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
20-11-2017	1.0	Pablo Elizalde	First draft
28-11-2017	1.1	Pablo Elizalde	Improve functional safety requirements definition

Table of Contents

[Instructions: We have provided a table of contents. If you change the document structure, please update the table of contents accordingly. The table of contents should show each section of the document and page numbers or links. Most word processors can do this for you. In Google Docs, you can use headings for each section and then go to Insert > Table of Contents. Microsoft Word has similar capabilities]

Purpose of the Functional Safety Concept

[Instructions: Answer what is the purpose of a functional safety concept?]
The ultimate goal of the functional safety is to reduce the risk to acceptable levels. For that, and with the system architectural design we define functional safety requirements and the allocate them to its appropriate place in the system item architecture.

Inputs to the Functional Safety Concept

Safety goals from the Hazard Analysis and Risk Assessment

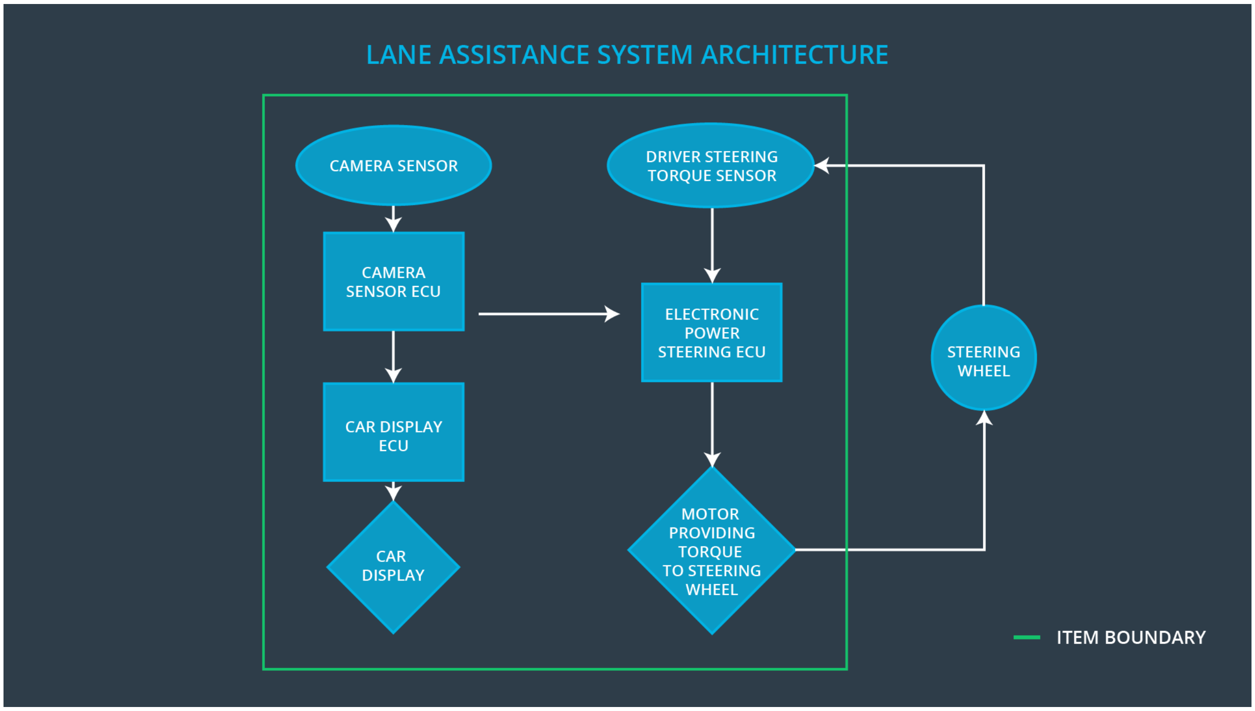
[Instructions:
REQUIRED:
Provide the lane departure warning and lane keeping assistance safety goals as discussed in the lessons and derived in the hazard analysis and risk assessment.

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 that the driver cannot misuse the system for autonomous driving.
Safety_Goal_03	The oscillating steering torque shall be deactivated when driving backwards.
Safety_Goal_04	The lane keeping assistance function shall be deactivated when there is a problem with the camera subsystem responsible of the lane tracking.

Preliminary Architecture

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


LANE ASSISTANCE SYSTEM ARCHITECTURE
CAMERA SENSOR
DRIVER STEERING TORQUE SENSOR
CAMERA SENSOR ECU
ELECTRONIC POWER STEERING ECU
STEERING WHEEL
CAR DISPLAY ECU
CAR DISPLAY
MOTOR PROVIDING TORQUE TO STEERING WHEEL
🟩 ITEM BOUNDARY

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	The camera sensor reads in images from the road.
Camera Sensor ECU	The camera sensor ECU identifies when the vehicle has accidentally departed its lane, and sends the appropriate messages to the Car Display ECU and the Electronic Power Steering ECU.
Car Display	The car display shows to the user information coming from the Car Display ECU.
Car Display ECU	The car display ECU receives input from the camera sensor ECU and makes the Car Display informs the driver.
Driver Steering Torque Sensor	The Driver Steering Torque Sensor informs to the Electronic Power Steering ECU about the amount of torque that the driver is applying.
Electronic Power Steering ECU	The Electronic Power Steering ECU receives input from the Camera Sensor ECU and the Driver Steering

	Torque Sensor. It will calculate the amount or torque that need to be apply and inform the motor.
Motor	The motor is in charge to provide the torque coming from 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	NO	The lane keeping assistance function is not limited in time duration which leads

	when active in order to stay in ego lane		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 EPS ECU shall ensure that the lane departure warning torque amplitude is below is Max_Torque_Amplitude.	C	50ms	Set oscillating torque to 0.
Functional Safety Requirement 01-02	The EPS ECU shall ensure that the lane departure warning torque frequency is below is Max_Torque_Frequency.	C	50ms	Set oscillating torque to 0.

