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CPS: Small: Generation of natural movement for a multiple degrees-of-freedom robot driven by stochastic cellular actuators
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The objective of this research is to understand mechanisms for generating natural movements of skeletal mechanisms driven by stochastically-controlled, biologically-inspired actuators. The approach is to verify the hypothesis that the variability associated with high redundancy and the stochastic nature of the actuation is key to generating natural movements. This project seeks to: (i) develop a method to model and characterize actuator array topologies; (ii) develop a method to analyze the force variability of stochastic actuator arrays; (iii) develop an analytical method to generate movements for a robot with multiple degrees of freedom by minimizing the effect of variability; and (iv) demonstrate the validity of the approach through the development of a robotic arm driven by multiple stochastic array actuators.

In the second year of the project, the “fingerprint” method to characterize complex actuator topologies has been extended to dynamic actuator arrays with Hill-type visco-elastic muscle model. A 2-degree-of-freedom robot manipulator driven by 32 binary-controlled shape memory actuators has been developed. A closed-loop control method, named “intersample discretization,” has been developed. This method modulates the timings among quantized impulses to suppress vibrations in compliant actuators. It has been confirmed that an appropriately modulated series of quantized impulses provides better control performances than unmodulated ones such as simple pulse-width-modulation (PWM). The PI and participating graduate students have provided a K-12 summer robot camp program at a local organization in Roswell, Georgia. Two journal articles have been accepted for publication.