Fully-Actuated Tension Adjustable Novel Deployable Entry Mechanism

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A unique robotic system for an Entry, Descent, Landing, and Locomotion vehicle to enable in-situ measurements is presented. This vehicle combines principles of mechanically deployable entry systems and tensegrity structures into one highly-configurability system that can be readily tailored to a variety of space missions, including landed missions on atmospheric bodies such as Venus, Titan, and Mars. Early studies show that a properly configured vehicle is capable of safely landing a payload in a tessera region on Venus and conducting science operations. This can enable detailed investigation into the physical and chemical properties of the Venusian surface as well as past and present surface-atmosphere interactions. All EDLL subsystems are mounted to an actively-controlled tensegrity frame resulting in a mass-efficient system architecture. The systems needed for landing and locomotion are also utilized during entry and descent, reducing the number of components used for one mission stage that otherwise act as dead mass. Through cable actuation the shape of the vehicle can be adjusted, allowing designers to select configurations with desirable aerodynamic and impact attenuation properties for each mission stage. A multi-body prototype with end caps fabricated using additive manufacturing was developed that enables active control of every cable throughout a tensegrity structure. A novel cable routing design removes all components along the actuated cable path, and tension springs are mounted such that they are constrained to 1D motion. Each end cap contains a universal mounting surface to allow for various end effectors to be mounted. End effectors can be selected to tune the performance of the vehicle, including attenuation of impact loads as well as enabling mounting and release of a heat shield or back shell.