Elektrobit

UDACITY

Functional Safety Concept Lane Assistance

Document Version: [Version]

Template Version 1.0, Released on 2017-06-21

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
2019-02-01	1.0	Amilendra Kodithuwakku	Initial draft

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 attaches attributes such as the ASIL level, fault tolerant time interval. safe state into each item in the system architecture that implements the safety requirements of the system, by looking at the general functionality of each item. The verification and validation steps needed to prove that each item meets the safety requirements are also included in the functional safety concept.

Inputs to the Functional Safety Concept

Safety goals from the Hazard Analysis and Risk Assessment

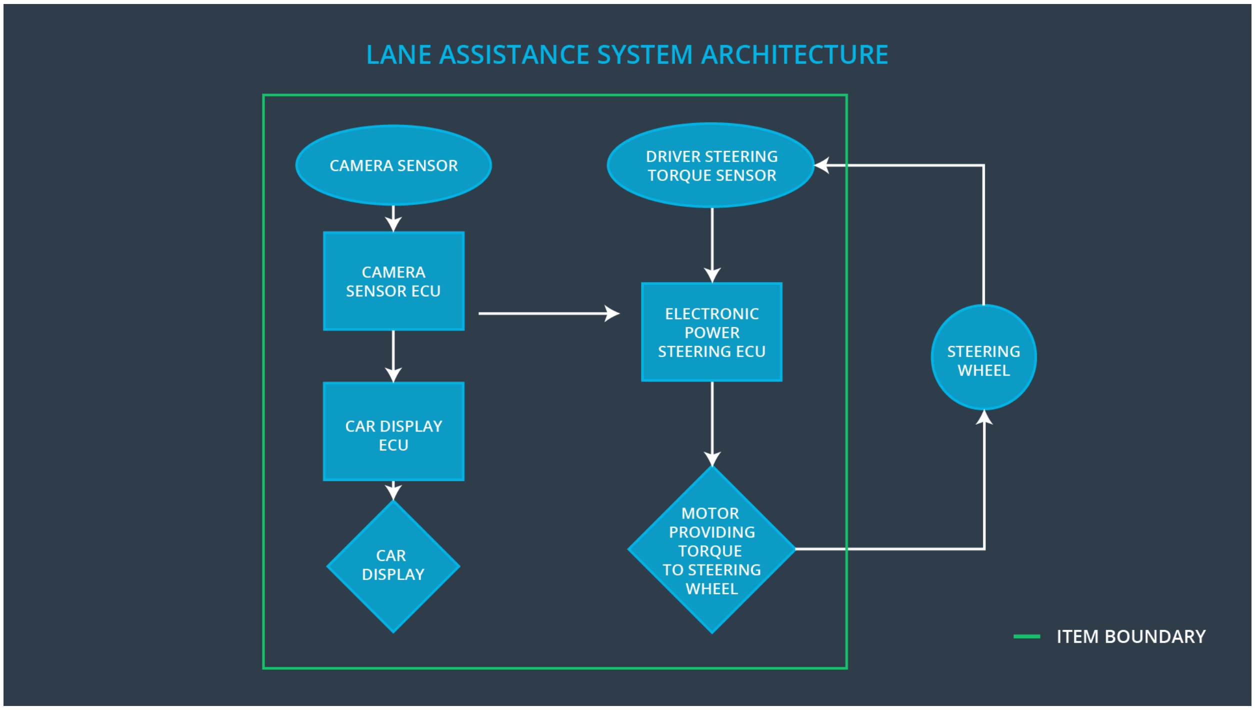
[Instructions:
REQUIRED:
Provide the lane departure warning and lane keeping assistance safety goals as discussed in the lessons and derived in the hazard analysis and risk assessment.

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.

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 and surroundings
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 visual feedback to the driver
Car Display ECU	Receives messages from the Camera Sensor ECU and creates and sends the visual feedback shown by the Car Display.
Driver Steering Torque Sensor	Reads the torque applied to the Steering wheel and sends messages to the Electronic Power Steering ECU
Electronic Power Steering ECU	Identifies when to deactivate the Lane Keep Assistance functionality. Also identifies the torque that needs to be applied to the Steering Wheel, and sends

	appropriate messages to the Motor.
Motor	Receives messages from the Electronic Power Steering ECU and applies the required torque 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	NO	The lane keeping assistance function is not limited in time duration which leads to misuse as an

	to stay in ego lane		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 lane departure oscillating torque amplitude is below Max_Torque_Amplitude	C	50 ms	ZERO
Functional Safety Requirement 01-02	The Electronic Power Steering ECU shall ensure that the lane departure oscillating torque frequency is below Max_Torque_Frequency	C	50 ms	ZERO

