Automating Infrastructure Assessment

Porto, J.A., Shahid, M., Ziakopoulos, A., Lopez, D.F., Bradford, J., Yannis, G., Ševrović, M.

IVORY Mid-Term Conference – “AI for Vision Zero in Road Safety”

Athens, 15 April 2026

This project has received funding from the European Union’s Horizon Europe research and innovation programme under grant agreement No 101119590

Introduction

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101119590

IVORY

Problem at Hand

- Most existing road assessment methods are manual
- High Cost and Resource Intensity
- Time consuming

- **The Shift Toward Automation:**
  by using **computer vision**, road infrastructure assessment can be automated and significantly accelerated.

Example of Time spend for detecting road attribute by manual/human analysis based approaches [1]

Attribute	Time [min/km]
Roadside severity Driver side object	15
Roadside severity Passenger side object	15
Intersection Type	9.4
Intersection channelization	9.4
Intersecting road volume	9.4
Intersection quality	9.4
Pedestrian crossing facilities – inspected road	9.4
Pedestrian crossing facilities – intersecting road	9.4
Pedestrian crossing quality	9.4
Land Use Driver Side	5
Land Use Passenger Side	5
Property access points	4.8
Sidewalk Driver side	3.7
Sidewalk Passenger side	3.7

[1] Saving Lives Assessing and Improving TEN-T Road Network Safety (SLAIN), Deliverable 7.3 & 7.4

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101119590

Contextualization

- Imagery data provides **meaningful information about the environment**
- From aerial imagery:
  - **Land use**
  - **Density**
  - **Road design**
- From street-view imagery (SVI):
  - **Road quality**
  - **Roadside attributes**
  - **Visual disturbancies**
- Can be further improved with use of **drones** and **LiDAR**
- Challenging ground-truth **labeling**

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101119590

SVI Applications in Transportation Research

- Researchers mostly rely on **pre-trained models**, although a few train **specific deep learning models** for crash prediction or perception generalization
- Results only sometimes converge
  - Higher **building density** leading to increase and decrease in crash risk
  - **Greenery** is consistently associated with higher perceived comfort and socioeconomic status
- On regression modelling, image-derived attributes tend to play a **secondary role**
- On the other hand, **clustering** those attributes provides meaningful contextual information with statistically significant effects
- What about **combining generic** features for context and **specialized** features for safety prediction?

