Elektrobit

UDACITY

Technical 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
3/13/2018	0.5	Tan Wang	First Draft
3/19/2018	1.0	Tan Wang	First Submission

Table of Contents

[Instructions: We have provided a table of contents. If the table of contents is not showing up correctly in your word processor of choice, please update it. 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 Technical Safety Concept

[Instructions: Answer what is the purpose of a technical safety concept?]
Technical Safety Concept is a document that aims to analyze each subcomponents of subsystems and allocate risk level to each subsystem in a more detailed view, so that it can facilitate the process to avoid accidents by reducing risk to acceptable levels.

There could be multiple levels of technical safety concepts that addresses safety analysis in different levels of detail.

Inputs to the Technical Safety Concept

Functional Safety Requirements

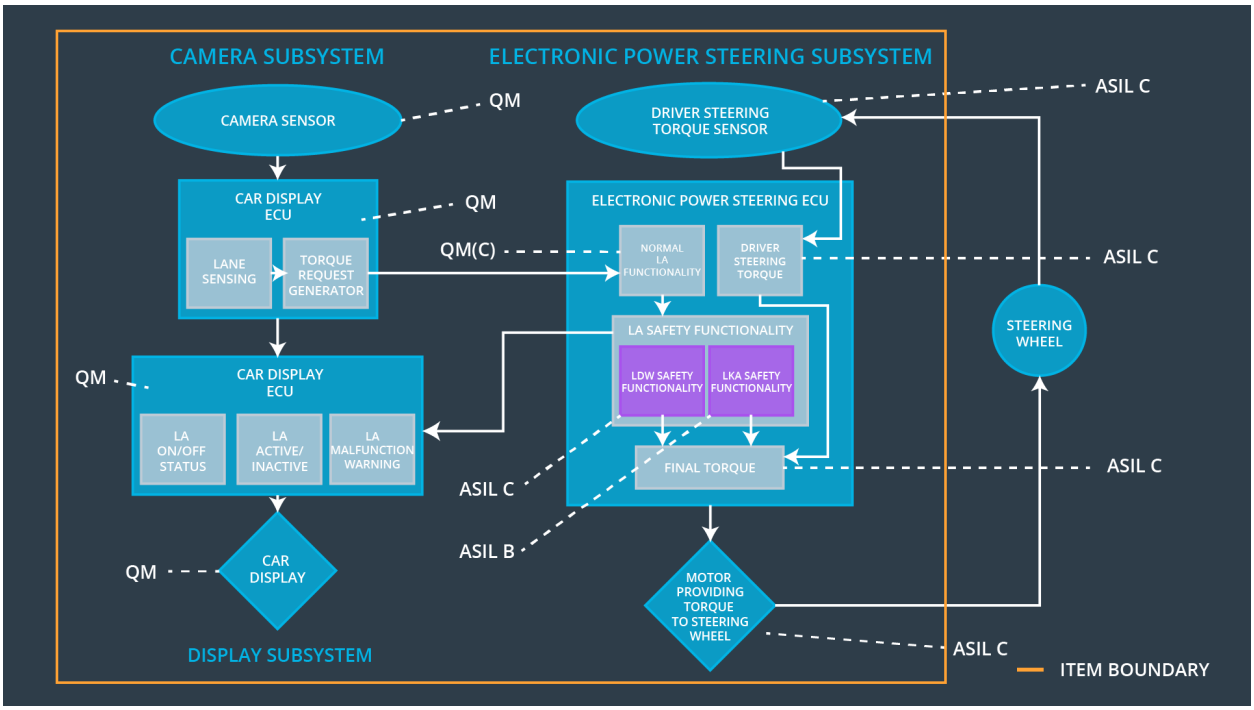
[Instructions: Provide the functional safety requirements derived in the functional safety concept]

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	The oscillating torque amplitude is set to 0
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	The oscillating torque frequency is set to 0
Functional Safety Requirement	the electronic power steering ECU shall ensure that the lane keeping assistance	B	500ms	The lane keeping assistance torque is not

02-01	torque is applied for only Max_Duration			applied

Refined System Architecture from Functional Safety Concept

[Instructions: Provide the refined system architecture from the functional safety concept]



Functional overview of architecture elements

[Instructions: Provide a description for each functional safety element; what is each element's purpose in the lane assistance item?]

