



Elektrobit



UDACITY

Functional Safety Concept Lane Assistance

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Document history

[Instructions: Fill in the date, version and description fields. You can fill out the Editor field with your name if you want to do so. Keep track of your editing as if this were a real world project.]

For example, if this were your first draft or first submission, you might say version 1.0. If this is a second submission attempt, then you'd add a second line with a new date and version 2.0]

Date	Version	Editor	Description
23/05/2018	1.0	Shubhadeep	First Attempt

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Purpose of the Functional Safety Concept

[Instructions: Answer what is the purpose of a functional safety concept?]

The purpose of a functional safety concept is to identify the system's high level requirements which are then allocated to different parts of item architecture.

Inputs to the Functional Safety Concept

Safety goals from the Hazard Analysis and Risk Assessment

[Instructions:

REQUIRED:

Provide the lane departure warning and lane keeping assistance safety goals as discussed in the lessons and derived in the hazard analysis and risk assessment.

OPTIONAL:

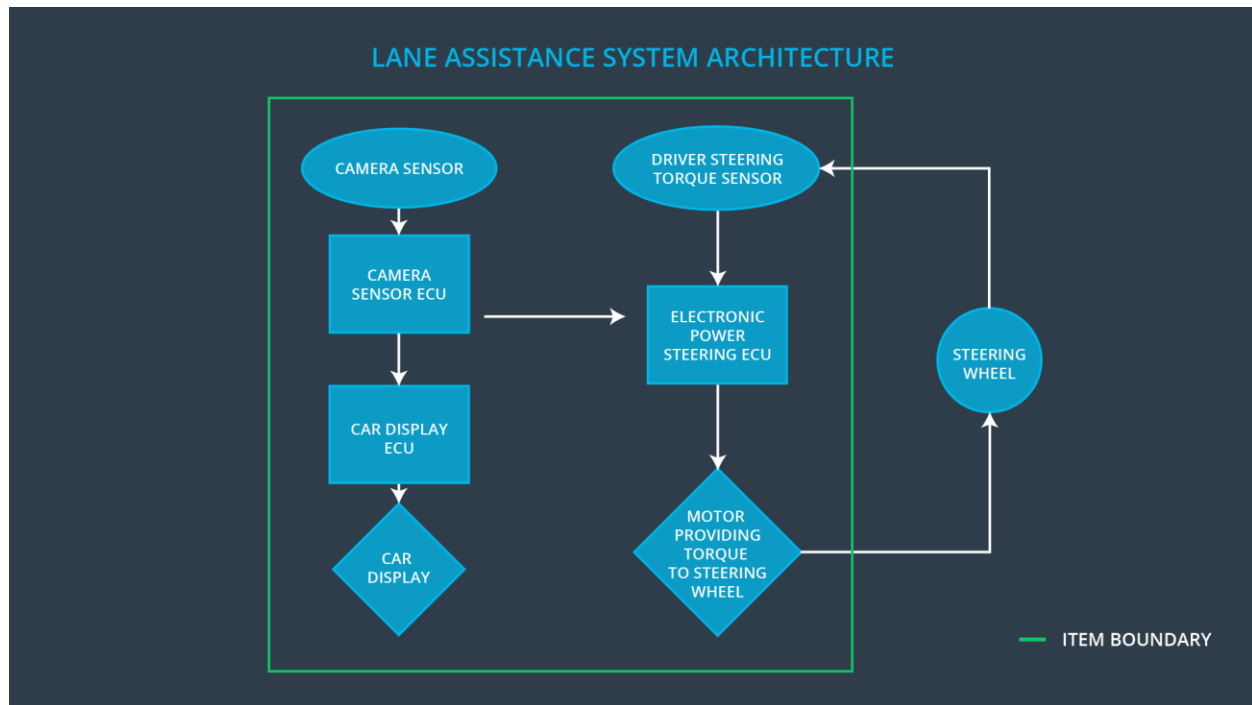
If you expanded the hazard analysis and risk assessment to include other safety goals, include them here.

]

ID	Safety Goal
Safety_Goal_01	The oscillating steering torque from the Lane Departure Warning function shall be limited.
Safety_Goal_02	The Lane Keeping Assistance function shall be time limited, and the additional steering torque shall end after a given time interval so the driver cannot misuse the system for autonomous driving.

