RoboSoft, Pisa, 1/04/2014

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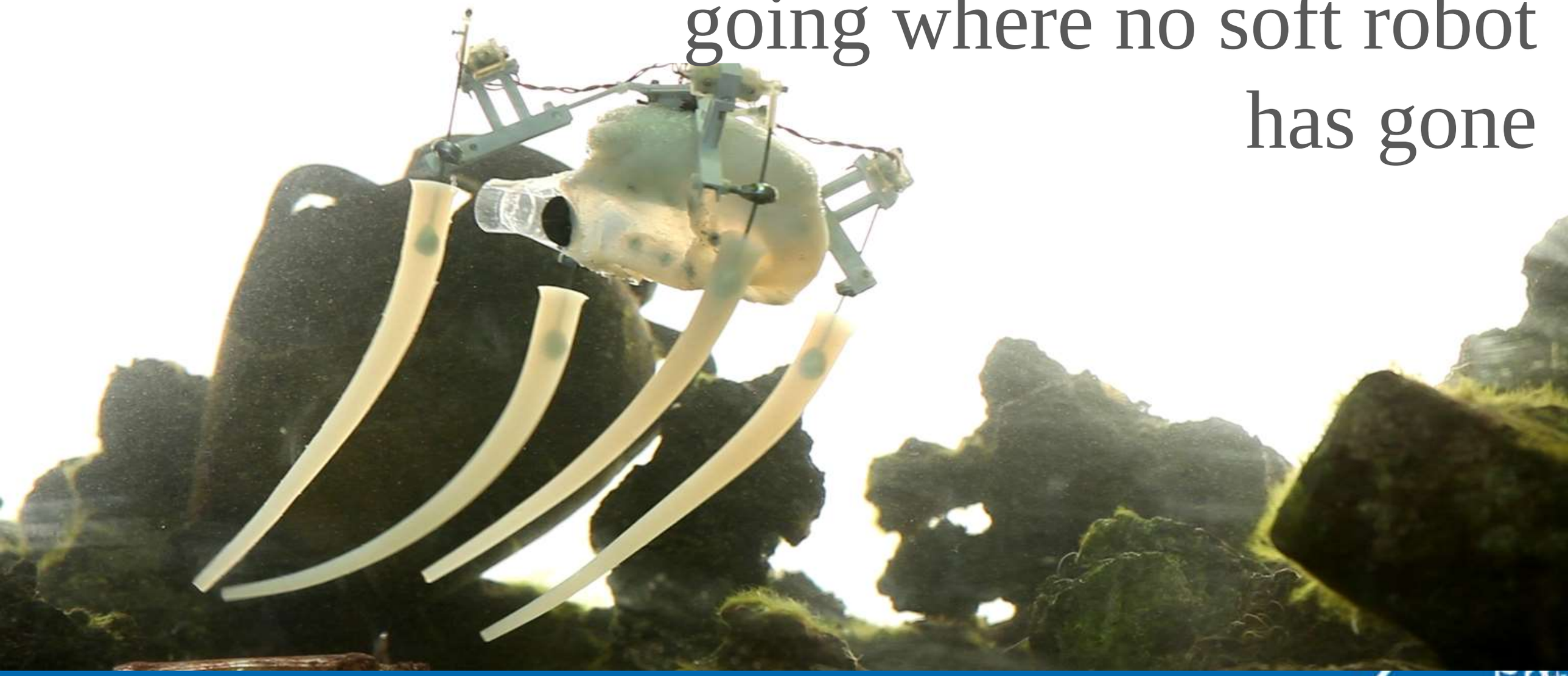
Scuola Superiore Sant'Anna

Soft robots for the offshore industry: going where no soft robot has gone



A. Arienti, M. Calisti, M. Giorelli, F. Renda, F. Giorgio Serchi and C. Laschi
Centre for Sea Technologies and Marine Robotics

