

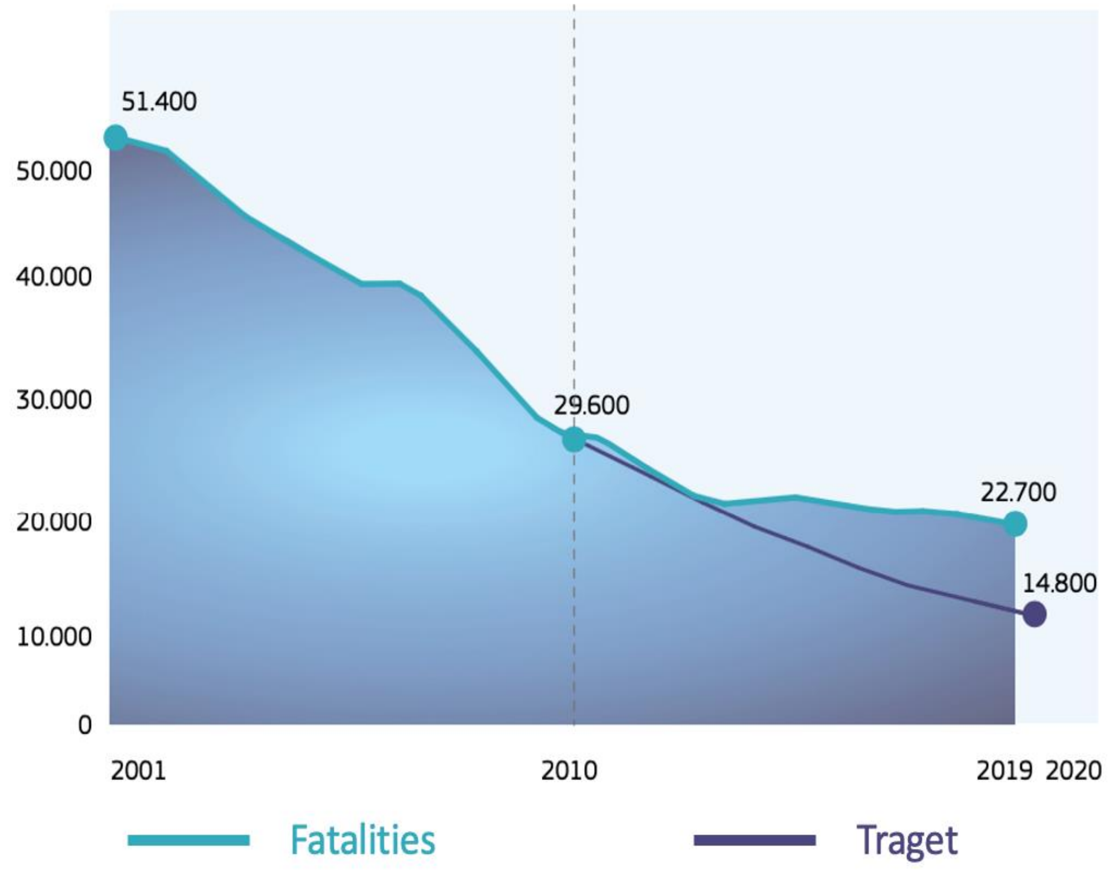


Figure 1: Number of road fatalities per year in the EU since 2001 [1]

Road Safety:

- EU struggles to reach the target for road fatalities
- Since 2014 the slope for road fatalities curve started to flatten

Computer Vision versus traditional safety systems:

- Most of traditional safety systems take action when the vehicle is in a dangerous situation
- Computer vision will avoid a dangerous situation in the first place by anticipation

1. INTRODUCTION

LEVELS OF SELF DRIVING CARS

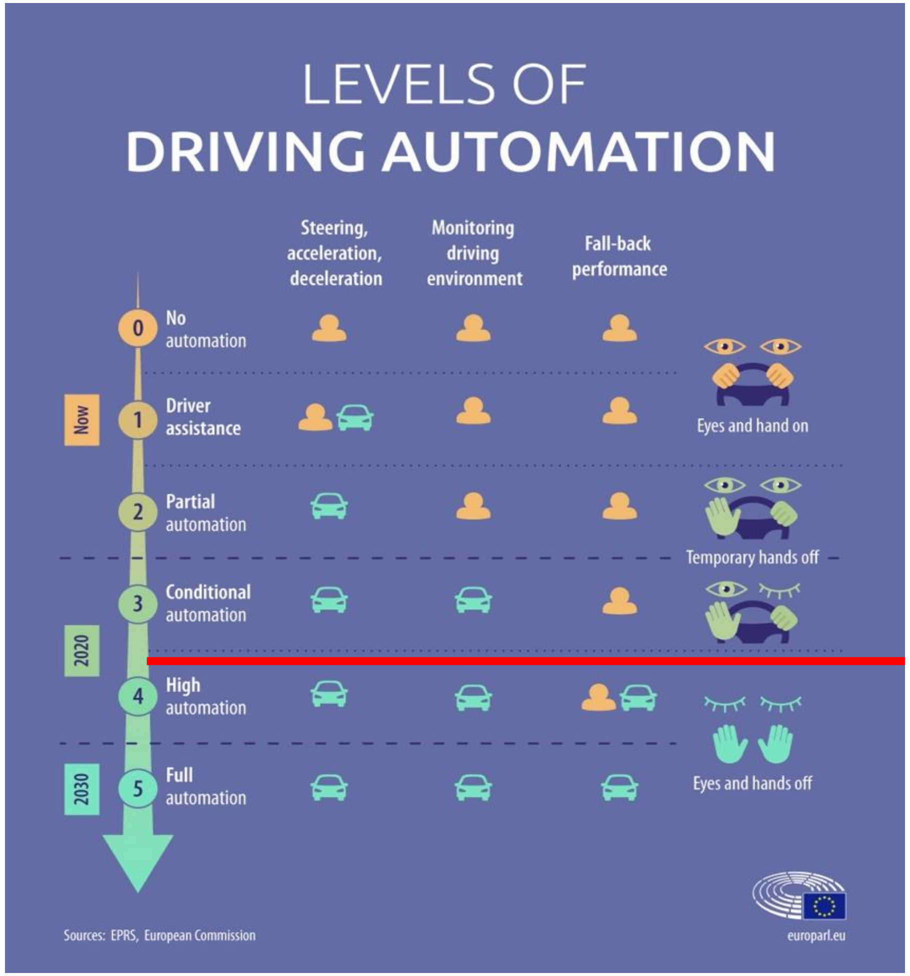


Figure 2 : Levels of driving automation [2]

