Developing Functional Test Scenarios for Around the Corner Navigation by Autonomous Vehicles

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ABSTRACT

ISO 26262 is a universal standard for safety when developing electric/electronic vehicle systems. Manufacturers must adhere to the ISO26262 to qualify their vehicles as road safe. The ISO26262 allows the application of scenarios in supporting the development process. Scenarios are a great way to test the functional safety of an autonomous vehicle, especially those with SAE level 4 and 5 autonomy (High automation or Full automation). Scenarios must reflect real-world events which would be impractical to replicate due to being dangerous, expensive and time-consuming. Furthermore, these scenarios must meet the standards set by the ISO 26262 for series productionIn the scope of this work, the term scenarios will be referring to the definition by [2]. For the development of scenarios, there are different abstraction levels for the different process steps of the V-model. [1] propose three abstraction levels for scenarios complying with the ISO 26262 which moves from a functional phase which uses linguistic vocabulary to a logical one, finally cumulating in a concrete scenario.

Functional Scenarios: This would be the most abstract level used at the concept stage. It requires concise language to ensure the understanding and development of scenarios. These scenarios are described on a semantic level.
Logical Scenarios: These scenarios give the functional stage practical meaning by providing state space variable, such as parameters and range of all entities involved.
Concrete Scenarios: These develop the logical scenarios by providing a section of concrete values from the parameter range in the logical scenarios. This can be used to test and validate.

This research will focus on developing functional scenarios. The requirement specification and validation process can be supported by a methodically identified scenario list in the concept phase of the development process. Scenarios identified methodically based on expert knowledge can help to improve requirements for engineering and safety analysis.[3]
The focus of the scenarios developed will be for around the corner detection. The term around the corner refers to dynamic objects that are in proximity but cannot be identified due to an obstacle (e.g. building) or a bend. An autonomous vehicle can perceive only up to 300 meters (~ 7 secs if a car is moving at 100miles/hr) and will sometimes not "see" everything particularly around blind corners, obscured locations and intersections [4]. The perception range would reduce further due to a bend/corner or another obstacle. Assuming a scenario where an autonomous vehicle only detected an obstacle 30m due to the angle of the bend and obstacle in its path. Considering the system reaction time and braking distance:

$$d = \frac{1}{2K_a} ln\left(1 + \frac{K_a}{K_t} v^2\right) \quad (1)$$

$$K_a = \frac{\rho}{2m}(C_D) \quad (2)$$

$$K_t = (0.01 + \mu)g \quad (3)$$

The braking distance would be greatly affected with weather conditions and placing μ (tire-road coefficient) at a value of 0.9 on a good day, stopping a collision by a few meters, and a value of 0.4 on a poor day. Autonomous vehicles are designed to improve safety and having a near miss of a few meters when all conditions meet a certain criterion is not safe enough.
This shows that information received from the sensors may not be enough and a vehicle may need to receive information from other sources (e.g. other vehicles) about dynamic objects missed by the vehicle's perception system.
The research proposes a linguistic-based system to create scenarios for the development of around the corner automated driving functions. Ontologies have successfully been implemented in the field of automated driving in recent years. Several of these concepts display, how the use of linguistic vocabulary can improve scene understanding driving scenario. Although, previous contribution has investigated developing ontologies for autonomous driving scenario none of these have focused on around the corner. Furthermore, to the best of my knowledge there have been no ontologies created for vehicle to vehicle communication or having sensor data collected from multiple vehicle simultaneously.

REFERENCES

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