Abstract Submitted
for the MAR17 Meeting of
The American Physical Society

Mimicking Muscle Nonlinear Force Generation using Electromagnetic Motors[1] JOS ALVARADO, ANETTE HOSOI, Massachusetts Inst of Tech-MIT — Animals routinely perform a wide range of mechanical tasks, including locomotion, and continue to inspire solutions in engineering applications. Yet despite numerous technological advances, robotic locomotion lags behind that of animals in terms of versatility and energy economy. One reason for this performance gap lies in actuation: electromagnetic motors are common actuators in engineered systems, whereas animals primarily use muscle. Researchers have long modeled muscle with a nonlinear force-velocity relationship, in contrast to motors linear behavior. Existing theoretical studies have predicted advantages to nonlinear force generation, including energy economy, stability, and simplified controls. Yet these advantages are difficult to verify experimentally because the force-velocity curve of intact muscle cannot be made linear. Here we establish a physical model system of muscle nonlinearity by programming an electromagnetic motor to exhibit linear and nonlinear behavior. Preliminary experimental and theoretical results show that for the simple task of lifting a weight against gravity, muscle-like nonlinearity merely reduces work output. We anticipate that for more complex mechanical tasks, muscles nonlinear properties could be mechanically advantageous.

[1]Army Research Office grant W911NF-14-1-0396

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Date submitted: 11 Oct 2016 Electronic form version 1.4