Figure 3: Object detection on open road with computer vision using YOLO

COMPUTER VISION VERSUS LIDAR

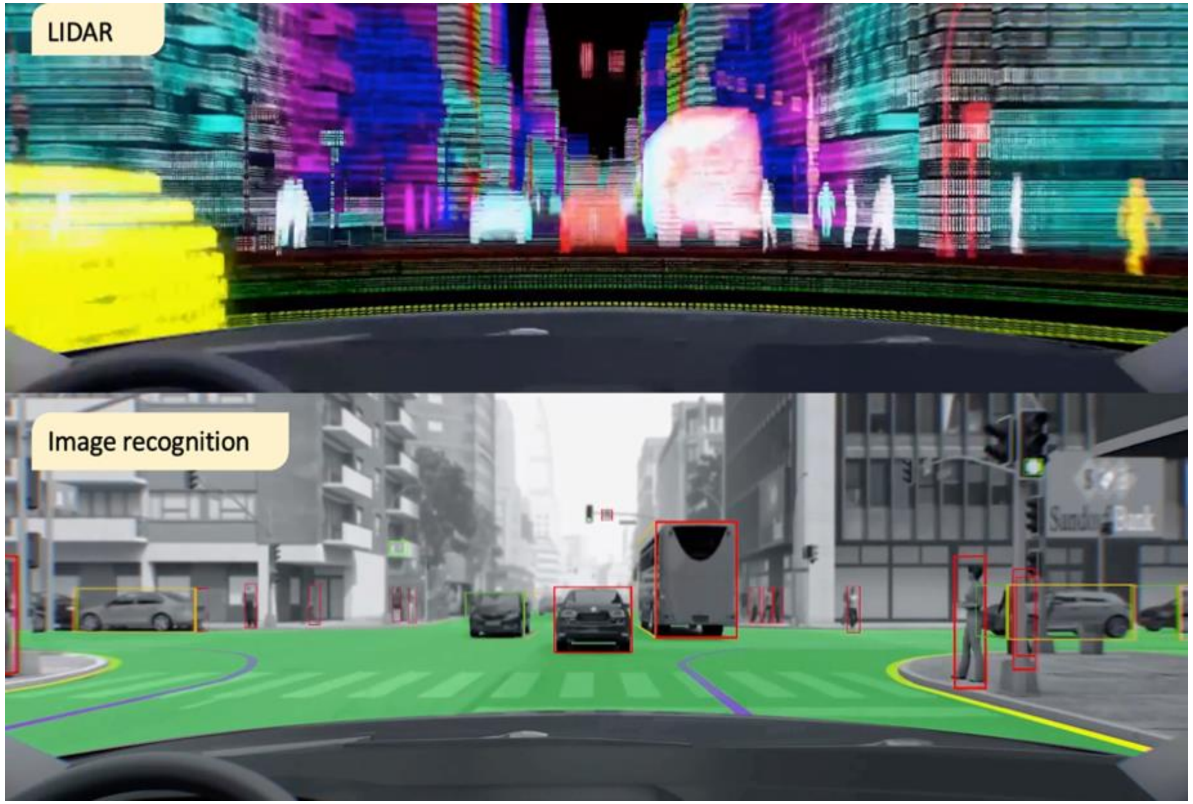


Figure 4: Environment detection:
Difference between LIDAR and image recognition [3]

Computer Vision **advantages** over LIDAR:

- Use current road infrastructure
- Less expensive than LIDAR $7500 (around 6200 euros) [4]

Computer Vision **disadvantages** compared to LIDAR:

- Wheatear conditions influence on object detection
- Processing 800 MB of raw data each second

2. OBJECT DETECTION WITH OPENCV

MODEL:

YOLO

ANACONDA

matplotlib

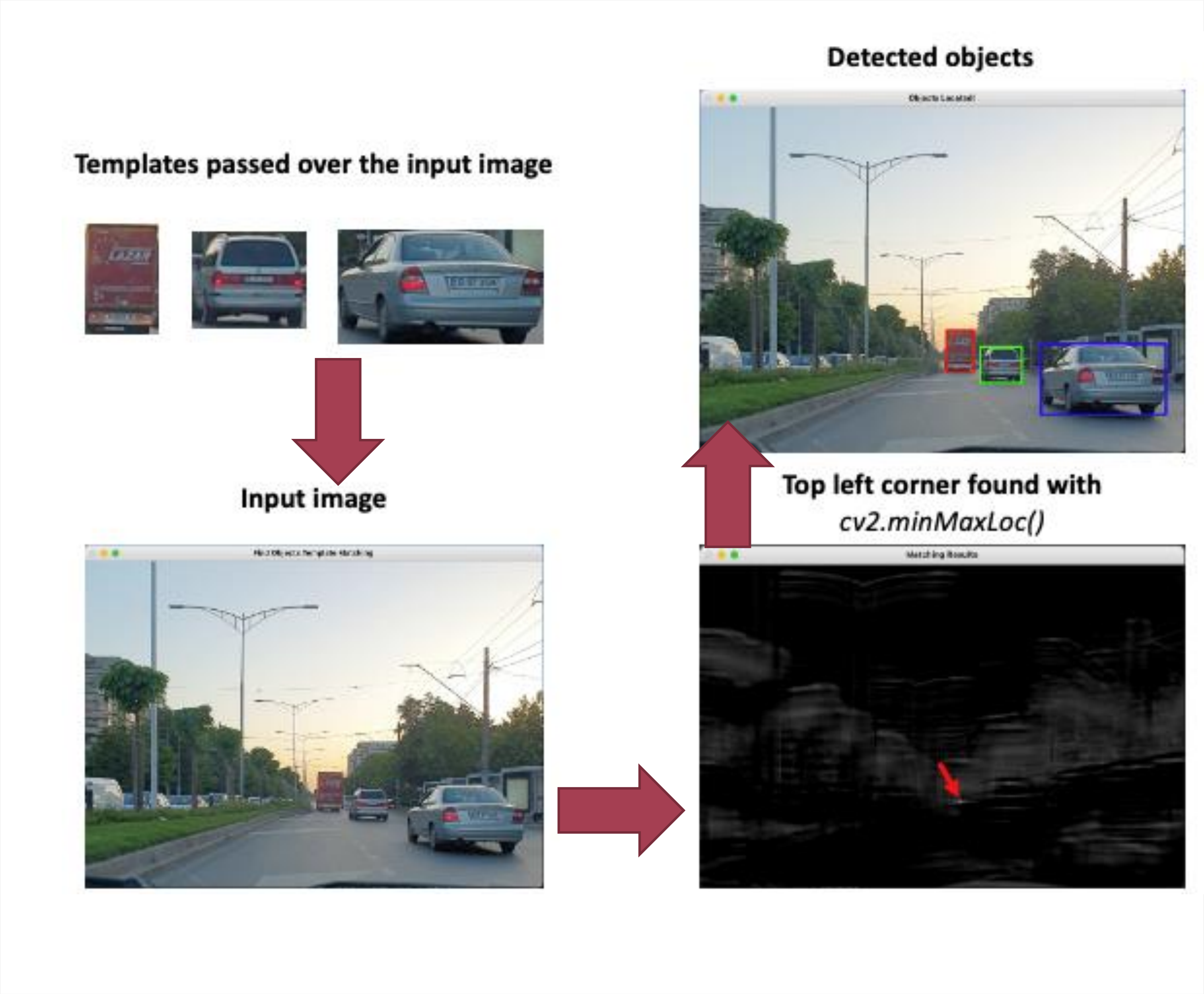
Visual Studio Code

PySpark

OpenCV

NumPy

VEHICLE DETECTION USING TEMPLATE MATCHING



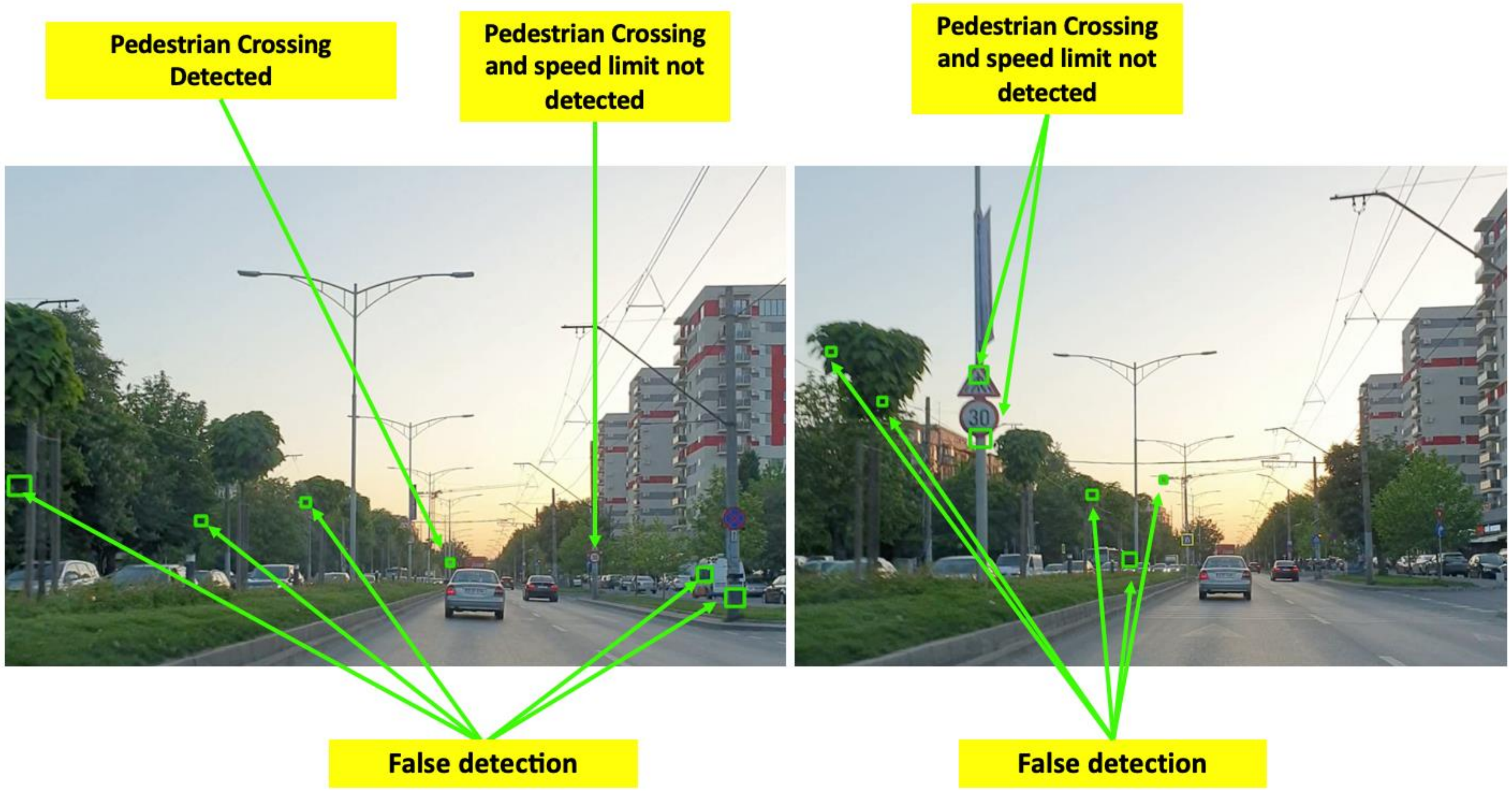
Advantages:

- Detection independent of the object position within the frame
- Fast and accurate method when detecting standard objects like traffic signs.