Underwater Robots: State of the Art

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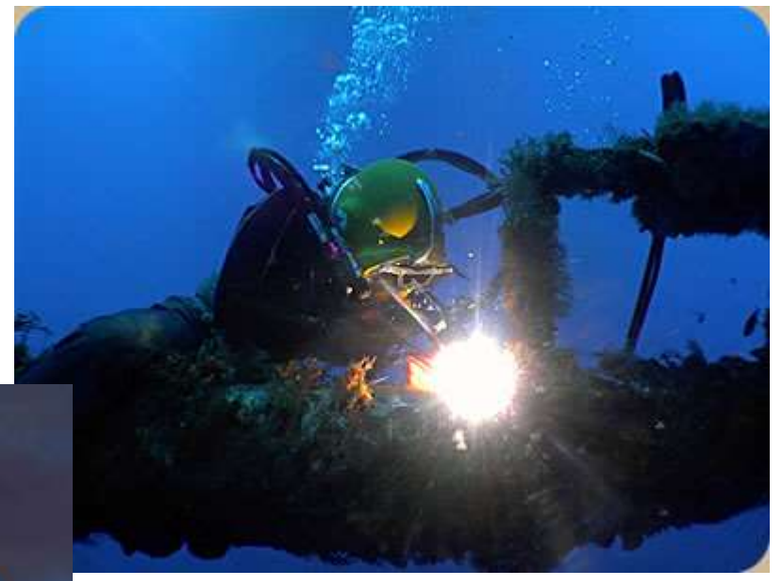
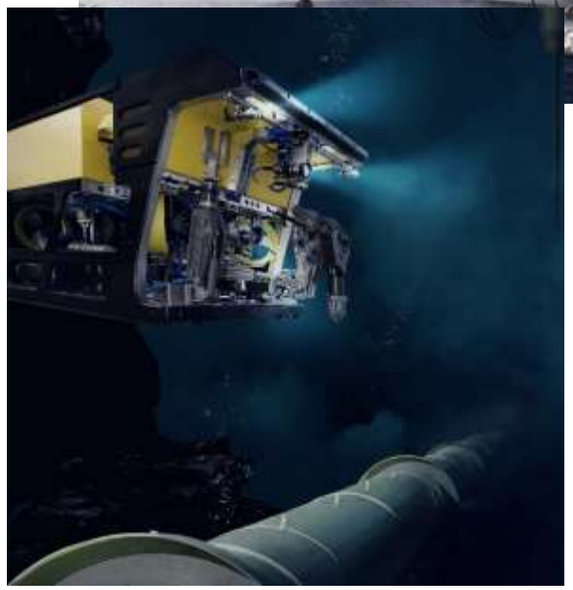
The offshore industry relies on robots extensively because:

- they are essential
  - big risks for divers
  - bad weather
  - high depth
  - proximity to structures





