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# **Video-Based Study of Pedestrian Compliance at Signalized and Non-Signalised Crossings in Athens**

Paper ID: 215

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# Introduction & Motivation

- Pedestrians account for a **significant share of road fatalities** in urban areas, a critical concern under the Safe System/Vision Zero framework.
- **Non-compliance at crossings** (red-light violations, mid-block crossings) is influenced by: waiting time, traffic flow, vehicle speed, road geometry, and social behaviour etc.
- Crash data are rare and lack trajectory detail → **Surrogate Measures of Safety (SMoS) (TTC, PET)** enable proactive risk assessment without relying on crashes.
- Computer vision & Machine Learning Models (YOLOv8, Kalman filter, homography) enable automated, scalable extraction of pedestrian/vehicle trajectories from video.
- The present study has combined **automated video analytics + SMoS + behavioural modelling** to directly compare signalised vs. non-signalised crossings.



# Objectives

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- **Quantify pedestrian compliance rates** and violation patterns at both signalised and non-signalised crossings in the Athens city centre.
- Identify environmental, traffic, and behavioural factors influencing pedestrian crossing decisions using **logistic and Poisson regression models**.
- Assess pedestrian-vehicle interaction severity using Surrogate Measures of Safety (SMoS) (TTC and PET) at both crossing types.
- Compare safety conditions between the Signalised Crossing Site and the Non-Signalised Crossing Site through statistical analysis.
- Demonstrate how automated video analytics can provide **cost-effective, scalable data** for pedestrian safety monitoring in real urban environments.



# Study Sites & Data Collection

## Study Sites

- Panepistimiou Street -> Signalised Crossing Site:  
3-lane arterial, traffic signals, public transport stops, high pedestrian demand.
- Vasilissis Sofias, Non-Signalised Crossing Site:  
4-divided lane, pedestrians cross freely to catch buses or avoid the next designated crossing.
- Both sites selected for diverse traffic conditions, mixed land use, and high pedestrian-vehicle interaction rates.

## Data Collection

- June 2024 (Tuesdays & Thursdays, peak + off-peak)
- Smartphone Cameras (iPhone 11 Pro Max on tripod, elevated position, ~29.47 fps).
- Captures pedestrian movements, vehicle movements, signal phases, and pedestrian-vehicle interactions.

Signalised Site  
Panepistimiou St.

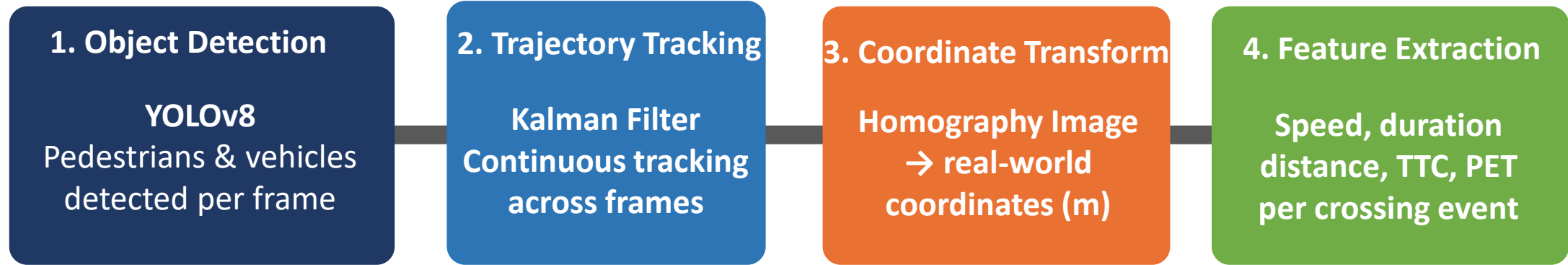


Non-Signalised Site  
Vasilissis Sofias Ave.



