Elektrobit

UDACITY

Functional Safety Concept Lane Assistance

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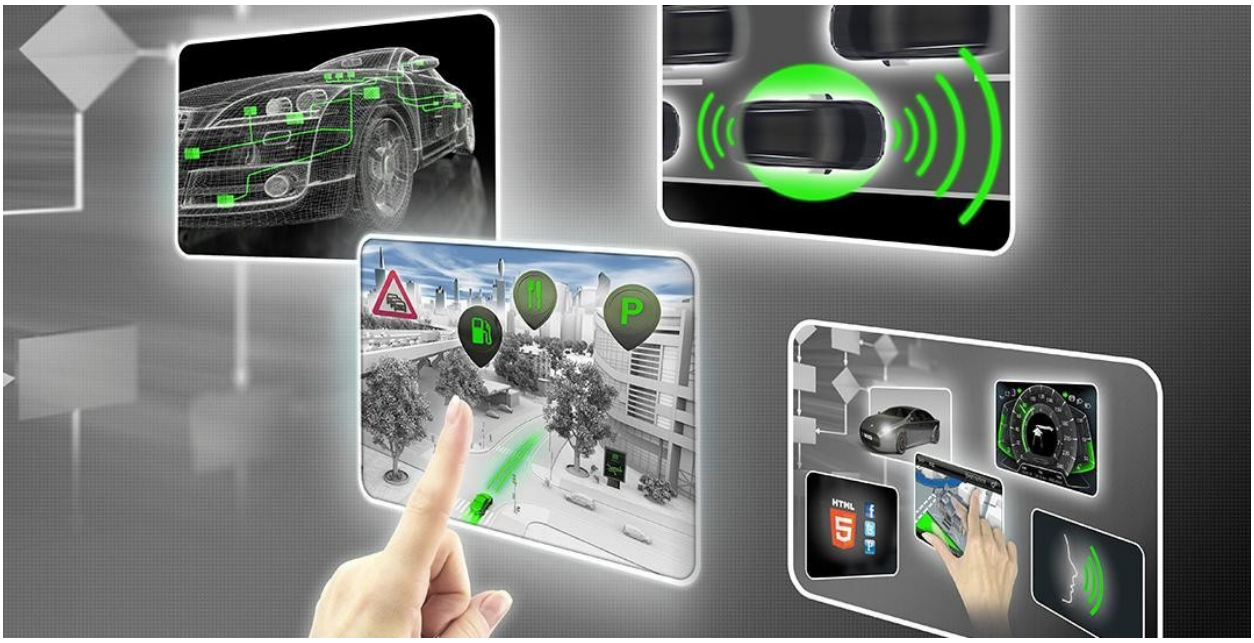

Document history

[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.

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Date	Version	Editor	Description
03.06.2018	1.1	Ankith Manjunath	Functional safety concept first version

Table of Contents

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Purpose of the Functional Safety Concept

