



MONASH  
University

# Embodied optimization in soft and multimaterial robots

From aerial to ground applications

25 March 2021

Surya G. Nurzaman ([sgnurzaman.org](http://sgnurzaman.org))

*LIFE* – Laboratory for Intelligent and Flexible Machine(s)

# AERIAL APPLICATION

## MOTIVATION

# Design optimization for aerial grasping

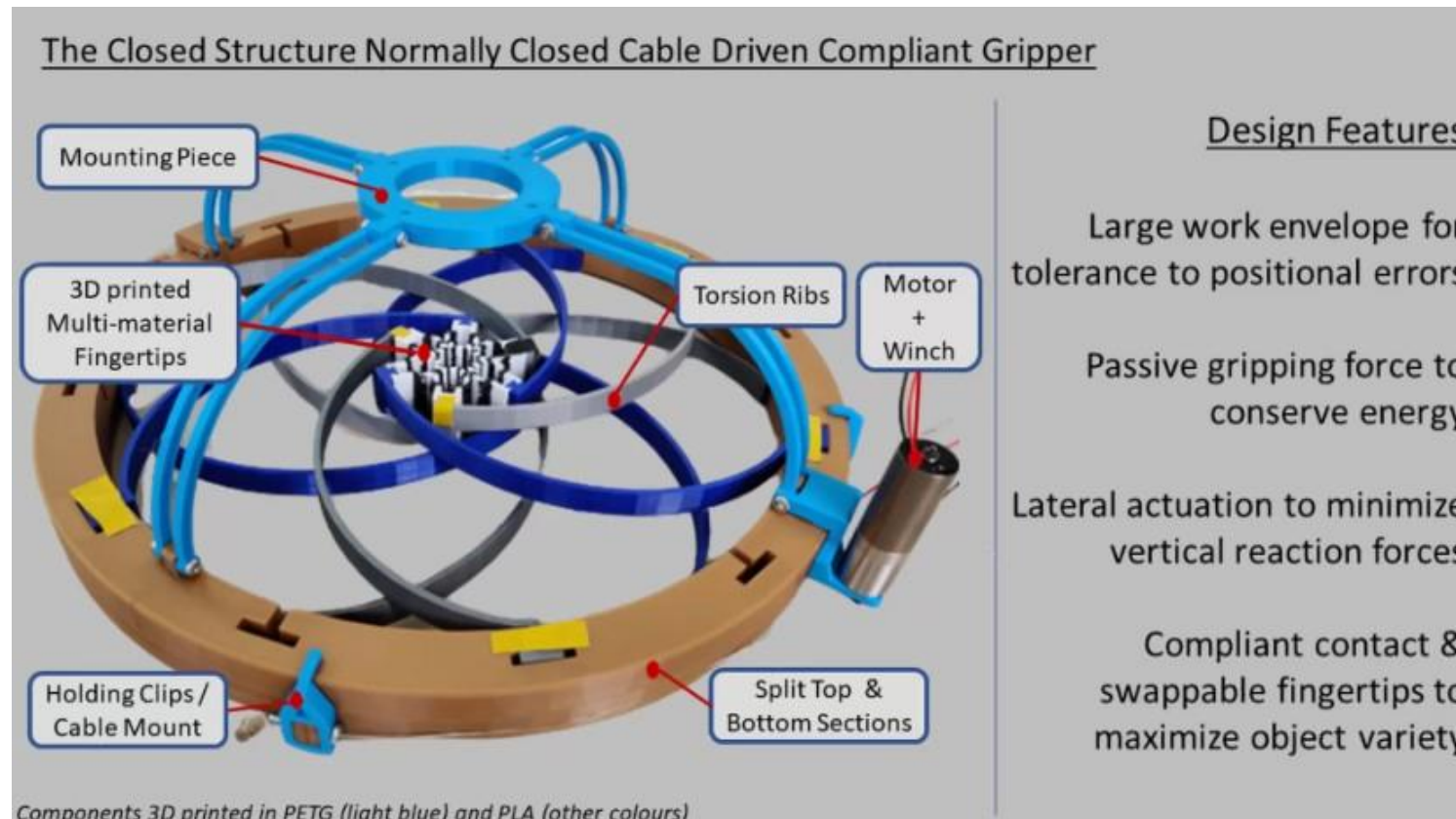
Aerial grasping by UAV needs to be able to cope with:

