Elektrobit

UDACITY

Functional Safety Concept Lane Assistance

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Document history

Date	Version	Editor	Description
6/18/2019	1.0	Bob Li	Initial version

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Purpose of the Functional Safety Concept

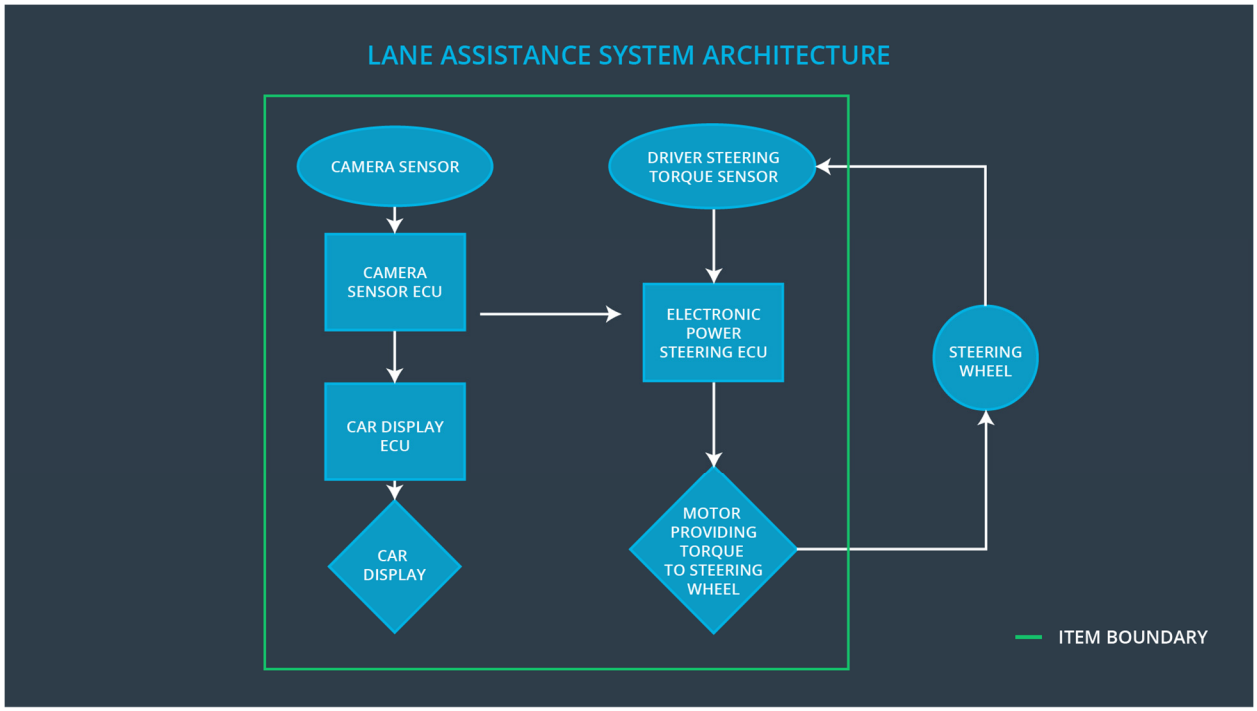
The Functional Safety Concept document the general functionality of the item. The safety goal will be refined and derive the functional safety requirements. These safety requirements are allocated to the relevant parts of the system diagram. Allocation means defining which part of the system architecture will implement each requirement.

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 function 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	Capture road images and provide them to the Camera Sensor ECU.

Camera Sensor ECU	Analyze the images from Camera Sensor and calculate the car position on the road respect to the road lanes.
Car Display	Provide information to the driver by display warnings and status of Lane Assistance System
Car Display ECU	Get information from Camera Sensor ECU and control the Car Display to show.
Driver Steering Torque Sensor	Measure the Handwheel torque of the driver
Electronic Power Steering ECU	Receive the Lane Assistance request from Camera Sensor ECU, receive the handwheel torque from the Driver Steering Torque Sensor. Calculate the steering torque applied by the Motor
Motor	Apply the motor torque request from the Electronic 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 lane departure warning function applies an oscillating torque with very high torque amplitude
Malfunction_02	Lane Departure Warning (LDW)	More	The lane departure

	function shall apply an oscillating steering torque to provide the driver a haptic feedback		warning function applies an oscillating torque with very high torque frequency.
Malfunction_03	Lane Keeping Assistance (LKA) function shall apply the steering torque when active in order to stay in ego lane	More	The lane keeping assistance function is not limited in time duration which leads to misuse as an autonomous driving function.

