A Fully Autonomous Tensegrity-Based Compliant Mobile Robot Using Shape Memory Alloy Actuators for Rapid Assembly and Deployment in Planetary Explorations, Search-and-Rescue and Surveillance Missions – Year II

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This project aims to develop compact robots that can be easily assembled and deployed, potentially in swarms. An autonomous mobile robot based on a Tensegrity structure is developed. The Icosahedron-shaped tensegrity structure offers compliance and shape-morphing capabilities useful for navigating tight spaces and withstanding falls in rough terrain. The robot uses Shape Memory Alloy (SMA) springs for actuation and motion generation. The choice of SMA springs was optimized for producing sufficient contraction and the necessary actuation force. Actuation currents through the SMAs were monitored to achieve fast actuation without overheating. Tests showed that a 50% linear contraction of the actuators initiated the robot's motion. For automation, an Arduino Nano microcontroller, MOSFET-based switches, a mechanical relay, and rechargeable LiPo batteries were assembled to form a Central Processing and Powering Unit (CPPU) that communicates via Bluetooth (BLE) with a Smartphone app. The CPPU is suspended in the cubical space at the center of the robot's 3D icosahedron structure, whose dimensions were determined by a Statics force analysis of the tensegrity. The robot can be remotely commanded to actuate specific SMAs to produce the desired motion. The prototype weighs about 190 grams with a maximum dimension of 8 inches. The robot exhibits directional and postural neutrality and possesses obstacle avoidance ability. Its net speed reaches about 6ft/min. Such mobile robots have applications in search and rescue operations, surveillance, and planetary explorations. The robot's mobility was successfully tested on various surfaces, including Regolith, concrete, and pavement. It is currently being tested at high and low temperatures and inside a lunar Regolith chamber.

Awards Won:
Fourth Award of $600
NC State College of Engineering: Alternates (not read aloud)