- Inaccuracies in positioning
- Energy constraints
- Perturbations to the UAV
- A variety of objects to be grasped

## APPROACH

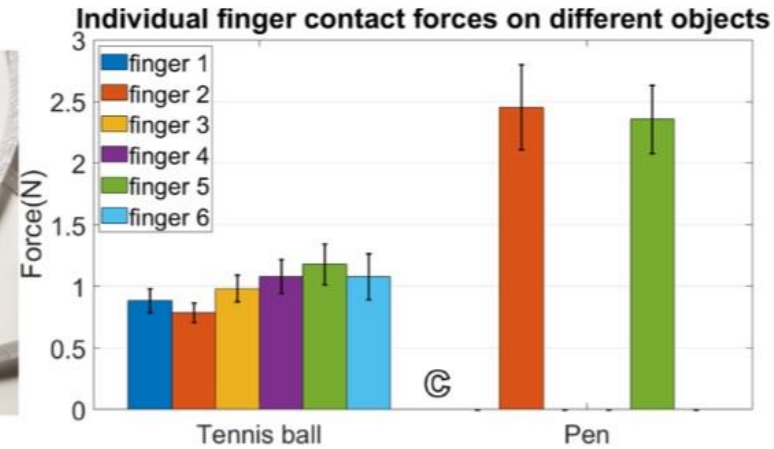
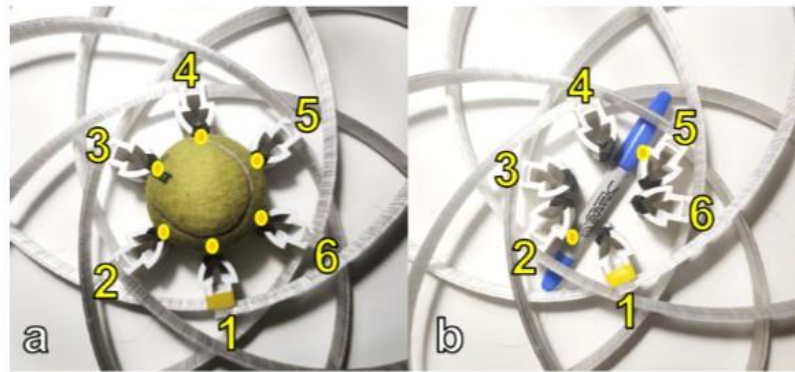
# Design optimization for aerial grasping

Closed structure, normally closed, compliant gripper with multimaterial fingertips