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101119590

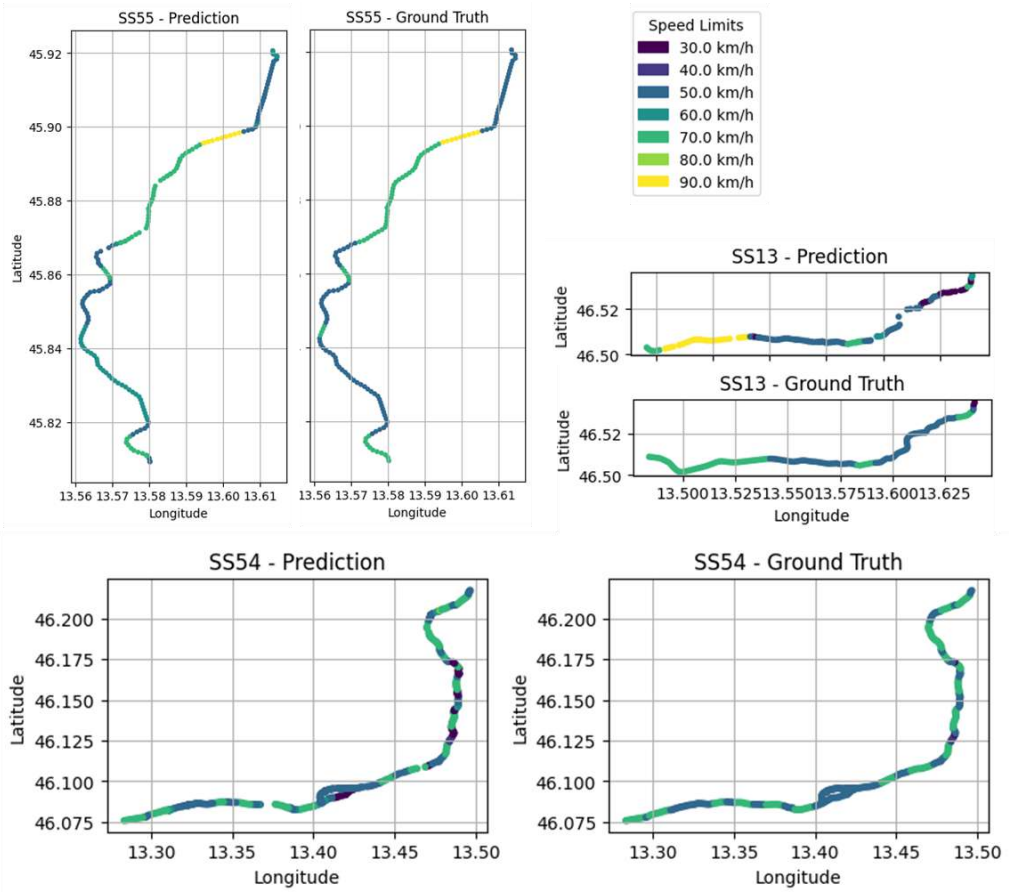
Road objects Detection & Segmentation

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101119590

IVORY

Trained Models for Fine-Grained Information

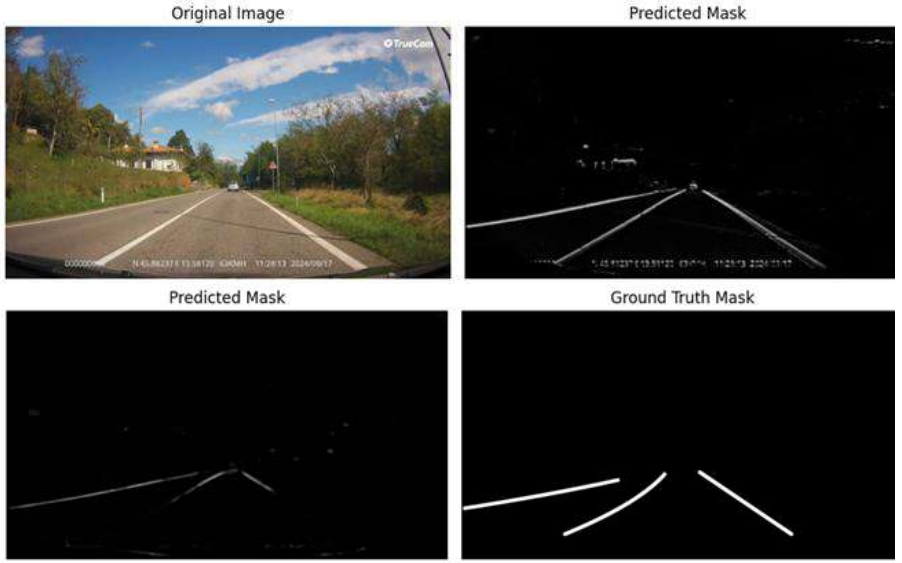
- Traffic speed limit:
  - YOLO and OCR model
  - Inclusion of Cancellation Speed Limit signs
  - Validation with iRAP-coded data

