Model-driven Software Engineering for Connected Vehicles Project (EMA Group)

Requirements

Last updated: 08.12.2020

Identifier	**Name**
REQ-1	Moving
Description	
The vehicle must be able to move from a set start point to a set end point in the simulator (REQ-1.1). It should also be able to pass through several set points that form a path (REQ-1.2).	
Type	**Dependencies**	**Approved**
FR	REQ-1.1, REQ-1.2	✓

Identifier	**Name**
REQ-1.1	Starting and moving the vehicle in the simulator
Description	
The vehicle must be able to move from a set start point to a set end point in the simulator. A valid point is a two-dimensional GPS coordinate (e.g. 50.777462660989144, 6.078223594733149).	
Type	**Dependencies**	**Approved**
FR	-	✓

Identifier	Name
REQ-1.2	Following a path

Description

The vehicle must be able to follow a path (a sequence of valid points) set by the user. A deviation of a few centimeters from the path shouldn't be seen as a failure to follow the path.
This does not apply when there is an obstacle in the path (REQ-3).

Type	Dependencies	Approved
FR	REQ-1.1	✓

Identifier	Name
REQ-2	Speed

Description

The speed must not exceed the upper speed limit (REQ-2.1) and must not be lower than the minimum speed limit (REQ-2.2).
If the user does not set a speed, the speed is automatically set to 5km/h below the upper speed limit. When different segments of the path have different speed limits, the vehicle must adjust its speed according to those speed limits.
The speed should be adjusted gradually (REQ-2.3).

Type	Dependencies	Approved
FR	REQ-1, REQ-2.1, REQ-2.2, REQ-2.3	✓

Identifier	Name
REQ-2.1	Upper speed limit

Description

The vehicle must not exceed the upper speed limit. If the driver does not set a speed within these constraints himself, the vehicle speed is automatically chosen to be 5km/h less than the upper speed limit.

Type	Dependencies	Approved
Safety	REQ-1	✓

Identifier	Name
REQ-2.2	Lower speed limit

Description

The vehicle must not go under the minimum speed limit of the road.
An exception would be getting the vehicle to move from a standstill and when it's trying to stop. In this case, the vehicle doesn't need to reach the lower speed limit at once. A transition time between a standstill and the reference speed is needed.

Type	Dependencies	Approved
NFR	REQ-1	✓

Identifier	Name
REQ-2.3	Comfortable acceleration and steering

Description

The acceleration shouldn't be too slow or too fast, but it must be at the most comfortable level for at least 85% of users as that is the industry average[1] (user testing is needed).
The steering should also be adjusted so that it is not too harsh for the average user.
[1] J. Schwarze, "Kundenorientiertes Qualitätsmanagement in der Automobilindustrie", 2003, p.28

Type	Dependencies	Approved
Comfort	-	✓

Identifier	Name
REQ-3	Collision avoidance

Description

If the sensors detect an obstacle (REQ-3.2), the vehicle must calculate the braking distance (REQ 3.3) and if the vehicle goes over a set threshold between itself and the obstacle it should engage in emergency braking (REQ 3.5). If the detected vehicle is moving but is closer than it should be, the safety distance must be restored (REQ 3.4).

Type	Dependencies	Approved
Safety	REQ-3.1, REQ-3.2, REQ-3.3, REQ-3.4	✓

Identifier	Name
REQ-3.1	Braking

Description

The car must be able to stop upon receiving a stop signal from the sensors.

Type	Dependencies	Approved
Mechanical	-	✓

Identifier	Name
REQ-3.2	Object detection

Description

The vehicle must be able to detect dangerous objects around it. Which objects are dangerous and which can be ignored can be taught to the system using machine learning.

For example: The car must be able to detect and calculate its distance to the objects within 300m if driving at 80mph on a slightly wet road, so that there is enough reaction time to stop. How far the vehicle should detect an object, https://www.draper.com/business-areas/commercial/automotive/object-detection-obstacle-avoidance

Type	Dependencies	Approved
FR	-	✓

Identifier	Name
REQ-3.3	Braking distance calculation

Description

At all times the vehicle must be able to calculate its braking distance. The braking distance depends on the speed at which the car is driving and the weather conditions.

Type	Dependencies	Approved
FR	-	✓

Identifier	Name
REQ-3.4	Safety distance

Description

After detecting another vehicle in the same lane, the car should keep a safe distance. Whether the distance is safe is to be determined using the benchmarks for a safety distance defined in the StVO.

Type	Dependencies	Approved
Safety	-	✓

Identifier	Name
REQ-3.5	Emergency braking

Description

Emergency braking is triggered when the vehicle goes over a space threshold between the obstacle and the vehicle, whereby any further delay of braking or the user applying non-maximum brake force could cause a collision. This is done to ensure a standstill before a collision occurs.

Type	Dependencies	Approved
Safety	REQ-3.1, REQ 3.2, REQ-3.3	✓

Identifier	Name
REQ-4	Turning

Description

The vehicle must turn after receiving a signal to turn from the steering-wheel-sensor. The angle at which the vehicle turns should be specified in the received signal.

