Supporting Information text

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Supplementary Methods The motion of an over-damped particle thermally fluctuating in the system described in Fig. 1 of the main text is described by the stochastic ODE:

$$\eta_x \dot{x}_i = -\omega_i(t) E'_a(x_i) - E'_e(x_i, l_i) + \sqrt{\eta_x k_B \theta}\,\Gamma(t), \tag{S1}$$

with

$$\begin{cases} <\Gamma(t)>= 0 \\ <\Gamma(t_1)\Gamma(t_2)>= 2\delta(t_1 - t_2). \end{cases} \tag{S2}$$

Since we are interested both in steady state and transient skeletal muscle behaviour, we approach the system of equations by direct numerical simulation using the Euler-Maruyama method [1]. Defining two subsequent times separated by the time step τ_{step} as $t_{n+1} = t_n + \tau_{step}$, we recursively define $x_i(t_n)$ as:

$$x_i(t_{n+1}) = x_i(t_n) - \eta_x^{-1}[\omega_i(t_n) E'_a(x_i(t_n)) - E'_e(x_i(t_n), l_i)]\tau_{step} + \sqrt{\eta_x^{-1} k_B \theta} \int_{t_n}^{t_{n+1}} \Gamma(t). \tag{S3}$$

From the properties of Γ detailed in (S2), the integral in the last term is a random variable which is normally distributed with zero mean and variance τ_{step}. Therefore we can substitute it with the function $\sqrt{2\tau_{step}}w(0,1)$, where

$$\begin{cases} < w >= 0 \\ < w_1 w_2 >= \delta_{12}. \end{cases} \tag{S4}$$

Simulations were performed with Matlab® and $w(0,1)$ was generated by the built-in function *randn*. Data analysis and plots were also generated by Matlab®.

The populations of attached (A) and detached (D) myosin molecules are described by the reaction:

$$A \leftrightarrows^{k_+}_{k_-} D \tag{S5}$$

where k_+ and k_- are the first order rate constants described in Fig. 1 of the main text. At each time step the populations are updated with probabilities of switching from one state to the other:

$$\begin{cases} p_{A-D} = \dfrac{k_-}{k_+ + k_-}\left(1 - e^{-\tau_{step}(k_+ + k_-)}\right) \\ p_{D-A} = \dfrac{k_+}{k_+ + k_-}\left(1 - e^{-\tau_{step}(k_+ + k_-)}\right) \end{cases} \tag{S6}$$

to a random number generated by the built-in function *rand*.

References

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