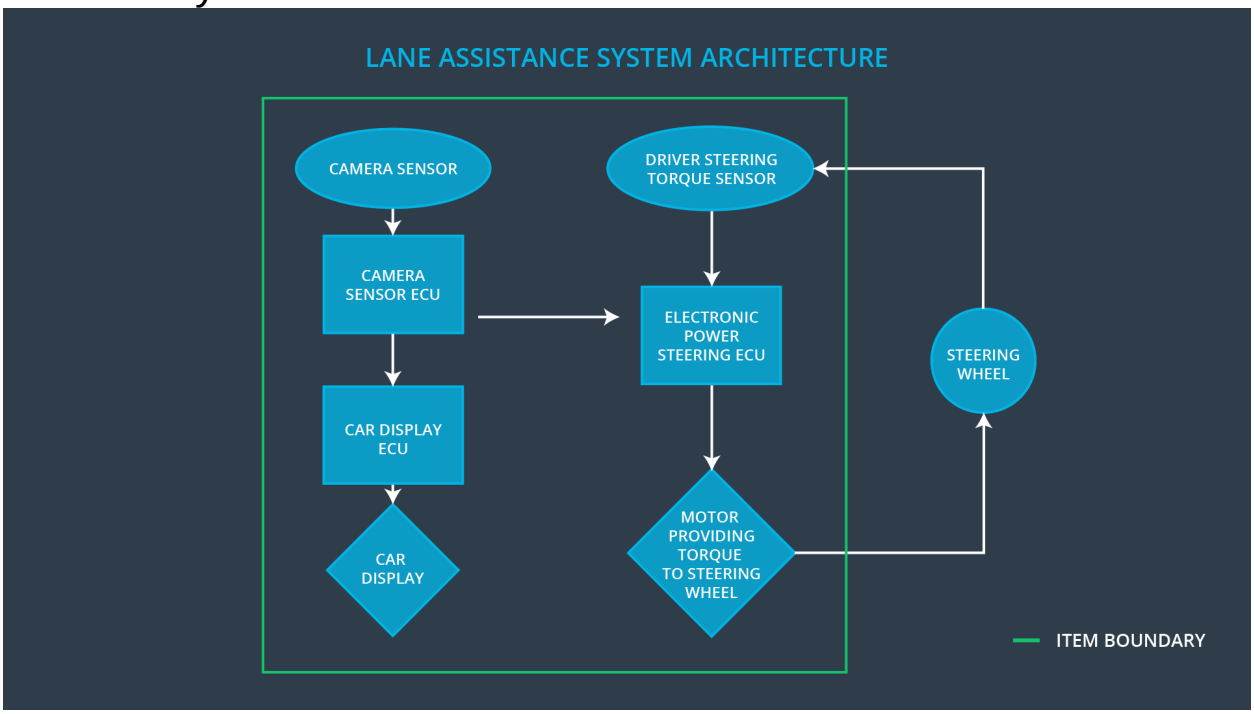
The main higher view of functional safety concept for a system under test is to make the system functionally safe. Functionally safe system has to reduce the impact of occuring hazardous situations.

Inputs to the Functional Safety Concept

Safety goals from the Hazard Analysis and Risk Assessment

ID	Safety Goal
Safety_Goal_01	The lane departure warning subsystem shall apply an oscillating torque less than the limit
Safety_Goal_02	The lane keeping assistance shall be time limited and shall apply steering torque for a limited period of time

Preliminary Architecture



Description of architecture elements

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Element	Description
Camera Sensor	Provide video feed of the road in front of the vehicle
Camera Sensor ECU	Detect lane markings from the video feed. Detect the position of the vehicle from the center of the lane.
Car Display	Display to the driver if functionality is on/off. Display the driver for a gradual degradation
Car Display ECU	Receive data about function on/off and also for function gradual degradation
Driver Steering Torque Sensor	Sense the steering wheel torque from the driver
Electronic Power Steering ECU	Determine the amount of steering torque needed for the functionality and normal operation mode
Motor	Provide the required torque from the software torque input

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

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	Vehicle out of control
Malfunction_02	Lane Departure Warning (LDW) function shall apply an oscillating steering torque to provide the driver a haptic feedback	LESS	Collision with another vehicle
Malfunction_03	Lane Keeping Assistance (LKA) function shall apply the steering torque when active in order to stay in ego lane	NO	Collision with another vehicle

Functional Safety Requirements

Lane Departure Warning (LDW) Requirements:

ID	Functional Safety Requirement	ASIL	Fault Tolerant Time Interval	Safe State
Functional Safety Requirement 01-01	The lane keeping item shall ensure that the torque amplitude by lane departure warning system is below MAX_TORQUE_AMPLITUDE	C	50ms	The lane keeping item is turned off and driver is notified
Functional Safety Requirement 01-02	The lane keeping item shall ensure that the torque frequency by the lane departure warning is below MAX_TORQUE_FREQUENCY	C	50ms	The lane keeping item is turned off and driver is notified

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 suitable value for MAX_TORQUE_AMPLITUDE	Verify the FTTI and safe state degradation using the validated MAX_TORQUE_AMPLITUDE
Functional Safety Requirement 01-02	Choose a suitable value for MAX_TORQUE_FREQUENCY	Verify the FTTI and safe state degradation using the validated MAX_TORQUE_FREQUENCY

