

Adaptive Cruise Control Requirements

Requirement 1– Lead Vehicle:

- Lead Vehicle is a vehicle which is driving in the road ahead of our drive vehicle. Two input signals (Signal Name: *CameraInput_LeadVehicle* & *RadarInput_LeadVehicle*).
- Ideally sensor fusion techniques will be deployed to process & analyze data from camera & radar. For complexity reasons, let's not adapt to any such algorithms.
- We can simply add both the radar & camera inputs & the corresponding output is read as Speed profile output (Signal Name: *LeadVehicle_Speed*).
- Speed data of the lead vehicle is critical in implementing the Adaptive Cruise Control algorithm.

Requirement 2 – Drive Vehicle:

- Drive Vehicle is the vehicle driven by the user & this is the vehicle which has ACC algorithm in it.
- Like the Lead Vehicle, Drive Vehicle algorithm also has 2 input signals (Signal Name: *CameraInput_DriveVehicle*, *RadarInput_DriveVehicle*) & one signal coming as an Input to this subsystem (Signal Name: *Acceleration_Mode*) – three inputs into this requirement in total.
- Like the above requirement, sensor fusion techniques will also be deployed here, for complexity reasons we are ignoring them.
- Two output signals come from this subsystem (Signal Name: *DriveVehicle_Speed* & *LeadVehicle_Detected*).
- Signal *DriveVehicle_Speed* is summation of three input signals mentioned above & *LeadVehicle_Detected* is renamed from Input Signal *RadarInput_DriveVehicle* by mere use of Signal Conversion block.

Requirement 3 – Adaptive Cruise Control Algorithm:

- Adaptive Cruise Control feature has 3 major modes of operation: OFF Mode, STANDBY Mode & ON Mode. This particular requirement has to be implemented as state machine logic in Simulink.
- The input signals to this state machine system are (Signal Name: *Time_Gap*, *Set_Speed*, *Set_Gap*, *CruiseSwitch*, *SetSwitch*).
- Also, the output signals (Signal Name: *DriveVehicle_Speed* & *LeadVehicle_Detected*) from requirement-2 is fed back as an input signal into this state machine block.
- Additionally, output signal (Signal Name: *LeadVehicle_Speed*) from requirement-1 is given as an input signal to this state machine block as well.
- Output from this subsystem is a signal (Signal Name: *Acceleration_Mode*) which governs the vehicular speed of the drive vehicle which automatically adjusts its speed & velocity to match the lead vehicle.

Requirement 3a – ACC OFF MODE state logic:

- This is the default state inside state machine logic. Output signal *Acceleration_Mode* is at value 0 in this state.
- This state is governed by input signal *CruiseSwitch*.
- If *CruiseSwitch* is equal to 1, state ACC STANDBY mode will get activated. If *CruiseSwitch* is equal to 0, state ACC OFF mode will get activated, from either *ACC ON mode* or *ACC STANDBY mode*

Requirement 3b – ACC STANDBY MODE state logic:

- This is the second activated state inside state machine logic. Output signal *Acceleration_Mode* is at value 1 in this state.
- This state is governed by both input signals *CruiseSwitch* & *SetSwitch*.
- If *CruiseSwitch* is equal to 1, state ACC STANDBY mode will get activated. If *CruiseSwitch* is equal to 0, state ACC OFF mode will get activated, from either *ACC ON mode* or *ACC STANDBY mode*
- If *SetSwitch* is equal to 1, state ACC ON mode will get activated. If *SetSwitch* is equal to 0, state ACC STANDBY mode will get activated.

Requirement 3c – ACC ON MODE state logic:

This state will be activated when input signal *SetSwitch* is equal to 1. There are 6 sub states to this state logic: They are:

- *LeadVehicle_Detected_Follow (Default)*
- *LeadVehicle_Not_Detected*
- *LeadVehicle_Detected_Resume*
- *LeadVehicle_Not_Detected_Resume*
- *LeadVehicle_Speed_less than_Set_Speed*
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Requirement 3c (i) – LeadVehicle_Detected_Follow (ACC ON MODE):

- This is the default sub state inside ACC ON MODE state. Output signal *Acceleration_Mode* is equal to 2.
- Condition to transit from *LeadVehicle_Detected_Follow* to *LeadVehicle_Not_Detected*; Input signal condition *LeadVehicle_Detected* == 0.
- Condition to transit from *LeadVehicle_Detected_Follow* to *LeadVehicle_Speed_less than_Set_Speed*; Input Signals condition $(LeadVehicle_Detected == 1) \ \&\& \ (LeadVehicle_Speed < Set_Speed) \ || \ (Time_Gap < Set_Gap)$