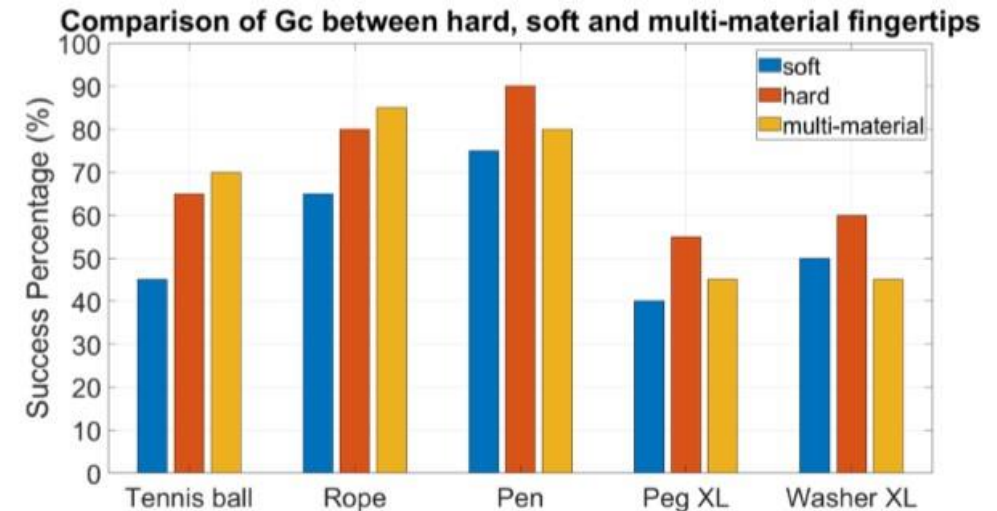
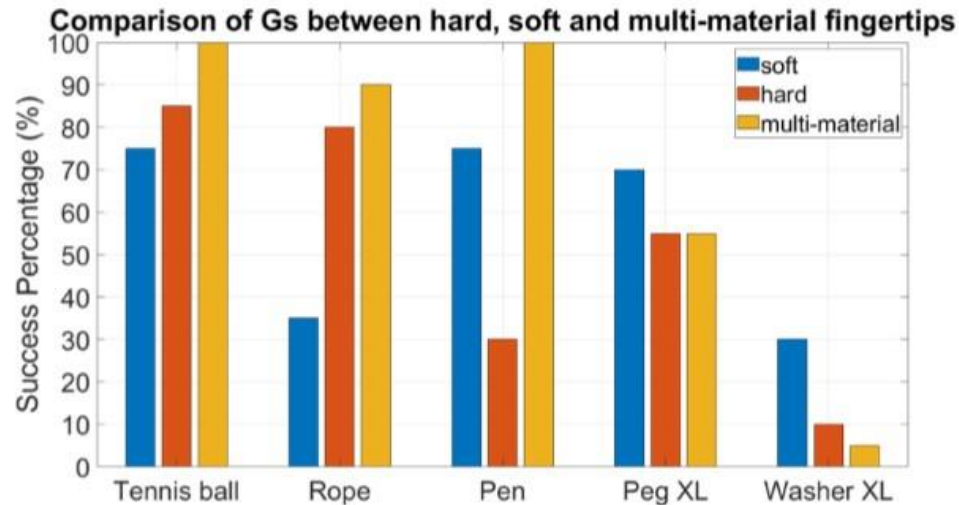
# RESULT

