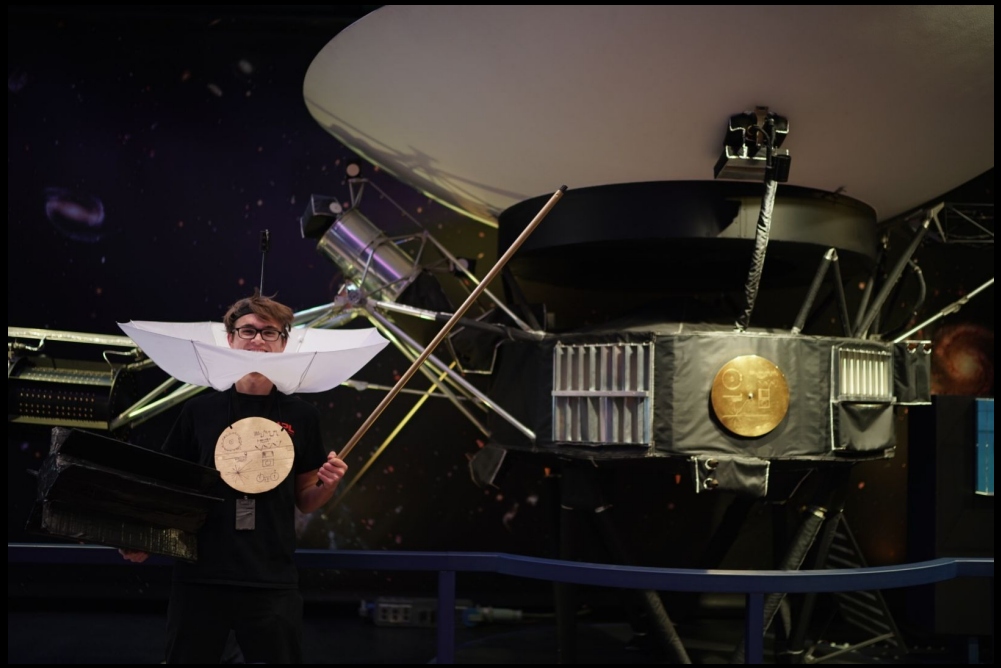
Andrew Galassi Portfolio



Hello!

I'm an MS student at UC Berkeley in the Embodied Dexterity Group, advised by Professor Hannah Stuart. My research is focused on robotic ice anchoring for mobility in extreme environments, funded by a NASA Space Technology Graduate Research Opportunity (NSTGRO) fellowship.

Previously, I graduated with a B.S. in Mechanical Engineering from Georgia Tech, including electives in Controls, Motion Systems, and Robotics. I was also a co-op for multiple semesters in the Extreme Environment Robotics Group at the NASA Jet Propulsion Lab.

I’m passionate about mechanism design, robotics, and controls—this is my portfolio, highlighting some of my experience in those areas!



Robotic Ice Anchoring Mechanism

Embodied Dexterity Group, UC Berkeley | Pi: Dr. Hannah Stuart
Collaboration with NASA Jet Propulsion Laboratory | PI: Ashitey Trebi-Ollennu

Individually responsible for the design, analysis, and field testing of an impact-anchoring ice mechanism, aimed toward future missions to Enceladus.

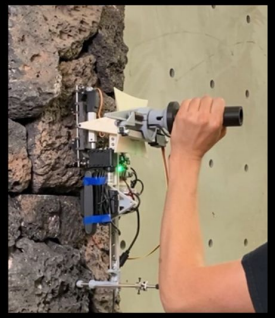
Capable of anchoring with 5x its own weight, as well as accomplishing all functions (arm, release, grasp, release, reset) with a single actuator input.

Demonstrated functionality in a field test in the French Alps on glacier ice, and developed new models of impact fracture.