Disadvantages of template matching:

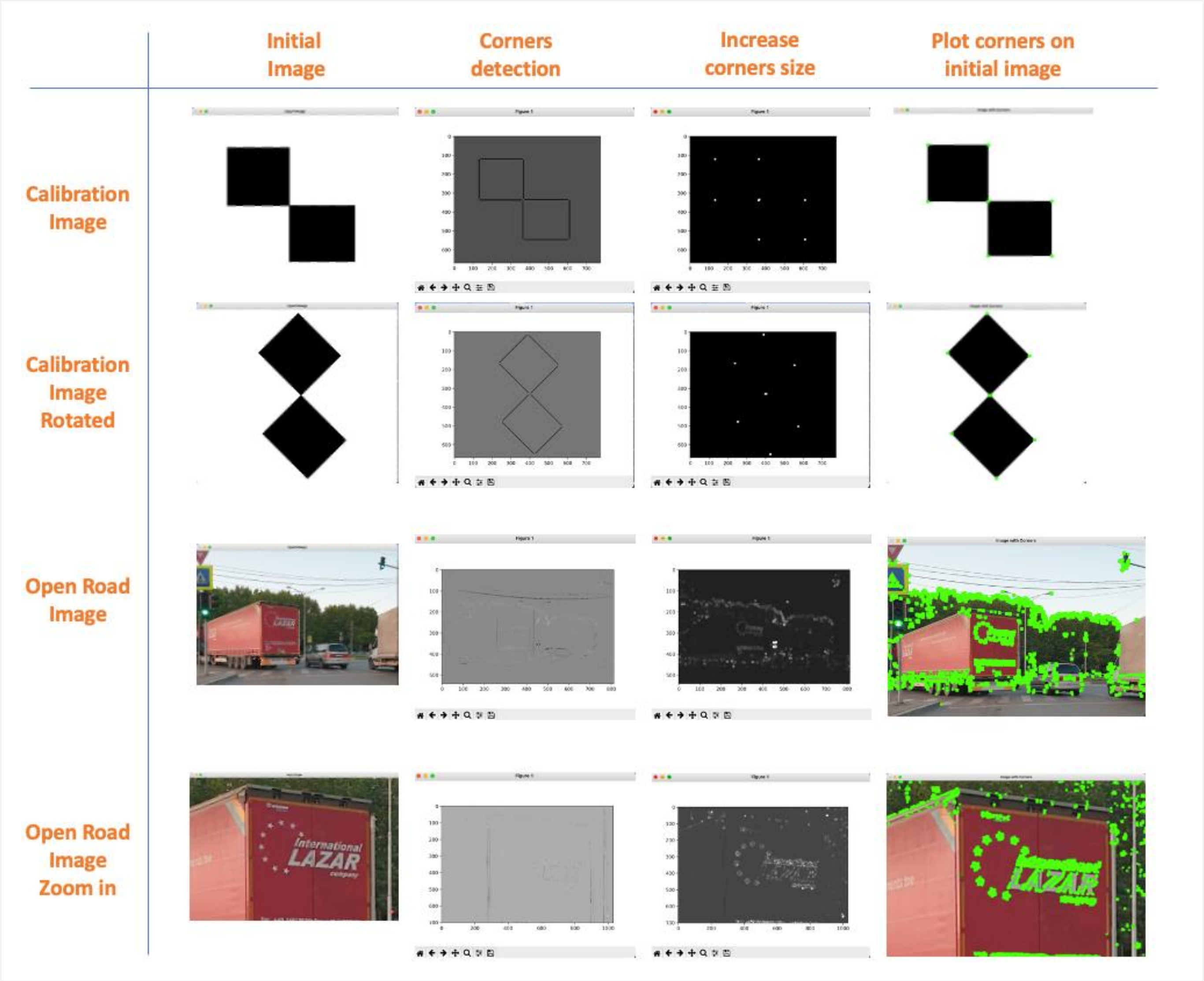
- The template and the input image must have the same orientation
- Image size and scale matters
- Driving conditions (weather – brightness and contrast) sensitiveness
- Perspective sensitiveness

TEMPLATE MATCHING AND PYRAMIDING FOR TRAFFIC SIGNS DETECTION



Applied together with pyramiding technique the template matching correct detection rate drops to 30 % in real driving conditions.

CORNER DETECTION USING CORNER HARRIS



Advantages

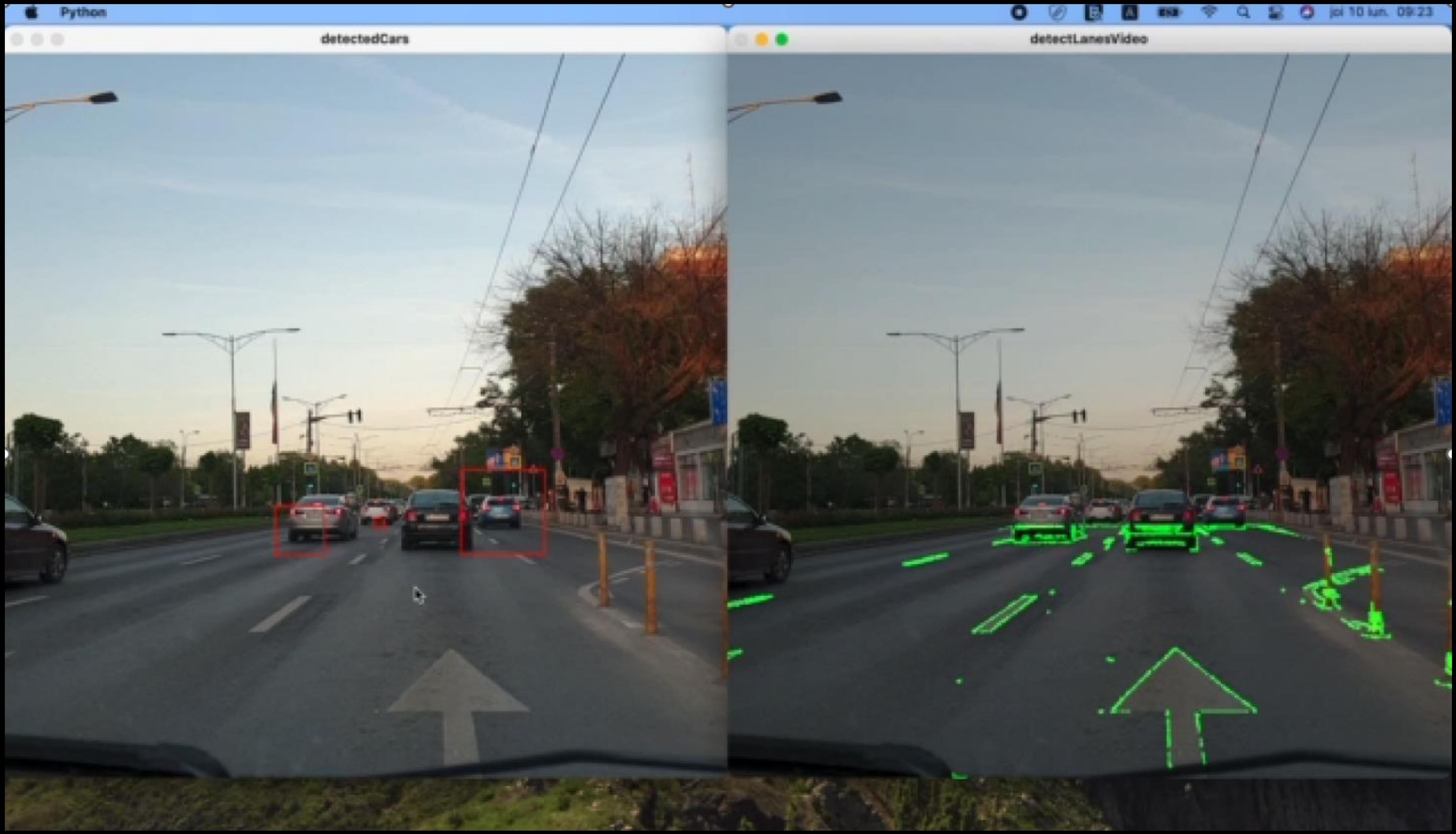
- Corner Harris method provides good results detecting corners in rotated images
- This method is suited to detect cornes of objects captured from different perspectives