# Design optimization for aerial grasping



G<sub>s</sub>: Success rate of grasping

G<sub>c</sub>: Success rate of pushing the object to the centre

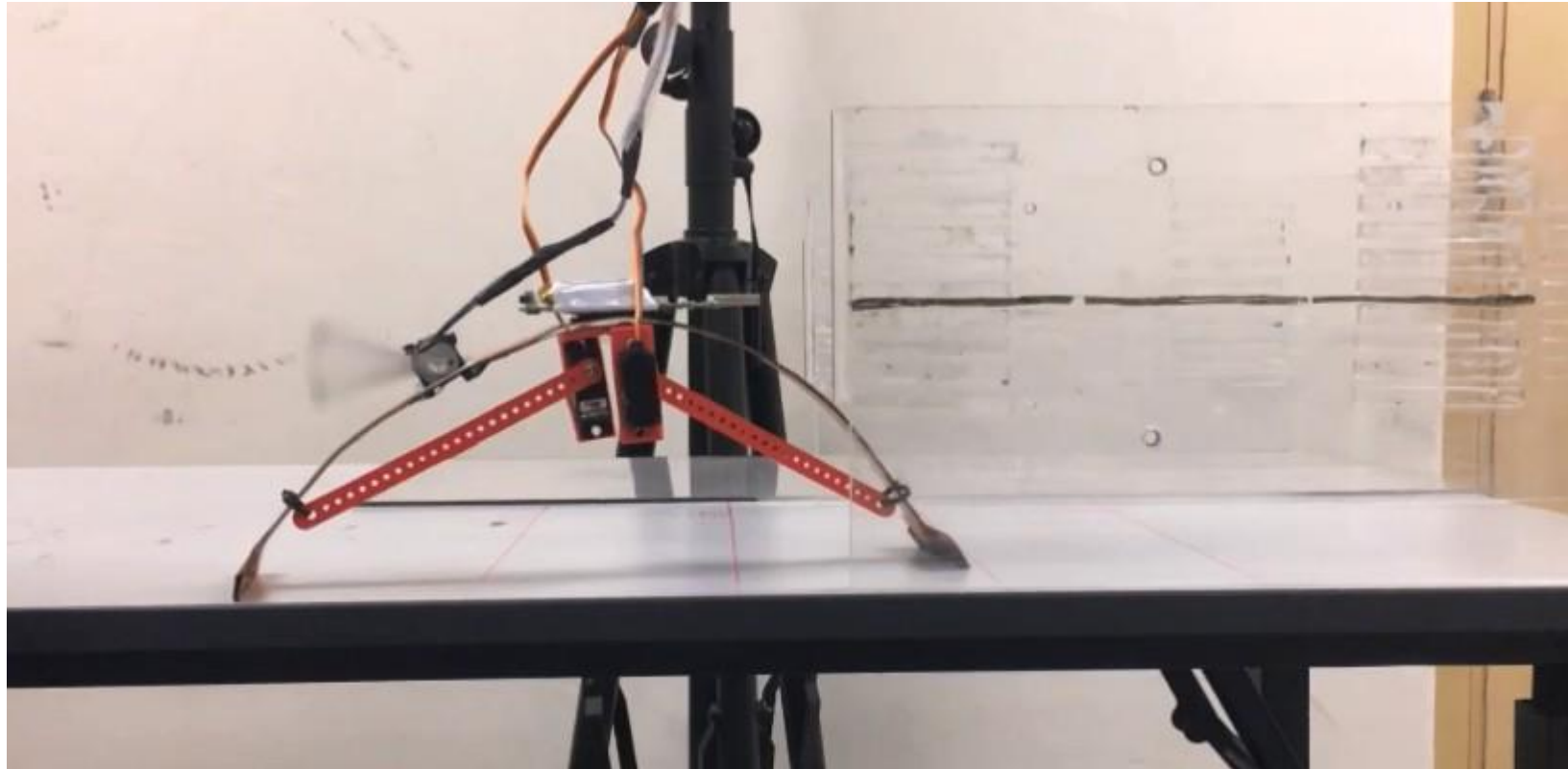


# GROUND APPLICATION

## MOTIVATION

# Power Efficient Adaptive Behavior in a Shape Changing Robot

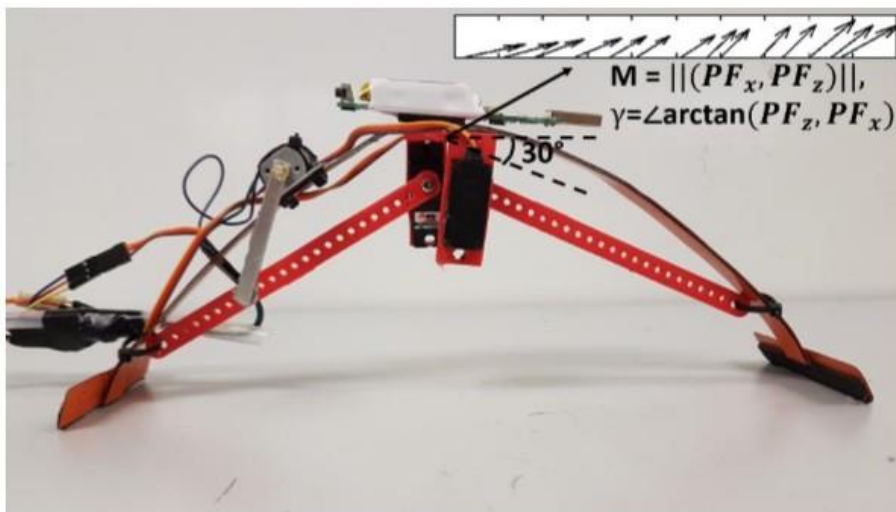
In order to adapt its behavior, should a robot rely more on changing its control input or shape?