Type	Dependencies	Approved
Mechanical	-	✓

Identifier	Name
REQ-5	Platooning

Description

Vehicles should be able to communicate with each other, so that they can drive in flocks. All other vehicles must follow the leading vehicles' maneuvers. This is possible when the leading vehicle communicates its target velocity, target trajectory and when it wants to brake/accelerate/decelerate/turn to the following vehicles. This way, the following vehicles can copy its actions upon receiving the information.
This would increase the capacity of the roads and is much more efficient for all the cars following the first car (energywise).

Type	Dependencies	Approved
FR	REQ-3.4	✓

Identifier	Name
REQ-6	Intersections

Description

The vehicle should be able to pass through signalized (REQ-6.2) and unsignalized (REQ-6.1) intersections while following the German Highway Code (StVO).

Type	Dependencies	Approved
FR	REQ-6.1, REQ-6.2	✓

Identifier	Name
REQ-6.1	Unsignalized intersection

Description

The vehicle is supposed to recognise an unsignalized intersection and act according to the German Highway Code (StVO).
In case of more than one platoon (one or more cars) arriving at the same intersection from more than one direction, a minimum breakage algorithm would calculate which vehicle goes in front of which, which would minimise the breakage or stopping of the vehicles. The algorithm would take into account the speed and distance to the intersection from every vehicle.

Type	Dependencies	Approved
FR	-	✓

Identifier	Name
REQ-6.2	Signalized intersection

Description

The vehicle is supposed to recognise a signalized intersection and stop at a red light or slow down at a yellow light or pass at a green light.

Type	Dependencies	Approved
FR	-	✓

Identifier	Name
REQ-7	Traffic jam detection

Description

The vehicle should be able to detect a traffic jam (many vehicles on its path that are not moving or are moving very slowly). When a vehicle detects a traffic jam it should send a signal to all other vehicles on the map telling them that there is a traffic jam and sending them its current position.

Type	Dependencies	Approved
NFR	REQ-3.2	✓

Identifier	Name
REQ-8	Adapting to weather conditions

Description

In the case of rain or ice, the speed needs to be adjusted so that the car doesn't skid and lose control.
In case of a wet road - the speed should be reduced by 30%.
In case of a snowy road - the speed should be reduced by 50%.
In case of a frozen road - the speed should be reduced by 70%.[2]
[2] https://www.tamsweg.at/Richtig_fahren_bei_Schnee_und_Eis

Type	Dependencies	Approved
FR	REQ-8.1	✓

Identifier	Name
REQ-8.1	Weather condition sensor

Description

The simulator should have a sensor which is able to determine if the road is dry, wet, snowy or icy.

Type	Dependencies	Approved
Mechanical	-	✓

Identifier	Name
REQ-9	Emergency Corridor

Description

The vehicles must form an emergency corridor when an emergency vehicle is seen or heard approaching as well as when a traffic jam occurs.
According to the law (StVO) the corridor should be created next to the leftmost lane. This means vehicles in the far left lane are required to drive as close to the left as possible while vehicles in the other lanes drive as close to the right as possible.

Type	Dependencies	Approved
FR	REQ-7	✓

Identifier	Name
REQ-10	Rerouting

Description

Upon encountering a blockage in a road or receiving a signal from another vehicle that there's in a traffic jam (REQ-7), the vehicle should be able to change its trajectory avoiding that road and still reaching its destination.

Type	Dependencies	Approved
NFR	REQ-7	✓

Identifier	Name
REQ-11	Switching lanes

Description

In the case that the vehicle needs to overtake another vehicle, the lane on the left (if present) needs to be taken. If a vehicle needs to take a right turn, it should switch to the rightmost lane. And for a left turn, to the leftmost lane going in the same direction.

Type	Dependencies	Approved
FR	REQ-16	✓

Identifier	Name
REQ-12	Battery level

Description

The vehicle is able to know how much battery it has left at all times.

Type	Dependencies	Approved
Mechanical	-	✓

Identifier	Name
REQ-13	Regenerative braking

Description

The vehicle would be able to take advantage of braking to fill up the battery. This is not possible if the battery is full.

Type	Dependencies	Approved
Mechanical	REQ-3.1, REQ-12	✓

Identifier	Name
REQ-14	Filling up the battery at a station

Description

We assume that the range that the battery can provide is 500km (based on Tesla Model S long range). If the path entered is longer than 500km or is longer than the current battery level can provide, the vehicle shows a warning to the user, saying that the battery needs to be charged a certain percent needed to reach the destination. If the path/destination is not entered, the vehicle shows a warning about the battery percentage when it is lower than 5%.
https://www.statista.com/statistics/797331/electric-vehicle-battery-range/

Type	Dependencies	Approved
NFR	REQ-12	✓

Identifier	Name
REQ-15	Parking

Description

Upon arriving at a destination, the vehicle should be able to find a place to park and park.

Type	Dependencies	Approved
FR	-	✓

Identifier	Name
REQ-16	Lane keeping

Description

The vehicle should drive on the right side of the road unless it's overtaking or making a turn that requires it to switch lanes (REQ-11)

Type	Dependencies	Approved
FR	-	□