Disadvantages

- Does not provide accurate results when it comes to scaling images.
- A corner in a smaller image can result in multiple corners for the increased size image.

3. MODEL WITH OPENCV AND CASCADE CLASSIFIER

DRIVABLE SPACE AND VEHICLES DETECTION DURING REAL DRIVING ON OPEN ROAD



4. CONVOLUTIONAL NEURAL NETWORKS

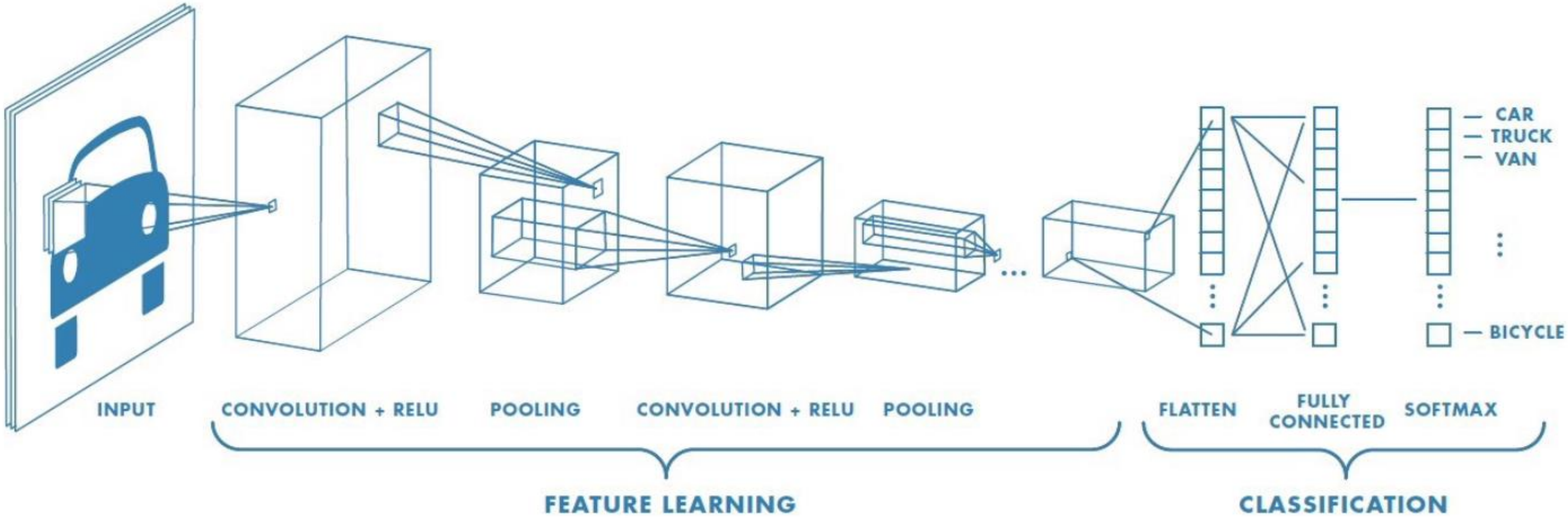


Figure 5 : CNN sequence [5]

Convolutional layer:

Detects the features of objects like horizontal or vertical edges, corners and histograms of oriented gradients

On the output of the 1st operation, we produce another convolution to detect combinations of features

Pooling layer:

Extract pixels values that are relevant for feature detection

Classification layer:

Detects the object based on the input features

5. OBJECT DETECTION WITH YOLO

OBJECT DETECTION SPEED FOR DIFFERENT COMPUTER VISION TECHNOLOGIES

	Pascal 2007 mAP	Speed		Travel distance at 50 km/h
R-CNN	66.0	.05 FPS	20 s/img	278 m
Fast R-CNN	70.0	.5 FPS	2 s/img	28 m
Faster R-CNN	73.2	7 FPS	140 ms/img	1,9 m
YOLO	63.4	45 FPS	22 ms/img	0,3 m

Figure 6: YOLO object detection speed and average precision compared with other CNNs [7]

