

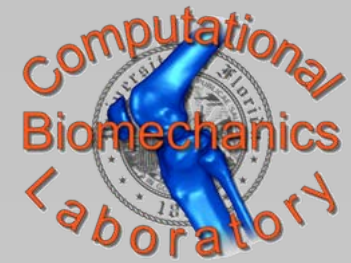
Lecture 20

Muscle Moment Arms

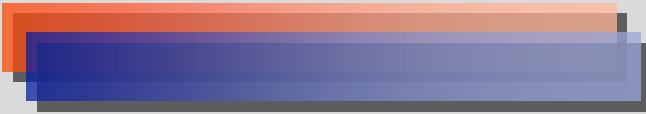
EML 5595
Mechanics of the Human Locomotor System



Outline

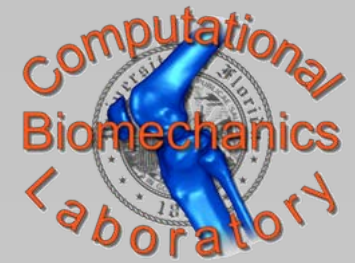


- Calculations Methods
- Journal Article Reviews
 - Arnold et al. (2000)
 - Murray et al. (2002)

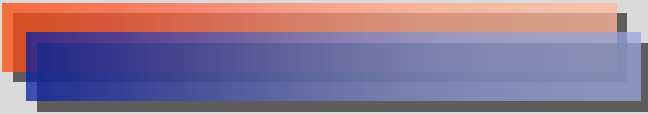




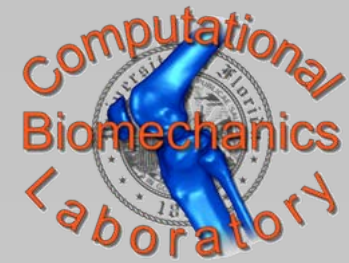
Outline



- Calculations Methods

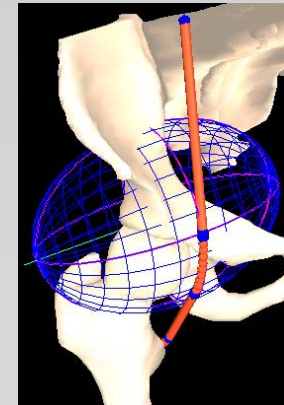


Moment Arm Calculation

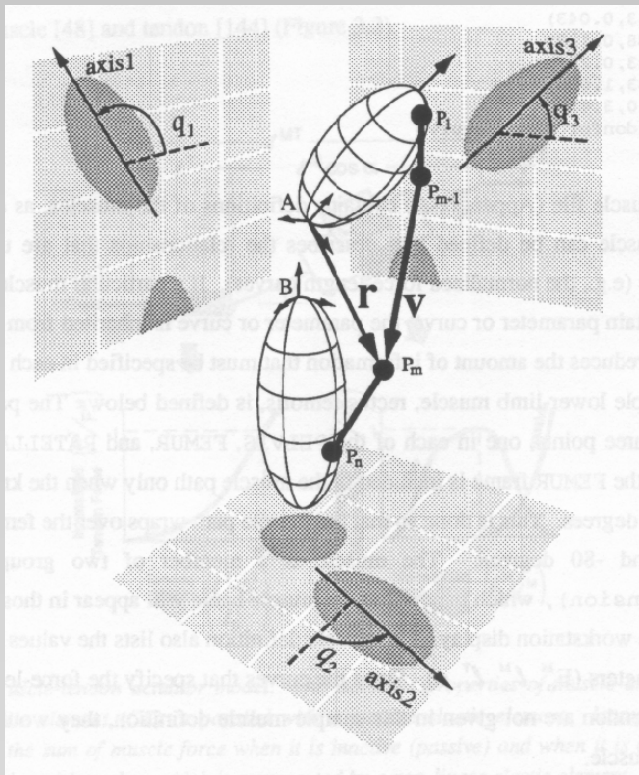


Given that we do not have true pin or ball-and-socket joints in our bodies, how do we calculate muscle moment arms?

- Tendon excursion method
- Partial velocity method

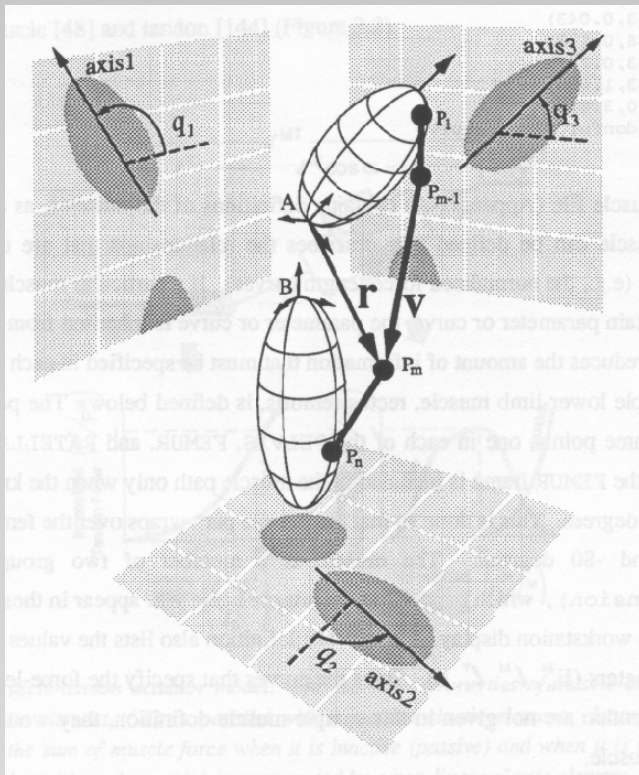


General Concepts



- For every joint that a muscle spans, the muscle has a moment arm for each generalized coordinate used in the joint definition.
- Muscle moment arms are calculated with respect to individual generalized coordinates, not joint centers.