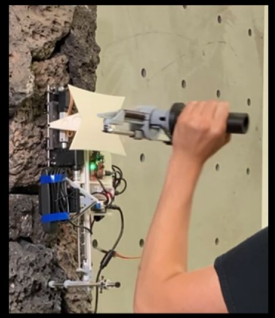


Andrew Galassi Portfolio

Deployment



1. Preload, anchoring, and pull test verification



2. End effector detachment



3. Instrument Operation

Retrieval



1. Preload with alignment error



2. Active realignment as fingers close



3. Microspine disengagement and retrieval

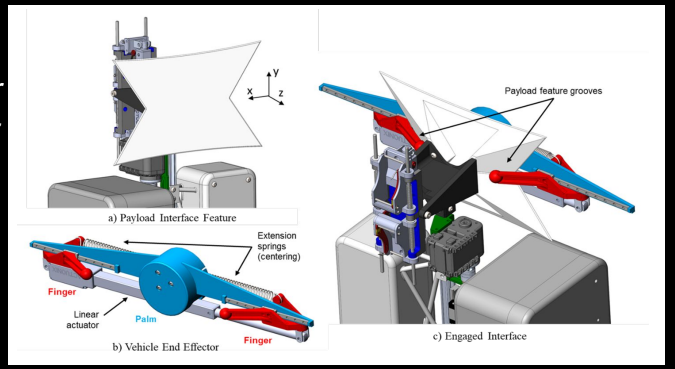
https://www.youtube.com/watch?v=k-JVjRQvGBs

Deployable Anchoring Payload

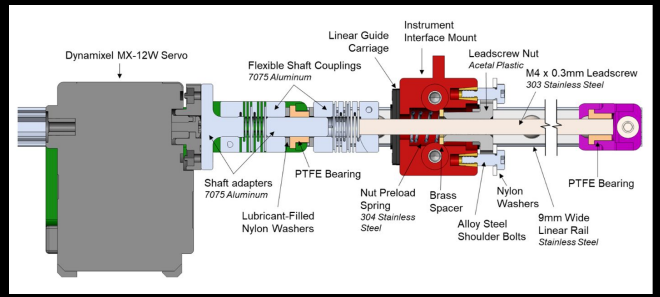
NASA Jet Propulsion Laboratory | PI: Dr. Arash Kalantari, Dr. Joel Burdick
Extreme Environment Robotics Group

Responsible for design of a anchoring instrument payload system to be deployed from a UAV, including mechanism design, electromechanical integration, hardware demonstration on analogue surface in the lab

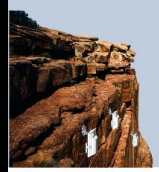
UAV end effector interface:



Miniature linear stage mechanism:



Poster presentation at 18th International Planetary Probe Workshop:



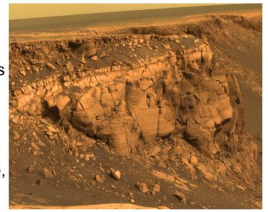
Deployable Anchoring Instrument Platform for the Exploration of Extreme Terrains on Mars

Andrew Galassi[1], Kyle Uckert[2], Spencer Backus[2], Arash Kalantari[2]

[1]Georgia Institute of Technology [2]Jet Propulsion Laboratory, California Institute of Technology

Background

Robotic exploration of planetary surfaces enables science investigations of high value targets. Exploration by conventional wheeled rovers may be restricted to measurements of targets on relatively flat surfaces. Deployment of science payloads by a UAV in extreme terrain, including steep cliff faces (e.g. Victoria Crater, shown), overhangs, or caves expands the potential science investigations for a mission. This mission architecture enables measurements over tens of kilometers by multiple, replaceable instruments, including long-term monitoring and short-duration high resolution spectral scans.