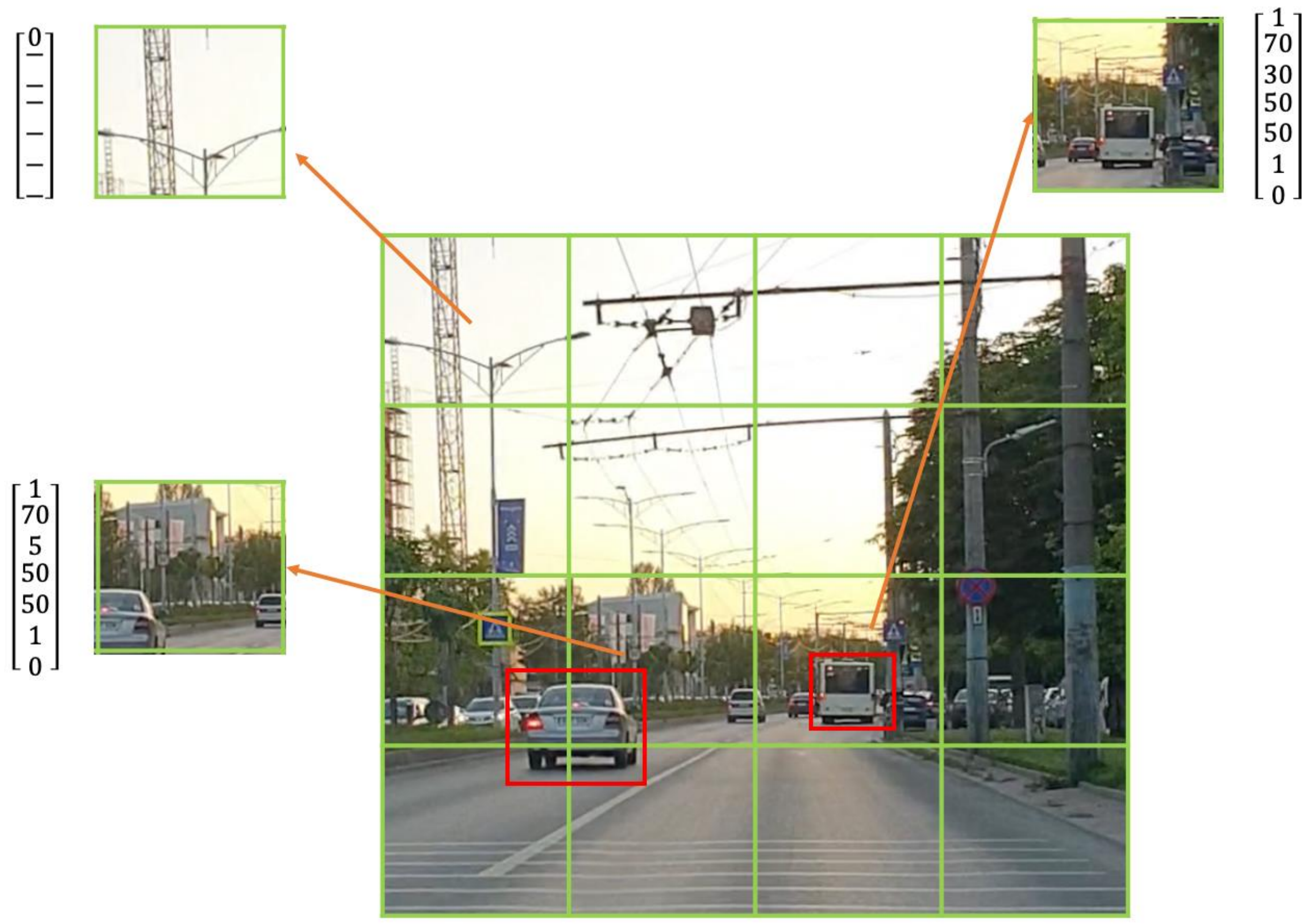
Using YOLO, a vehicle traveling at 50 km/h will cover just 0,3 m until it detects an object

The average human driver reaction time is around 1800 ms [6]

YOLO detection speed of just 22 ms leaves plenty of time for the other components involve in the system like braking and steering to react in the same amount of time as human driver.

6. MODEL WITH YOLO

YOLO DETECTION METHOD



YOLO method

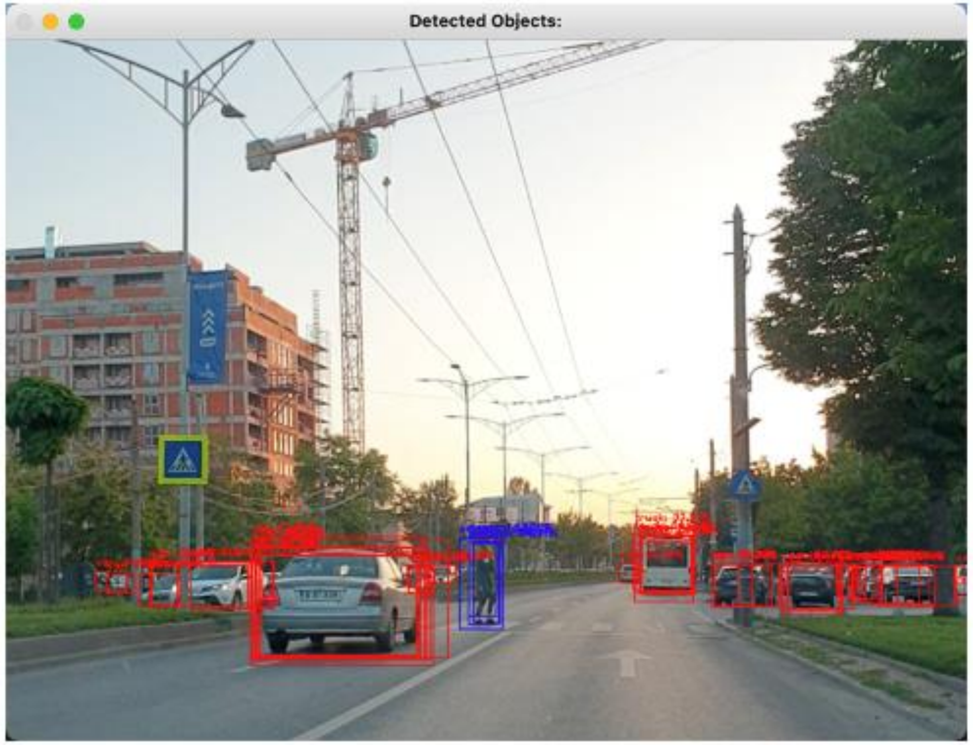
- The algorithm divides and analyses all parts of the images to detect the objects.
- The algorithm needs to decide in what part of the image the object is found and where is the center of the object in order to draw the bounding box

