The Loughborough 6dof Model (v6) I/O

Inputs

Steer inputs are at the top level of the model – just a step block in the default model. Replace this block with a ramp, or a clock followed by look-up table, or any other suitable Simulink Source block, to specify other types of input. Bear in mind that this is the steer applied to the steered wheels (see steering distribution gain block), not the steering wheel, and it is in radians.

The driveline is simplified to a scalar (constant, in the default model) torque applied at the driven wheels through an open differential with gear ratio (default 2.8). If this input torque is set negative the torque is instead distributed directly to the wheels, simulating braking which opposes wheel motion. Standard wheel rolling resistance and aerodynamic drag losses are also included (the aero drag losses are applied in the BODY block).

Initial speed is set in the init file (`u0`), and note that the wheel speeds are also initialised at the same effective (contact patch) speed.

If cruise control is turned on in the init file, this over-rides the torque input to the driveline submodel, and instead the torque is set by proportional / integral (PI) feedback of the error in forward speed, inferred simply by averaging the four wheel speeds ('tread' speeds, `wv`). The PI gains have been tuned to give reasonably realistic behaviour, so in most simulations there is still some variation of speed over time, and you will see that this influences many other variables.

Output variables and their meanings

The Simulink model is provided with a number of 'To Workspace' blocks (terminating blocks, with variable names but no block name). These provide a comprehensive set of output information for analysing the results, but can be added to, or removed as desired. The list below is not comprehensive; it is likely that more outputs will be present in the model than are listed here. (Note that the **`drawcar`** script requires the outputs `X`, `Y`, `psi` and `delta`, and the **`viewer`** requires an even larger set of outputs)

Each output variable has one row per simulated time step, and if the variable outputs a vector of values (many of them are in sets of four or eight, because there are four wheels), these will comprise the columns of the output matrix. All values are in SI units, and in the vehicle axis reference frame, unless otherwise stated.

Name	Columns	Description
t	1	Time

(This is actually configured in the data import/export tab of Simulation>>Configuration parameters, so doesn't appear in a To Workspace block)

(inputs)		
delta	4	steer angle input to each of the wheels
(vehicle body states)		
u	1	vehicle body CG longitudinal velocity
v	1	vehicle body CG lateral velocity
w	1	vehicle body CG vertical velocity
p	1	vehicle body roll angular velocity
q	1	vehicle body pitch angular velocity
r	1	vehicle body yaw angular velocity
phi	1	vehicle body roll angle
theta	1	vehicle body pitch angle
psi	1	vehicle body yaw angle
z	1	vehicle body CG vertical position
(acceleration)		
accs	6	acceleration of vehicle CG, translational, then rotational
(Wheels and tyres) NB : the tyre reference frame is the vehicle reference frame with axes rotated by δ to align with the tyre (ie z components are the same).		
torq	1	total drive (or brake) torque applied
wv	4	wheel spin speed, expressed in terms of contact patch speed ($r_r\omega$, m/s)
Fz	4	vertical load on the tyre
Fs	4	vertical load on the body (-**Fz** usually)
slip	8	absolute longitudinal and lateral slip, in the tyre reference frame
Fxyt	8	longitudinal and lateral force generated by the tyre, in the tyre reference frame
Fxy	8	longitudinal and lateral force experienced by the body at a given wheelstation (in the vehicle reference frame)
(other useful outputs generated)		
X	1	global X position of vehicle CG
Y	1	global Y position of vehicle CG
uv	1	vehicle total speed ($\sqrt{u^2+v^2}$)
s	1	distance travelled along vehicle path