Introduction:

This menu documents all parameters and variables used for torque vectoring (TV) system. To make the menu easy to read, the order of parameters and variable follows the order in Simulink file (up to down and left to right manner).

1. Constant Parameters
2. Vehicle Body 3DOF Dual Track

|  |  |  |  |
| --- | --- | --- | --- |
| Particulars | Remark | Value | Unit |
| Vehicle Mass | None | 308 | kg |
| Longitudinal distance from center of mass to front axle | None | 0.7922471 | m |
| Longitudinal distance from center of mass to rear axle | None | 0.7828529 | m |
| Vertical distance from center of mass to axle plane | Vertical Distance from CoG to axle | 0.295 | m |
| Front track width | Distance between two front wheels measured in the middle of wheels | 1.29579 | m |
| Rear track width | Distance between two rear wheels measured in the middle of wheels | 1.24204 | m |
| Polar Inertia of Yaw | None | 4000 | kg\*m2 |
| Longitudinal drag area | Aerodynamics properties | 1.0221 | m2 |
| Longitudinal drag coefficient | Aerodynamics properties | 1.149 | 1 |
| Longitudinal lift coefficient | Aerodynamics properties |  | 1 |
| Longitudinal drag pitch moment | Aerodynamics properties | 0.1 | 1 |
| Relative wind angle vector | Aerodynamics properties | [0:0.01:0.3] | 1 |
| Side force coefficient vector | Aerodynamics properties | [0:0.03:0.9] | 1 |
| Yaw moment coefficient vector | Aerodynamics properties | [0:0.01:0.3] | 1 |
| Absolute pressure | Environmental pressure | 101325 | Pa |
| Air temperature | None | 273 | K |

1. Wheel

|  |  |  |  |
| --- | --- | --- | --- |
| Particulars | Remark | Value | Unit |
| Rolling Radius | Currently set to actual radius | 0.22 | m |
| Longitudinal stiffness | Not actual number | 2E5 | N/m |
| Longitudinal damping | Not actual number | 1000 | N/(m/s) |
| Tire Inertia | Not actual number | 0.03 | Kg\*m2 |

Vehicle Parameters: def\_constants

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Particulars | Name | Type | Value | Unit |
| mu | Friction Coefficient | Matrix | [0.8,0.8,0.8,0.8] | 1 |
| g | Gravitational Constant | Number | 9.81 | m/s2 |
| P\_L | Motor Power Limit, Positive | Matrix | [15,15,15,15] | kW |
| P\_L\_brake | Motor Power Limit, Negative | Matrix | [-15, -15, -15, -15] | kW |
| eff\_m | Motor efficiency | Matrix | [0.85,0.85,0.85,0.85] | 1 |
| tau | Motor Response Time Constant | Number | 0.29 | 1/s |
| t\_minmax | Torque Limit on Motor | Matrix | [-20,20] | N\*m |
| r | Tire radius | number | 0.22 | m |
| s | Halftrack width | Matrix | [0.647895, 0.62102] | m |
| l | Wheelbase | Matrix | [0.7922471,0.7828529] | m |
| J\_z | Polar Moment of Inertia | number | 4000 | kg\*m2 |
| K\_u | Understeer Gradient | number | 0.05 | 1 |
| GR\_f | Front Gear Ratio | number | 6.6304 | 1 |
| GR\_r | Rear Gear Ratio | number | 7.9565 | 1 |
| eff\_g | Gearbox Efficiency | number | 0.97 | 1 |

Vehicle Parameters: Layer 1

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Particulars | Name | Type | Value | Unit |
| T2F | Motor Torque to Tire Force convertor | number | Derivative of Several Constants | 1/m |
|  |  |  |  |  |

Vehicle Parameters: Layer 2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Particulars | Name | Type | Value | Unit |
| x | K2 Vehicle yaw moment constant | Matrix | Function of steering angle | m |
| y | K2 Vehicle yaw moment constant | Matrix | Function of steering angle | m |
| txe\_term | Coefficient to establish motor torque boundaries | Number | 0.9495907868 | 1 |
| c\_lower | Minimum Negative change in Torque | Number | -1.26023033 | Nm |
| c\_upper | Minimum Positive change in Torque | Number | 1.26023033 | Nm |
| c\_constant | Baseline torque the motor is at | Number |  | Nm |

