Biomimetics Dexterous Manipulation Laboratory

Landing Envelope Modeling for Gecko-Adhesive Perching

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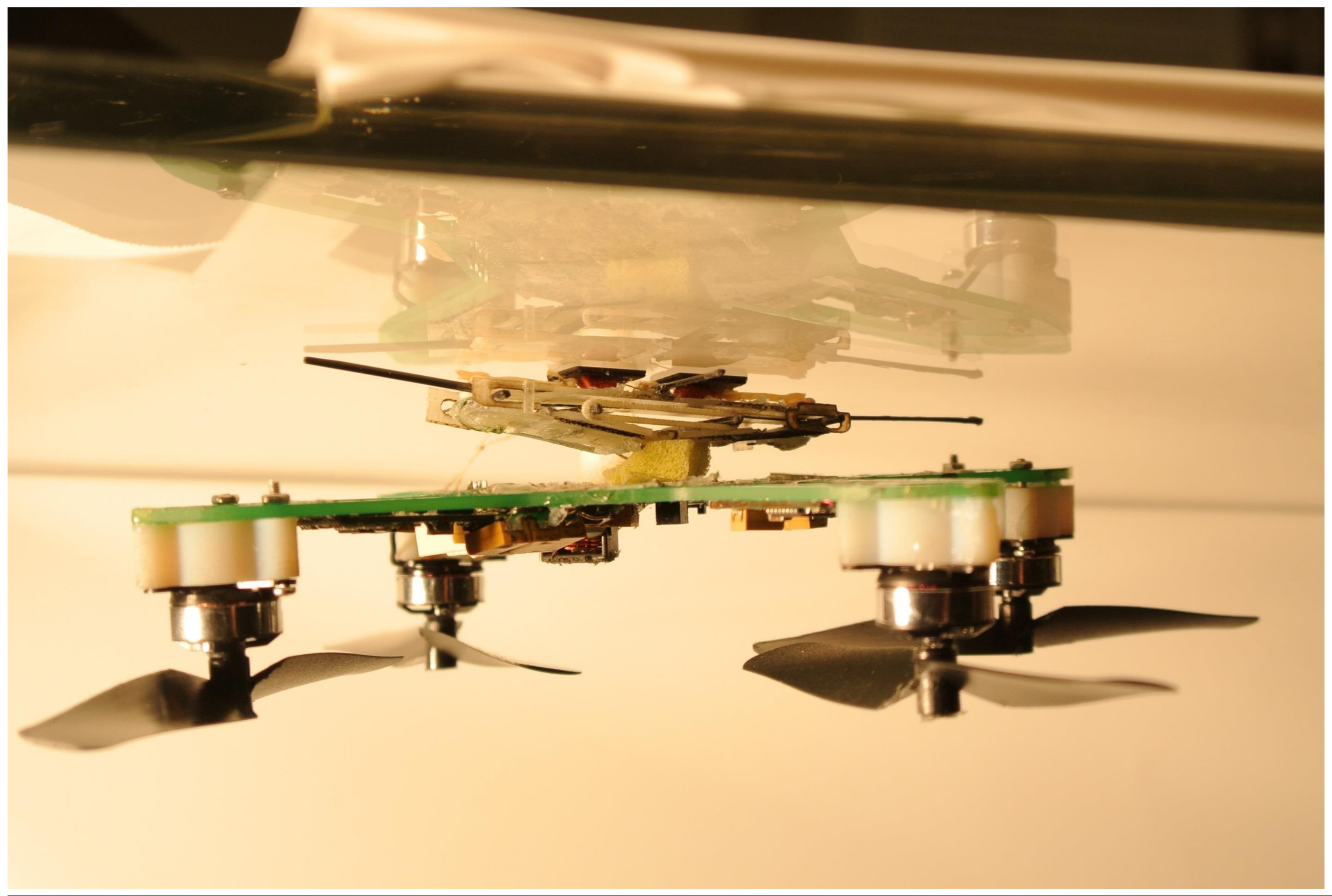
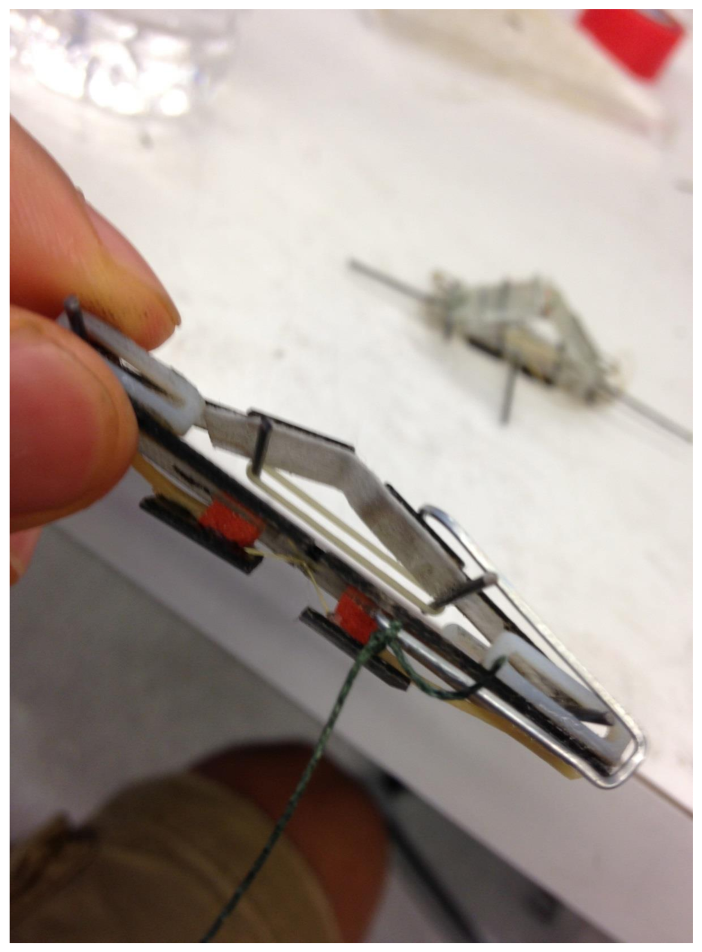