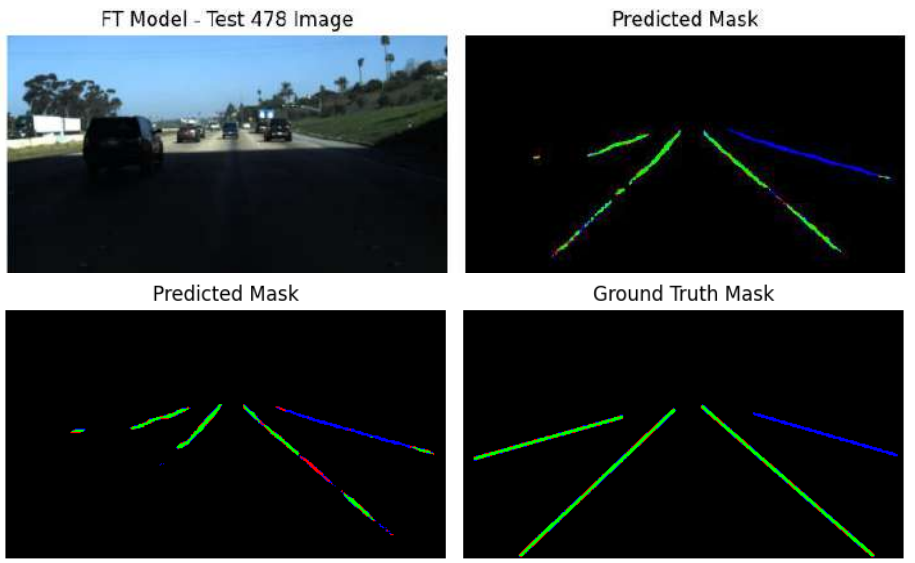


This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101119590

Trained Models for Fine-Grained Information

- Road lane segmentation:
  - Weak Supervision or Fine Tuning with Contrastive Loss
  - Binary segmentation: label generator for proprietary dataset and TuSimple dataset
  - Multiclass segmentation: continuous, dashed and unmarked from TuSimple dataset





This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101119590

Roadside objects Detection & Distance Calculation using Yolo model & Lidar data

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101119590

IVORY

Forgiving Roadside Design

Remove the Obstacle
The safest option: eliminate the hazard entirely

Redesign the obstacle so it can be safely traversed
Example: Ditch and slope treatments

Relocate the obstacle to a point where it is less likely to be struck
Move it outside the clear zone

Reduce impact severity by using an appropriate breakaway device
Example: Fragile signposts or light poles

Shield the obstacle
The safest option: eliminate the hazard entirely

Delineate the obstacle
Marking or highlighting the hazard to increase driver awareness

Remove and Relocate

Side Slope Improvements

Fragile Light Poles

Source: AASHTO. (2011). Roadside Design; Mitra et al., (2022). Guide to Integrating Safety into Road Design

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101119590

Roadside Safety Attributes

- Yolo model is trained on Lidar road survey dataset
- 13 roadside severity objects are detected

- Roadside object, present varying levels of risk based on their distance from the road edge, with objects closer to the traveled way posing a significantly higher hazard to safety. Therefore, we have also calculated their distances as well.

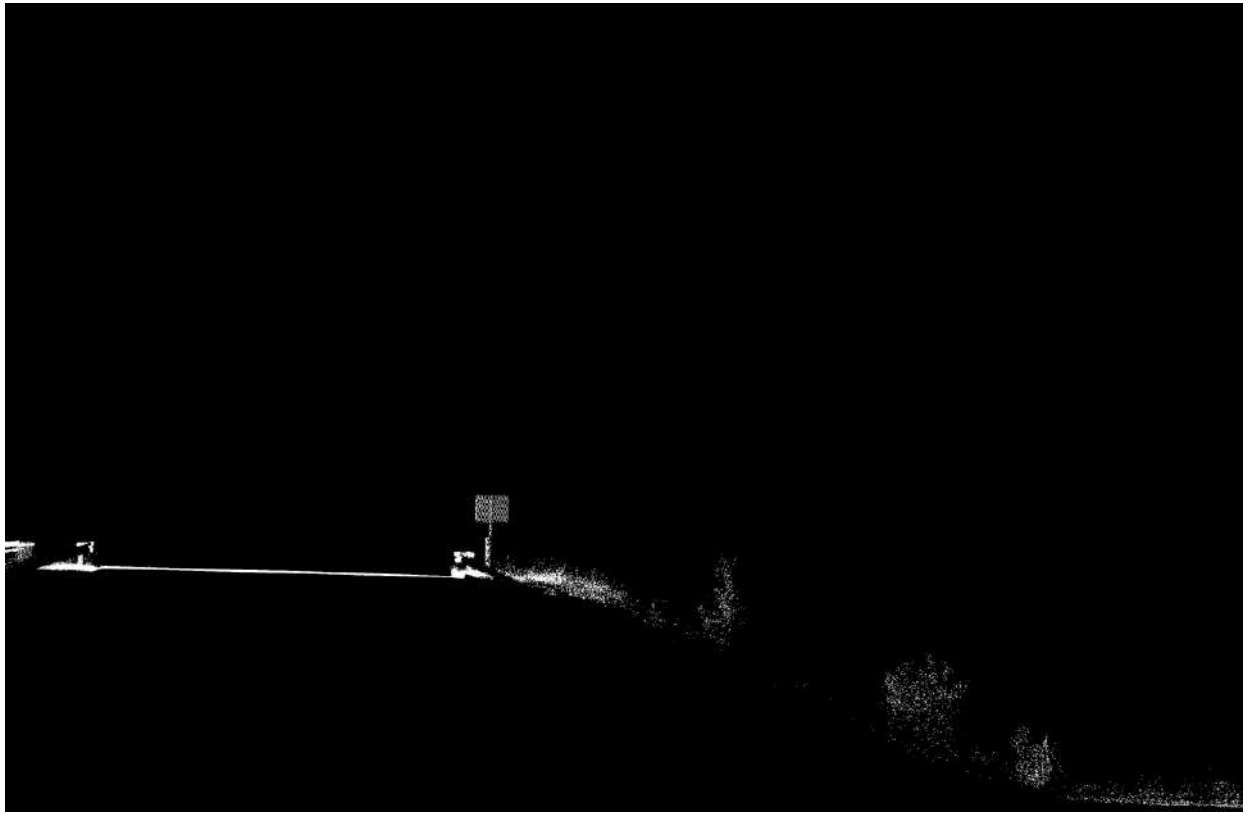
Road-Side Object Type (13 classes)

