Conflict detection and analysis in urban arterial roads of Brasília, Brazil, using HD-CCTV monitoring cameras and the YOLO model

Paper 187

Julia Alves Porto[a]

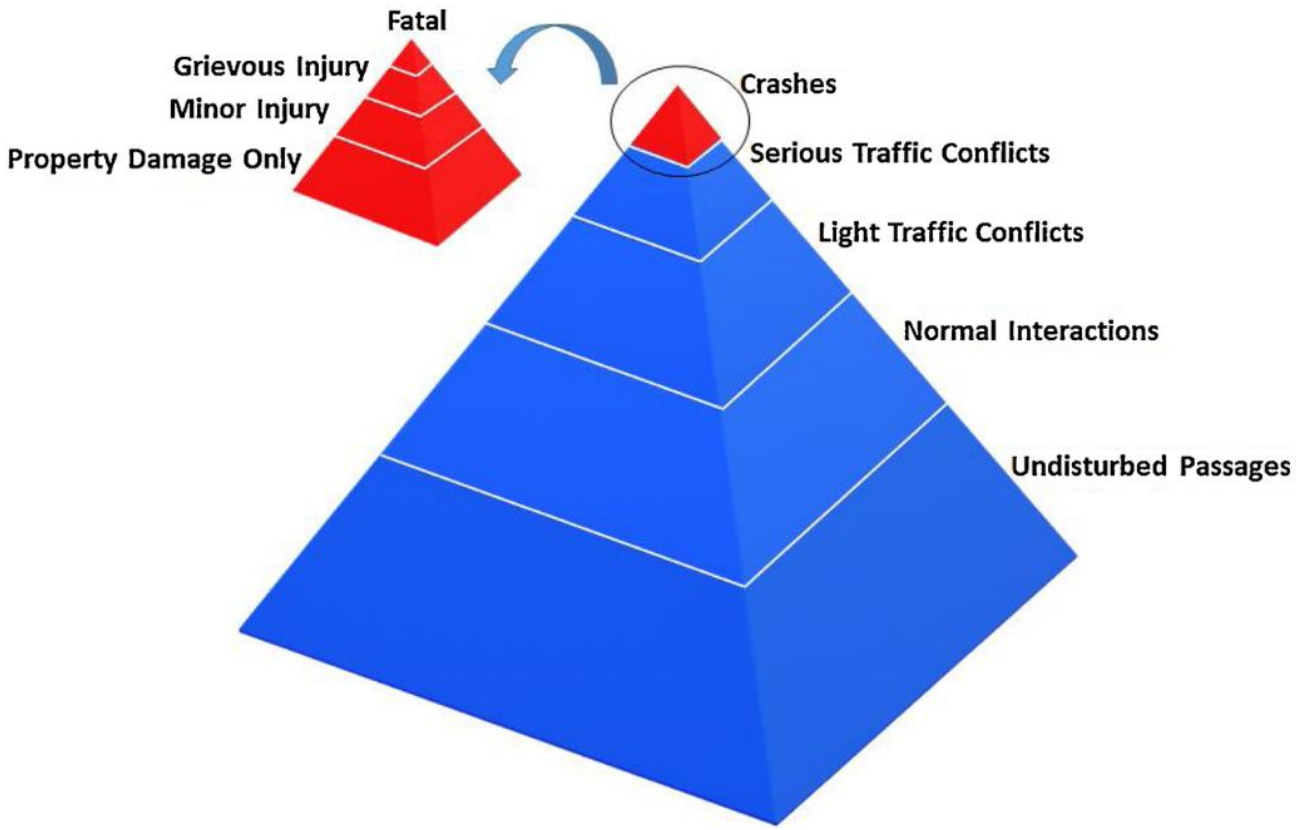
Together with Stella Roussou[a], Michelle Andrade[b], Apostolos Ziakopoulos[a], George Yannis[a]