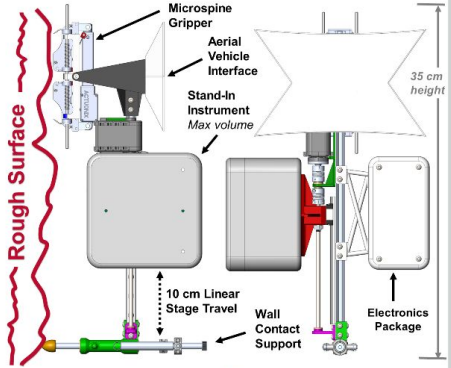
Cape St. Vincent, a geologically interesting outcrop imaged by Opportunity, was unreachable for sampling due to its 8m height. *[Squyres, Steven W., et al. Science 324.5930 (2009): 1058-1061]*

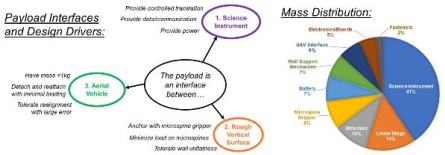
Potential Investigations Enabled

- Biosignature detection on cliff faces and outcrops
- Geologic characterization of exposed strata
- Atmospheric monitoring from strategic deployments
- Network of air flow and atmospheric compositional monitoring in lava tube caves

Current Package Design Overview

An anchoring instrument "package" targeting Earth-analog field tests



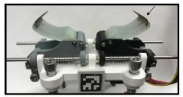


Microspine Gripper (Anchor)

The package adheres to the wall using a gripper consisting of two rows of pointed steel hooks (microspines) cast in flexible resin. Once preloaded to a rough surface, an actuator pulls the two rows of spines together. As they are dragged across the surface, each individual spine is able to grab hold of tiny surface irregularities. This lightweight (100 g) gripper can withstand loads up to 10 N and 5 N in the shear and normal directions.



Gripper Open



Gripper Closed (Anchoring)

Prototype Design Specifications

Supported Instrument

Mass: 500g
Volume: 12cm x 12cm x 8cm
Continuous Power: 5 W / 1 hour
Linear Stage Travel: 10 cm

Entire Package

Total Mass: 1.2 kg
Stowed Volume: 35cm x 24cm x 17cm
Operation Time: 3 hours on a single charge, with 1 hour total of instrument use
Surface Roughness Tolerated: +/- 2 cm

Instrument Candidates

- UV Imager
- LIBS
- APXS
- Atmospheric Sensor
- Green Raman Spectrometer
- Dosimeter
- Multispectral Imager
- Microscopic Imager

Example Investigation ConOps

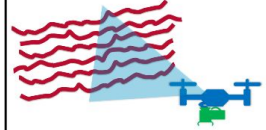
Repeat process with multiple packages and multiple deployments

1. Aerial vehicle acquires an instrument package from the lander



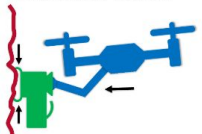
Each package supports a 500 gram instrument or suite of instruments.

2. Aerial vehicle surveys a surface for potential targets



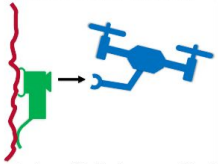
Potential placement locations are evaluated for scientific value and favorability for robust anchoring.

3. Aerial vehicle preloads package to the surface, and anchoring activates



Timing is coordinated via a wireless communication link.

4. Anchoring is verified, and the aerial vehicle detaches



Anchoring verification is accomplished with a pull test prior to detachment.

5. Science instrument acquires measurements



Linear stage enables fine positioning of instrument within 10 cm.

6. Package is retrieved and redeployed, or returned to lander.



Steps 1-6 are repeated with multiple packages and multiple deployments.