1. Safety Barrier Metal
2. Safety Barrier Concrete
3. Rockface
4. Upward Slope Rollover
5. Upward Slope No Rollover
6. Drainage
7. Down Slope
8. Tree
9. Pole
10. Rigid
11. Semi Rigid
12. Safety Barrier End
13. Rock

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101119590

Roadside severity objects detection using Lidar

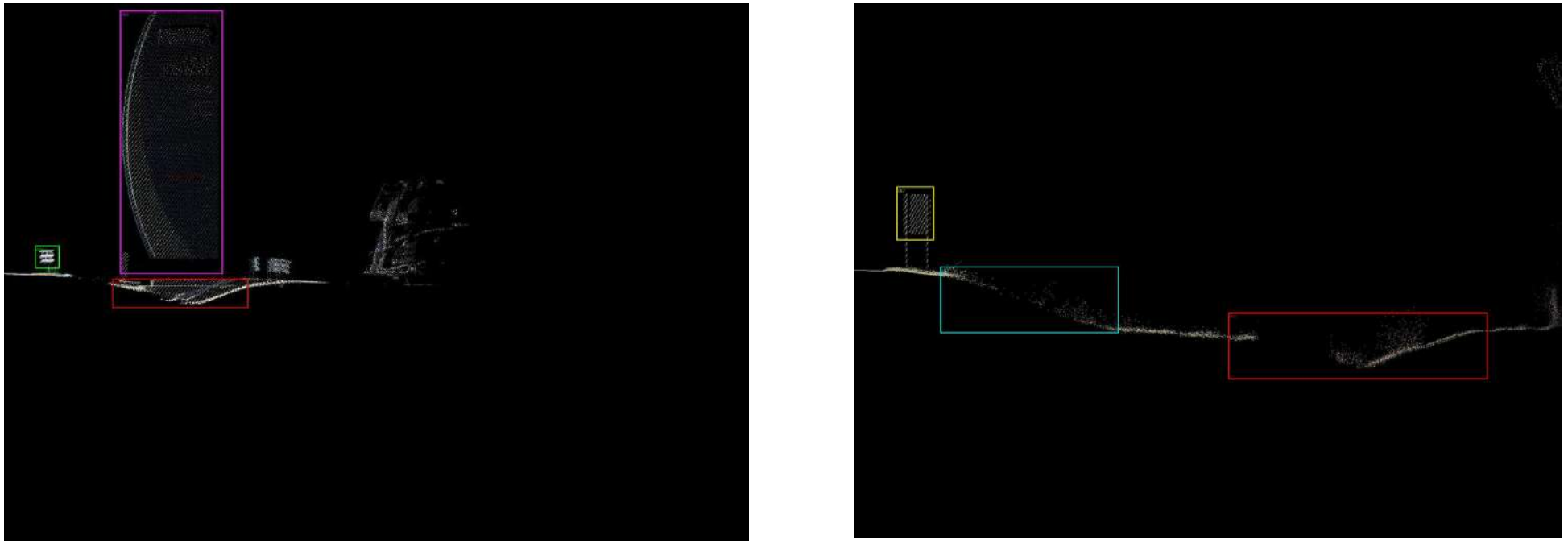
RGB Image



LiDar Image

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101119590

Dataset creation- bounding boxes



LiDar Image – Road Side Objects Bounding Boxes