[a]National Technical University of Athens, [b]University of Brasilia

julia_porto@mail.ntua.gr

Motivation

- Crash underreporting
- Reactive vs Proactive safety
- Conflict analysis as SMoS
- Cost of manual observations
- Resource availability

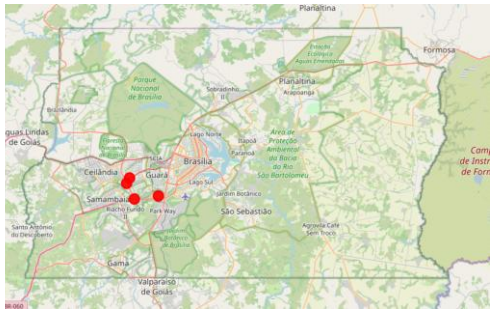


Source: Arun et al., 2021

Setup | Method | Results

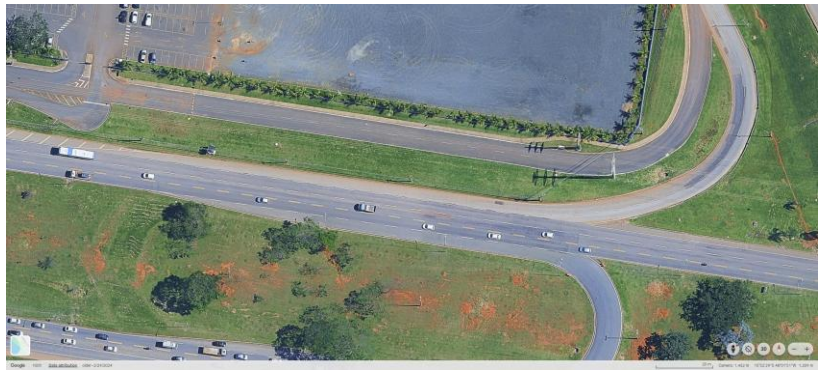
Objective

- Assess the use of video footage from operational traffic monitoring systems applied currently in Brasília, Brazil, for collecting road safety data relying on automated object detection and trajectory extraction