Element	Description
Camera Sensor	Gets visual perception (images and videos) of the environment
Camera Sensor ECU - Lane Sensing	Extracts lane lines from sensor images and calculates the real world position of lane lines

Camera Sensor ECU - Torque request generator	Calculates the torque required to drive the car back to the center of the lane, and send the torque request.
Car Display	Presents status information and warnings to drivers
Car Display ECU - Lane Assistance On/Off Status	Controls the display of lane assistance on/off status based on the signals from lane assistance.
Car Display ECU - Lane Assistant Active/Inactive	Controls the display of lane assistance active/inactive status based on the signals from lane assistance.
Car Display ECU - Lane Assistance malfunction warning	Controls the display of lane assistance malfunctioning status based on the signals from lane assistance.
Driver Steering Torque Sensor	Gets the torque applied to the steering wheel by drivers
Electronic Power Steering (EPS) ECU - Driver Steering Torque	Converts and filters the torque value from driver steering torque sensor to the common scale/ coordinate system used in EPS ECU with a lower error/noise rate. (Like what a Kalman filter does)
EPS ECU - Normal Lane Assistance Functionality	Fetches the torque request from camera sensor ECU and the torque from the previous component, determine whether interventions are required.
EPS ECU - Lane Departure Warning Safety Functionality	Generates an oscillating torque value that vibrates the steering wheel
EPS ECU - Lane Keeping Assistant Safety Functionality	Generates a torque value that turn the car to the center of the lane
EPS ECU - Final Torque	Combines the torque value from all previous 4 torque values and generates a final torque value to motor
Motor	Applies torque to the steering wheel when the car is drifting away from the lane by mistake

Technical Safety Concept

Technical Safety Requirements

[Instructions: Fill in the technical safety requirements for the lane departure warning first functional safety requirement. We have provided the associated functional safety requirement in the first table below. Hint: The technical safety requirements were discussed in the lesson videos. The architecture allocation column should contain element names such as LDW Safety block, Data Transmission Integrity Check, etc. Allocating the technical safety requirements to the "EPS ECU" does not provide enough detail for a technical safety concept.]

Lane Departure Warning (LDW) Requirements:

Functional Safety Requirement 01-01 with its associated system elements
(derived in the functional safety concept)

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	X		

Technical Safety Requirements related to Functional Safety Requirement 01-01 are:

ID	Technical Safety Requirement	ASIL	Fault Tolerant Time Interval	Architecture Allocation	Safe State
Technical Safety Requirement 01	The LDW safety components shall ensure that the amplitude of the ‘LDW_Torque_Request” to the “Final electronic power steering Torque’ component is below Max_Torque_Amplitude	C	50ms	LDW safety components	A malfunction signal is sent
Technical Safety Requirement 02	The validity and integrity of data transmission for ‘LDW_Torque_Request’ signal shall be ensured	C	50ms	Data Transmission Integrity Check	A malfunction signal is sent
Technical	As soon as a failure is detected	C	50ms	LDW Safety	The LDW is

Safety Requirement 03	by the LDW function, it shall deactivate LDW feature and 'LDW_Torque_request" shall be 0			components	deactivated and the torque sent is 0
Technical Safety Requirement 04	As soon as the LDW function deactivates the LDW feature, the 'LDW safety' software block shall send a signal to car display ECU to turn on warning light	C	50ms	LDW safety components	The warning signal is sent
Technical Safety Requirement 05	Memory test shall be conducted at start up of the EPS ECU to check for any faults in memory	A	Ignition Cycle	Safety startup	A malfunction signal is sent

[Instructions: Fill in the technical safety requirements for the lane departure warning second functional safety requirement. We have provided the associated functional safety requirement in the table below. Hint:. Most of the technical safety requirements will be the same. At least one technical safety requirement will have to be slightly modified because we are talking about frequency instead of amplitude. These requirements were not given in the lessons]

Functional Safety Requirement 01-2 with its associated system elements (derived in the functional safety concept)

ID	Functional Safety Requirement	Electronic Power Steering ECU	Camera ECU	Car Display ECU
Functional Safety Requirement 01-02	The lane keeping item shall ensure that the lane departure oscillating torque frequency is below Max_Torque_Frequency	X		