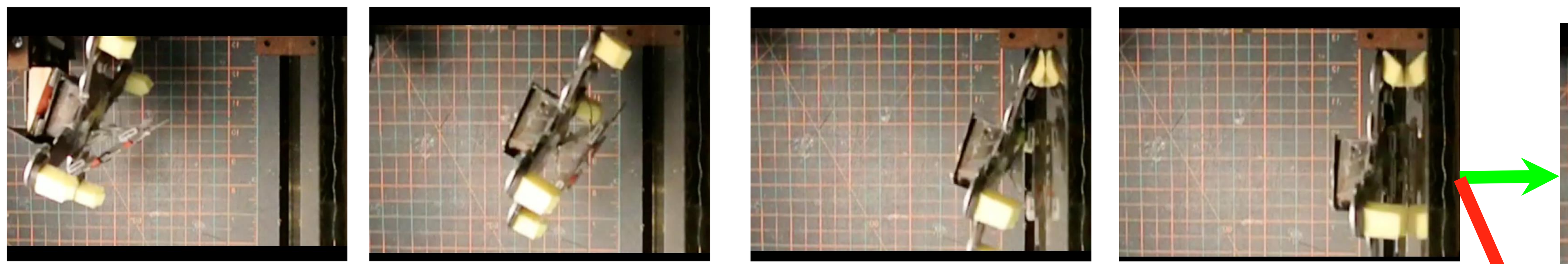
Introduction

Unlike conventional adhesive, gecko-adhesive allows for variable adherence dependent on the direction of an applied force. Pads of gecko-adhesive stick to a surface when high shear force is applied, yet are easy to remove when the shear force is relaxed.[1]