Inverted Pendulum

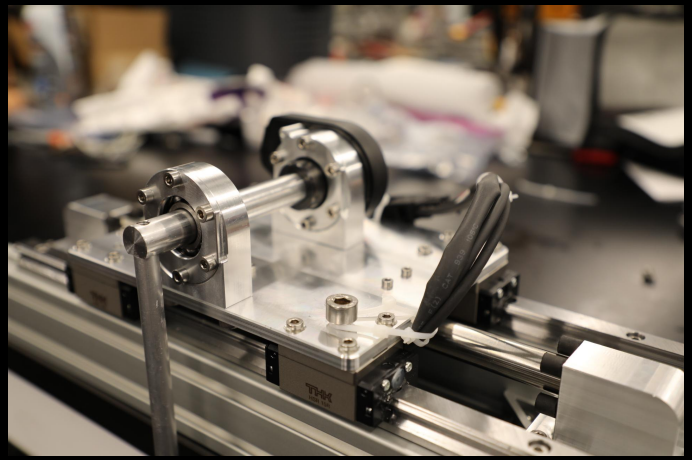
Caltech Summer Undergraduate Research Fellowship
Advanced Mechanical Bipedal Robotics Lab | PI: Dr. Aaron Ames

Independent design, build, control, and demonstration of a robotic inverted pendulum on a cart testbed using a new linear brushless DC motor.

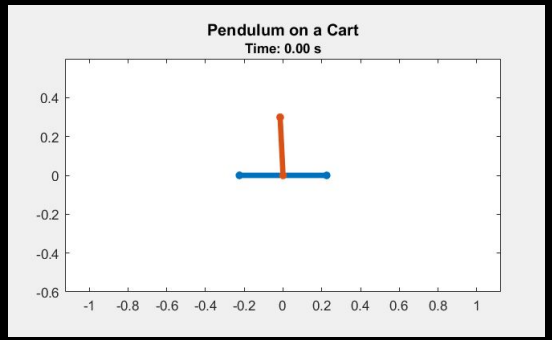
After designing the testbed and CNC machining the custom parts, I modeled the system in MATLAB, designed an LQR controller to stabilize it, and demonstrated it stabilizing on hardware.



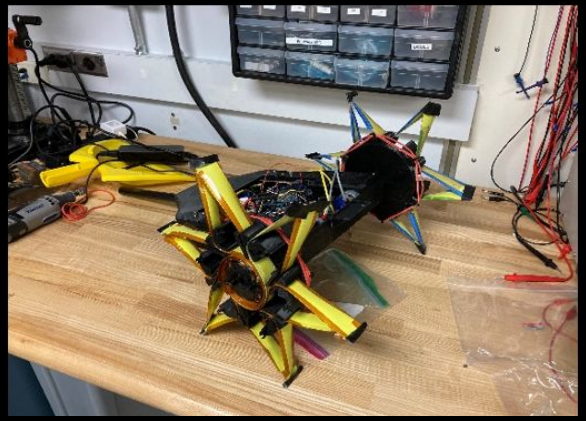
https://www.youtube.com/watch?v=H8tvrXtkK6M

