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
2017/12/31	1.0	MIURA Yasuyuki	First Attempt

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 functional safety concept looks at the general functionality of the item.

Inputs to the Functional Safety Concept

Safety goals from the Hazard Analysis and Risk Assessment

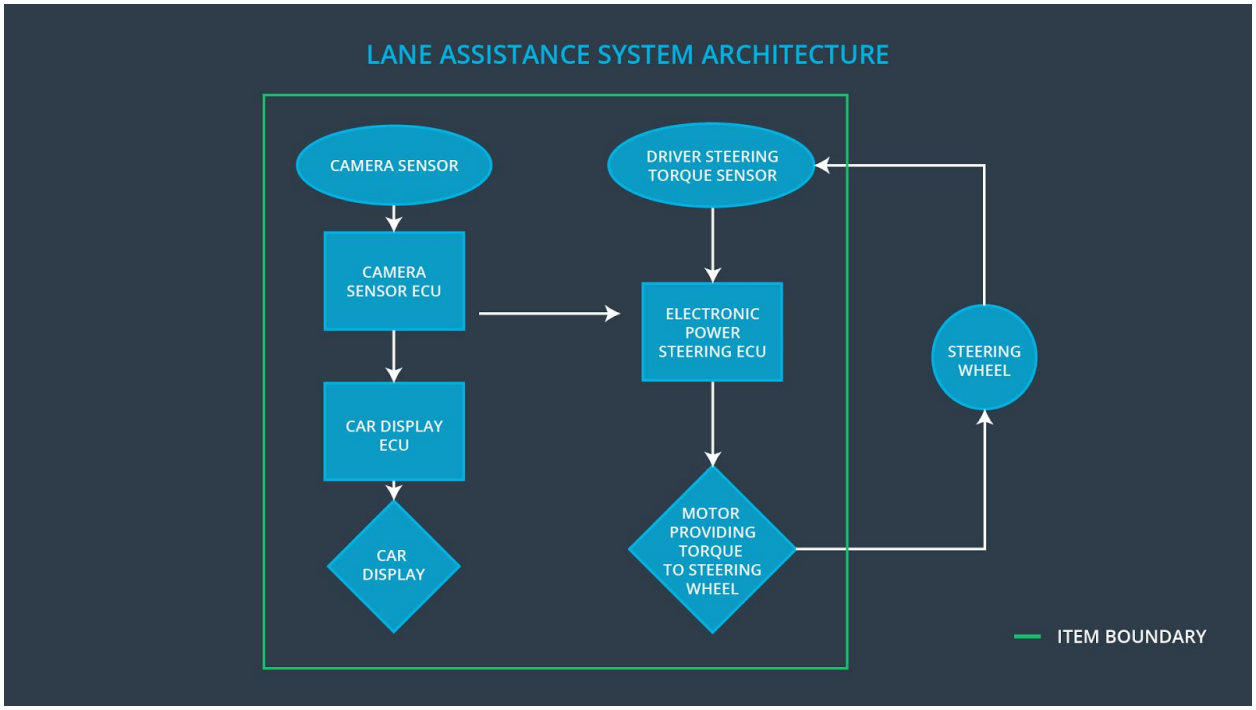
[Instructions:
REQUIRED:
Provide the lane departure warning and lane keeping assistance safety goals as discussed in the lessons and derived in the hazard analysis and risk assessment.

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 LDW function shall be limited.
Safety_Goal_02	The LKA 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

[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	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 controls a light that tells the driver if the lane keeping item is on or off, and will control a light telling the driver that the lane departure warning is activated.
Car Display ECU	The Car Display ECU receives the message and display it on the display.
Driver Steering Torque Sensor	The Driver Steering Torque Sensor will sense how

	much the driver is turning the steering wheel.
Electronic Power Steering ECU	The Electronic Power Steering ECU will receive the vibrational torque request from the Camera ECU, and will add these torque requests together to output a final torque to the Motor.
Motor	The Motor moves 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 leads 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 Electronic Power Steering ECU shall ensure that the oscillating torque amplitude requested by the LDW function is below Max_Torque_Amplitude.	C	50 ms	LDW will set the ocsillating torque amplitude to 0.
Functional Safety Requirement 01-02	The Electronic Power Steering ECU shall ensure that the oscillating torque frequency requested by the LDW function is below Max_Torque_Frequency.	C	50 ms	LDW will set the ocsillating torque frequency 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	For whatever value we end up choosing for the max torque amplitude, we need to validate that we chose a reasonable value. We would need to test how drivers react to different torque amplitudes and frequencies to prove that we chose an appropriate value.	when the torque amplitude crosses the limit, the lane assistance output is set to zero within the 50 ms fault tolerant time interval. For this specific case, we would probably do a software test inserting a fault into the system and seeing what happens.
Functional Safety Requirement 01-02	For whatever value we end up choosing for the max torque amplitude, we need to validate that we chose a reasonable value. We would need to test how drivers react to different torque amplitudes and frequencies to prove that we chose an appropriate value.	when the torque amplitude crosses the limit, the lane assistance output is set to zero within the 50 ms fault tolerant time interval. For this specific case, we would probably do a software test inserting a fault into the system and seeing what happens.

