# Tailored Nonlinear Negative Stiffness Mechanisms for Linear Motion

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**Abstract.** Traditional ways to achieve the desired motion of mechanisms or deformation of morphing structures require external energy for actuation. Frequently the use of these actuators to drive the system can cost noteworthy energy for each cycle of operation and the spent energy cannot be recovered. This work investigates a passive energy balancing concept for linear motion systems by using a negative stiffness mechanism. The energy balance concept is achieved by employing a negative stiffness system to couple with the positive stiffness mechanical system to create zero stiffness which can be driven with lower energy requirements. The negative stiffness mechanism proposed here uses a pre-tensioned spring to produce a passive torque and therefore to transfer the passive torque through a crankshaft for linear motion Therefore, the negative stiffness mechanism reduces the actuation requirements by strategically locating negative stiffness devices in parallel to the positive stiffness of the linear motion system. The kinematics of the negative stiffness mechanism is first developed to satisfy the required linear motion and its geometry is then optimised to achieve minimal energy requirements. The performance of the optimised negative stiffness mechanism is evaluated through the net force and the total required energy. Exploiting the negative stiffness mechanism has a significant benefit in the field of energy sensitive applications.