香港科技大學
THE HONG KONG UNIVERSITY OF
SCIENCE AND TECHNOLOGY

Seahorse Tail-inspired Soft Pneumatic Actuator Utilizing Dual-mode Actuation

Dickson Chiu Yu Wong, Zijian Zhou, Garmisch Lai Yin Wong, and Rob B.N. Scharff

Key Features

- Inspired by the structure of the **seahorse tail**
- A **3D-printed** soft pneumatic pre-curved actuator
- With **dual actuation mode**, which straightens under negative pressure and further rolls under positive pressure
- Generates a maximum force of **23N** and **79N** under atmospheric and positive pressure, respectively

Design And Fabrication

- Base Shape: family of logarithmic spirals

$$r = ae^{b\theta}$$

- The pillow's width increases uniformly from x_{first} to x_{last}, based on the geometric sequence as follows:

$$q = \sqrt[n-1]{\frac{x_{last}}{x_{first}}}$$

- x_{first}, x_{last} : width/height of the first and last units
- q: geometric ratio
- n: the actuation unit number.
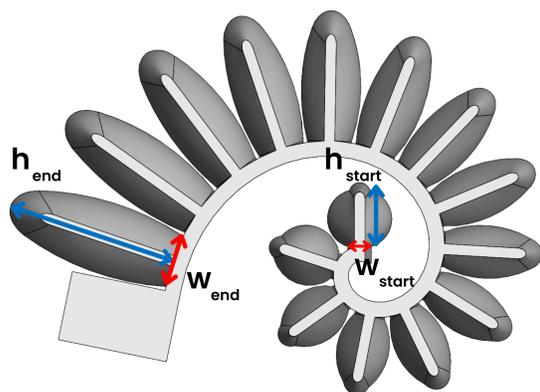
Parameter	Description
w_{start}	First segment arc length.
w_{end}	Last segment arc length.
h_{start}	First pillow height.
h_{end}	Last pillow height.
n	Number of segments.
g_w	Geometric ratio for the width increment.
g_h	Geometric ratio for the height increment.

Testing and Results

Actuation Performance Test

Atmospheric Pressure

−50kPa

100kPa

Holding Force Test
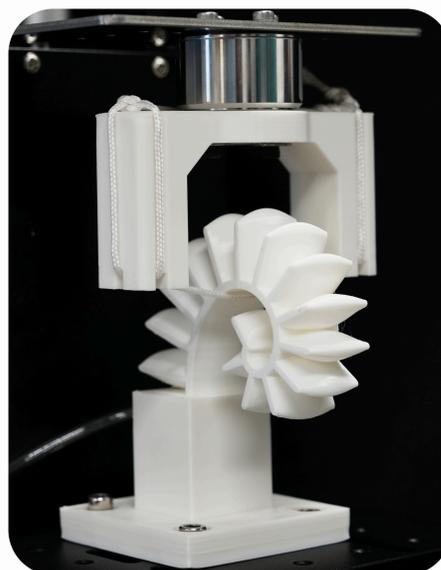
- Actuator Pressure: 100 kPa
- Speed: 8mm/s
- Inextensible String Diameter: 3mm

Force Generation
- **Atmospheric pressure: 23N**
- **100kPa: 79N**

Summary

Dual-mode actuation capability:
- Straighten under negative pressure
- Further curl under positive pressure
- Provides a versatile range of movements

Material composition and **3D printing fabrication** method allow for holding force generation:
- Maximum passive holding force of **23N** under atmospheric pressure
- Maximum active holding force of **79N** under positive pressure
- Passive holding force utilizing material strength

Superior force generation capabilities, ease of fabrication, and versatile actuation mechanisms make it a promising solution for various grasping and anchoring applications.