(VIDEO)

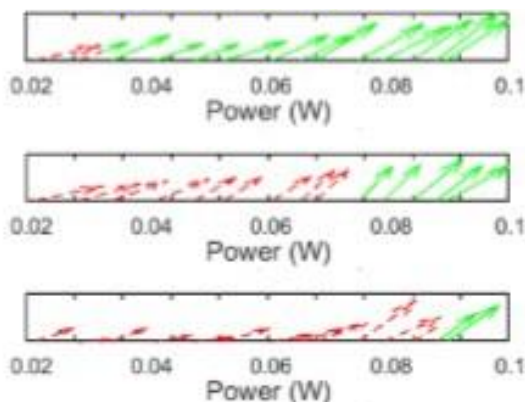
# APPROACH & RESULT

## Power Efficient Adaptive Behavior in a Shape Changing Robot



Red arrows:  
"Sliding" behavior

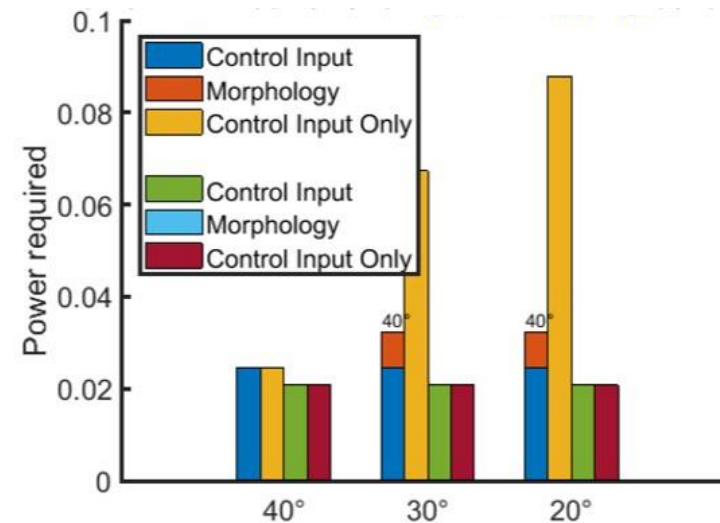
Green arrows:  
"Hopping" behavior



40 DEG  
SHAPE

30 DEG  
SHAPE

20 DEG  
SHAPE



Power to  
achieve  
"hopping"

Power to  
achieve  
"sliding"



# SUMMARY

The importance of optimizing soft and multimaterial body, demonstrated in different applications

# ACKNOWLEDGEMENT

All members of *LIFE* - Laboratory for Intelligent and Flexible Machine(s): [sgnurzaman.org/people](http://sgnurzaman.org/people)

FRGS Grant (Project no:  
FRGS/1/2017/ICT02/MUSM/03/3)

**THANK YOU**

# RELATED PUBLICATIONS

Lee LY, Syadiqeen OA, Chee Pin T, Nurzaman SG (2021). Closed-structure compliant gripper with morphologically optimized multi-material fingertips for aerial grasping, IEEE Robot. Autom. Lett. 6(2): 887-894. ([link](#))

Katiyar SA, Gouwanda D., Iida F., Nurzaman SG (2021). Power efficient adaptive behavior through shape changing elastic robot, Adaptive Behavior. ([link](#))

Lee LY, Nurzaman SG, Chee Pin T. Design and analysis of a gripper with interchangeable soft fingers for ungrounded mobile robots. IEEE Int. Conf. on Cybernetics and Intelligent Systems (CIS) and IEEE Conference on Robotics, Automation and Mechatronics (RAM), 2019. ([link](#))

Katiyar SA, Iida F, Nurzaman SG. Energy harvesting in soft robot locomotion with complex dynamics. IEEE Int. Conf. on Cybernetics and Intelligent Systems (CIS) and IEEE Conference on Robotics, Automation and Mechatronics (RAM), 2019. ([link](#))

Katiyar SA, Kandasamy G, Kotalunga E, Mustafizur M, Iida F, Nurzaman SG. Morphological adaptation in an energy efficient vibration-based robot. IEEE Int. Conf. on Robotics and Automation (IEEE ICRA), 2018, pp. 1575-1582. ([link](#))

# OTHER PUBLICATIONS OF LIFE

[sgnurzaman.org/publications](http://sgnurzaman.org/publications)