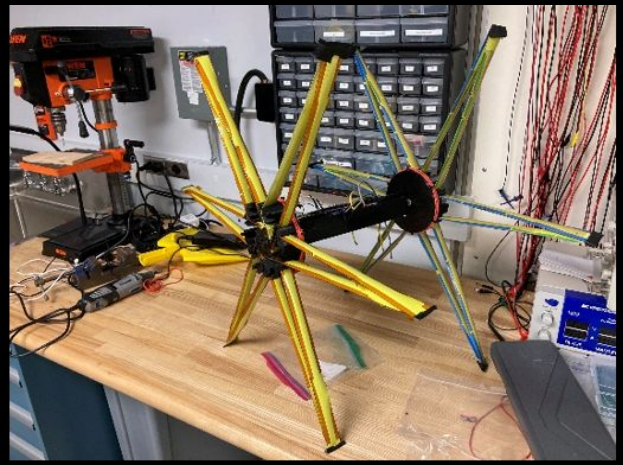






Variable Diameter Wheel Mechanism



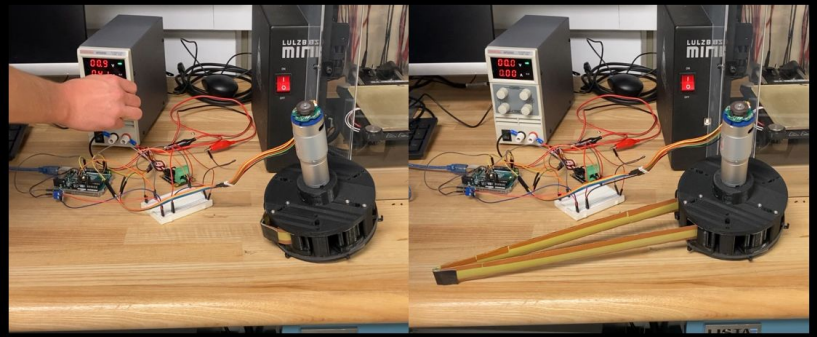


Georgia Tech Dynamic Adaptive Robotic Technologies Lab | PI: Dr. Anirban Mazumdar

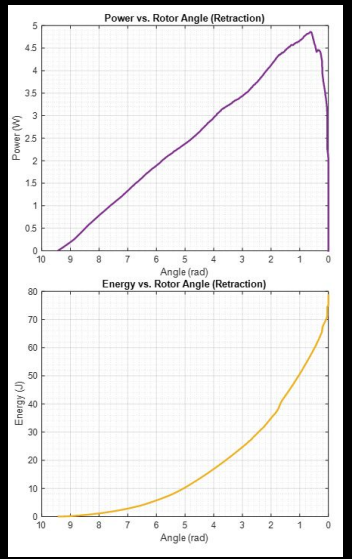
Led design of a high deployment ratio rimless wheel for adaptive wheeled mobility using bistable tape springs

Presented poster with preliminary work at Georgia Tech Undergraduate Research Symposium (following slide)

Recording energy consumption with rotor angle for deployment and retraction:



https://youtu.be/WcAjFmADPzY



Preliminary Design of A High Deployment Ratio Variable Diameter Wheel for Adaptive Robotic Mobility

Andrew Galassi, Joshua Fernandez, Anirban Mazumdar
George W. Woodruff School of Mechanical Engineering, Georgia Tech
Dynamic Adaptive Robotic Technologies Lab

Motivation

Small robots are limited by their mobility. Although a small form factor is beneficial for constrained environments and compact storage, wheel diameter directly limits the range of obstacles and terrains a robot can traverse.

Wheels with large and controllable variable diameter can enable small robot mobility for:

- Distributed wildlife monitoring, with highly unstructured terrain connected by service roads *(Pictured: Fisher Mountain, NH)*
- Planetary exploration, with extreme volume constraints *(Pictured: Gale Crater, Mars)*
- Mobility across sand, rocks, and shallow water *(Pictured: Pismo Beach, CA)*



Background

Although many designs for variable diameter wheels have been presented in recent years, existing approaches are characterized by either A) limited deployment ratio constrained by mechanism geometry or B) an expanding wheel diameter "stored" as wheel width in the stow configuration (resulting in a minimal reduction in volume).



Zheng, 2019
Small-scale passively expanding wheel (Deployment ratio must be < 2, constrained by geometry)



Lee, 2021
Large, high-load hydraulically-actuated origami wheel (Converts width to diameter)

Mechanism Concept

Bistable tape springs enable compact rolled storage and deployment to extreme lengths, proposed here for use as deployable legs to increase effective wheel diameter.

An individual tape spring segment is susceptible to buckling due to bending loads. To prevent this:

1. Single "spokes" are made using two lengths of steel tape connected at the edges prevent local buckling *(Pictured)*
2. Each triangular leg is comprised of two spokes connected at the free end—bending loads are transmitted axially to the individual beams *(Pictured below)*



Measuring tapes are low-cost, rollable, bistable tape springs



A closed lenticular cross section is stronger in bending

Static Load Testing



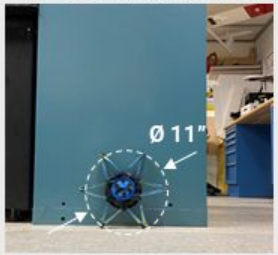
A prototype with a single leg was tested to benchmark strength against traversing obstacles.