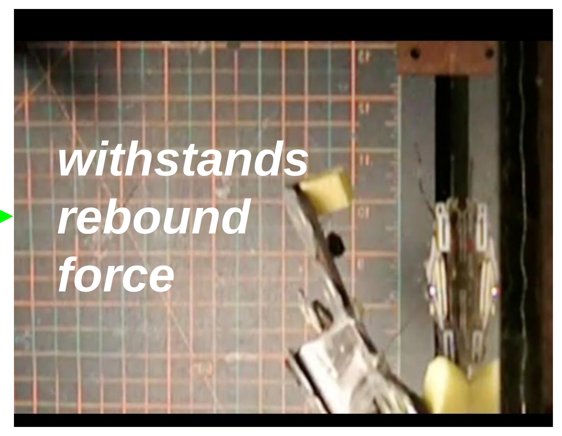
The quadrotor perching device makes use of gecko-adhesive to land and stick to smooth vertical walls and ceilings. The objective of this project is to measure the forces acting on the quadrotor perching mechanism when it collides with a s surface, and to find the range of velocities that allow for successful landing and attachment.



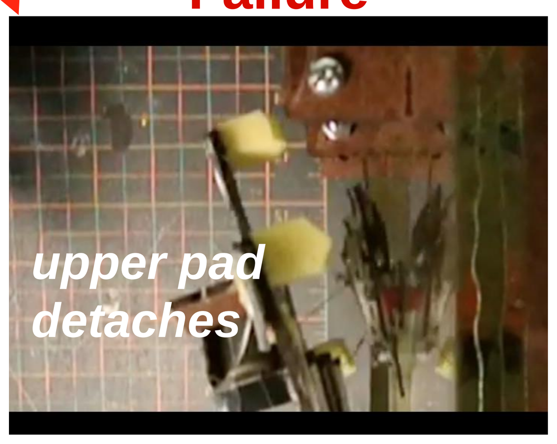
Experimental Setup



Success



Failure

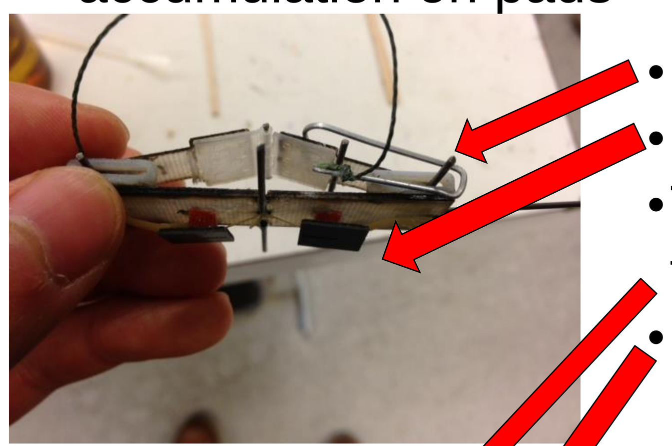


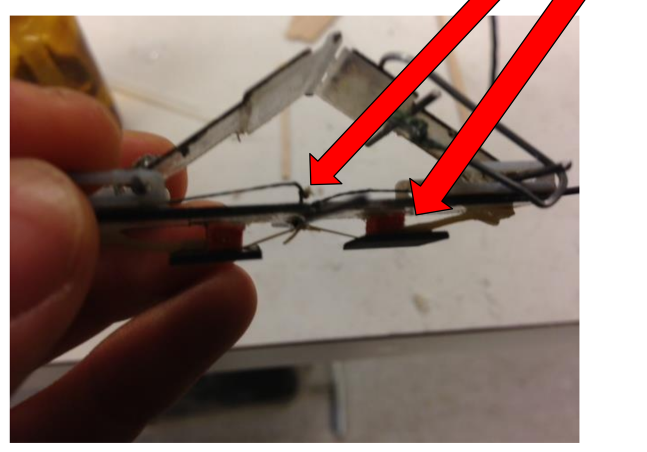
High speed video was used to measure velocity and angle of the perching mechanism at impact. Adhesion was tested for floor landings, vertical wall landings, and inverted ceiling landings. A six-axis force sensor was used to measure normal and shear forces for the floor and the vertical wall landings.