- 3h footage
- 4 locations
- October 2021
- DER

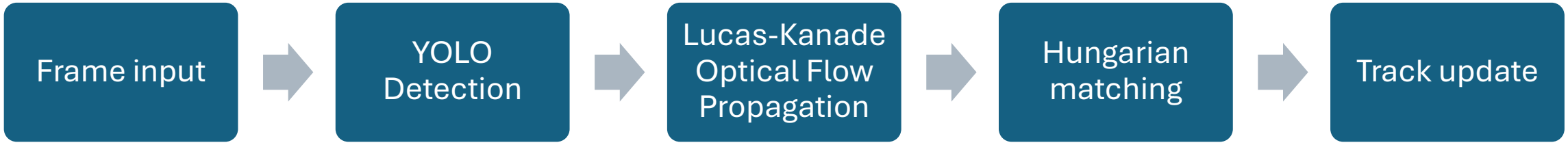
Basemap: OpenStreetMap



Pre-processing

Setup | Method | Results

Detection and Tracking Pipeline

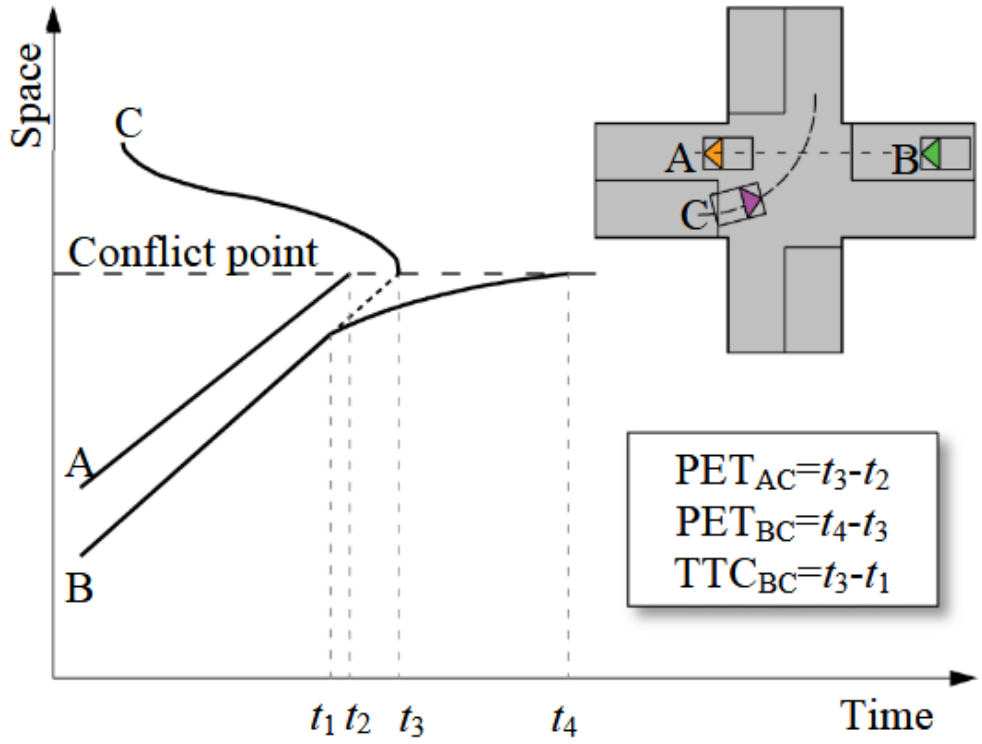


- Model specifications
  - YOLOv11m
  - 4 road users: car, motorcycle, bus, truck
  - Confidence = 0.50
  - IoU = 0.50
- Matching criteria
  - Projected centroid distance
  - Threshold at 200 pixels

Speed and Time to Collision

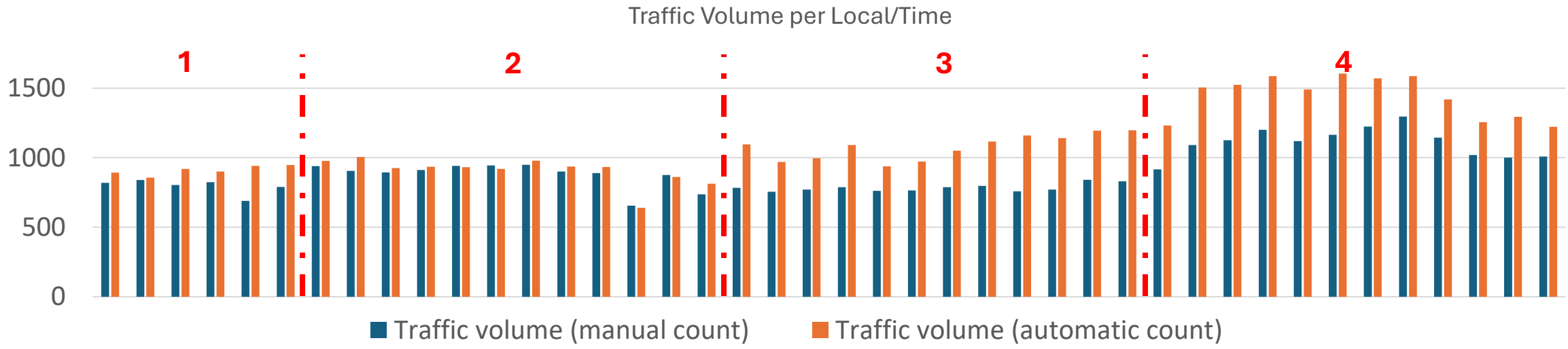
- Track output smoothening
  - 15-frame rolling window
  - Calculation per 10 frames
  - Maximum speed clipped at 40 m/s

