SimBALink

1 Vehicle

This system models the forces acting on the vehicle.

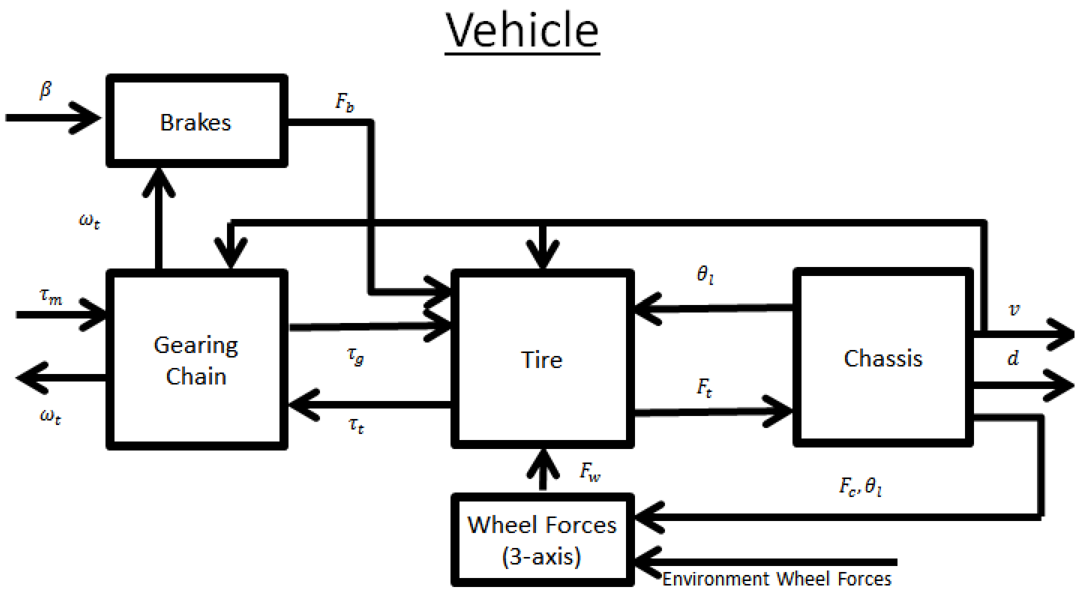

Figure 1: Vehicle Diagram

1.1 Gearing and Chain

$$\dot{\omega}_t = \frac{\tau_m - \tau_t}{J_m + J_g + J_t} \tag{1}$$

$$\tau_g = \frac{\tau_m \eta(\omega_t)}{R_g} \tag{2}$$

1.2 Brakes

1.3 Inputs and outputs

1.3.1 Inputs

Input	Symbol	Unit
Brake Command	*beta*	%
Wheel Speed	ω_t	rad/s

1.3.2 Outputs

Output	Symbol	Unit
Brake Force on Tire	F_b	N

1.3.3 Background, rationale, modeling strategy

The brake is modeled as a friction force

$$F_b = \mu_b \omega_t \beta \tag{3}$$

1.3.4 Variables

Output	Symbol	Unit
Brake Coefficenct of Friction	μ_b	$\frac{N}{rad/s}$

1.3.5 Parameters

No tuning parameters

1.3.6 Assumptions

- Throttle percentage to friction force is linear

1.4 Tires

Rolling Resistance

$$K_t = \begin{cases} 0.0085 + \frac{0.18}{p_t} + \frac{1.59*10^{-6}}{p_t} & : v_{kph} \leq 165(km/h) \\ \frac{0.18}{p_t} + \frac{2.91*10^{-6}}{p_t} & : v_{kph} > 165(km/h) \end{cases} \tag{4}$$

Wheel Slip

$$\kappa = \frac{v - \omega_t r_t}{v} \tag{5}$$

$$\mu_{t,gnd} = D_\kappa \sin(C_\kappa \arctan[B_\kappa \kappa - E_\kappa (B_\kappa \kappa - \arctan B_\kappa \kappa)]) \tag{6}$$

Load and Torque

$$\tau_t = \tau_g - \frac{F_{w,long}}{r_t} - \frac{F_b}{r_b} - K_t F_{w,n} v_{kph}^2 \tag{7}$$

Traction Limiting

$$F_{max} = \mu_{t,gnd} F_{w,n} \tag{8}$$

$$F = \tau r_t \tag{9}$$

$$F_t = \begin{cases} F & : -F_{max} \leq F \leq F_{max} \\ F_{max} & : -F_{max} > F > F_{max} \end{cases} \tag{10}$$

The tire coefficient ($\mu_{t,gnd}$) is modeled using the "Magic Formula" as shown below. Where D_κ is the maximum tire coefficient of the tire.

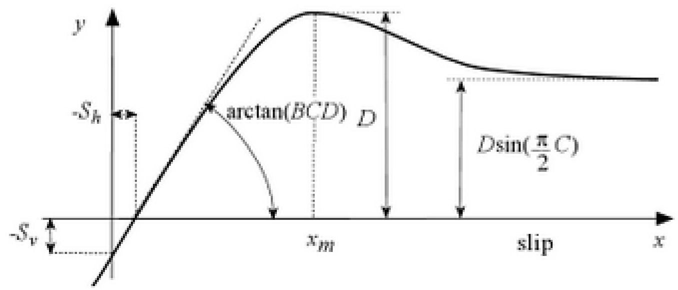

Figure 2: Magic Formula

1.5 Wheel Forces

$$F_{\omega,long} = F_{c,long} \tag{11}$$
$$F_{\omega,n} = F_{c,n} \tag{12}$$

1.6 Chassis

$$F_a = \frac{1}{2}\rho(d)C_dAv^2 \tag{13}$$
$$F_{c,long} = F_a + gm\sin(\theta_r(d)) \tag{14}$$
$$F_{c,n} = mg\cos(\theta_r(d)) \tag{15}$$
$$\dot{v} = mF_t \tag{16}$$

2 Environment

This system models the environment of the motorcycle is riding in.

$$given : h(d) \tag{17}$$
$$\theta_r = \frac{d}{dd}h(d) \tag{18}$$
$$T_amb(d) = T_0 - Lh(d) \tag{19}$$
$$P(d) = P_0\left(1 - \frac{Lh(d)}{T_0}\right)^{\frac{gM}{RL}} \tag{20}$$
$$\rho(d) = \frac{PM}{1000RT} \tag{21}$$