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

Lane Keeping Assistance (LKA) Requirements:

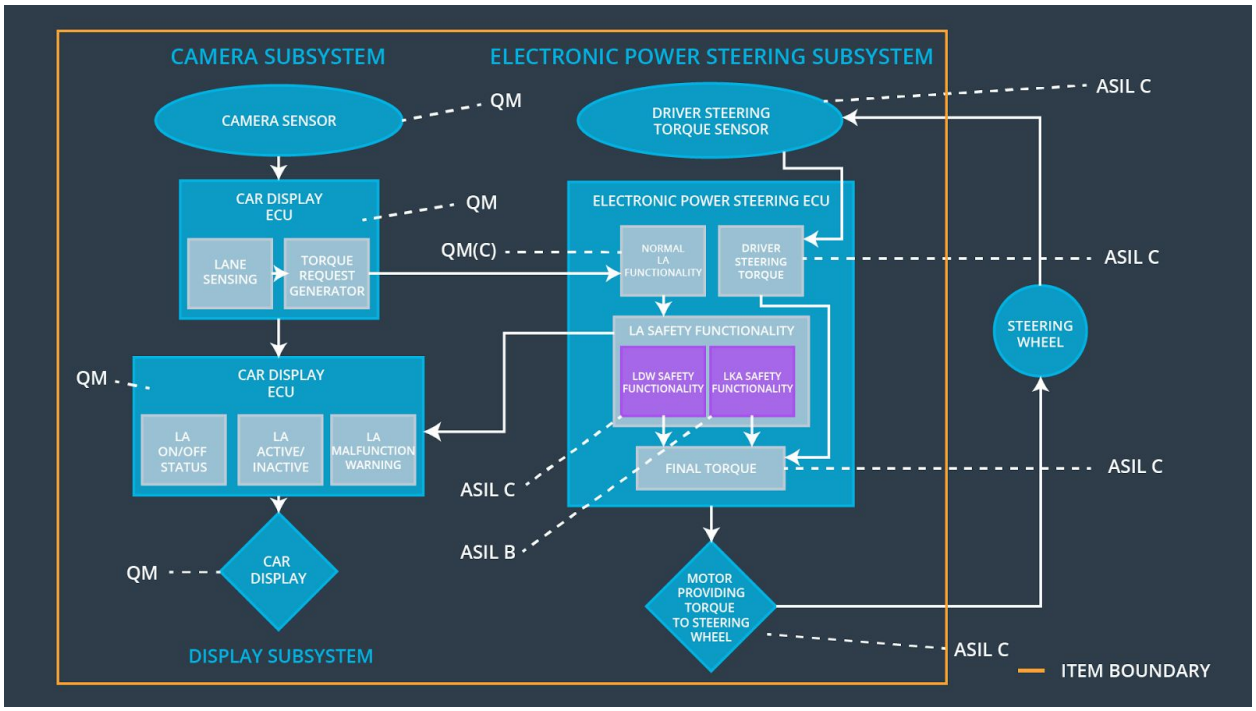
ID	Functional Safety Requirement	ASIL	Fault Tolerant Time Interval	Safe State
Functional Safety Requirement 02-01	The Electronic Power Steering ECU shall ensure that the lane keeping assistance torque is applied for only Max_Duration.	B	500 ms	LKA will set the ocsillating torque duration to 0.

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	We would have to test and validate that the Max_Duration chosen really did dissuade drivers from taking their hands off the wheel.	We would verify that the system really does turn off if the lane keeping assistance every exceeded 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 oscillating torque amplitude requested by the LDW function is below Max_Torque_Amplitude.	X		
Functional Safety Requirement 01-02	The Electronic Power Steering ECU shall ensure that the oscillating torque frequency requested by the LDW function is below Max_Torque_Frequency.	X		
Functional Safety Requirement 02-01	The Electronic Power Steering ECU shall ensure that the lane keeping assistance torque is applied for 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	we will display a warning on the driver	when the steering wheel ECU receives	Yes	Beyond the lane.

	dashboard.	a vibrational torque request beyond the allowed maximum		
WDC-02	we will display a warning on the driver dashboard.	when the steering wheel ECU receives a vibrational torque request beyond the allowed maximum	Yes	Driver please drive.