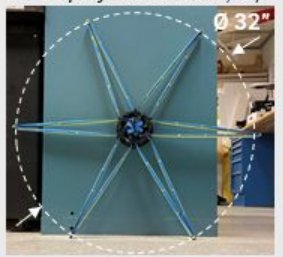
For a future two-wheeled, 2 kg vehicle, a ~1 kg load supported by a single spoke indicates concept feasibility.

Deployment Testing

The first prototype of the tape spring wheel uses six legs. Deployment is actuated by twisting the center spool by hand, unrolling the 12 tape spring spokes.

11" stowed diameter, D_i *32" deployed diameter, D_f*





This prototype has a **deployment ratio** of D_f / D_i = **2.9**

Future Work

There are three main areas of work going forward:

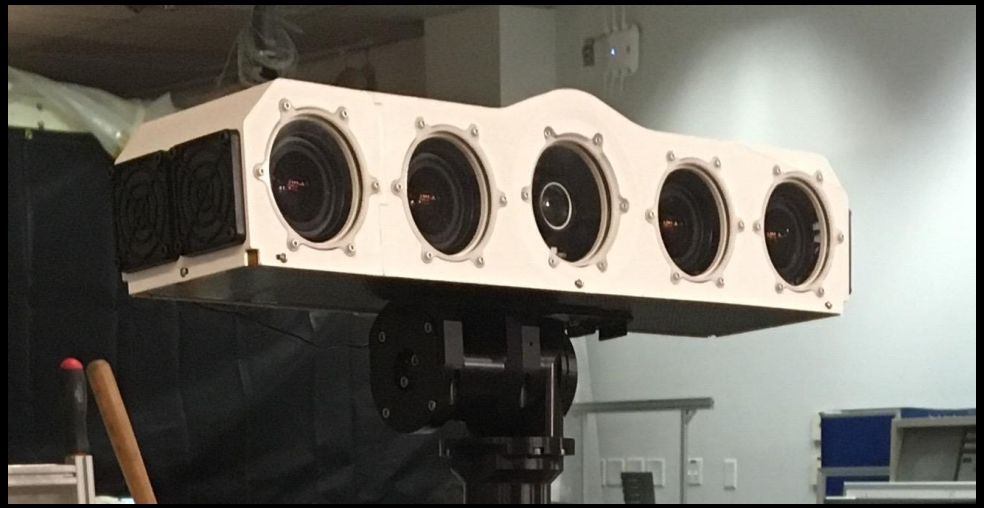
1. Integration of two wheels onto an existing robot
2. Implementation of actuation to deploy the legs
3. Mobility testing across a wide range of terrain



An existing two-wheeled, 2 kg robotic vehicle planned for use in outdoor mobility testing



Potential testing location: unstructured forested terrain near Piedmont Park in Atlanta, GA

