Elektrobit

UDACITY

Functional Safety Concept Lane Assistance

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Document history

Date	Version	Editor	Description
20 June, 2018	1.0	Akhil Suri	Initial Submission

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Purpose of the Functional Safety Concept

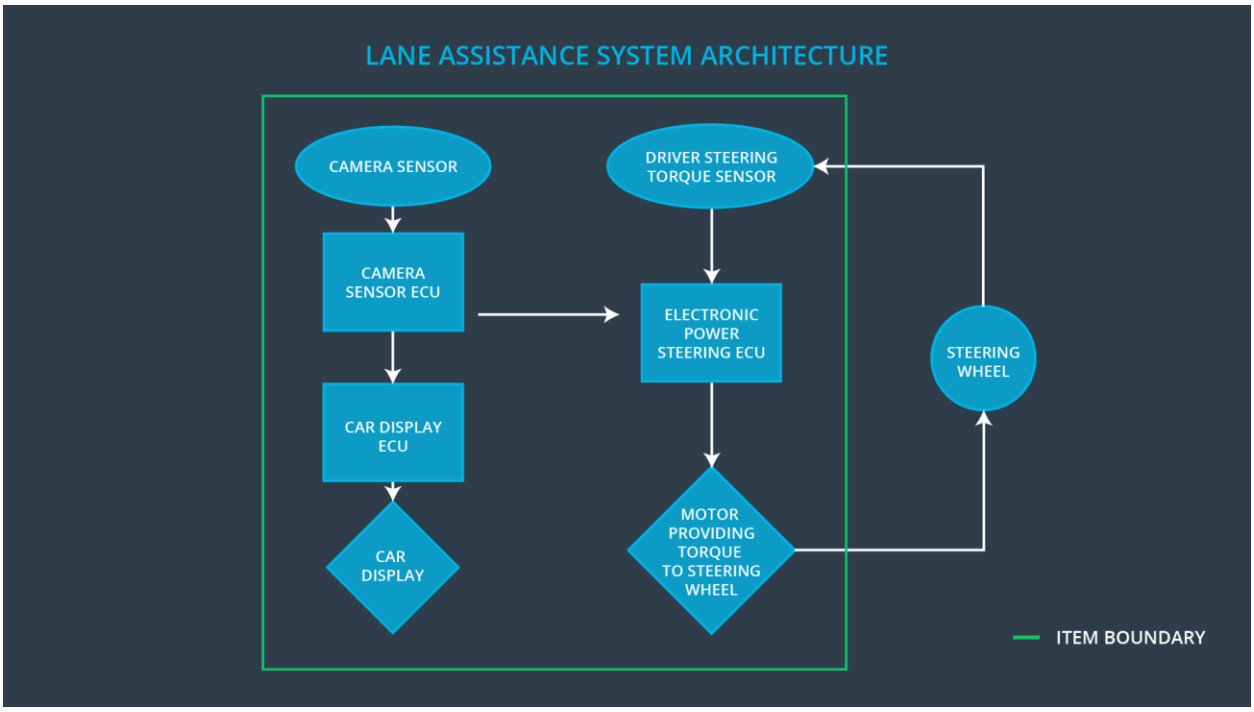
The Functional Safety Concept documents the identified system high level requirements. These requirements are allocated to different parts of the item architecture. Technical safety requirements will be derived from the safety concepts. The validation and verification concepts for these requirements are presented as well.

Inputs to the Functional Safety Concept

Safety goals from the Hazard Analysis and Risk Assessment

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 shall be time limited and the additional steering torque shall end after a given time interval so that the driver cannot misuse the system for autonomous driving.

Preliminary Architecture



Description of architecture elements

Element	Description
Camera Sensor	To provide the images captured from camera to the camera Sensor ECU.
Camera Sensor ECU	Images will be analyzed and will calculate the car position and detect the lane lines.
Car Display	It will display warning to the driver.
Car Display ECU	It will show the lane departure and lane keeping assistance warning status, by controlling the car display component.
Driver Steering Torque Sensor	It measures the torque applied to the steering wheel.
Electronic Power Steering ECU	It will process the inputs from Driver steering torque sensor, Camera Sensor ECU and request the required torque which will be applied by the motor.
Motor	The component is responsible for applying the work required to produce the torque required to execute actions delivered to the power steering ECU.

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

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 oscillating amplitude is too high.
Malfunction_02	Lane Departure Warning (LDW) function shall apply an oscillating steering torque to provide the driver a haptic feedback	MORE	The oscillating frequency is too high.
Malfunction_03	Lane Keeping Assistance (LKA) function shall apply the steering torque when active in order to stay in ego lane	NO	The lane departure oscillating torque amplitude is below Max_Torque_Amplitude

Functional Safety Requirements

Lane Departure Warning (LDW) Requirements:

ID	Functional Safety Requirement	ASIL	Fault Tolerant Time Interval	Safe State
Functional Safety Requirement 01-01	The lane departure oscillating torque amplitude is below Max_Torque_Amplitude	C	50 ms	Turn off the functionality or system

Functional Safety Requirement 01-02	The lane departure oscillating torque frequency is below Max_Torque_Frequency	C	50 ms	Turn off the functionality or system

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

ID	Validation Acceptance Criteria and Method	Verification Acceptance Criteria and Method
Functional Safety Requirement 01-01	Validating the Max_Torque_Amplitude and check if it is low which will not cause the steering loss.	To verify that the system goes turn off when the Max_Torque_Amplitude is exceeded.
Functional Safety Requirement 01-02	Validating the Max_Torque_Frequency and check if it is low which will not cause the steering loss.	To verify that the system goes turn off when the Max_Torque_Frequency is exceeded.