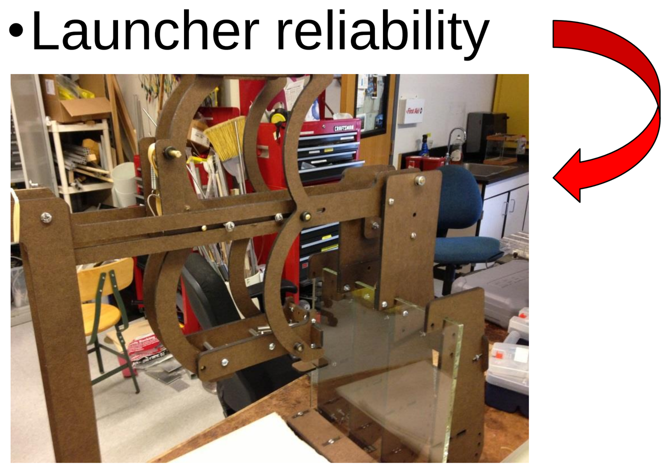
- Successful landing entails adhesion to the surface and complete collapsing of the perching mechanism, with the collapsing latch engaged.
- Possible failures include pad failure (adhesive fails to properly engage) or mechanical failure (the perching truss does not collapse or the latch does not engage, even if the adhesive sticks).

Challenges

- Lack of repeatability
- Particulate accumulation on pads
- Lack of robustness in perching mechanisms
- Broken latches
- Bad pads
- Tendons worn through
- Unoptimized tension angle
- Launcher reliability



