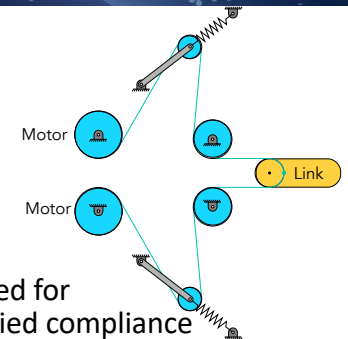
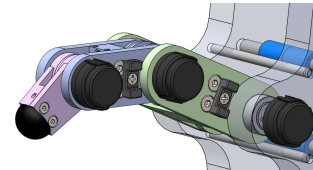
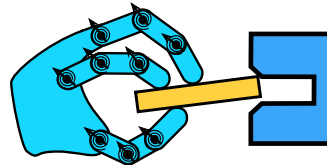
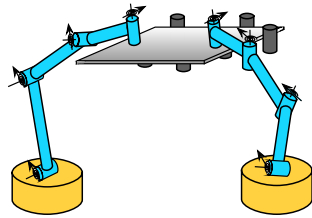


# NRI: FDN: Dexterous Manipulation using Multi-Serial Manipulator Systems with Real-time Compliance Modulation

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<https://www.eng.mu.edu/schimmelsj/research.html>



## Challenge

- Achieve robot dexterity in **any** constrained manipulation task
- Identify and realize the task-appropriate passive compliance that can be readily adjusted in real-time for fast constrained manipulation with regulated contact forces
- Single manipulator systems are not able to project compliance center outside its workspace so task-beneficial compliance behavior not attainable

## Solution

- Realize much larger set of passive compliant behaviors using multi-serial manipulator systems
- Variable stiffness actuation used in each manipulator allows both position control and stiffness modulation of each joint

## Societal Broader Impact

- Provides manipulation assistant for:
  - senior assistance (food preparation, cleaning)
  - manufacturing (assembly, material handling)
  - agriculture (picking/handling fruit/vegetables)
  - nuclear remediation
  - ordnance disposal

## Scientific Impact

- Identify the necessary and sufficient conditions needed for different mechanism topologies to achieve any specified compliance
- Develop procedures to synthesize any desired compliant behavior by specifying joint locations and joint stiffnesses when each manipulator is:
  - rigidly coupled to part (multi-serial compliant manipulator systems (above))
  - making point contact with part (fingers of compliant hand (above))
- Develop procedures to track a position/compliance trajectory for kinematic and actuator redundant systems
- Design and test a planar variable stiffness actuated robot hand (above) that is
  - tendon driven
  - antagonistically actuated with quadratic springsto demonstrate manipulation 8x faster w/ lower contact forces

## Educational Broader Impact

- Funding supports:
  - 1 Ph.D. student, 2 M.S. students
  - Compliance Selection/Realization Workshop
- Work complements:
  - FASN Advanced Manufacturing Center

## Technical Broader Impact

- Allows dexterous robot manipulation in any constrained task involving:
  - large/heavy objects (multi-arm system)
  - small/fragile objects (multi-finger system)