Table 2.1: Main equations of the muscle model from H.Geyer.

Main equations

Name	Equation	Signification
F_{mtu}	$F_m = F_{se} = F_{ce} + F_{pe} - F_{be}$	Force of generated by the MTU
F_{se}	$F_{se} \quad = \quad \begin{cases} F_{max} \cdot (\frac{\varepsilon}{\varepsilon_{ref}})^2, & \text{if } \varepsilon > 0 \\ 0, & \text{else} \end{cases}.$	Force generated by the tendon
F_{pe}	$F_{pe} = \begin{cases} F_{max}(\frac{l_{ce}-l_{opt}}{l_{opt}w})^2 \cdot f_v(v_{ce}) & \text{if } l_{ce} > l_{opt} \\ 0 & \text{else.} \end{cases}$	Force of the parallel element preventing muscle overextension
F_{be}	$F_{be} = \begin{cases} F_{max}(\frac{l_{opt}-w-l_{ce}}{l_{opt}w/2})^2 & \text{if } l_{mtu} - l_{ce} > l_{slack} \\ 0 & \text{else} \end{cases}.$	Force of the parallel element preventing muscle to collapse
F_{ce}	$F_{ce} = A \cdot F_{max} \cdot f_l(l_{ce}) \cdot f_v(v_{ce})$	Force generated by the muscle (ce)
A	$\tau \frac{dA}{dt} = \cdot (S(t) - A)$	Muscle activation is equal to the integral of the input signal $I(t)$. Biologically, the input signal can be viewed as the normalized frequency of neuronal spike that reaches the muscle (i.e. restricted to the $[0;1]$. interval). The activation is thus also limited to this interval.
$f_l(l_{ce})$	$f_l(l_{ce}) = exp(c \left\| \frac{l_{ce}-l_{opt}}{l_{opt}w} \right\|^3)$	Muscle force - muscle length relationship function (function of the muscle length (l_{ce})
$f_v(v_{ce})$	$f_v(v_{ce}) = \begin{cases} \frac{v_{max}-v_{ce}}{v_{max}+Kv_{ce}} & \text{if } v_{ce} \geqslant 0 \\ N + (N-1)\frac{v_{max}+v_{ce}}{7.56Kv_{ce}-v_{max}} & \text{if } v_{ce} < 0 \end{cases}.$	Muscle force - muscle velocity relationship function (function of the muscle velocity (v_{ce})
$v_{ce}(f_v)$	$v_{ce}(f_v) = \begin{cases} v_{max} \cdot \frac{1-f_v}{1+K*f_v} & \text{if} f_v < 1.0 \\ v_{max} \cdot \frac{f_v-1}{7.56K(f_v-N)+1-N} & \text{else} \end{cases}.$	Inverse of the muscle force - velocity function. This function is used for the resolution of the muscles equations.
l_{ce}	$l_{ce} = \frac{dv_{ce}}{dt}$	Muscle (ce) length
l_{se}	$l_{se} = l_{mtu} - l_{ce}$	Tendon (se) length
l_{mtu}	$l_{mtu} = l_{slack} + l_{opt} + \Delta l_{mtu}$	MTU length
Δl_{mtu}	$\Delta l_{mtu} = pennation \cdot r_0 \cdot \int_{\theta_{ref}}^{\theta} t_{\theta\rightarrow\tau}(\theta, \theta_{max})$	MTU length changes from MTU slack length