Underwater Robots: State of the Art

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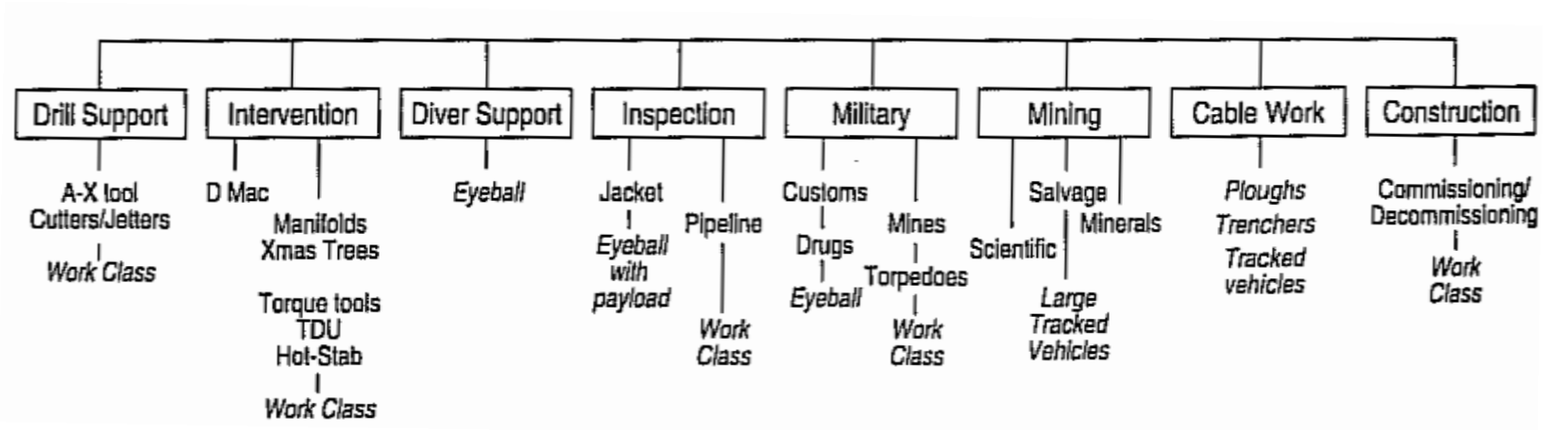
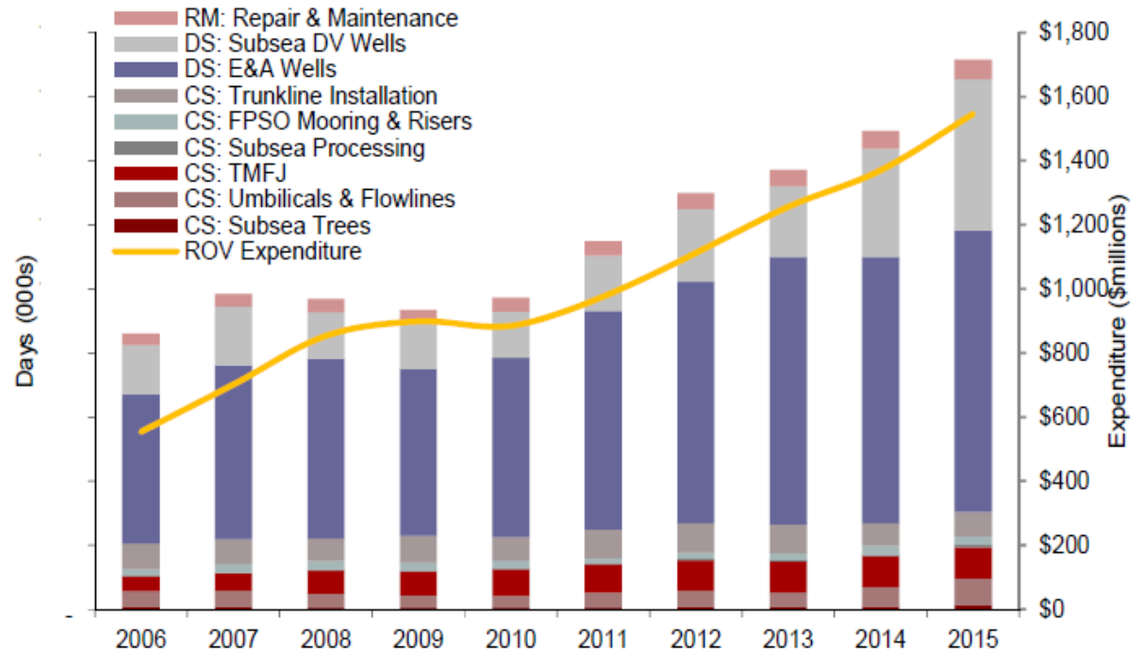
The offshore industry relies on robots extensively because:

- they are essential
- the tasks:
  - are numerous
  - are relatively simple
  - have to be carried out frequently

