Centre for Biosystems Science and Engineering

S E M I N A R

at 4:00 PM on February 27, 2017
Meeting Room, BSSE

What Is the Contribution of One Muscle to a Task?

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Consider question A: If a given muscle was strengthened, weakened, removed, or its joint fused, how would that effect a person's ability to do a particular task?

An intriguing and promising answer to this question uses "Induced Acceleration" (IA) analysis. I will introduce this concept and it's great appeal. Then Claims:

- **Induced Acceleration (IA) analysis does not help answer A.**
- **There is no simple answer to question A.**
- **A candidate (yet mostly untried) answer is based on the optimization theory of animal coordination. (based on the controversial claim that evolution can, sometimes, be viewed as an optimization process).**

What is IA? Despite the famous non-linearities in dynamics equations (e.g. chaos etc), the classical dynamics equations, often used for whole-body models of locomotion and other biological tasks, are linear in accelerations, in angular accelerations, linear in muscle forces, linear in constraint forces and linear in some other terms. Thus, in a given body configuration, one can express this or that reaction force or acceleration of interest as a sum of terms, with one contributing term from each muscle force. This is IA analysis

What is wrong with IA? It is not wrong. It just does little to answer question A (except in particular situations). Here are some issues a) Muscles are no more force sources than they are velocity sources. But the equivalant linear sum, based on a velocity-muscle model, gives completely different answers than does the IA sum; b) IA answers are highly sensitive to modeling details, such as whether the foot is effectively one bone or a collection of bones; c) Some tasks are poorly related to optimization of a scalar quantity.

Other simple cases will be shown using other simple model systems. What might answer question A better than IA? Here is an idea: Look at performance P as a function of the strength S or presence of a given muscle, holding other mechanical properties fixed but optimizing over the neurological controls. The function P(S) seems to indicate much more about the actual role of a muscle than any possible IA-like analysis.

About the speaker:

Andy Ruina is a professor of Mechanical Engineering at Cornell. He studied friction. Now he's mainly interested in biomechanics, dynamics and robotics. This includes collisions, bicycles, human walking and walking robots.