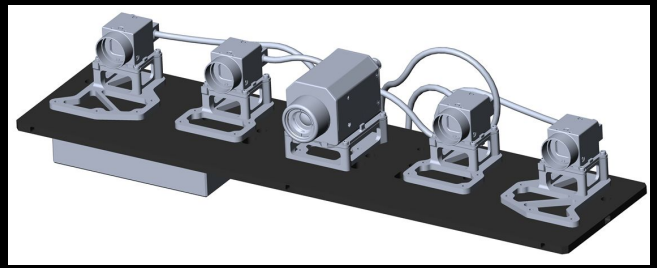


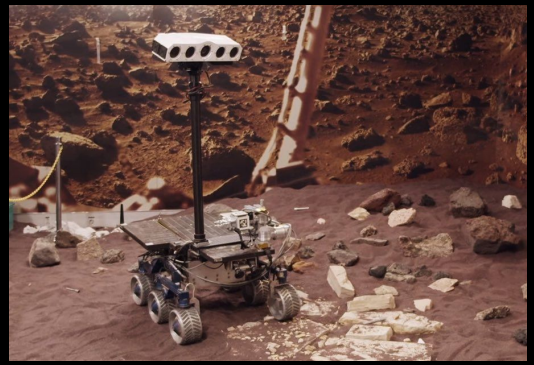
Rover Masthead

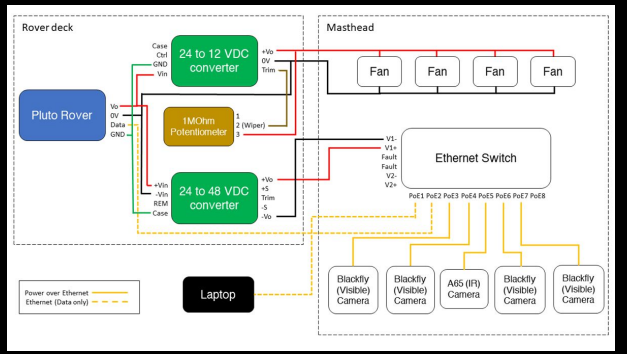
NASA Jet Propulsion Laboratory
Extreme Environment Robotics Group

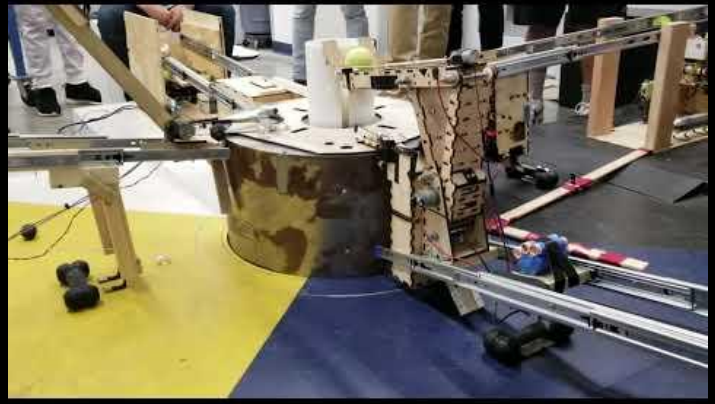
Responsible for mechanical and electrical design of a rover masthead for field testing.

Considered dust robustness, mount stiffness, window materials, and cooling fans to prepare for computer vision testing in Death Valley.







