



**INTERNATIONAL CONGRESS ON
TRANSPORT INFRASTRUCTURE AND SYSTEMS
IN A CHANGING WORLD**

Vulnerable Road Users Safety

**Analysis of sight distances at urban intersections
from a vulnerable users' approach: A case study**

Keila González & María Castro
Universidad Politécnica de Madrid



POLITÉCNICA

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- Introduction & goals
- Background
- Procedure
- Case study & evaluation
- Results & discussions
- Conclusions

Introduction

- Road intersections contain dissimilar users
- Vulnerable road users with lack of outer protection →
Recent increase due to shared mobility services
- VRU and roundabouts in terms of safety
- Available sight distance and safety
- LiDAR data allow fully 3D analyses
- GIS tools allow the consideration of distinct observers

Goal

Evaluate the available sight distance of an urban intersection from its vulnerable users' point of view: this distance is later compared with required values > 3Dly

➤ Case study a roundabout in Madrid, Spain

Background

- Roundabouts alter common conflict points ➤ high rate of accidents involving cyclists
- Importance of VRU's behavior and their dedicated facility



Background

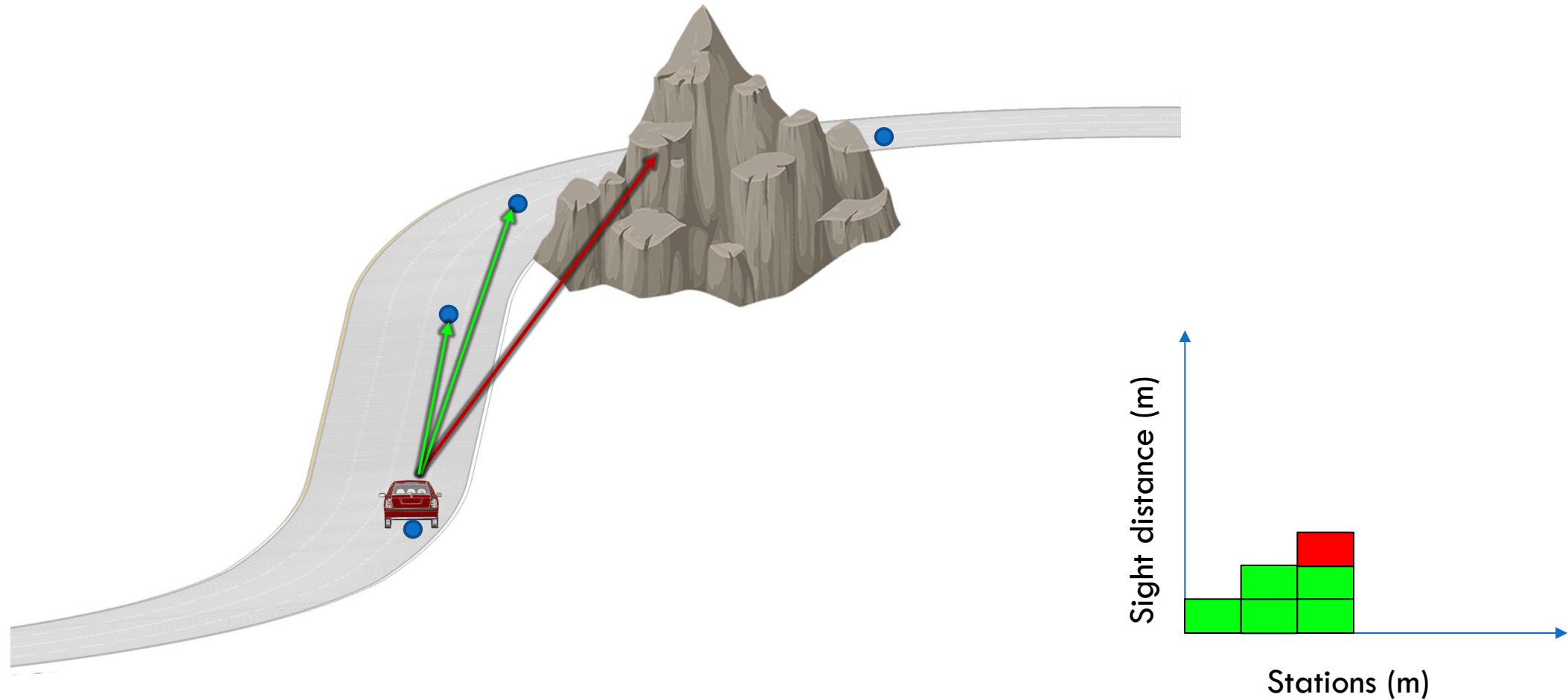
- Role of visibility in roundabout safety
- Authors reflected 2-D approaches could misestimate ASD ➤ seeking 3-D approaches many authors use LiDAR data for ASD estimations
- Digital models are used to accurately portray road settings