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	Choose a reasonable value for Max_Torque_Amplitude	Verify that the system turns off within 50ms when the torque amplitude crosses the limit.
Functional Safety Requirement 01-02	Choose a reasonable value for Max_Torque_Frequency	Verify that the system turns off within 50ms when the torque frequency crosses the limit.

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

Lane Keeping Assistance (LKA) Requirements:

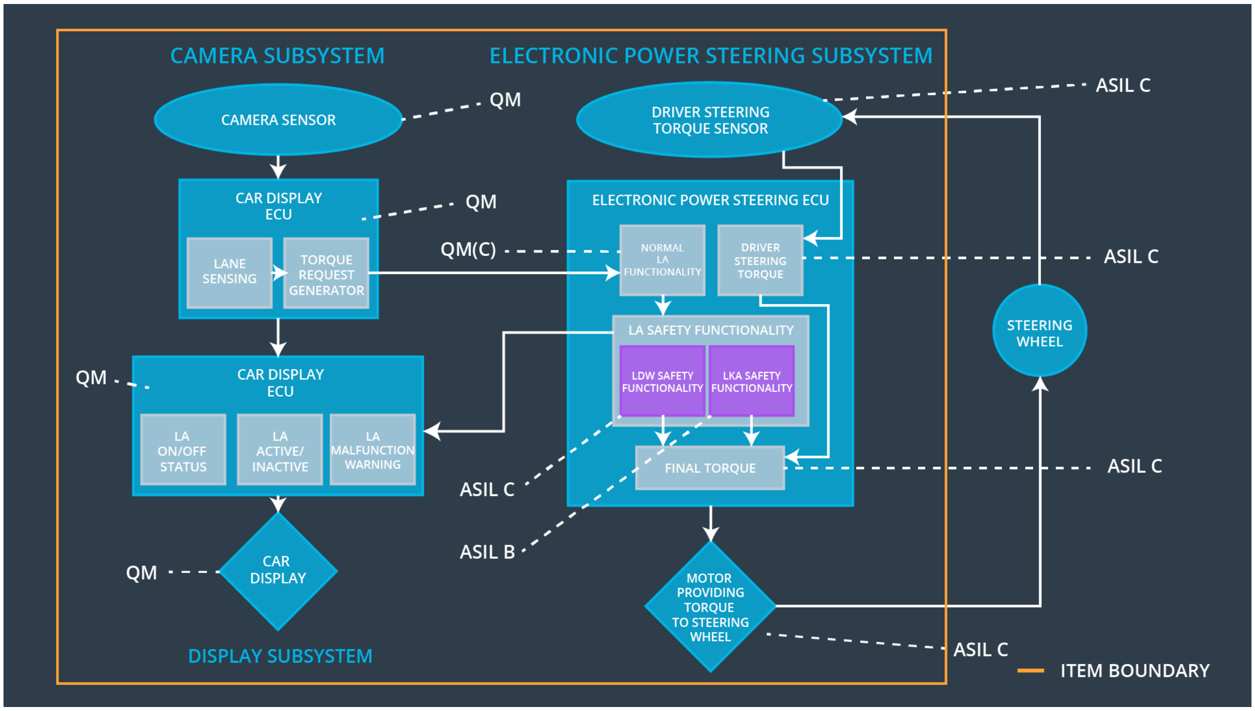
ID	Functional Safety Requirement	ASIL	Fault Tolerant Time Interval	Safe State
Functional Safety Requirement 02-01	The electronic power steering ECU shall ensure that the lane keeping assistance torque is applied for only Max_Duration.	B	500ms	Turns off the system.

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 that the Max_Duration dissuades drivers from taking their hands off the wheel.	Verify that the system turns 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 electronic power steering ECU shall ensure that the lane departure oscillating torque amplitude is below Max_Torque_Amplitude	X	-	-
Functional Safety Requirement 01-02	The electronic power steering ECU shall ensure that the lane departure oscillating torque frequency is bellow Max_Torque_Frecuency	X	-	-
Functional	The electronic power steering	X	-	-

Safety Requirement 02-01	ECU shall ensure that the lane keeping assistance torque is applied for only Max_Duration.			

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 functionality	The torque oscillation is applied is above Max_Torque_Amplitude or Max_Torque_Frecuency.	Yes	A light in the dashboard.
WDC-02	Turn off functionality	The driver keeps its hands off the wheel for a longer time than Max_Duration.	Yes	A light in the dashboard.