Requirement 3c (ii) – LeadVehicle_Not_Detected (ACC ON MODE):

- Output signal *Acceleration_Mode* is equal to 1.
- Condition to transit from *LeadVehicle_Not_Detected* to *LeadVehicle_Detected_Follow*; Input signals condition $[(LeadVehicle_Detected == 1) \ \&\& \ (DriveVehicle_Speed == Set_Speed) \ \&\& \ (LeadVehicle_Speed \geq Set_Speed) \ \&\& \ (Time_Gap \geq Set_Gap)]$
- Condition to transit from *LeadVehicle_Not_Detected* to *LeadVehicle_Speed_less than_Set_Speed*; Input signals condition $[(LeadVehicle_Detected == 1) \ \&\& \ (LeadVehicle_Speed < Set_Speed) \ || \ (Time_Gap < Set_Gap)]$

Requirement 3c (iii) – LeadVehicle_Detected_Resume (ACC ON MODE):

- Output signal *Acceleration_Mode* is equal to 3.
- Condition to transit from *LeadVehicle_Detected_Resume* to *LeadVehicle_Detected_Follow*; Input signals condition $[(DriveVehicle_Speed == Set_Speed) \ \&\& \ (LeadVehicle_Speed \geq Set_Speed) \ \&\& \ (Time_Gap \geq Set_Gap)]$
- Condition to transit from *LeadVehicle_Detected_Resume* to *LeadVehicle_Not_Detected_Resume*; Input signal condition *LeadVehicle_Detected* == 0.
- Condition to transit from *LeadVehicle_Detected_Resume* to *LeadVehicle_Speed_equal_Set_Speed*; Input Signal condition $[(DriveVehicle_Speed < Set_Speed) \ \&\& \ (LeadVehicle_Speed > DriveVehicle_Speed) \ \&\& \ (Time_Gap \geq Set_Gap)]$

Requirement 3c (iv) - LeadVehicle_Not_Detected_Resume (ACC ON MODE):

- Output signal *Acceleration_Mode* is equal to 1.

Requirement 3c (v) - LeadVehicle_Speed_less than_Set_Speed (ACC ON MODE):

- Output signal *Acceleration_Mode* is equal to 4.
- Condition to transit from *LeadVehicle_Speed_less than_Set_Speed* to *LeadVehicle_Not_Detected*; Input signal condition $[(LeadVehicle_Detected == 0) \ \&\& \ (DriveVehicle_Speed == Set_Speed)]$
- Condition to transit from *LeadVehicle_Speed_less than_Set_Speed* to *LeadVehicle_Speed_equal_Set_Speed*; Input signals condition $[(LeadVehicle_Speed * 1.25 \geq DriveVehicle_Speed) \ \&\& \ (LeadVehicle_Speed * 0.75 \leq DriveVehicle_Speed) \ \&\& \ (DriveVehicle_Speed < Set_Speed) \ \&\& \ ((Time_Gap \leq 1.25 * Set_Gap) \ \&\& \ (Time_Gap \geq 0.75 * Set_Gap))]$

Requirement 3c (vi) - LeadVehicle_Speed_equal_Set_Speed (ACC ON MODE):

- Output signal *Acceleration_Mode* is equal to 5.
- Condition to transit from *LeadVehicle_Speed_equal_Set_Speed* to *LeadVehicle_Not_Detected_Resume*; Input signal conditions is $[(LeadVehicle_Detected == 0) \ || \ (DriveVehicle_Speed \leq Set_Speed)]$

- Condition to transit from *LeadVehicle_Speed_equal_Set_Speed* to *LeadVehicle_Detected_Resume*; Input signal conditions $[(DriveVehicle_Speed < Set_Speed) \&\& (LeadVehicle_Speed > DriveVehicle_Speed) \parallel (Time_Gap \geq Set_Gap)]$
- Condition to transit from *LeadVehicle_Speed_equal_Set_Speed* to *LeadVehicle_Speed_less than_Set_Speed*; Input signals conditions $[(LeadVehicle_Speed < Set_Speed) \&\& (LeadVehicle_Speed < DriveVehicle_Speed) \parallel (Time_Gap == 0.75 * Set_Gap)]$