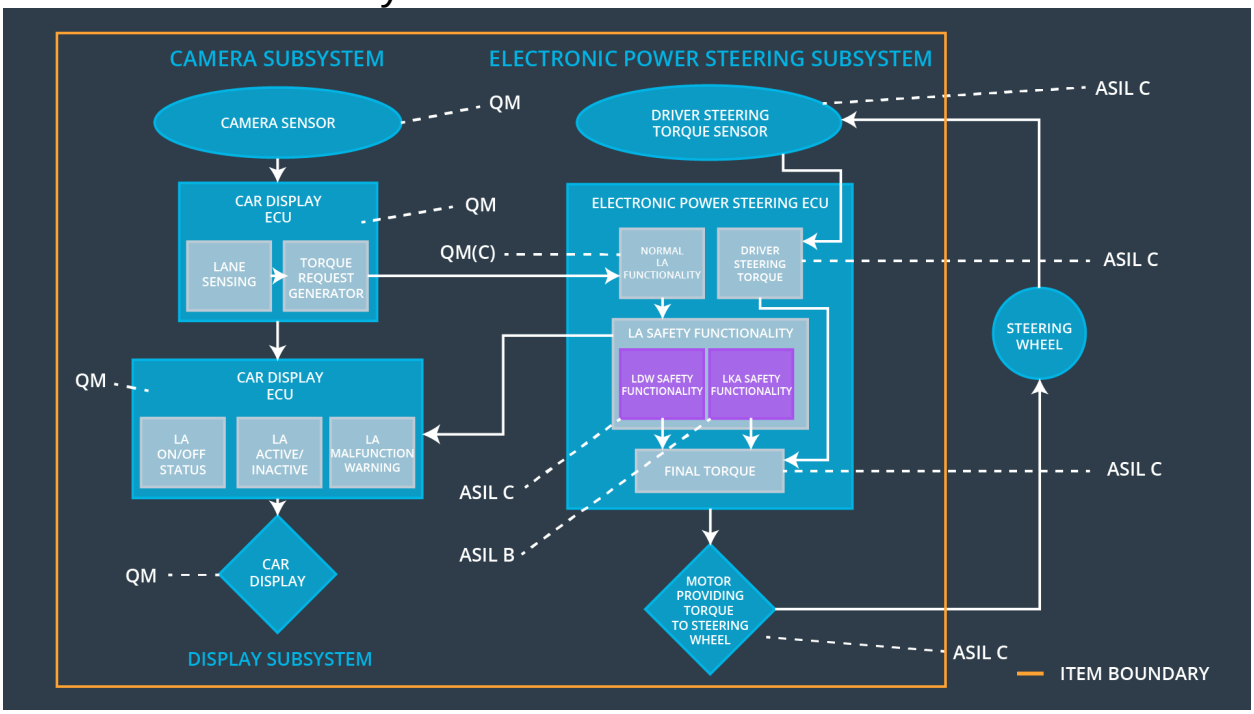
Lane Keeping Assistance (LKA) Requirements:

ID	Functional Safety Requirement	ASIL	Fault Tolerant Time Interval	Safe State
Functional Safety Requirement 02-01	The lane keeping item shall ensure that the steering torque TIME_FOR_TORQUE is applied for a limited period of time .	B	500ms	The lane keeping item is turned off and driver is notified

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 the TIME_FOR_TORQUE such that the system is not misinterpreted as an autonomous function	The FTTI and safe state is verfied using the validated TIME_FOR_TORQUE

Refinement of the System Architecture



Allocation of Functional Safety Requirements to Architecture Elements

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 torque amplitude by lane departure warning system is below MAX_TORQUE_AMPLITUDE	**x**	**-**	**-**
Functional Safety Requirement 01-02	The lane keeping item shall ensure that the torque frequency by the lane departure warning is below MAX_TORQUE_FREQUENCY	**x**	**-**	**-**
Functional Safety Requirement 02-01	The lane keeping item shall ensure that the steering torque TIME_FOR_TORQUE is applied for a limited period of time .	**x**	**-**	**-**

Warning and Degradation Concept

ID	Degradation Mode	Trigger for Degradation Mode	Safe State invoked?	Driver Warning
WDC-01	Turn off functionality	Malfunction_01 Malfunction_02	Yes	LDW warning on the screen
WDC-02	Turn off functionality	Malfunction_03	Yes	LKA warning on the screen, Driver to take over the car