ADHESION MECHANISMS INSPIRED BY OCTOPUS SUCKERS

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PURPOSE

Nature offers many interesting adhesion mechanisms where attachment forces can be generated in a binary on/off state. This study aims at investigating the natural adhesion solution in order to extract new design criteria for innovative bio-inspired adhesion devices [1-2]. In particular, we identified octopus suckers as a key biological model because of their flexibility, dexterity, and capability to generate large forces on different substrates [3-4].

WHY SUCTION CUP?

ADVANTAGES	LIMITS
▪ industrial-strength reliability	▪ low efficiency
▪ excellent grip	▪ requirement of a vacuum pump
▪ ease of use	▪ periodic maintenance
▪ use in delicate applications	▪ need of a smooth surface

TAB. 1: Advantages and limits of suction cups [5-6]. These systems are one of the more common solutions used in robotics field for robot locomotion in unstructured environments and for objects manipulation.

WHY OCTOPUS SUCKERS?

The main drawbacks of artificial cups are overcome or, better, completely absent in octopus suckers.

On the contrary, octopus suckers:

- show high efficiency
- perform adhesion on almost any non-porous surfaces.

FIG. 1: *O. vulgaris* suckers.

MORPHOLOGICAL INVESTIGATION

FIG.2: Schematic structure of octopus sucker. **A**, acetabulum; **SP1**, primary sphincter muscle; **SP2**, secondary sphincter muscle; **IN**, infundibulum.

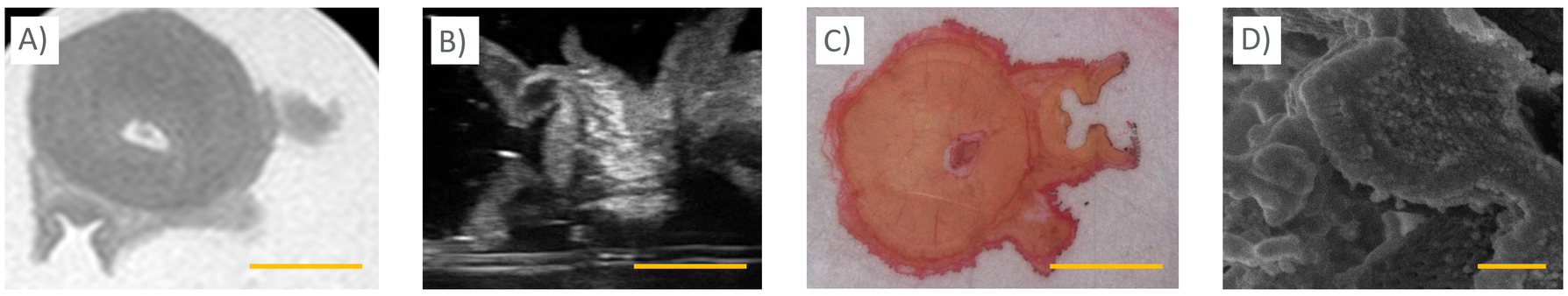
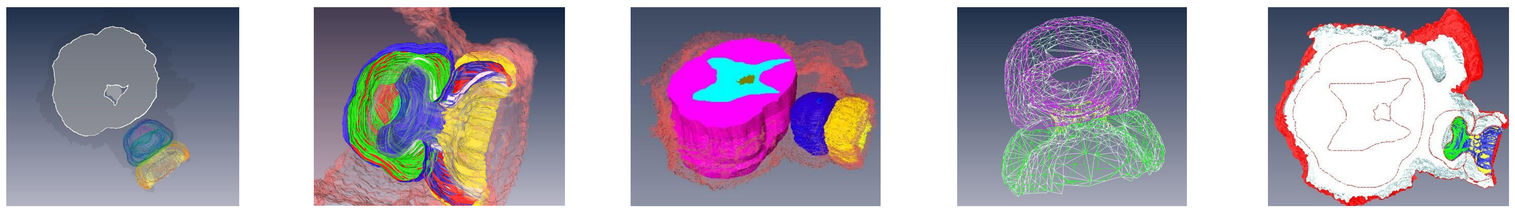


FIG. 3: **A**) MR image of octopus arm with one sucker, the scale bar equals 1 cm; **B**) ultrasound image of a sucker, the scale bar equals 0.5 cm; **C**) histological image of octopus arm with one sucker, the scale bar equals 0.5 cm; **D**) detail of denticle located in the infundibular portion, the scale bar equals 2µm.

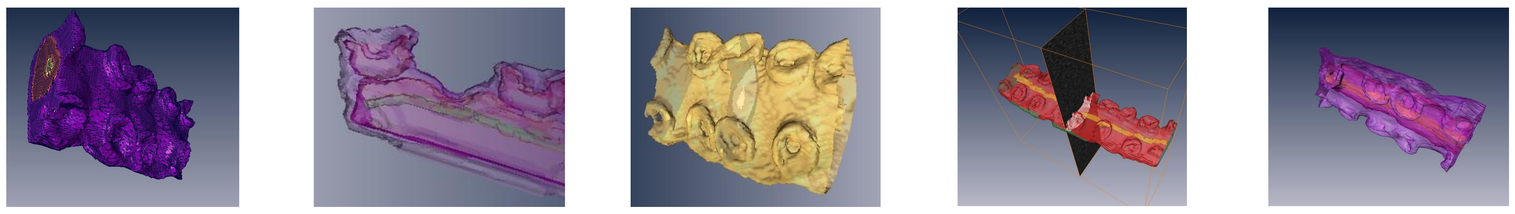
3D RECONSTRUCTION

- **FROM HISTOLOGICAL IMAGES**



- **FROM MAGNETIC RESONANCE IMAGES**

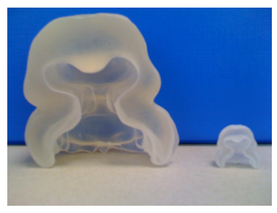
amira 5 VISAGE IMAGING



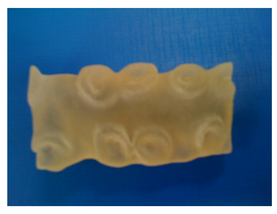
FROM 3D reconstructions

TO prototypes

3:1 1:1



1:1



CONCLUSIONS

This study investigates the strategic approach applied by octopus suckers to accomplish adhesion for extended periods of time, with a negligible energetic effort. Octopus seems to be able to address the adhesion tasks by means of elastic energy stored in the crossed connective tissue fibers and thereby performs adhesion without muscular contraction [7]. This hypothetical finding could contribute to overcome current limits of artificial suction cups in terms of efficiency.

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