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Tensegrity engineering: Using control theory for form-finding in tensegrity structures

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Traditionally structure and control design are treated as separate problems and the methods used to solve those problems do not preserve desirable features of the other discipline. That is, we currently have no theory which can guarantee a minimal mass structure design (a statics problem), while guaranteeing minimal control energy for the control problem (a dynamics problem). By integrating structure and control design one can save both structural mass and control energy. Tensegrity Engineering is a phrase used to describe our attempt to integrate these multi-disciplinary design functions. This talk will focus only on the static design, the tensegrity form-finding problem, while preserving the controllability features of the structure. We will design a dynamic feedback control law that can take the structure from some initial configuration to a pre-specified desired final configuration. Then this final steady state stable equilibrium is a solution to the desired form-finding problem to minimize mass subject to yield or buckling constraints. This "dynamic relaxation" method of form-finding integrates the dynamic equations of motion to steady state and then observes the final stable equilibrium configuration. If this final steady-state configuration is not acceptable, then changes in the design are made and dynamic relaxation is tried again. Our method modifies the structural dynamics (by adding a control law) to guarantee convergence to the desired configuration, if the desired configuration is achievable.

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