Preliminary Architecture

[Instructions: Provide a preliminary architecture for the lane assistance item. Hint: See Lesson 3: Item Definition]



Description of architecture elements

[Instructions: Provide a description for each of the item elements; what is each element's purpose in the lane assistance item?]

Element	Description
Camera Sensor	takes images of the road and passes it to Camera Sensor ECU
Camera Sensor ECU	detects accidental lane departures, then sends signal to Car Display ECU to display warning, and provides details to Electronic Power Steering ECU about how much to steer
Car Display	displays warnings and status of Lane Departure Assistance to driver
Car Display ECU	receives warnings from Camera Sensor ECU and displays on the Car Display to driver
Driver Steering Torque Sensor	measures the turning of the steering wheel by the driver
Electronic Power Steering ECU	utilizes the signal received from the Driver

	Steering Torque Sensor and compares it with the torque requested by the Lane Keeping Assistance and Lane Warning and then if required, alerts the driver, and outputs a torque value to the Motor actuator.
Motor	provides the torque indicated by the Electronic Power Steering ECU to the steering wheel.

Functional Safety Concept

The functional safety concept consists of:

- Functional safety analysis
- Functional safety requirements
- Functional safety architecture
- Warning and degradation concept

Functional Safety Analysis

[Instructions: Fill in the functional safety analysis table below.]

Malfunction ID	Main Function of the Item Related to Safety Goal Violations	Guidewords (NO, WRONG, EARLY, LATE, MORE, LESS)	Resulting Malfunction
Malfunction_01	Lane Departure Warning (LDW) function shall apply an oscillating steering torque to provide the driver a haptic feedback	MORE	The Lane Departure Warning function applies an oscillating torque with very high torque amplitude (above limit)
Malfunction_02	Lane Departure Warning (LDW) function shall apply an oscillating steering torque to provide the driver a haptic feedback	MORE	The Lane Departure Warning function applies an oscillating torque with very high

			torque frequency (above limit)
Malfunction_03	Lane Keeping Assistance (LKA) function shall apply the steering torque when active in order to stay in ego lane	NO	The Lane Keeping Assistance function is not limited in time duration which lead to misuse as an autonomous driving function.

Functional Safety Requirements

[Instructions: Fill in the functional safety requirements for the lane departure warning]

Lane Departure Warning (LDW) Requirements:

ID	Functional Safety Requirement	ASIL	Fault Tolerant Time Interval	Safe State
Functional Safety Requirement 01-01	The Lane Departure Warning item shall ensure that the lane departure oscillating torque amplitude is below Max_Torque_Amplitude.	C	50 ms	Vibration torque amplitude below Max_Torque_Amplitude.
Functional Safety Requirement 01-02	The Lane Departure Warning item shall ensure that the lane departure oscillating torque frequency is below Max_Torque_Frequency.	C	50 ms	Vibration frequency is below Max_Torque_Frequency.

Lane Departure Warning (LDW) Verification and Validation Acceptance Criteria:

ID	Validation Acceptance	Verification Acceptance
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	Criteria and Method	Criteria and Method
Functional Safety Requirement 01-01	Validate Max_Torque_Amplitude by taking response from driver whether they are able to detect it.	If torque amplitude surpasses the limit, the lane assistance's output is set to 0 within 50 ms fault tolerant time interval.
Functional Safety Requirement 01-02	Validate Max_Torque_Frequency by taking response from driver whether they are able to detect it.	If torque frequency surpasses the limit, the lane assistance's output is set to 0 within 50 ms fault tolerant time interval.

[Instructions: Fill in the functional safety requirements for the lane keeping assistance]

Lane Keeping Assistance (LKA) Requirements:

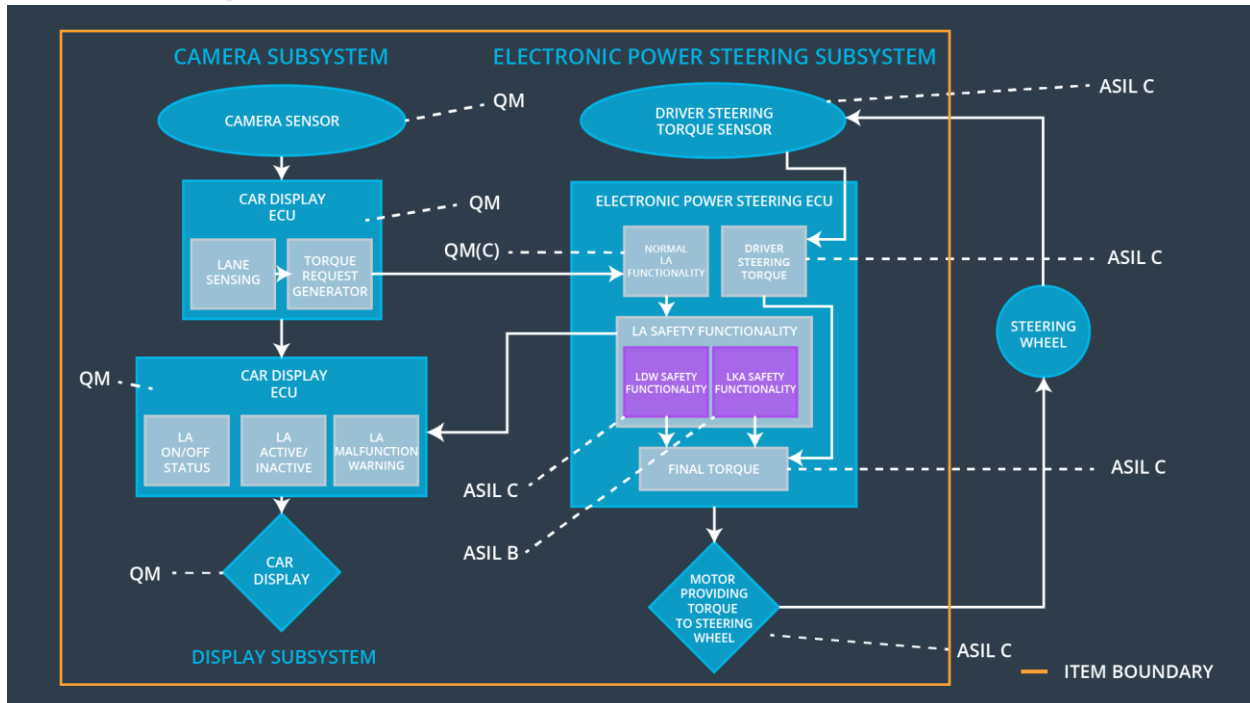
ID	Functional Safety Requirement	ASIL	Fault Tolerant Time Interval	Safe State
Functional Safety Requirement 02-01	It shall be ensured by Electronic Power Steering ECU that Lane Keeping Assistance torque is applied for only Max_Duration.	B	500 ms	Lane Keeping Assistance torque is 0.

Lane Keeping Assistance (LKA) Verification and Validation Acceptance Criteria:

ID	Validation Acceptance Criteria and Method	Verification Acceptance Criteria and Method
Functional Safety Requirement 02-01	Validate Max_Duration that drivers don't take their hands off the wheel and treat it as Self-Driving car.	Verify that system goes off if the lane keeping assistance exceeds Max_Duration

Refinement of the System Architecture

[Instructions: Include the refined system architecture. Hint: The refined system architecture should include the system architecture from the end of the functional safety lesson including all of the ASIL labels.]



Allocation of Functional Safety Requirements to Architecture Elements

[Instructions: Mark which element or elements are responsible for meeting the functional safety requirement. Hint: Only one ECU is responsible for meeting all of the requirements.]

ID	Functional Safety Requirement	Electronic Power Steering ECU	Camera ECU	Car Display ECU
Functional Safety Requirement 01-01	The Lane Keeping item shall ensure that the lane departure oscillating torque amplitude is below Max_Torque_Amplitude.	X		

Functional Safety Requirement 01-02	The Lane Keeping item shall ensure that the lane departure oscillating torque frequency is below Max_Torque_Frequency.	X		
Functional Safety Requirement 02-01	The Lane Keeping item shall ensure that the Lane Keeping Assistance torque is applied only Max_Duration.	X		

Warning and Degradation Concept

[Instructions: Fill in the warning and degradation concept.]

ID	Degradation Mode	Trigger for Degradation Mode	Safe State invoked?	Driver Warning
WDC-01	Turn off Lane Departure Warning functionality	Malfunction_01, Malfunction_02	Yes	Haptic feedback and display warning to driver
WDC-02	Turn off Lane Keeping Assistance functionality	Malfunction_03	Yes	Beep sounds and display warning to driver