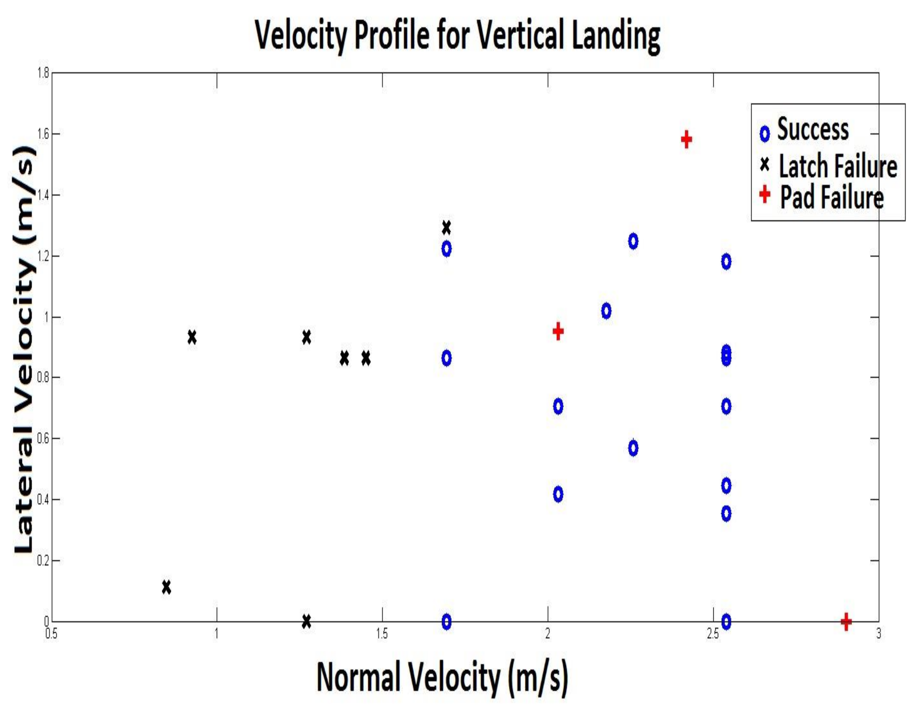


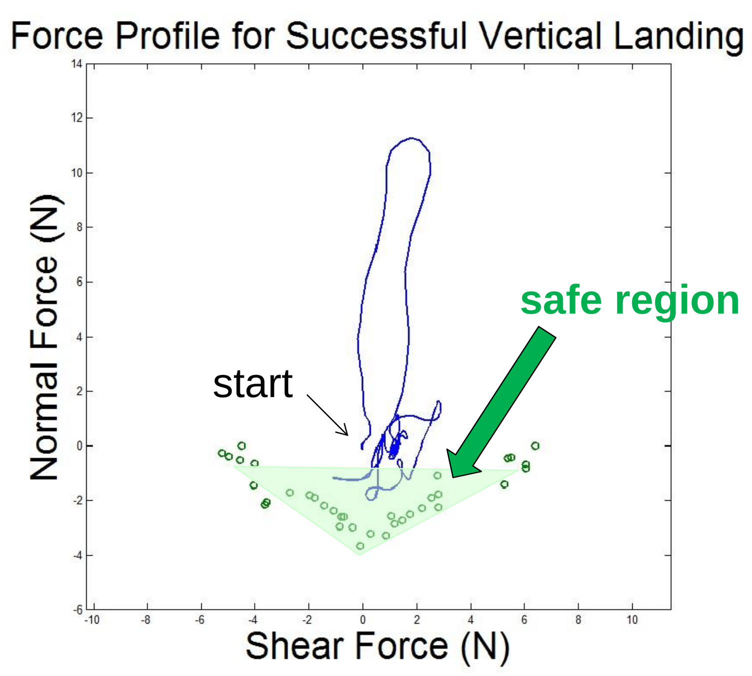


Results

The force profile graph as well as the velocity profile graph are representative of the graphs analyzed for a large set of trials from which the eventual result was found:

	Minimum Velocity	Maximum Velocity
Floor Landing	1.0 m/s	3.5 m/s
Vertical Landing	1.3 m/s	2.6 m/s

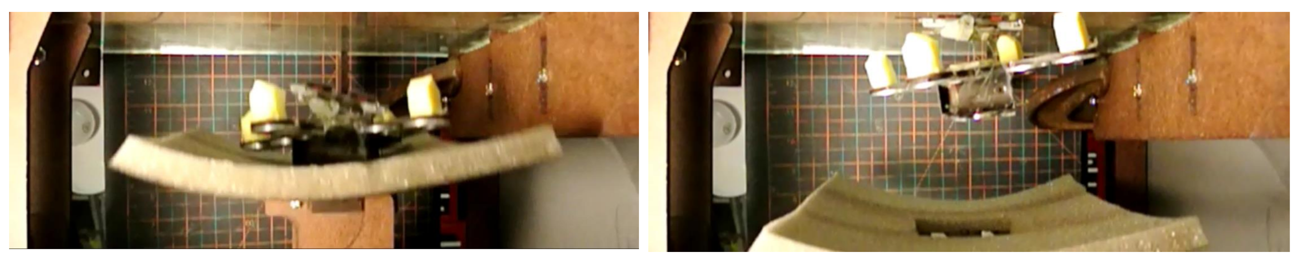




Future Work

- Extend force and video measurements to ceiling landings.
- Compare with results of computer models of the landing dynamics

The same process can also be applied to a microspine-based attachment mechanisms for rough surfaces such as concrete.[2]



References

1. Day, P., Eason, E. V., Esparza, N., Christensen, D., & Cutkosky, M. (2013). Microwedge Machining for the Manufacture of Directional Dry Adhesives. *Journal of Micro and Nano-Manufacturing*, *1*(1), 011001-011001.
2. Asbeck, A. T., Kim, S., Cutkosky, M. R., Provancher, W. R., & Lanzetta, M. (2006). Scaling hard vertical surfaces with compliant microspine arrays. *The International Journal of Robotics Research*, *25*(12), 1165-1179.

Acknowledgements

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