Procedure

- Projection of Line of Sights from observers to targets
 - Targets belong to own path, conflicting path or specific POI
- Main inputs:
 - Object and target location → Contained in their trajectories
 - Road geometry definition → Digital terrain model
 - Roadside obstructions → 3-D objects

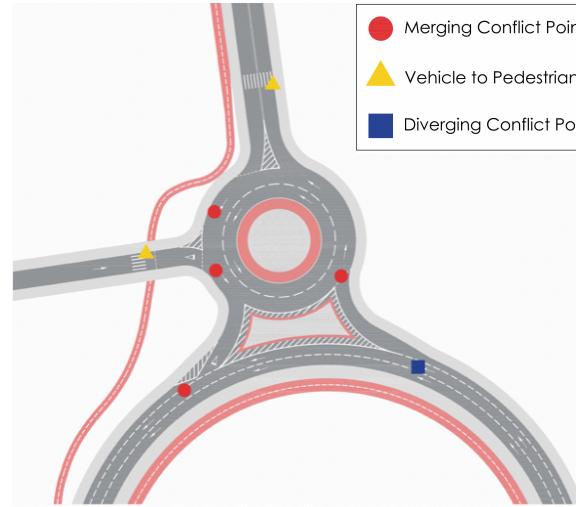


Procedure



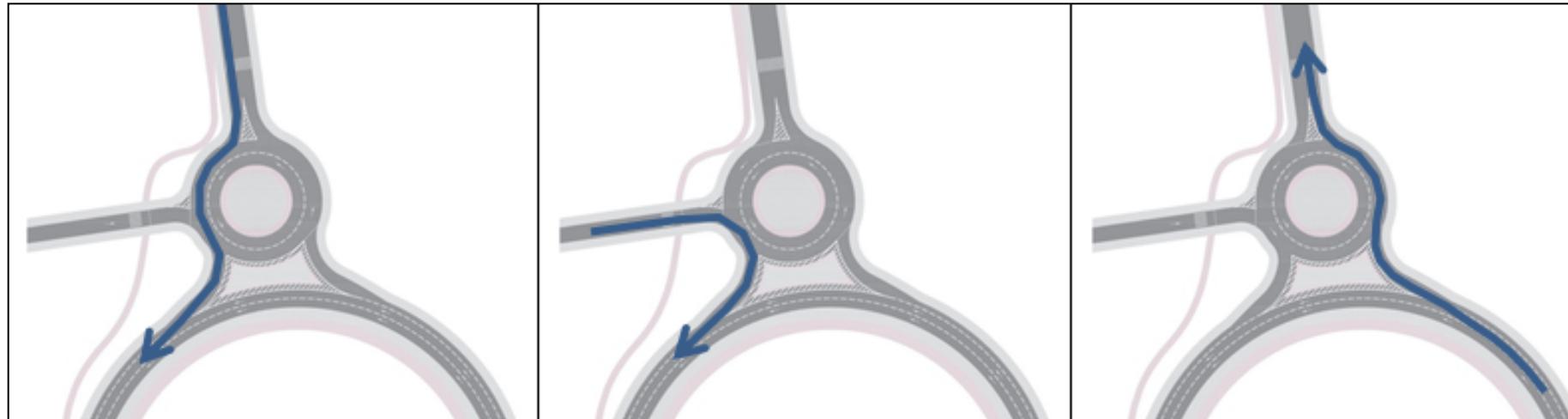
Case study

- Urban two-lane roundabout with 3 entries and two exits
 - Approach width of 5.5 m
 - Entry width 6.3 m
 - Straight crosswalks without refuges
- Posted speed limits of 40 km/h



Evaluation goals

- Assessment of SSD and ISD for drivers, riders & cyclists for all turns



- Pedestrians visibility
- Verification of required sight distance values

Evaluation

	Eye Height (m)	Lane position
Pedestrians	1.70	Center sidewalk
Cyclists using their facilities	1.40	Center of their lanes
Cyclists sharing the lane	1.40	1 m equidistant to the center of the lane
Scooter rider	1.80	Center of the lane
Car driver	1.08	Center of the lane