# Methodology-Computer Vision Pipeline

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## Output Dataset - Per Crossing Event:

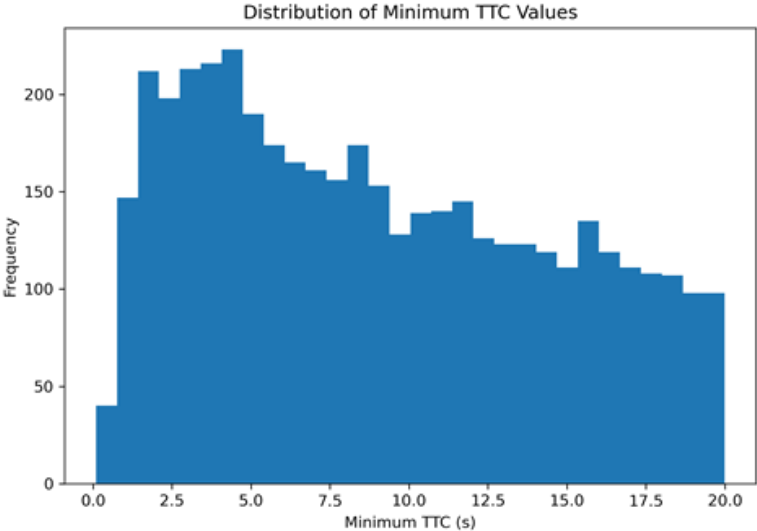
- Crossing duration (s)
- Pedestrian speed (m/s)
- Traffic signal phase (signalised site)
- Compliance label: legal / illegal
- Vehicle speed & flow (veh/min)
- Minimum TTC (s) - Time to Collision
- Minimum PET (s) - Post Encroachment Time
- Interaction severity category (Safe, Low, Medium, High)

# Results (1)

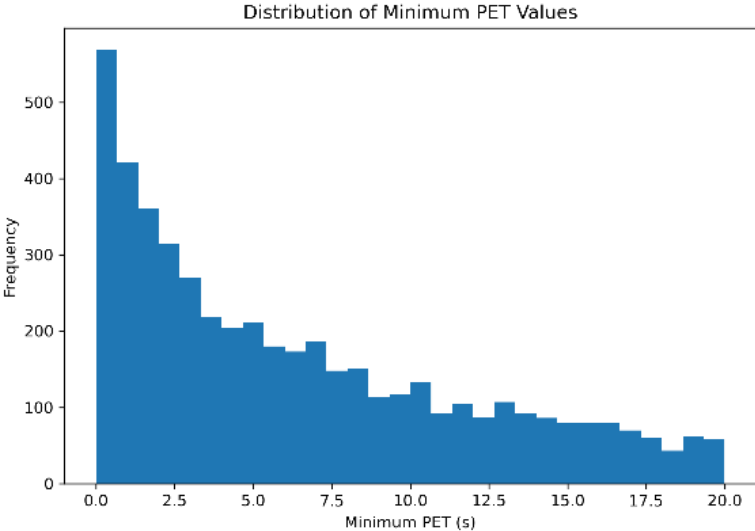
Descriptive Statistics (Signalised Site)						
Indicator	Mean	Median	Min	Max	P25	P75
Min TTC (s)	9.06	8.37	0.095	19.990	4.292	13.565
Min PET (s)	6.37	4.90	0.001	19.994	1.723	10.083

Threshold analysis	Metric	Percentage		Metric	Percentage
	TTC_lt_5	30.537		PET_lt_2	27.729
	TTC_lt_3	15.280		PET_lt_1	16.276
	TTC_lt_1_5	4.825		PET_lt_0	9.277
	TTC_lt_1	1.907			

TTC Severity Categories



PET Severity Categories



# Introduction & Motivation

## Non-Signalised Crossing Site - PET Analysis

**0.89 s**

Median min. PET  
(very limited clearance)

