Scenario-Based Autonomous Vehicle Validation: From Functional to Logical Scenarios

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Abstract

Autonomous vehicle (AV) technology is positioned to have a significant impact on various industries. Hence, artificial intelligence powered AVs and modern vehicles with advanced driver-assistance systems have been operated in street networks for real-life testing. Suggestion: Let's introduce the idea as a method to generate logical scenarios from functional scenarios and use accidents as the demonstration example As these tests become more frequent, accidents have been inevitable and there have been reported crashes. The data from these accidents are invaluable for generating edge case test scenarios and understanding accident-time behavior. In this paper, we use the existing AV accident data and provide a methodology to generate a logical scenario from a functional scenario described in AV crash report. Our approach formulates accident scenarios from these reports and defines them in the measurable Scenario Description language (M-SDL). This approach provides an automated method to translate a functional scenario to a logical scenario.

Index Terms

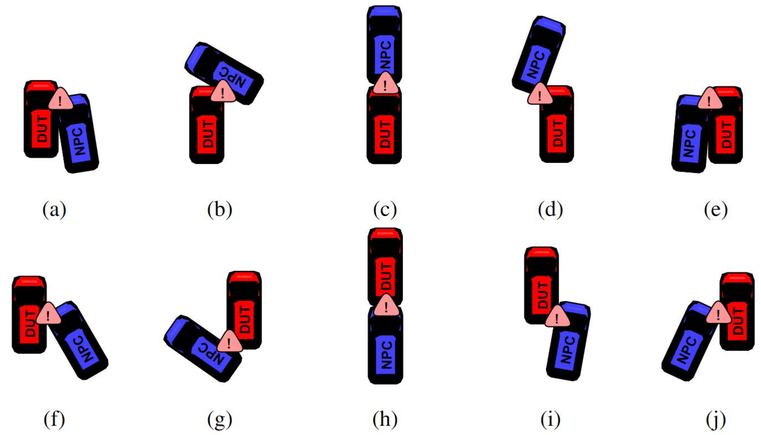
Autonomous vehicles, AV crashes, Simulation, Validation

Approach

In states such as Florida [1] and California [2], any collision resulting in property damage, injury, death, or a disabled vehicle removed by a wrecker must be reported to the departmentof motor vehicles within ten days. These reports summarize thecollision as recollected by the drivers, passengers, witnesses,and the police officer who responds to the collision. As part of the report, a few sentences describe the collision. This is a functional scenario. An autonomous vehicle accident is reported at 10:36am June 1st, 2020, in San Francisco, California. The accident involves an AV Chevrolet Bolt manufactured by Cruise LLC and a non-AV Chevrolet Astro van. The accident descriptionis as follows: https://www.dmv.ca.gov/portal/uploads/2020/06/CruiseOL316060120R edacted.pdf An autonomous vehicle accident is reported at 10:36am June 1st, 2020, in San Francisco, California. The accidentinvolves an AV Chevrolet Bolt manufactured by Cruise LLC and a non-AV Chevrolet Astro van. The accident descriptionis as follows: https://www.dmv.ca.gov/portal/uploads/2020/06/CruiseOL316060120Redacted.pdf *A Cruise autono- mous vehicle (“Cruise AV”), operating inautonomous mode, was coming to a complete stop in responseto stopped traffic on southwest bound Mission Street near theintersection with 10th Street when another vehicle approach-ing from the rear made contact with the Cruise AV’s rearbumper, damaging the rear right fascia light bracket..*

Table I: Key terms from functional scenarios with the logical equivalent.

Term	Value	Event
Position		
behind	[-30..10]ft + DUT.x	
ahead of/in front of	[-10..30]ft + DUT.x	
beside/next to	[-10..10]ft + DUT.x	
approach/advance	[-100..10]ft + DUT.x	
departure/distancing	[-10..100]ft + DUT.x	
Velocity		
Faster than	[0..50]mph + DUT.v	
slower than	$\max$([-50..0]mph +DUT.v, 0)	
accelerate	[0..50]mph + DUT.v	end
brake	$\max$([-50..0]mph + DUT.v, 0)	end



(a) (b) (c) (d) (e)

(f) (g) (h) (i) (j)

Figure 1: DUT and NPC Positions when a collision begins.

Table II: Lane assignments predicted based on collision location.

NPC	Start	End
Fig. 1a	right of DUT	same as DUT
Fig. 1b	right of DUT	same as DUT
Fig. 1c	same as DUT	same as DUT
Fig. 1d	left of DUT	same as DUT
Fig. 1e	left of DUT	same as DUT
Fig. 1f	right of DUT	same as DUT
Fig. 1g	same as DUT	left of DUT
Fig. 1h	same as DUT	same as DUT
Fig. 1i	same as DUT	right of DUT
Fig. 1j	left of DUT	same as DUT

References

1. F.Statute.http://www.leg.state.fl.us/statutes/index.cfm?Appmode=DisplayStatute&URL=0300-0399/0316/Sections/0316.066.html,2020. [Online; accessed 2-December-2020]. California Department of Motor Vehicles, “Autonomous vehicle col-lision reports.
2. “https://www.dmv.ca.gov/portal/vehicle-industry-services/autonomous-vehicles/autonomous-vehicle-collision-reports/, 2020. [On-line; accessed 5-June-2020].