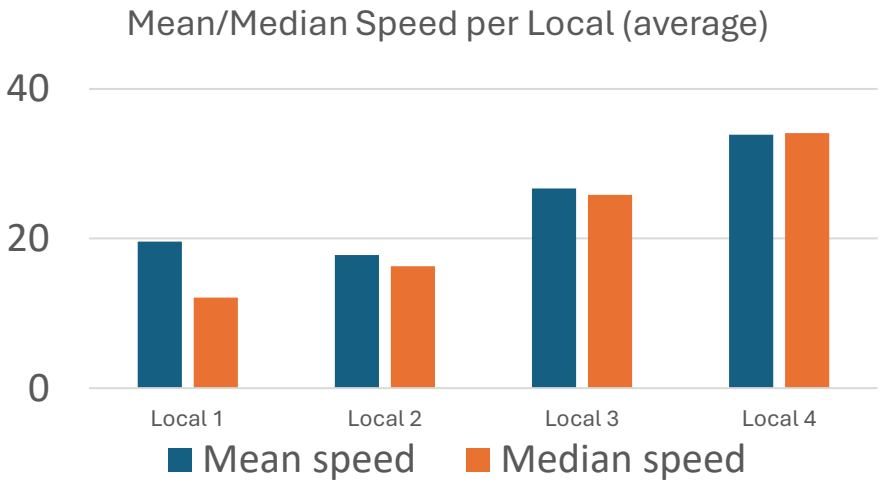
- Time to Collision
  - Discard first and last second of tracking
  - Triggered intersections: TTC <= 1.5s



Source: Zheng and Sayed, 2019

Results: Volume and Speed

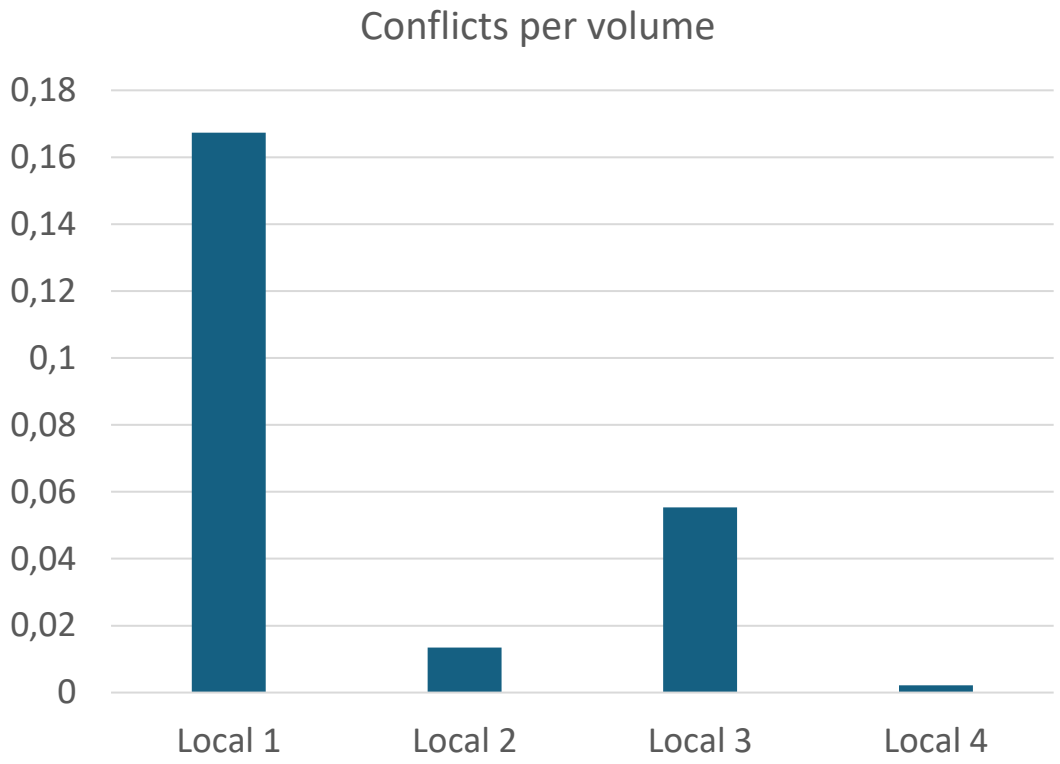




- Automated counts generally overestimate
- Fragmented trajectories cause duplicate ID
- Local 01 most affected by steep camera angle