**50.0%**

Events with  
PET < 1 s

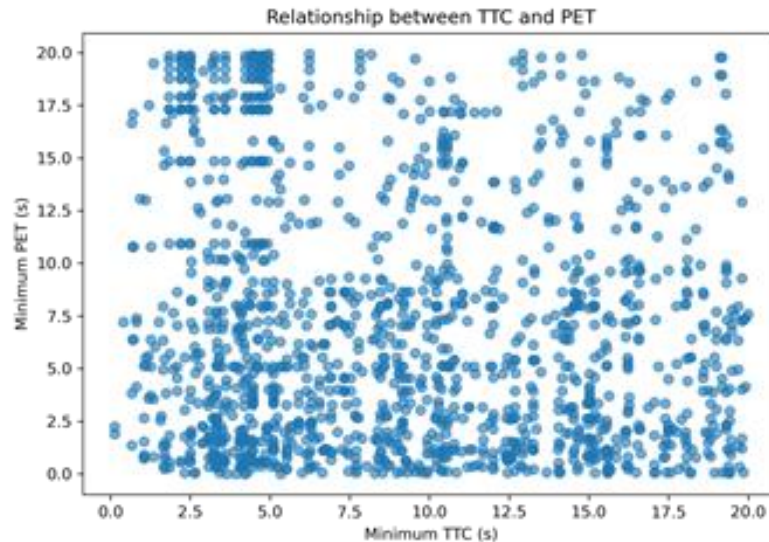
**37.5%**

Events with  
PET < 0.5 s

**18**

Total interaction  
events analysed

TTC Category	Count	Percentage	PET Category	Count	Percentage
Safe	3023	69.462	Safe	3521	72.27
Low	664	15.257	Low	558	11.45
Medium	455	10.454	Medium	452	9.27
High	210	4.825	High	341.6	6.99



## Key Comparative Findings

- Signalised site median PET  $\approx$  6.20 s vs. non-signalised  $\approx$  0.89 s  $\rightarrow$  7 times safer clearance margin.
- At signalised site: only 5.9% of events < 1 s PET, but at non-signalised: 50.0%.
- Mann-Whitney test confirms the difference is statistically significant (not due to random variation).
- Non-signalised crossings show gap-acceptance behaviour with much narrower temporal safety margins.
- Signal control substantially structures interactions and reduces risk - supports infrastructure investment.

# Results (3)

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## Compliance at Signalised vs. Non-Signalised Crossings

### Signalised Site

**~1/3 of pedestrians crossed during red phase**

particularly when perceived waiting times were long or vehicle approach speeds were low

### Non-Signalised Site

**Higher violation frequency**

more frequent in smaller road segments and under moderate / congested traffic flow conditions

## Statistical Modelling - Predictors of Non-Compliance

- **Logistic regression** -> likelihood of violation at signalised crossings - signal phase, vehicle flow, vehicle speed, crossing width, pedestrian characteristics.
- **Poisson regression** -> frequency of violations at non-signalised crossings - moderate/congested flow significantly associated with more violations.
- Signalised crossings -> **compliance significantly higher**, but long waiting times and slow vehicle speeds reduce compliance.
- Behavioural trade-off at non-signalized as **pedestrians weigh perceived risk against delay cost** when accepting gaps.

# Discussion

- Signal control substantially improves pedestrian safety margins—median PET 7 times higher at signalised vs. non-signalised crossing.
- **Even signalised crossings are not risk-free** as approximately 30% of interactions have  $TTC < 5s$  and 16% have  $PET < 1s$ , indicating persistent conflicts especially outside the marked crossing area.
- **Non-signalised crossings show gap-acceptance** behaviour with high proportions of critical interactions (50%  $PET < 1s$ ) - urgent priority for safety intervention.
- **Compliance rates are higher at signalised crossings**, but red-phase violations remain common when waiting times are long or vehicle speeds are low - signal timing optimisation is key.
- Combined use of **TTC and PET provides a more complete picture of interaction risk** as TTC captures approach speed/distance and PET captures temporal clearance at conflict point.
- Automated video analytics (YOLOv8 + Kalman + homography) proved cost-effective and scalable - viable for monitoring pedestrian safety across multiple locations without camera infrastructure.



# Conclusions & Future Work

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## Key Conclusions

- Automated video analytics (YOLOv8, Kalman filter, homography) successfully extracted **surrogate safety indicators** from real urban video data.
- Compliance is **higher at signalised crossings, but red-phase violations persist - particularly** when waiting times are long or vehicle speeds are low.
- **Non-signalised crossings show opportunistic gap-acceptance** behaviour with substantially narrower temporal safety margins, highlighting the need for safety interventions.

## Future Research Directions

- **Expand to a larger number of sites** and interaction events to strengthen statistical validity and generalisability.
- Incorporate **additional contextual variables (weather, pedestrian demographics, land use)** into behavioural models.
- Evaluate the **safety impact of infrastructure interventions** (signal installation, crossing redesign) using the same automated video methodology.



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