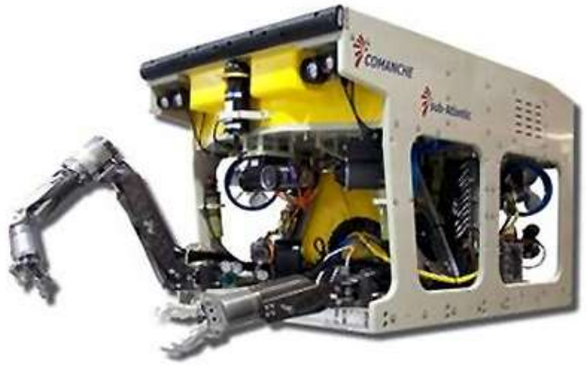




Underwater Robots: State of the Art

Underwater operations are carried out by UUVs:

- ROVs (observation and operation)
- AUVs (monitoring and survey)



Unresolved challenges for standard UUVs entail:

- Work in every sea condition
- Work close to sea bottom or structures
- Work in synergy with divers
- Work in confined space
- Precise manipulation control problem
- Operate close to moving structures

Soft Robots

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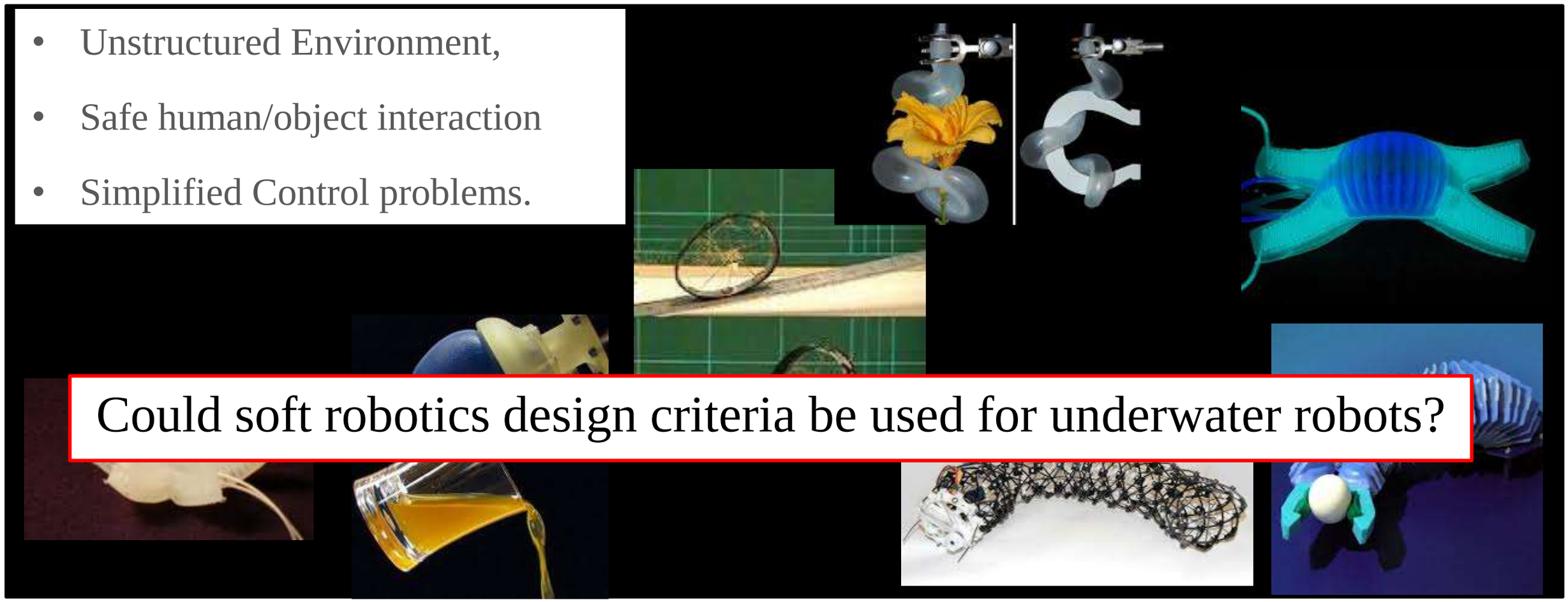
The soft robotics design proves to be suited for dealing with:

- Unstructured Environment,
- Safe human/object interaction
- Simplified Control problems.



