Where is The Hazard
Spectrum-Based Hazard Analysis for ADS Systems

Research content

Nowadays, personal mobility and goods transportation are undergoing a significant transformation thanks to Autonomous Driving Systems (ADS). However, in ADS, errors may cause disruptive damages, even the loss of human lives; thus, its validation is essential. This work proposes an approach to investigate the relation of different system configurations to the hazard. By integrating the spectrum configurations and the ego vehicle's behaviours obtained from the execution of ADS simulators, we identify which components are "suspicious "to the hazard, e.g., a detected accidental collision, and how they cause this hazard.
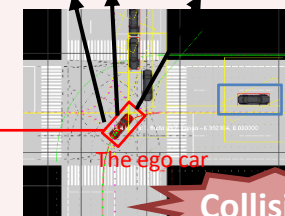
What to solve?

Configurations ⟷ **Driving Characteristics**
speed curvature acceleration

weight_accerlation,
weight_deceleration,
weight_curvature,
weight_lateralAcc
weight_speed
weight_safeDistance

The ego car

Explanation: which settings? → which driving characteristics? → collision

Collision!

Approach

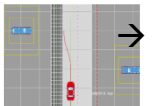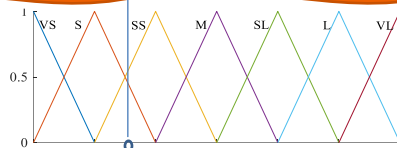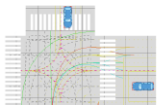### Fuzzification

Parameter *p* (acceleration, weight_acceleration)

7 Fuzzy Sets: Very Small (VS), Small (S), SS (Slight Small), Median (M), Slight Large (SL), Large (L), Very Large (VL)

→ w_lateral = 2500 → **coverage**

VS	S	SS	M	SL	L	VL
0.0	0.5	0.5	0.0	0.0	0.0	0.0

Testing /Simulation:

Spectrum-based analysis

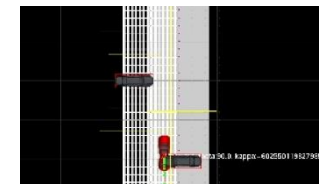$$a_h^{\pi_j^{w_{xx}}} = \sum_{t \in T} (\pi_j^{w_{xx}}(v_i) \cdot t.c)$$

$$a_s^{\pi_j^{w_{xx}}} = \sum_{t \in T} (\pi_j^{w_{xx}}(v_i) \cdot (1 - t.c))$$

Configurations: Penalty Acc. *Small*
Driving Characteristics: Acc. *large*

Hazard!

Case study
Traffic Situation

why?

Different configurations → Sometimes collision
Sometimes no collision

rank	weight w_i	π_j	$\Phi^{\pi_j^{w_i}}$
1	$w_{safeDist}$	L	0.48
2	$w_{safeDist}$	SL	0.46
3	$w_{safeDist}$	VL	0.42
4	$w_{...}$	S	0.34

	decmax	0.00
4	rf_spd	0.00
4	rf_curvature	0.00
4	rf_safeDist	0.00

Explanation: $w_{safeDist}$ *too large* → too afraid of getting close to other cars → the car cannot take aggressive actions in this emergent situation

Zhang, Xiao-Yi, Paolo Arcaini, Fuyuki Ishikawa, and Kun Liu. "Investigating the Configurations of an Industrial Path Planner in Terms of Collision Avoidance." ISSRE'20