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# University of Idaho RLEP Ball Bot

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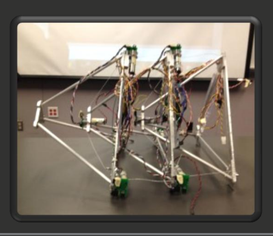
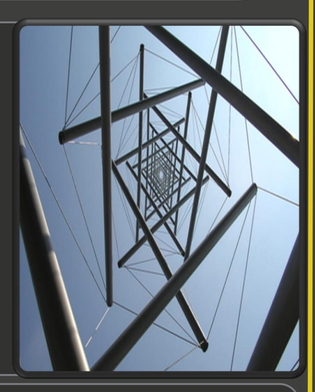
## Abstract

The first step toward replacing current, more complex EDL systems, this robot will deploy from a stored compact state and land using the structure itself to absorb the impact instead of a powered landing system, parachute or airbag. Once on the surface the robot will deform itself through manipulation of its tensile members to explore its surroundings. The focus of this project is to develop a spherical Tensegrity robot that is capable of deploying from a compact state and surviving a drop at a terminal velocity similar to what would be seen on Saturn's largest moon, Titan.

## Introduction



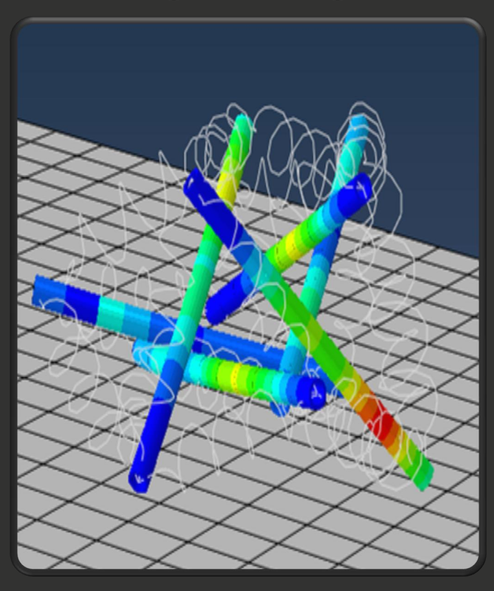
**Tensegrity** defines a type of structure where all elements are in either pure compression or pure tension. The stability or int*egrity* of these structures is due to the constant *tens*ion network, hence the word *tensegrity*. External forces are dispersed through the structure making it extraordinarily resilient to impulse loading seen during high speed impact.



## Simulation

Simulated drop tests with relevant impact velocities and used results to select tension members.

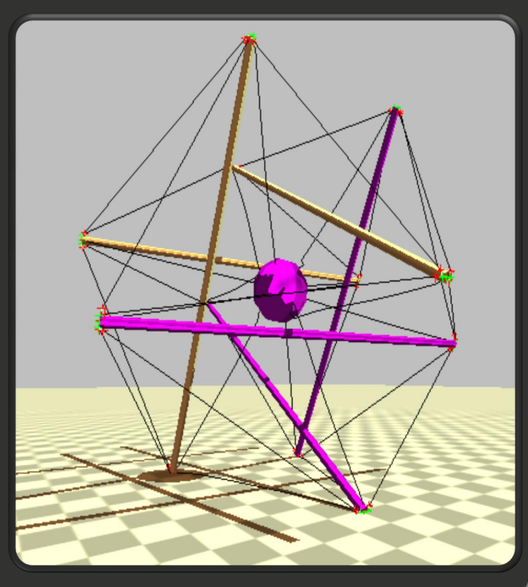
Abaqus:
FEA engineering tool



| Spring Constant (lb/in) | Max Load (lbf) |
|---|---|
| 1.5* | 79 |
| 28 | 97 |
| 85 | 148 |
| 8.56e5 | 2,000 |

*6 strings 21 lb/in, rest are given spring rate to simulate actual robot

Bullet:
Open source physics engine



## Advantages of Tensegrity

- High Strength to Weight Ratio
- Only Normal Stresses
- Open space in structure allows for compact storage
- Inherent structural compliance
- Highly redundant structure, one failure is not catastrophic

## Drop Testing

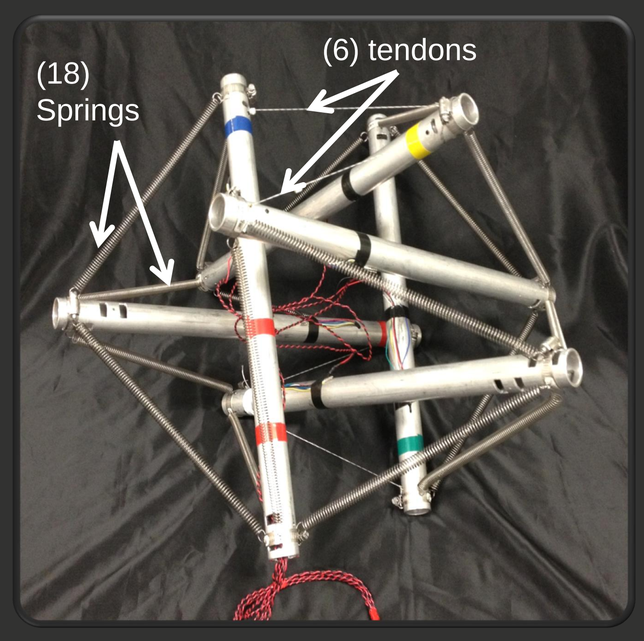
Survive fall representing terminal velocity on Titan (11.4 m/s)

Survival criterion:
- All motors and sensors functional after drop
- Non-critical plastic deformation in structural elements permitted

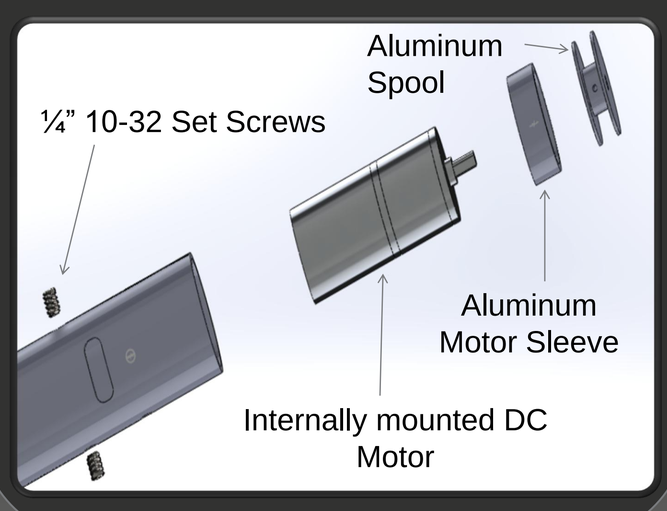
Results: ~13 meter per second impact with no damage to motors or sensors and manageable plastic deformation in some springs.

## Mechanical structure

Six strut Icosahedron:
- Central space allows for payload
- Resilient to externally applied forces
- Requires six actuators for basic motion




Motor subassembly:
Motors control length of rigid tensile members (tendons)




## Stored state

Two configurations for storage:

“Star”
Achieved by extending all actuated tendons

“Bi-pyramid”
Achieved by tightening all actuated tendons

## Summary

All past drop tests have been successful with expected plastic deformation in springs. Future work will add a central payload with g-force and gyroscopic sensors to collect data during drop tests. Future drop tests will be captured by multiple camera angles and high speed video.

Website:
seniordesign.engr.uidaho.edu/2012-2013/tensegrity/index.html