How Static Optimization Works

As described in Inverse Dynamics, the motion of the model is completely defined by the generalized positions, velocities, and accelerations. The Static Optimization Tool uses the known motion of the model to solve the equations of motion for the unknown generalized forces (e.g., joint torques) subject to one of the following muscle activation-to-force conditions:

ideal force generators:

$$\sum_{m=1}^{n} (a_m F_m^0) r_{m,j} = \tau_j$$

or, constrained by force-length-velocity properties:

$$\sum_{m=1}^{n} [a_m f(F_m^0, l_m, v_m)] r_{m,j} = \tau_j$$

while minimizing the objective function:

$$J = \sum_{m=1}^{n} (a_m)^p$$

where n is the number of muscles in the model; a_m is the activation level of muscle m at a discrete time step; F_m^0 is its maximum isometric force; l_m is its length; v_m is its shortening velocity; $f(F_m^0, l_m, v_m)$ is its force-length-velocity surface; $r_{m,j}$ is its moment arm about the j^{th}joint axis; τ_j is the generalized force acting about the j^{th} joint axis; and p is a user defined constant. Note that for static optimization $f(F_m^0, l_m, v_m)$ computes the active fiber force along the tendon assuming an inextensible tendon and does not include contribution from muscles' parallel elastic element.

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