Technical Safety Requirements related to Functional Safety Requirement 01-02 are:

ID	Technical Safety Requirement	ASIL	Fault Tolerant Time Interval	Architecture Allocation	Safe State
Technical Safety Requirement 01	The LDW safety components shall ensure that the frequency of the 'LDW_Torque_Request" to the "Final electronic power steering Torque' component is below Max_Torque_Frequency	C	50ms	LDW safety components	A malfunction signal is sent
Technical Safety Requirement 02	The validity and integrity of data transmission for 'LDW_Torque_Request' signal shall be ensured	C	50ms	Data Transmission Integrity Check	A malfunction signal is sent
Technical Safety Requirement 03	As soon as a failure is detected by the LDW function, it shall deactivate LDW feature and 'LDW_Torque_request" shall be 0	C	50ms	LDW Safety components	The LDW is deactivated and the torque sent is 0
Technical Safety Requirement 04	As soon as the LDW function deactivates the LDW feature, the 'LDW safety' software block shall send a signal to car display ECU to turn on warning light	C	50ms	LDW safety components	The warning signal is sent
Technical Safety Requirement 05	Memory test shall be conducted at start up of the EPS ECU to check for any faults in memory	A	Ignition Cycle	Safety startup	A malfunction signal is sent

Lane Departure Warning (LDW) Verification and Validation Acceptance Criteria:

[OPTIONAL: For each technical safety requirement, identify both the verification and validation acceptance criteria. "Validation" asks whether or not you chose the appropriate parameters. "Verification" involves testing to make sure the vehicle behaves

as expected when the parameter value is crossed. There is not necessarily one right answer. Look at your verification and validation acceptance criteria from the functional safety concept for inspiration.]

Lane Keeping Assistance (LKA) Requirements:

[Instructions: Fill in the technical safety requirements for the lane keeping assistance functional safety requirement 02-01. We have provided the associated functional safety requirement in the table below. Hint:. You can reuse the technical safety requirements from functional safety requirement 01-01. But you need to change the language because we are now looking at a different system. The ASIL and Fault Tolerant Time Interval are different as well.]

Functional Safety Requirement 02-1 with its associated system elements
(derived in the functional safety concept)

ID	Functional Safety Requirement	Electronic Power Steering ECU	Camera ECU	Car Display ECU
Functional Safety Requirement 02-01	The lane keeping item shall ensure that the lane keeping assistance torque is applied for only Max_Duration	X		

Technical Safety Requirements related to Functional Safety Requirement 02-01 are:

ID	Technical Safety Requirement	ASIL	Fault Tolerant Time Interval	Allocation to Architecture	Safe State
Technical Safety Requirement 01	The LKA safety components shall ensure that the duration of LKA_torque_request sent to the “Final electronic power steering Torque’ is below “Max_Duration”	B	500ms	LKA safety components	A malfunction signal is sent
Technical Safety Requirement	The validity and integrity of data transmission for ‘LKA_Torque_Request’ signal	B	500ms	Data Transmission Integrity Check	A malfunction signal is sent

