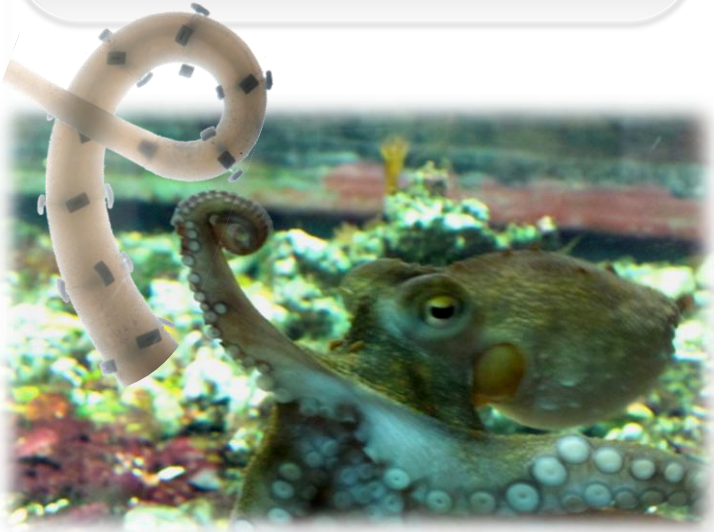
Having no rigid structures, OCTOPUS will be the world's first entirely soft robot, with eight flexible arms, able to reach impracticable places and simultaneously showing manipulation capability, which could open up new scenarios for marine exploration and underwater rescue.



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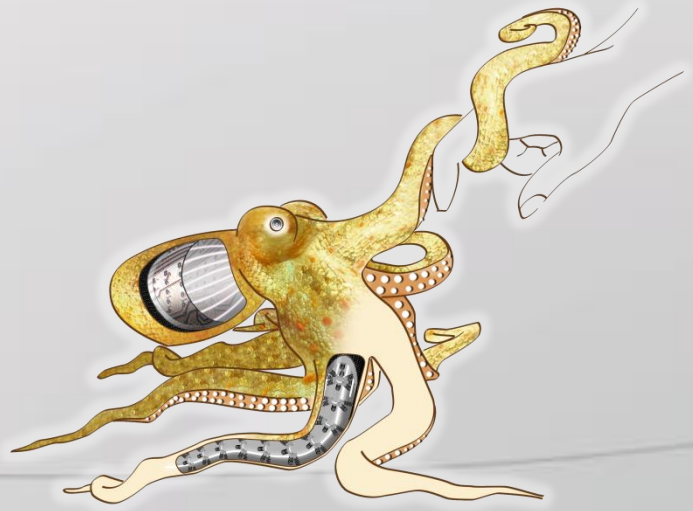
Future and Emerging Technologies

OCTOPUS

Novel Design Principles and Technologies for a New Generation of High Dexterity Soft-bodied Robots Inspired by the Morphology and Behaviour of the Octopus



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The octopus as a paradigm for Embodied Intelligence and as source of inspiration for Soft Robotics

The octopus has **no rigid structures** and it can flexibly squeeze into very small apertures or adapt the shape of its body and arms to the environment.

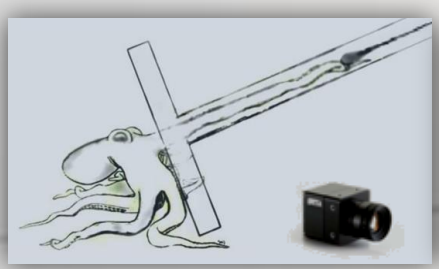
In the special muscular structure (***muscular hydrostat***) of the octopus arms, muscles are packed in a three-dimensional array, and have constant volume during movement. By opposing or promoting the movement, muscles serves as modifiable skeleton, allowing the octopus to actively **control the stiffness** of its arms.

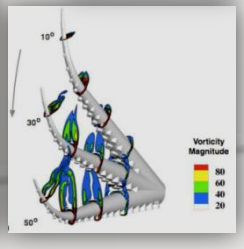
The 8 arms are a fascinating model of dexterity, with unique motor capabilities of **twisting**, **elongating up to two times the resting length**, **bending in all directions and at any point,** and can apply very **high forces** (up to 40N) in **pulling** and **grasping**.

The octopus effectively uses the arms to locomote on the diverse substrates of the sea bottom and to reach, grasp and even manipulate objects with **unexpected precision**.
The control of this **large number of degrees of freedom** is highly distributed and is simplified by the use of stereotyped movements.
The octopus shows a rich behavioural repertoire, with also learning, memory and camouflage capabilities.

The OCTOPUS project aims at investigating and understanding the key principles of the octopus body and brain, by building a soft 8-arm robot, able to move in water, to elongate its arms, to reach and grasp, and to locomote

Bioengineering and biological methods are applied to study, measure and model octopus performance, with results of **new scientific data** beyond the state of the art, as well as **novel design principles and specifications for robotics** purpose.



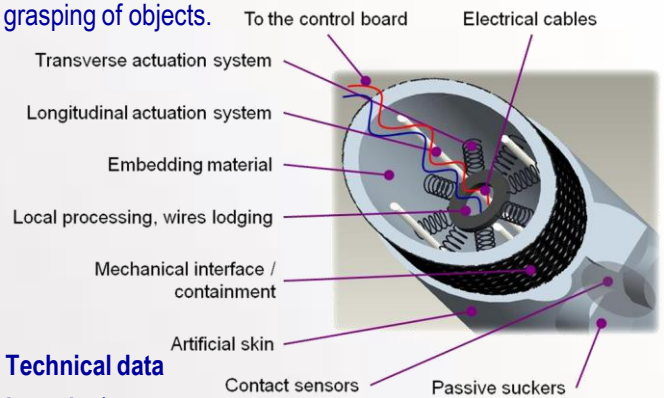


New Science and Novel Design Principles

New Soft Robotics Technologies

The **first soft arm prototype** has been developed using the **biological specifications** appropriately translated **into novel design principles.**

The features of the octopus arm, as the muscular, nervous and connective tissue arrangement and biomechanics, have been replicated for the **soft actuators, electrical cables and mechanical interface structure and performance.** Longitudinal cables and transverse SMA substitute muscle fibres, controlling contractions as soft actuators within the robot arm.
A **sensitive skin**, with contact sensors embedded into silicone rubber, surrounds the arm with **passive suckers** allowing the grasping of objects.



Technical data

Length: 457mm
Base Diameter: 30mm
Actuators: 4 longitudinal cables, 12 transverse SMA modules (8 SMA springs each)
Degree of freedom: 16
Switch contact sensors
Passive silicone suckers