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101119590

Two-Stage Detection Pipeline

Road Detection

Single-class YOLO model trained on road cross-section images · Outputs road bounding box + right edge X coordinate (road_edge_x)

Edge Extraction & Crop

Road right edge (Xmax) defines transition from road to roadside · Roadside crop defined relative to road_edge_x for Stage 2 input

Object Detection

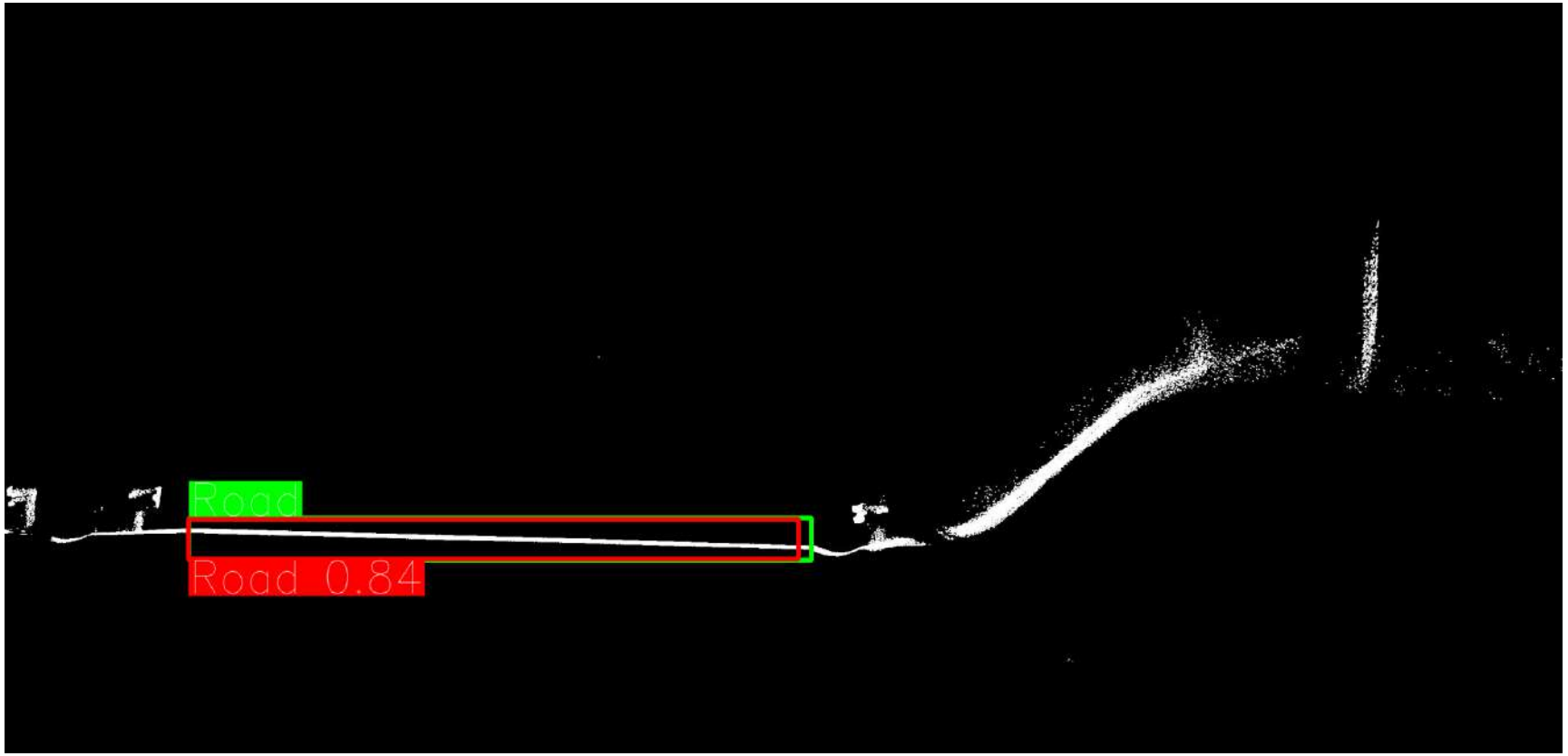
13-class YOLO model identifies roadside hazard type·