Drawbacks

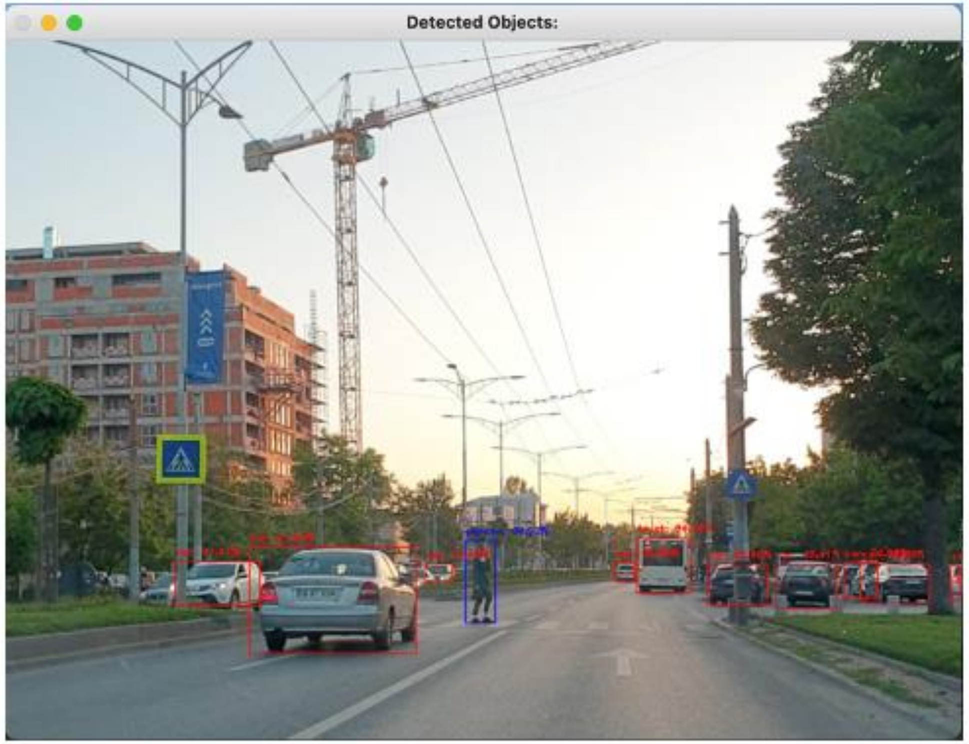
- Output more than one bounding boxes for one object, because the object is splitted among parts of the entire image that are analyzed separately.