Evaluation: Required sight distances

Stopping SD: Distance required to safely stop

$$SSD = 0.278 Vt + 0.039 \frac{V^2}{a}$$

- V Speed (km/h)
- t Perception-and-reaction time (2 s)
- a deceleration rate (3.4 m/s)

Intersection SD: Stream distances required to react to conflicting trajectories

$$d_1 = 0.278 V_e t_c$$

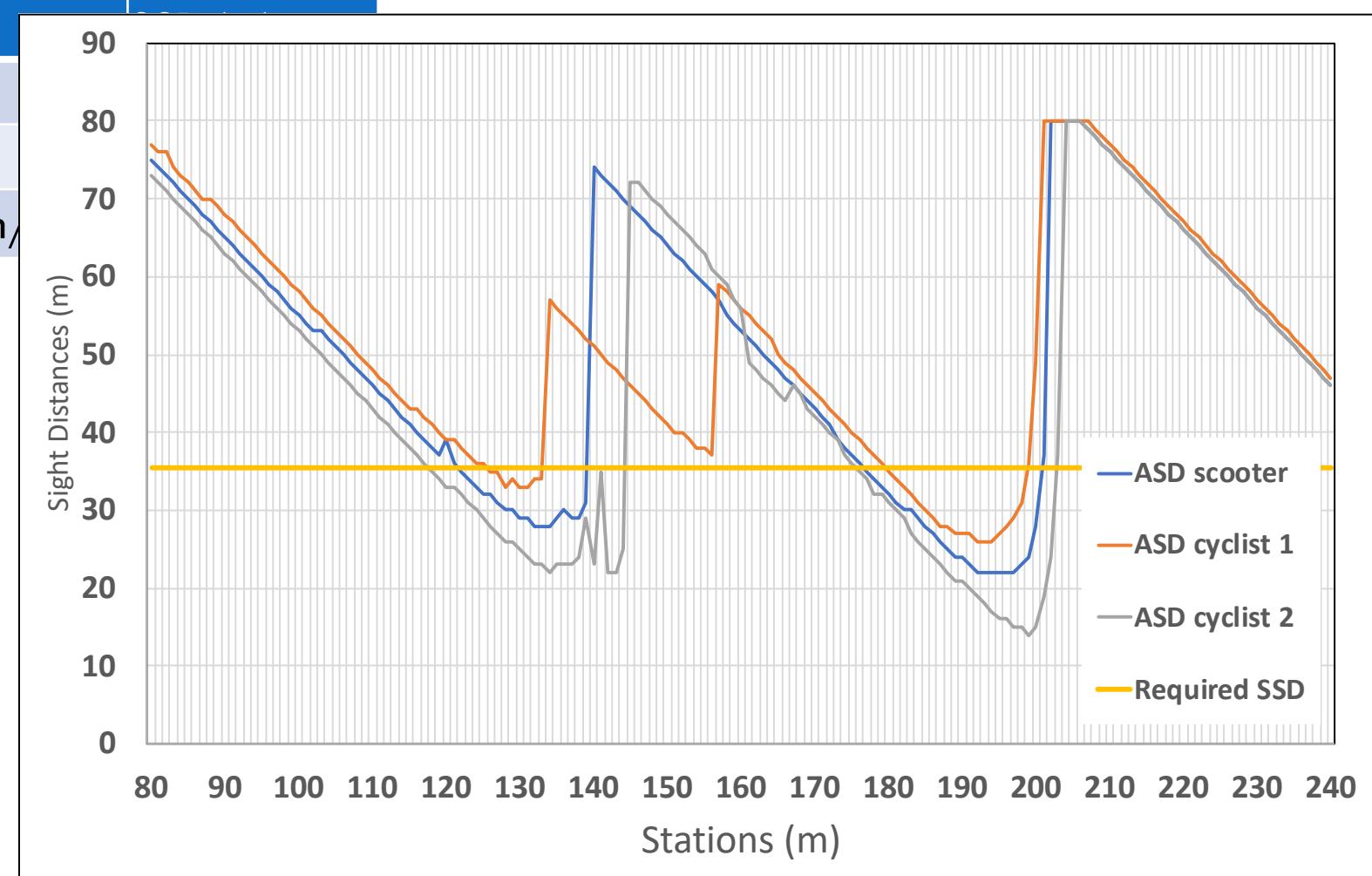
$$d_2 = 0.278 V_c t_c$$

- V Speed of entering stream (km/h)
- t Critical headway for entering major road (5 s)

Results: SSD

Observer
Driver (40 km/h)
Cyclist (30 km/h)
Personal Device Rider (30 km/h)