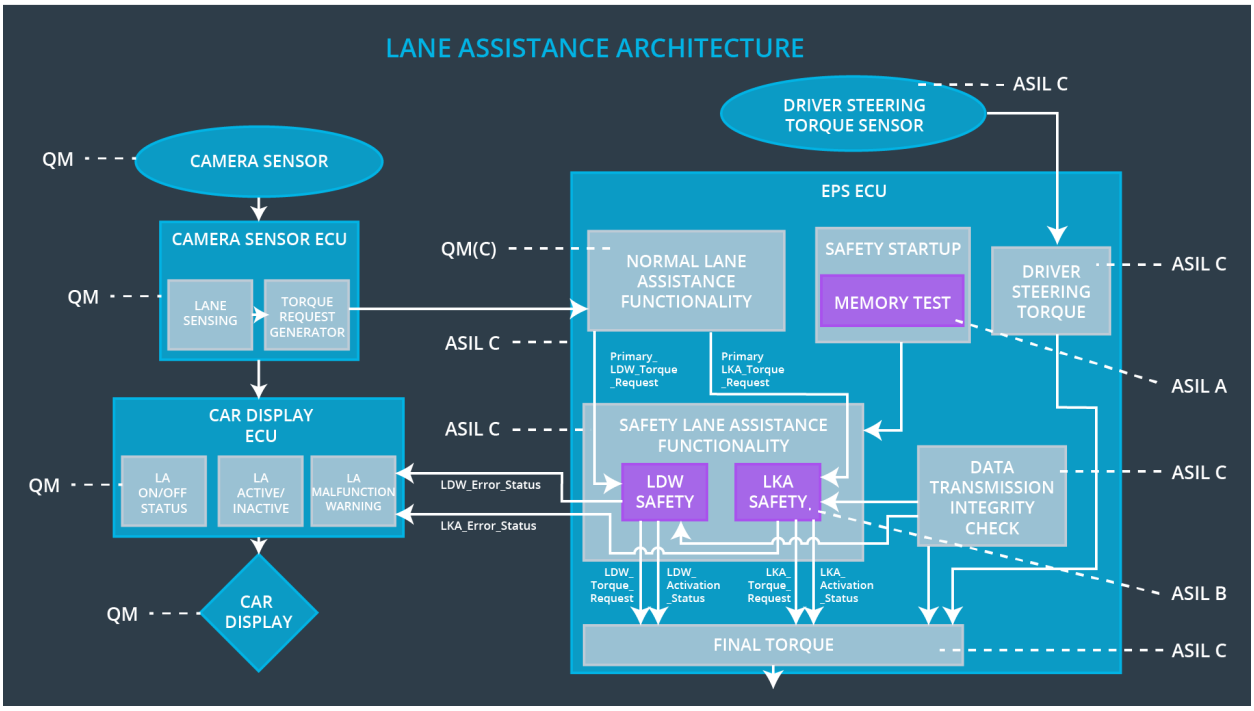
02	shall be ensured				
Technical Safety Requirement 03	As soon as a failure is detected by the LKA function, it shall deactivate LKA feature and ‘LKA_Torque_request” shall be 0	B	500ms	LKA Safety components	The LKA is deactivated and the torque sent is 0
Technical Safety Requirement 04	As soon as the LKA function deactivates the LKA feature, the ‘LKA safety’ software block shall send a signal to car display ECU to turn on warning light	B	500ms	LKA safety components	The warning signal is sent
Technical Safety Requirement 05	The LKA safety components shall ensure that the timer used to track the duration of applied torque is running correctly	B	500ms	LKA safety components	A malfunction signal is sent

Lane Keeping Assistance (LKA) Verification and Validation Acceptance Criteria:

[OPTIONAL: For each technical safety requirement, identify both the verification and validation acceptance criteria. “Validation” asks whether or not you chose the appropriate parameters. “Verification” involves testing to make sure the vehicle behaves as expected when the parameter value is crossed. There is not necessarily one right answer. Look at your verification and validation acceptance criteria from the functional safety concept for inspiration.]

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 technical safety lesson, including all of the ASIL labels.]



Allocation of Technical Safety Requirements to Architecture Elements

[Instructions: We already included the allocation as part of the technical requirement tables. Here you can state that for this particular item, all technical safety requirements are allocated to the Electronic Power Steering ECU]

All technical safety requirements are allocated to the Electronic Power Steering ECU

Warning and Degradation Concept

[Instructions: We've already identified that for any system malfunction, the lane assistance functions will be turned off and the driver will receive a warning light indication. The technical safety requirements have not changed how functionality will be degraded or what the warning will be.

So in this case, the warning and degradation concept is the same for the technical safety requirements as for the functional safety requirements. You can copy the functional safety warning and degradation concept here.

Oftentimes, a technical safety analysis will lead to a more detailed warning and degradation concept.]

ID	Degradation Mode	Trigger for Degradation Mode	Safe State invoked?	Driver Warning
WDC-01	Turn off the functionality	The oscillation amplitude or frequency is greater than the maximum value allowed	Yes	A warning message will be flashed on car display showing that lane departure warning system is malfunctioning
WDC-02	Turn off the functionality	The LKA torque is applied for more than the maximum time allowed	Yes	A warning message will be flashed on car display showing that LKA is applied for too long, which will prompt the drivers to hold the steering wheel drive manually