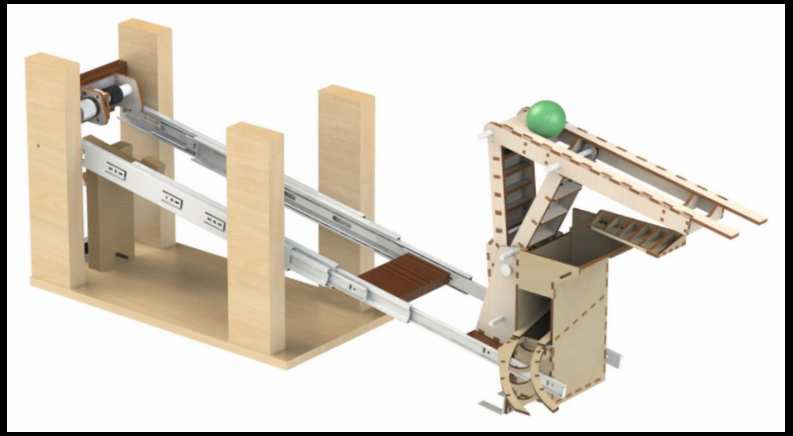


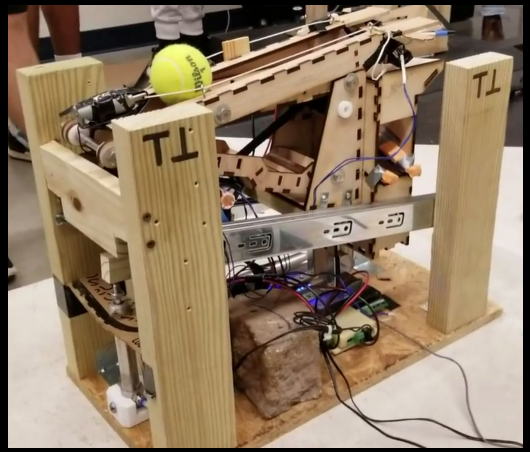
Laser-Cut Competition Robot

Georgia Tech ME 2110 - Creative Decisions and Design

Led mechanism design and fabrication for the 1st place design review entry in Georgia Tech's sophomore design course.

Emphasized modularity and press-fit laser cut joints requiring no adhesive, altogether enabling rapid integration, iteration, and adjustment.







Robotic Hand Outreach Demo

Georgia Tech Laboratory for Intelligence and Autonomous Robots

Designed demonstration for grade school students during National Robotics Week tours. A Raspberry Pi running OpenCV would recognize the “openness” of any person’s hand, and an Arduino PID controller would then actuate a 3D-printed hand to mimic it.



https://www.youtube.com/watch?v=c9F7bkaSM40



Lantern with Automated Music Processing (LAMP)



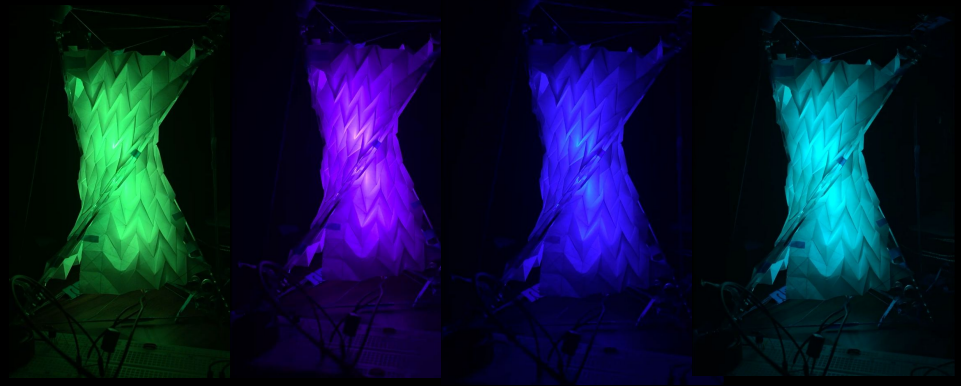
https://www.youtube.com/watch?v=Vw7iPU2GogA

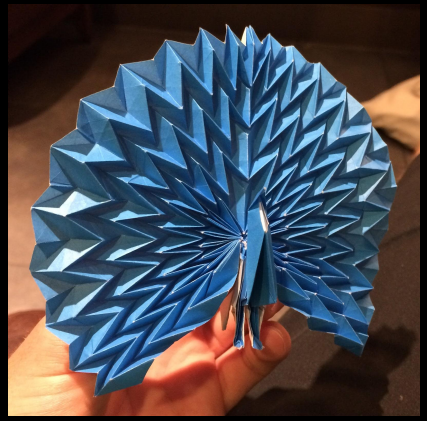
Georgia Tech BuildGT Hackathon

Adapted open-source MATLAB script to enable real-time chord-correlated color changes.

Designed a tensegrity suspension for an LED strip “core” with a unique origami Miura-fold shroud for light diffusion.

2nd place entry in BuildGT, Georgia Tech’s annual hardware-centric hackathon.







Fun Stuff

Free time activities include folding origami, baking, playing music (baritone saxophone in Two Factor Authentication, Georgia Tech's #1 cybersecurity themed funk band, and the Jazz Propulsion Band, JPL's big band), and participating in the LGBTQ organizations at Georgia Tech and JPL.



