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
9/7/2018	1.0	Terry Lu	First Submission

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?]

Functional safety concept is documents about refining the safety goals into high level functional safety requirements.

Inputs to the Functional Safety Concept

Safety goals from the Hazard Analysis and Risk Assessment

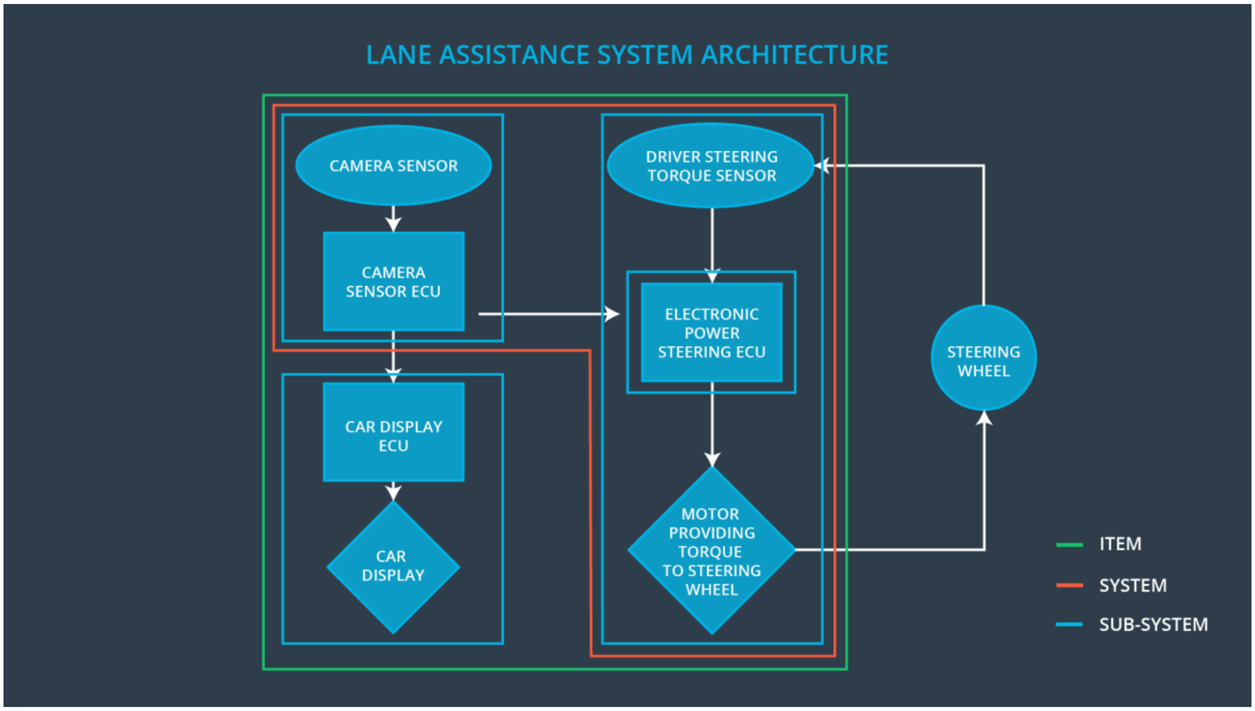
[Instructions:
REQUIRED:
Provide the lane departure warning and lane keeping assistance safety goals as discussed in the lessons and derived in the hazard analysis and risk assessment.

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
CAMERA SENSOR ECU
CAR DISPLAY ECU
CAR DISPLAY
DRIVER STEERING TORQUE SENSOR
ELECTRONIC POWER STEERING ECU
MOTOR PROVIDING TORQUE TO STEERING WHEEL
STEERING WHEEL
ITEM
SYSTEM
SUB-SYSTEM

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	Get image data of the road.
Camera Sensor ECU	Detect lane from camera image. Identify when the vehicle has accidentally departed its lane.
Car Display	Notifications on driver dashboard.
Car Display ECU	Sends messages to be displayed by the Car Display.
Driver Steering Torque Sensor	records current steering wheel torque.
Electronic Power Steering ECU	Decide final steering torque.
Motor	Providing torque to 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 LDW 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 line keeping item shall ensure that the lane departure oscillating torque amplitude is below Max_Torque_Amplitude.	C	50ms	LDW will set the oscillating torque amplitude to 0.
Functional Safety Requirement 01-02	The line keeping item shall ensure that the lane departure oscillating torque frequency is below Max_Torque_frequency.	C	50ms	LDW will set the oscillating torque amplitude 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	Criteria: Test how drivers react to different torque amplitudes to prove selection of an appropriate Max_Torque_Amplitude Method: Live driving simulations	Criteria: When torque amplitude crosses Max_Torque_Amplitude, lane assistance output is set to 0 within 50ms fault tolerant time interval Method: software test inserting fault into system to observe results
Functional Safety Requirement 01-02	Criteria: Test how drivers react to different torque frequencies to prove selection of an appropriate Max_Torque_Frequency Method: Live driving simulations	Criteria: When torque frequency crosses Max_Torque_Frequency, lane assistance output is set to 0 within 50ms fault tolerant time interval Method: Software test

[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	The Electronic Power Steering ECU shall ensure that the lane keeping assistance	B	500ms	LKA will set oscillating torque

Requirement 02-01	torque is applied for only Max_Duration			amplitude 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	Criteria: Test if drivers are dissuaded from taking hands off wheel based on selected Max_Duration value Method: Live driving simulations	Criteria: When max duration crosses Max_Duration, lane assistance output is set to 0 within 500 ms fault tolerant time interval Method: Software test

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 line keeping item shall ensure that the lane departure oscillating torque amplitude is below Max_Torque_Amplitude.	**X**		
Functional Safety Requirement 01-02	The line keeping item shall ensure that the lane departure oscillating torque frequency is below Max_Torque_frequency.	**X**		

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	**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	LDW disabled; torque request will be set to 0.	The LDW warning is giving MORE torque than what is safe.	Yes	Warning light appears on dashboard.
WDC-02	LKA disabled; torque request will be set to 0.	The LKA function had run above time limit.	Yes	Warning light appears on dashboard.