YOLO APPLIED ON A SINGLE FRAME

Result without NMS function

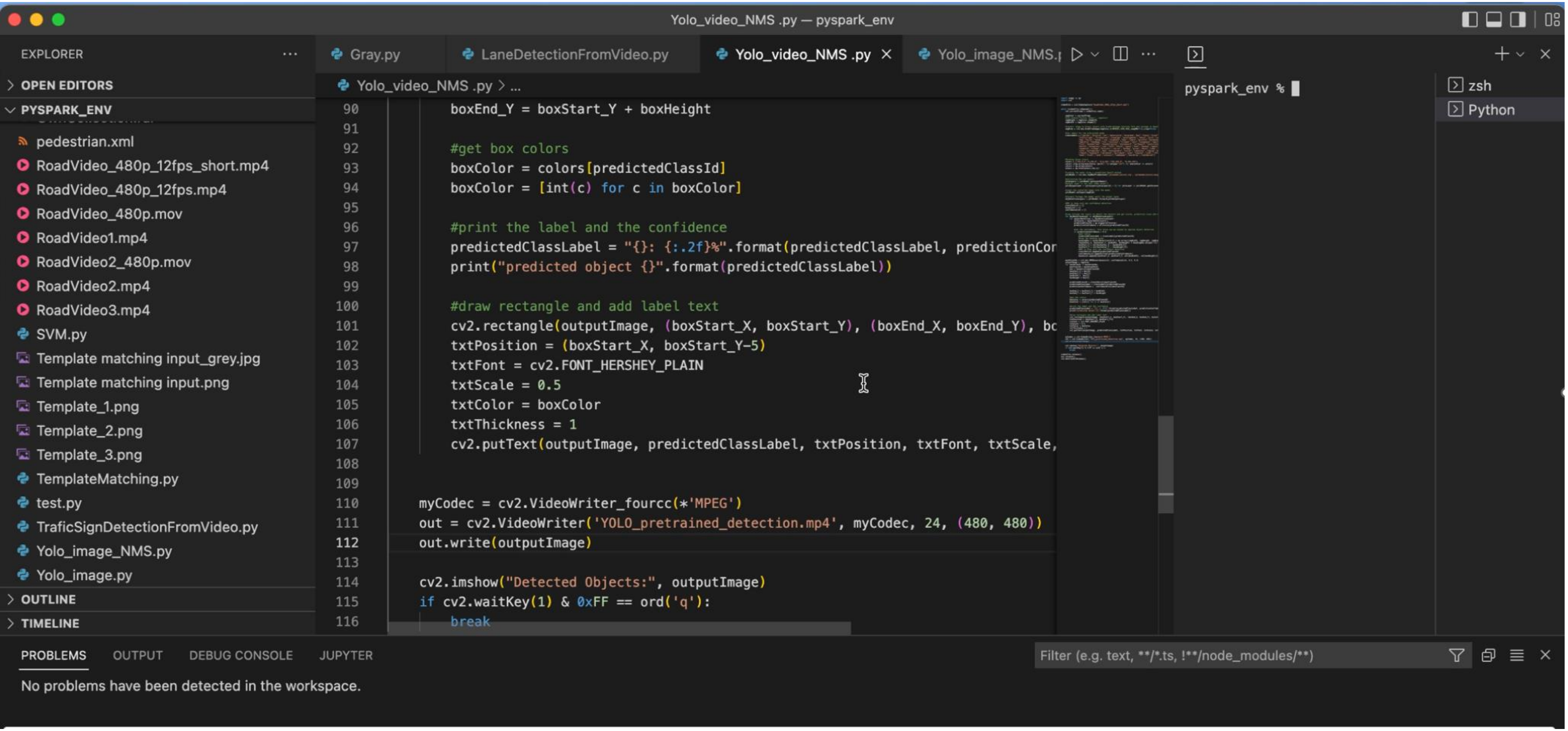


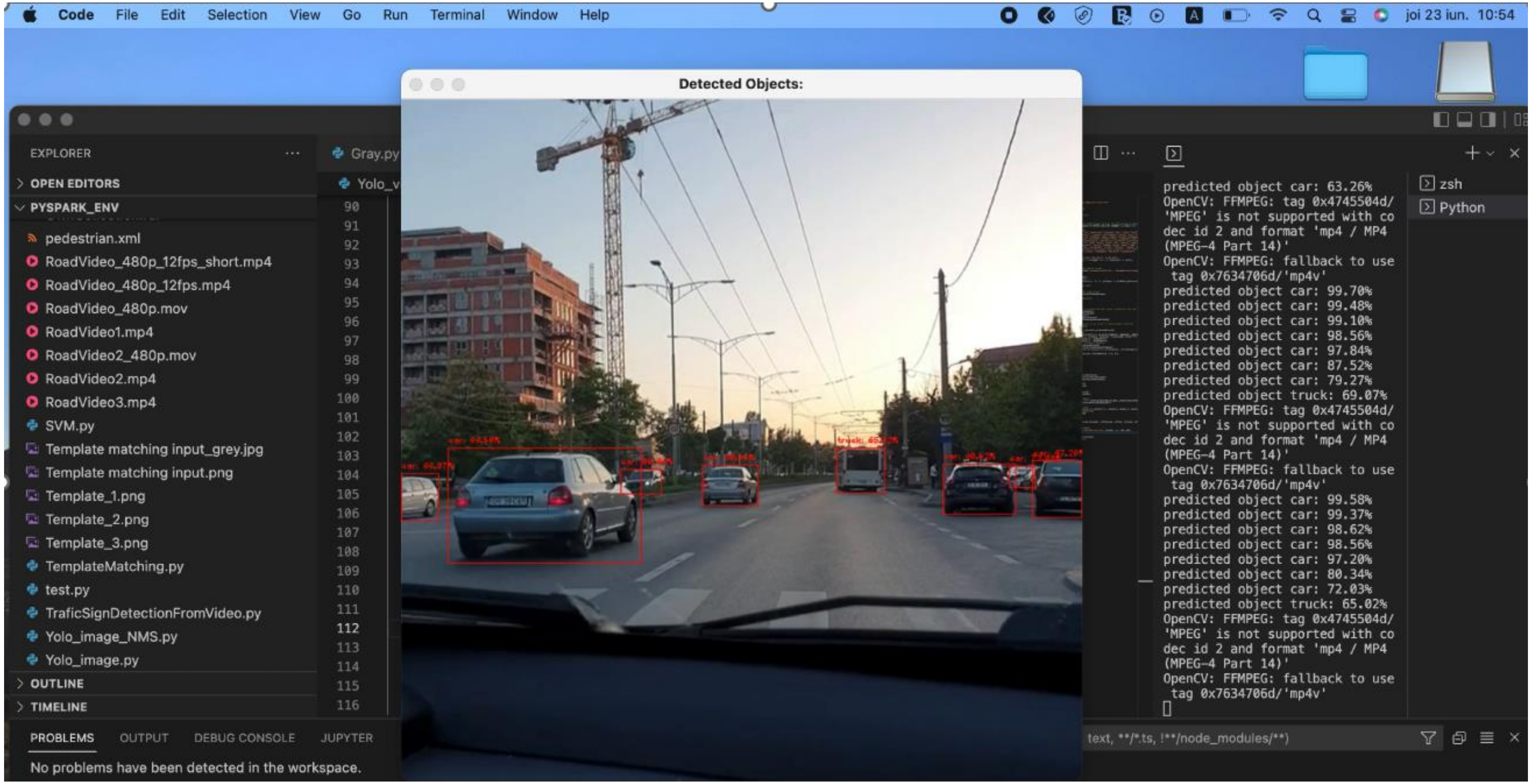
Result with NMS function



Non-Maximum Suppression method removes all, but the maximum confidence detection therefor the output will be consisted of a single bounding box.

6. MODEL WITH YOLO




Code File Edit Selection View Go Run Terminal Window Help
joi 23 iun. 10:54
Detected Objects:
EXPLORER
OPEN EDITORS
PYSPARK_ENV
pedestrian.xml
RoadVideo_480p_12fps_short.mp4
RoadVideo_480p_12fps.mp4
RoadVideo_480p.mov
RoadVideo1.mp4
RoadVideo2_480p.mov
RoadVideo2.mp4
RoadVideo3.mp4
SVM.py
Template matching input_grey.jpg
Template matching input.png
Template_1.png
Template_2.png
Template_3.png
TemplateMatching.py
test.py
TraficSignDetectionFromVideo.py
Yolo_image_NMS.py
Yolo_image.py
OUTLINE
TIMELINE
Gray.py
PROBLEMS OUTPUT DEBUG CONSOLE JUPYTER
No problems have been detected in the workspace.
zsh
Python
predicted object car: 63.26%
OpenCV: FFMPEG: tag 0x4745504d/'MPEG' is not supported with codec id 2 and format 'mp4 / MP4 (MPEG-4 Part 14)'
OpenCV: FFMPEG: fallback to use tag 0x7634706d/'mp4v'
predicted object car: 99.70%
predicted object car: 99.48%
predicted object car: 99.10%
predicted object car: 98.56%
predicted object car: 97.84%
predicted object car: 87.52%
predicted object car: 79.27%
predicted object truck: 69.07%
OpenCV: FFMPEG: tag 0x4745504d/'MPEG' is not supported with codec id 2 and format 'mp4 / MP4 (MPEG-4 Part 14)'
OpenCV: FFMPEG: fallback to use tag 0x7634706d/'mp4v'
predicted object car: 99.58%
predicted object car: 99.37%
predicted object car: 98.62%
predicted object car: 98.56%
predicted object car: 97.20%
predicted object car: 80.34%
predicted object car: 72.03%
predicted object truck: 65.02%
OpenCV: FFMPEG: tag 0x4745504d/'MPEG' is not supported with codec id 2 and format 'mp4 / MP4 (MPEG-4 Part 14)'
OpenCV: FFMPEG: fallback to use tag 0x7634706d/'mp4v'
text, **/*.ts, !**/node_modules/**

7. CONCLUSIONS

Computer vision progress in terms of speed and accuracy of detection and localization have increased the adoption of this technology for self driving cars

Machine learning models require a lot of data to be trained but they can become more and more accurate and work in poor visibility condition

If a human can label an object within an image a machine learning model can be trained to detect it

Next steps

Study the distance measuring using computer vision only through triangulation and over LIDAR technology advantage on computer vision

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Q&A

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