1. Variables
2. Initial Conditions

|  |  |  |  |
| --- | --- | --- | --- |
| Particulars | Remark | Initial Value | Unit |
| Longitudinal Vehicle Velocity |  | 0 | m/s |
| Lateral Vehicle Velocity |  | 0 | m/s |
| Yaw Rate |  | 0 | rad/s |
| Motor Torque Output |  | [0, 0, 0, 0] | N\*m |

1. Simulation Inputs

All simulation inputs are with respect to a single time series. Data points Interpreted by linearization.

|  |  |  |  |
| --- | --- | --- | --- |
| Particulars | Remark | Range | Unit |
| driver\_input | A unitless variable to measure how much the drive accelerate/brake | [-1,1] | 1 |
| P\_A | Amount of battery power available for positive torque | [0,60000] | W |
| batt\_temp | Battery temperature |  | K |
| steering\_angle | The angular displacement of steering wheel | [-30,30] | Degree |
| wind x | The velocity of wind in longitudinal direction |  | m/s |
| wind y | The velocity of wind in lateral direction |  | m/s |
| wind z | The velocity of wind in vertical direction |  | m/s |
| B\_A | Amount of battery power available for negative torque | [? , 0] | w |

1. Changeable Parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Location | Function | Current value | Unit |
| c\_factor | def\_constant | Regulating Max Yaw Rate. increase this to increase the effect of sideslip angle (for a larger angle) | 0.8 | 1 |
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1. Block Variables: Layer 1

|  |  |  |
| --- | --- | --- |
| Name | Remark | Unit |
| F\_max | Maximum friction on wheels, in [1x4] | N |
| v\_cog | Velocity of center of gravity (cog) | m/s |
| yaw\_des | Ideal yaw rate at currently velocity | rad/s |
| yaw\_max | Maximum achievable yaw rate at v\_cog | rad/s |
| Yaw\_ref | Reference yaw rate in [1x2], if yaw\_des > yaw\_max, yaw\_max will be reference, else, yaw\_des is actual reference | rad/s |

1. Block Variables: Layer 2

|  |  |  |
| --- | --- | --- |
| Name | Remark | Unit |
| yaw\_err | Error in yaw rate | rad/s |
| omega\_m | Motor shaft angular speed, [1x4] | rad/s |
| Fy\_wheel | Lateral force for each wheel in wheel direction, [1x4] | N |
| Fx\_max2 | Non-slip longitudinal force limit, [1x4] | N |
| slip\_limit | Non-slip torque limit on motor, [1x4] | N\*m |
| power\_limit | Max Power limit for each motor, [1x4] | N\*m |
| prev\_torque | Torque output from motor 1 step time (of controller) earlier | N\*m |
| t\_upper | torque limit of increasing due to speed of response of motor | N\*m |
| t\_lower | torque limit of decreasing due to speed of response of motor | N\*m |
| P\_C | Demand of power from driver’s input | W |
| omega\_real | Actual shaft rotational speed (always positive) [1x4] | Rad/s |
| omega\_m | Rotational speed of shaft (sign may change for calculation), [1x4]. | Rad/s |
|  |  |  |

1. Block Variables: LP\_Calc

|  |  |  |
| --- | --- | --- |
| Name | Remark | Unit |
| ub | Upper boundary of torque output for motors, [1x4]. | N\*m |
| lb | Lower boundary of torque output for motors, [1x4]. | N\*m |
| ub\_f | Upper boundary of longitudinal force on wheels, [1x4]. | N |
| lb\_f | Lower boundary of longitudinal force on wheels, [1x4]. | N |
| M\_max | Maximum Yaw moment achievable for vehicle body, two directions, [1x2] | N\*m |
| Aeq | Coefficients for torques to yaw moment of LP model’s equation, [1x4]. |  |
| beq | Yaw moment to be achieved during torque vectoring [1x4]. |  |
| A | Coefficients for torque to power of LP model’s inequality, [1x4]. |  |
| b | Total power limit of LP model’s inequality, [1x4]. | W |
| objfun | Objective function, which is minimized by the optimization model, [1x4]. |  |
| Tx | Torque command to motor | Nm |