- Partial provision of SSD but riders and cyclists sharing the road are limited

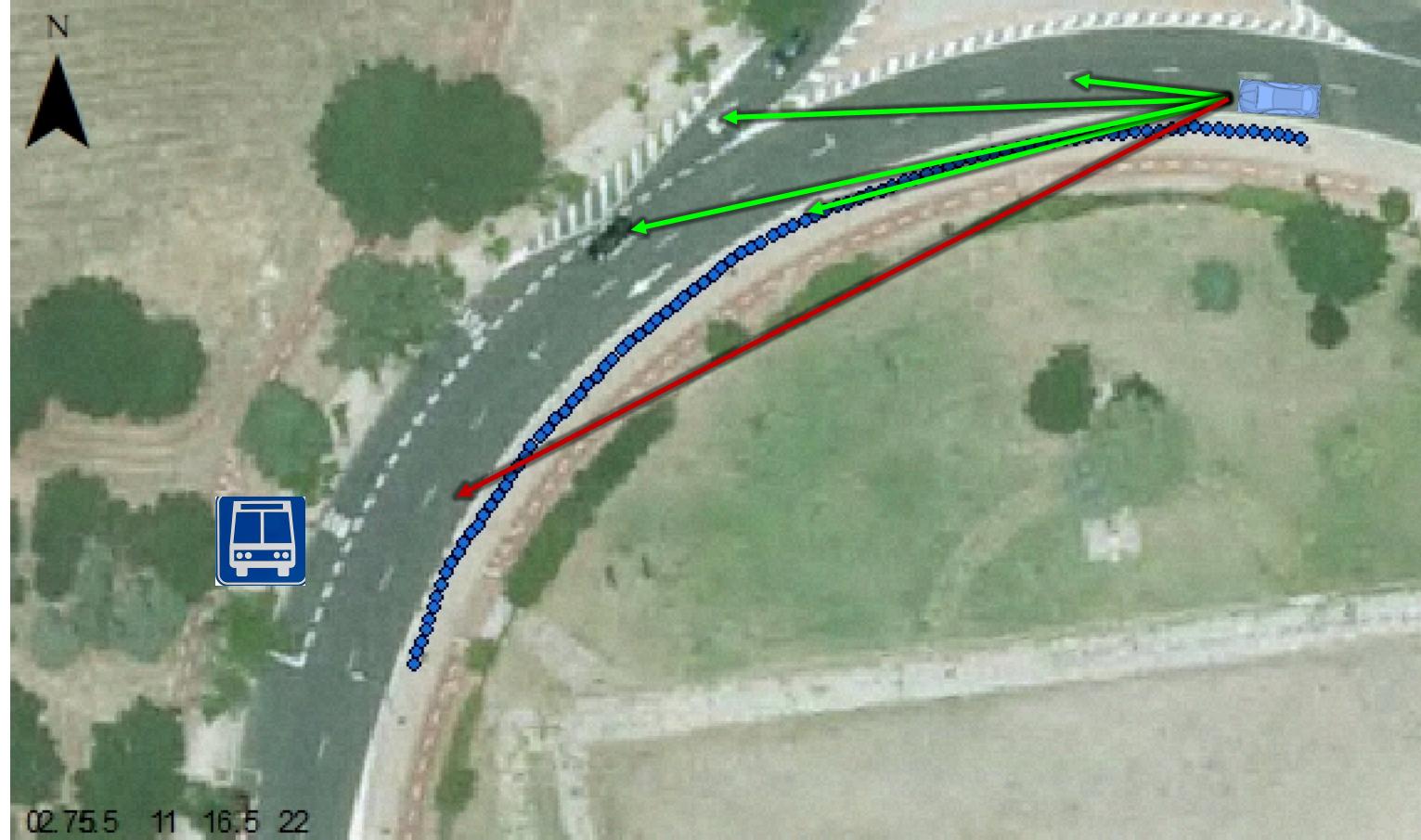


Results: ISD



- Vegetation hinders proper spotting of minor road entry

Results: Pedestrians darting out



- Drivers located 60 m from the bus stop would not spot pedestrians darting out

Conclusions

- Increasing number of VRU with distinct levels of expertise are present in urban settings
- Operational urban roads require verification of visibilities for all users ➤ not only car's perspective
- Case study showed restricted ASD on the approaches
- Cyclists riding near sidewalk lack good sight of minor road
- Not all sections comply with required SSD
- Proactive search and identification of potentially risky locations is key to prevention

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