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 how drivers react to different torque amplitudes and validate that we have chosen an appropriate value for Max_Torque_Amplitude	Verify that if the torque amplitude exceeds Max_Torque_Amplitude for 50 ms, the Lane Departure Warning (LDW) System output is set to zero
Functional Safety Requirement 01-02	Test how drivers react to different torque frequencies and validate that we have chosen an appropriate value for Max_Torque_Frequency	Verify that if the torque frequency exceeds Max_Torque_Frequency for 50 ms, the Lane Departure Warning (LDW) System output is set to zero

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

Lane Keeping Assistance (LKA) Requirements:

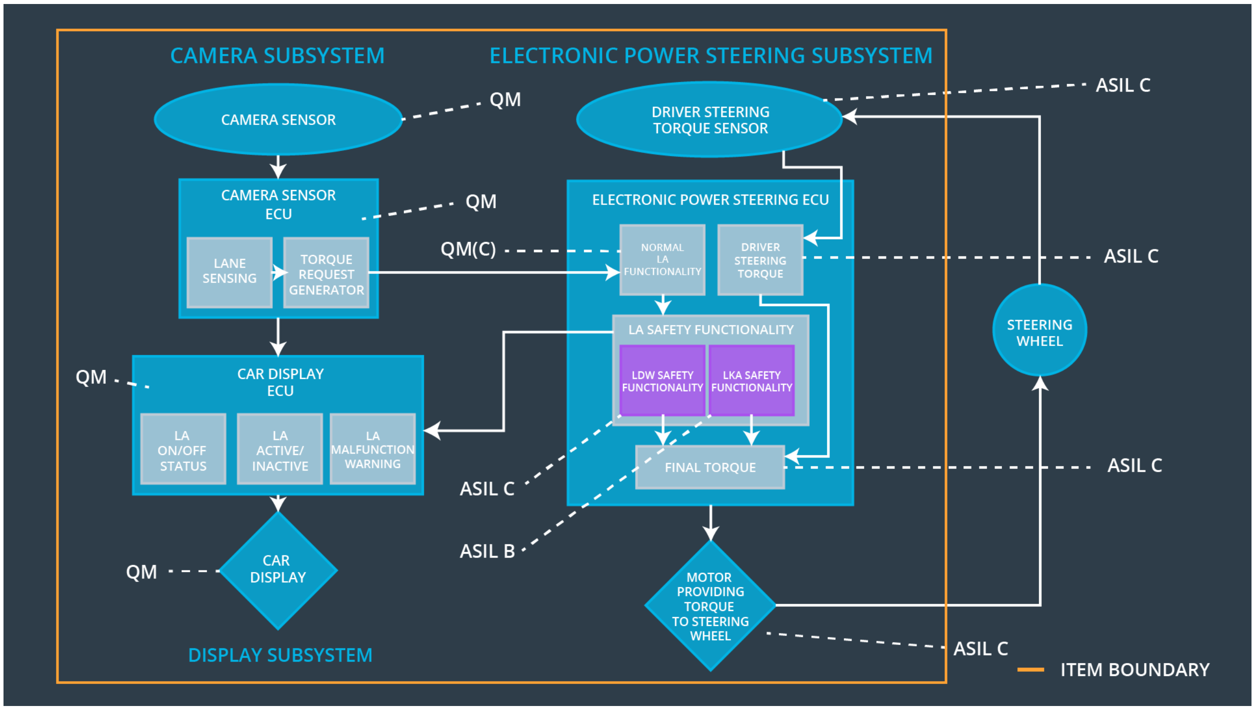
ID	Functional Safety Requirement	ASIL	Fault Tolerant Time Interval	Safe State
Functional Safety Requirement 02-01	The electronic power steering ECU shall ensure that the lane keeping assistance torque is applied for only Max_Duration	C	500 ms	OFF

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 how drivers react to different time limits and validate that it is more likely to keep their hands on the wheel at all times when Max_Duration is used.	Verify that the Lane Keeping Assistance (LKA) System output switches off after being active for 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		X		
Functional Safety Requirement 01-02		X		
Functional Safety Requirement 02-01		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	Malfunction_01 Malfunction_02	Yes	No Warning needed.
WDC-02	Turn Off	Malfunction_02	Yes	Warning Light