Setup → Method → Results

Results: Conflicts and Tracking Accuracy

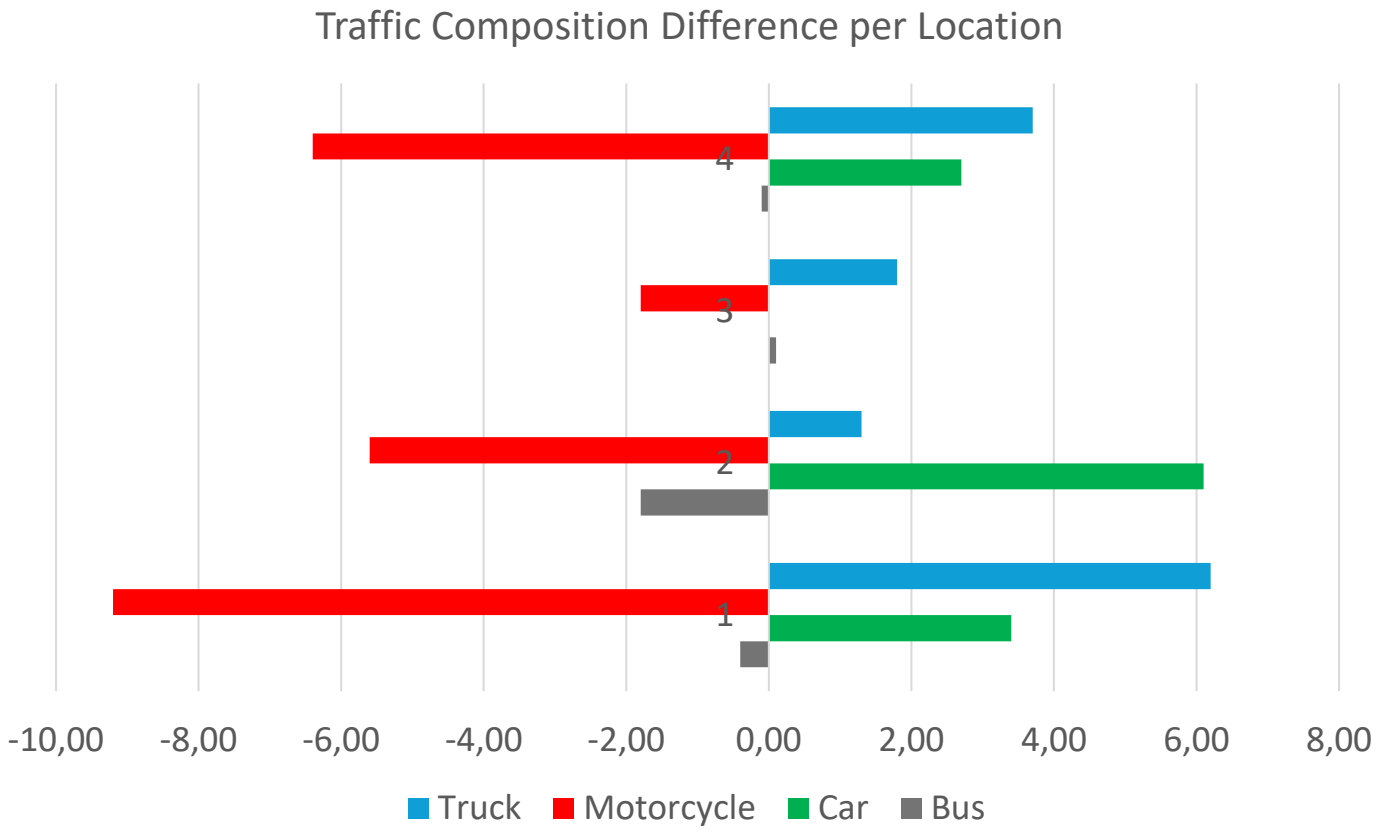


– The low frequency of triggered interactions in Location 04 reflects not only better tracking, but most importantly, total flow separation.