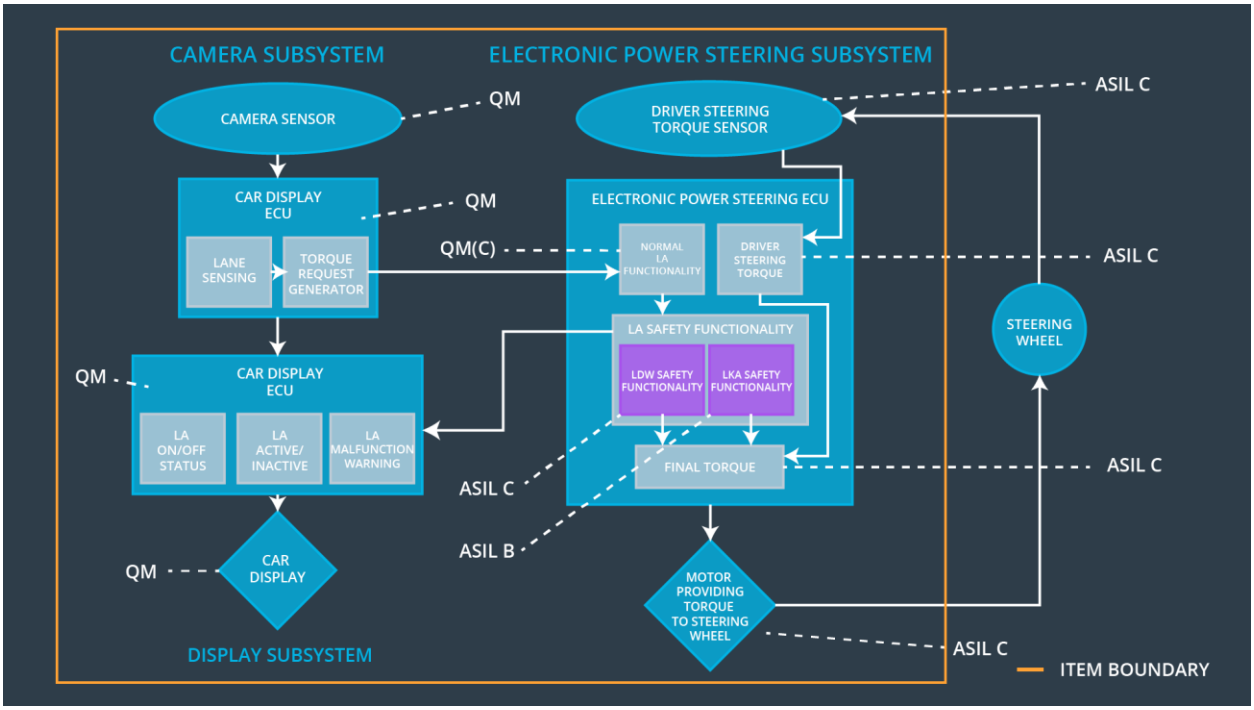
Lane Keeping Assistance (LKA) Requirements:

ID	Functional Safety Requirement	ASIL	Fault Tolerant Time Interval	Safe State
Functional Safety Requirement 02-01	Lane keeping assistance function shall be time limited and the additional steering torque shall end after a given timer interval so that the driver cannot misuse the system for autonomous driving	B	500 ms	Turn the system off

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	The max_duration chosen really did dissuade drivers from taking their hands off the wheel	The system really does turn off if the lane keeping assistance every exceeded max_duration.

Refinement of the System Architecture



Allocation of Functional Safety Requirements to Architecture Elements

ID	Functional Safety Requirement	Electronic Power Steering ECU	Camera ECU	Car Display ECU
Functional Safety Requirement 01-01	The electronic power steering ECU should be ensuring that the lane departure oscillating torque frequency is below Max_Torque_Frequency	**x**		
Functional Safety Requirement 01-02	The electronic power steering ECU should be ensuring that the lane departure oscillating torque Amplitude is below	**x**		

	Max_Torque_Amplitude			
Functional Safety Requirement 02-01	The electronic power steering ECU should be ensuring that the lane keeping torque is applied for less than the Max_Duration.	**x**		

Warning and Degradation Concept

WDC-01 is for Lane Departure Warning function
WDC-02 is for Lane Keeping assistance function

ID	Degradation Mode	Trigger for Degradation Mode	Safe State invoked?	Driver Warning
WDC-01	Turn off the functionality	Malfunction_01 Malfunction_02	Yes	a warning light on the dashboard
WDC-02	Turn off the functionality	Malfunction_03	Yes	a warning light on the dashboard