Tendon Excursion Method

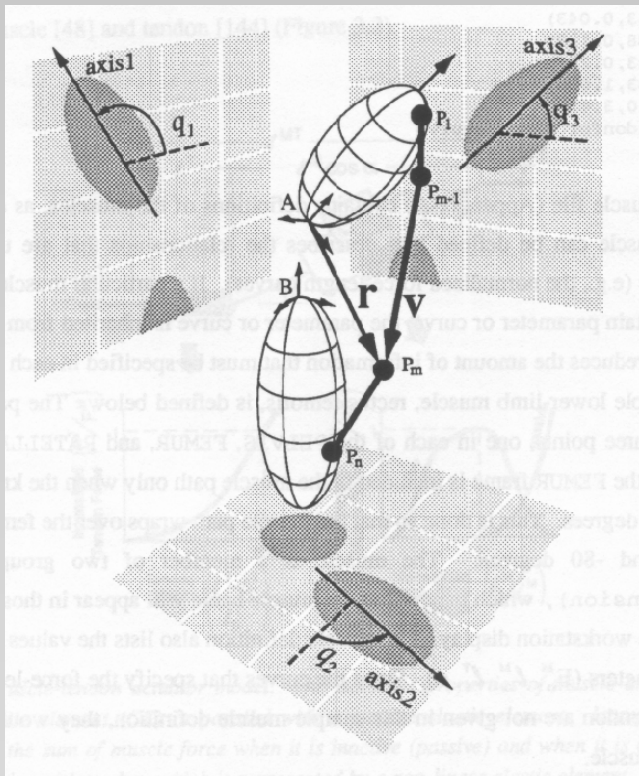


If ma is the moment arm,
 ℓ^{MT} is the muscle-tendon length, and
 q_i is the generalized coordinate, then

$$ma = \frac{\partial \ell^{MT}}{\partial q_i}$$

defines the moment arm of the muscle
 about the joint for that particular
 generalized coordinate.

Partial Velocity Method

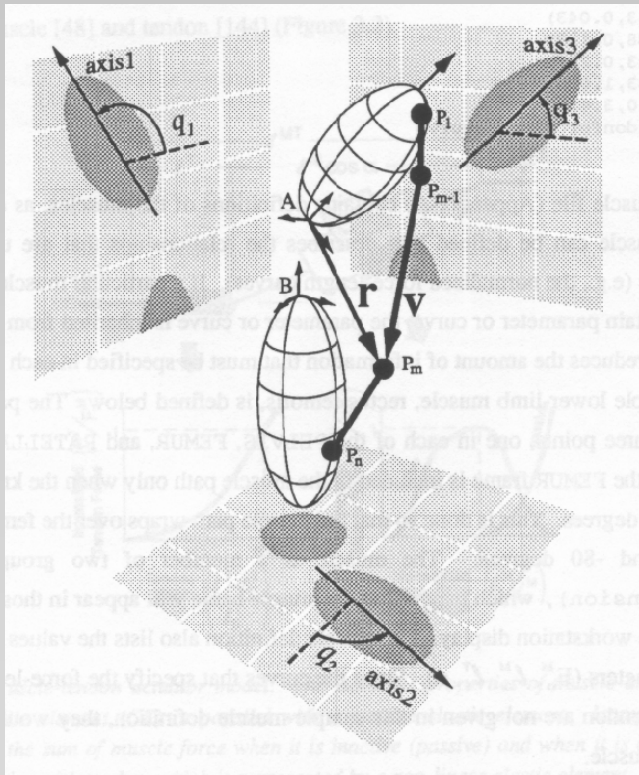


Given the following joint definition describing the position and orientation body B with respect to body A:

Translations : tx, ty, tz

Rotations : $r1, r2, r3$ about $\lambda_1, \lambda_2, \lambda_3$

Partial Velocity Method



Calculate:

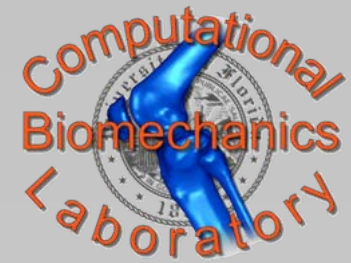
$$\mathbf{u} = \left(\frac{\partial tx}{\partial q_i} \right) \mathbf{x} + \left(\frac{\partial ty}{\partial q_i} \right) \mathbf{y} + \left(\frac{\partial tz}{\partial q_i} \right) \mathbf{z}$$

$$\boldsymbol{\omega} = \left(\frac{\partial r1}{\partial q_i} \right) \boldsymbol{\lambda}_1 + \left(\frac{\partial r2}{\partial q_i} \right) \boldsymbol{\lambda}_2 + \left(\frac{\partial r3}{\partial q_i} \right) \boldsymbol{\lambda}_3$$

$${}^A \mathbf{v}_i^{P_m} = \mathbf{u} + \boldsymbol{\omega} \times \mathbf{r}$$

$$m\mathbf{a} = {}^A \mathbf{v}_i^{P_m} \cdot \mathbf{v}$$

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