Distance Calculation

Pixel distance from road_edge_x to object reference point

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101119590

Stage 1: Road detection

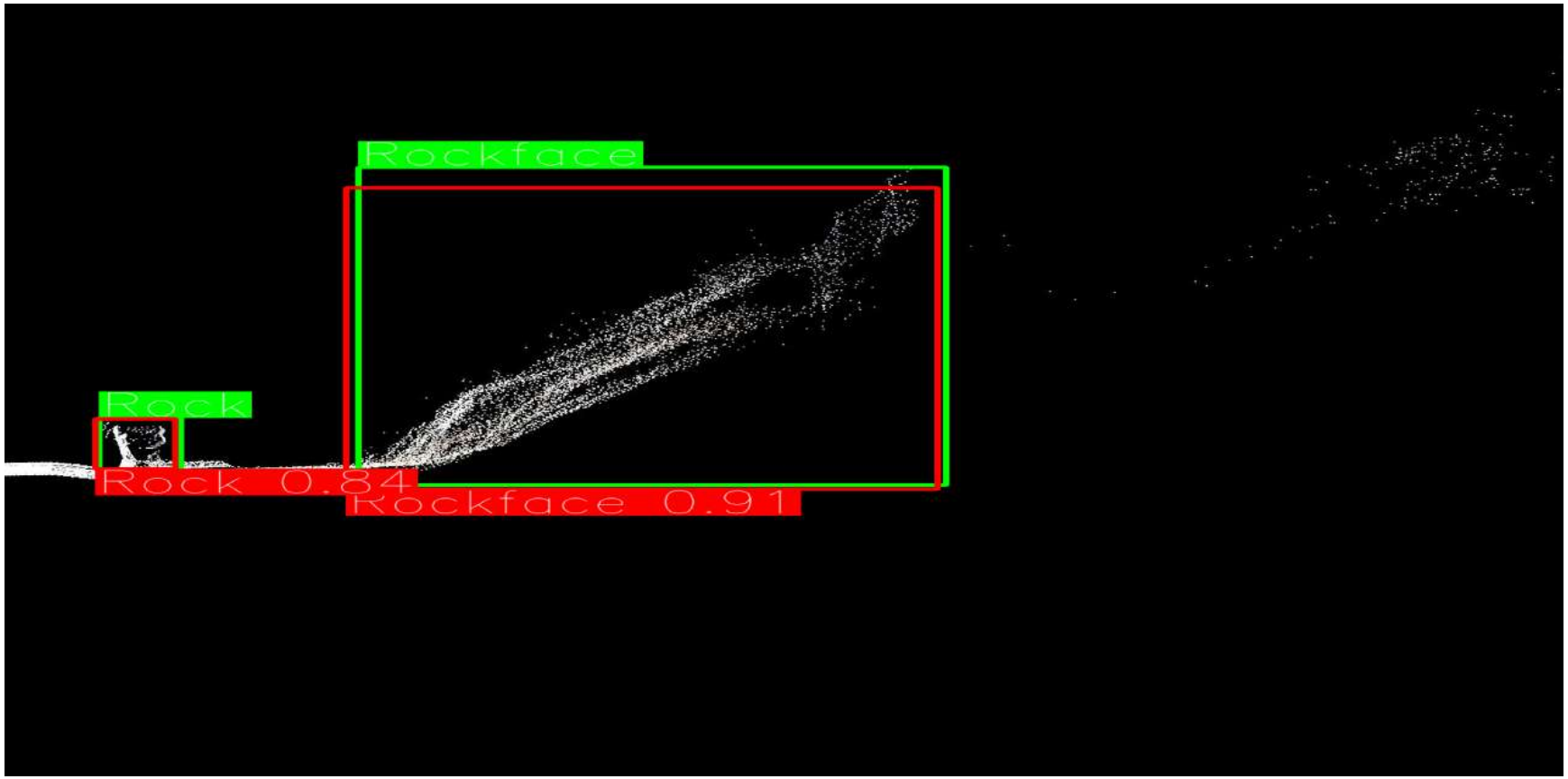


Ground truth

Prediction

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101119590

Stage 2: Roadside objects detection

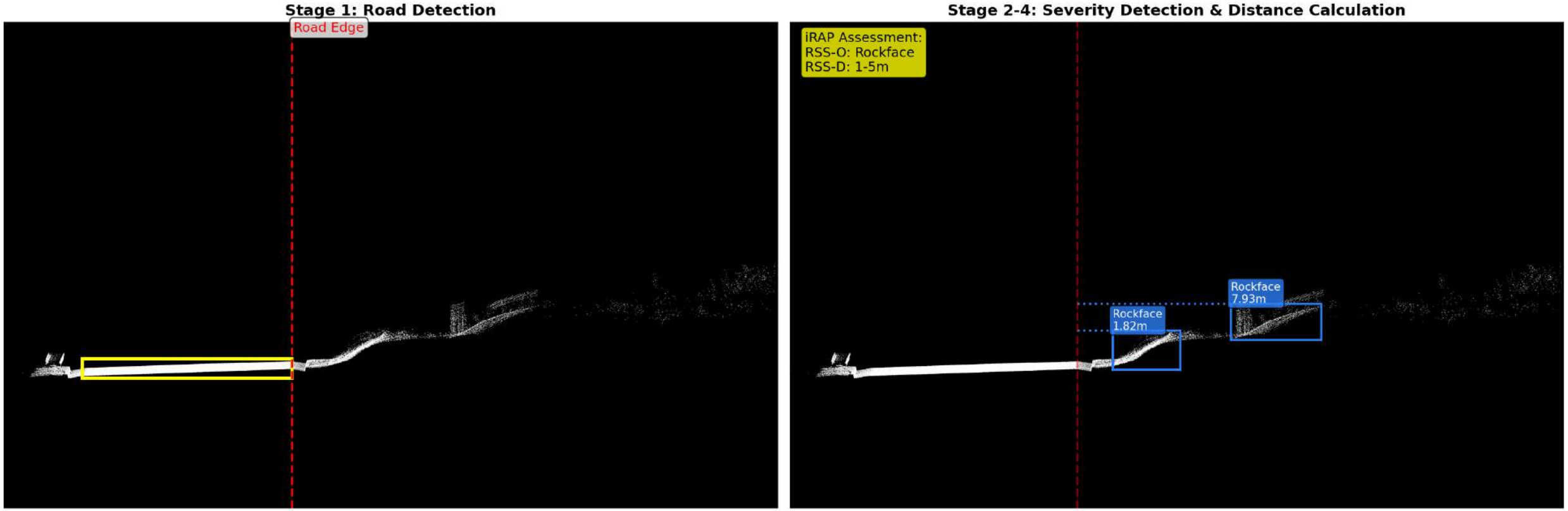


Ground truth

Prediction

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101119590

Model Inference on Test Dataset



Yolo model detected the road, then detected the roadside objects after that it calculated the distance of each roadside object to road edge line.

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101119590

Thank you!

Porto, J.A., Shahid, M., Ziakopoulos, A., Lopez, D.F., Bradford, J., Yannis, G., Ševrović, M.

National Technical University of Athens
Department of Transportation Planning and Engineering

&

University of Zagreb
Faculty of Transport and Traffic Sciences

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101119590