Tracking Accuracy:

Local	Previous Pipeline (%)	Current Pipeline (%)	Improvement (%)
01	36	40	4
02	75	91	16
03	74	94	20

Traffic Composition: Model Bias



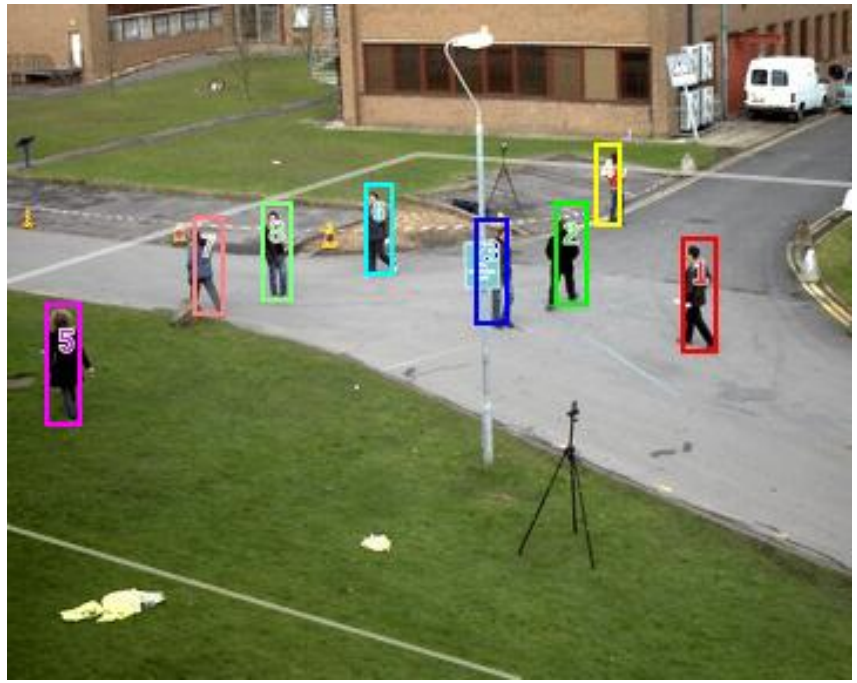
- Motorcycles: consistently under-detected
  - Especially after sunset
- Trucks: over-detected
  - fragmented trajectories
- Cars: reasonably stable across locations

Discussion

- Camera geometry matters most
  - Location 02 had the best performance: favorable angle
  - Location 01 had the worst performance: steep and congested
- Flow separation induces safety perception
  - Location 04 had near-zero triggered interactions despite high volume
- VRUs remain the gap
  - Motorcycles and pedestrians are the most hazardous road users but also most difficult to track
- TTC as relative, not absolute value
  - Manual inspection shows many triggered events are tracking artifacts

Future Work

- Better VRU detection
  - Dedicated motorcycle/pedestrian model or fine-tuning
- Richer re-identification
  - Lane-level analysis
  - Background-normalized color histograms
  - Embedding features from hidden layers
- Calibration robustness
  - Adaptive TTC thresholds
  - Location-specific calibration



Source: Berclaz et al., 2011

Conclusion

- YOLO-based pipeline improved tracking over previous approach at 2 of 3 locations
- Camera configuration was the dominant factor in tracking quality
- Complete flow separation reduces conflicts
- Framework is conditionally scalable using existing infrastructure

European Commission

Thank you!

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IVORY

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