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 keeping item shall ensure that the lane departure oscillating torque amplitude is below Max_Torque_Amplitude	C	50ms	Turn system off
Functional Safety Requirement 01-02	The lane keeping item shall ensure that the lane departure oscillating torque frequency is below Max_Torque_Frequency	C	50ms	Turn system off

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	Test and validate that the Max_Torque_Amplitude chosen is low enough that the driver does not loss control of the car.	Verify that the system does turn off in time if Max_Torque_Amplitude is exceeded.

Functional Safety Requirement 01-02	Test and validate that the Max_Torque_Frequency chosen is low enough that the drive does not loss control of the car.	Verify that the system does turn off in time if Max_Torque_Frequency is exceeded.

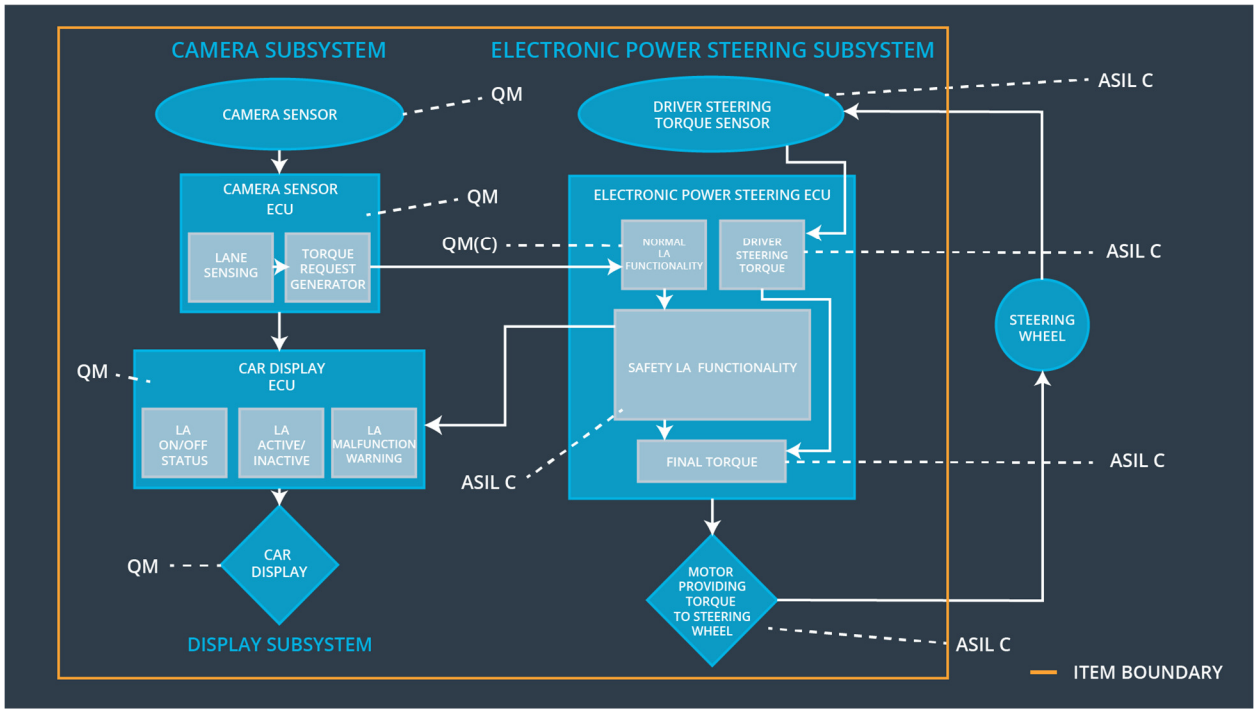
Lane Keeping Assistance (LKA) Requirements:

ID	Functional Safety Requirement	ASIL	Fault Tolerant Time Interval	Safe State
Functional Safety Requirement 02-01	The lane keeping item shall ensure that the lane keeping assistance torque is applied for only Max-Duration	B	500ms	Turn 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	Test and validate that the Max_Duration chosen really won't lead driver misuse the LKA function.	Verify that the system does turn off the LKA function if the function activation time is 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 lane keeping item shall ensure that the lane departure oscillating torque amplitude is below Max_Torque_Amplitude	√		
Functional Safety Requirement 01-02	The lane keeping item shall ensure that the lane departure oscillating torque frequency is below Max_Torque_Frequency	√		
Functional Safety Requirement 02-01	The lane keeping item shall ensure that the lane keeping assistance torque is applied for only Max-Duration	√		

Warning and Degradation Concept

ID	Degradation Mode	Trigger for Degradation Mode	Safe State invoked?	Driver Warning
WDC-01	Turn system off	Malfunction_01 Malfunction_02	Yes	Warning light on the car display
WDC-02	Turn system off	Malfunction_03	Yes	Warning light on the car display