Could soft robotics design criteria be used for underwater robots?

Design of a Soft Unmanned Underwater Vehicle

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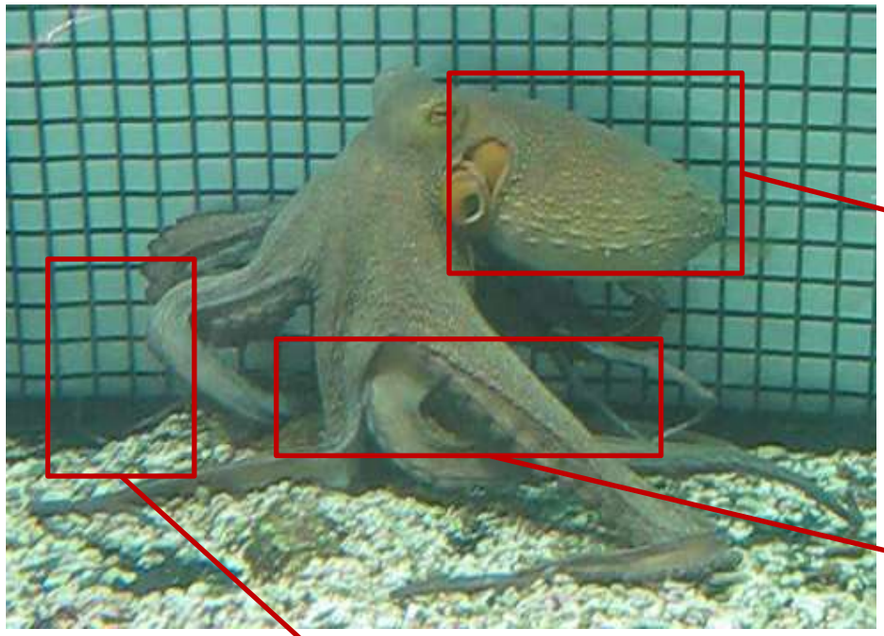
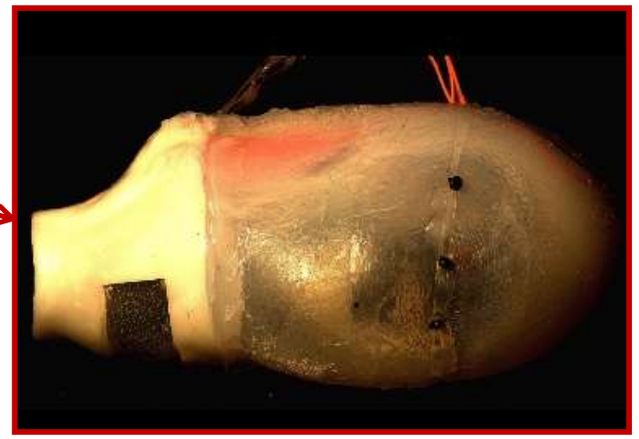
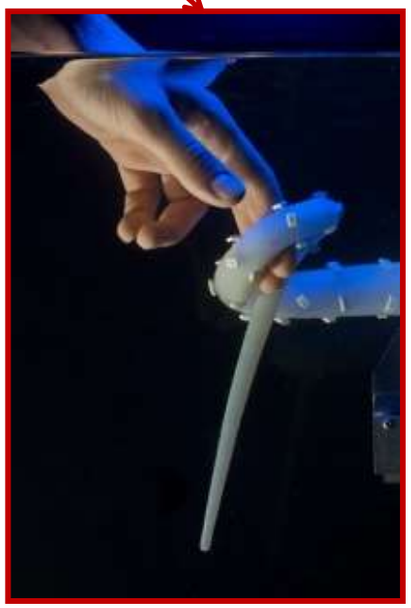
Sought after features:

- Swimming
- Manipulation
- Legged Locomotion
- Flexible/adaptable

The Octopus is the perfect paradigm of Soft Unmanned Underwater Vehicle







Components integration: the birth of PoseiDRONE

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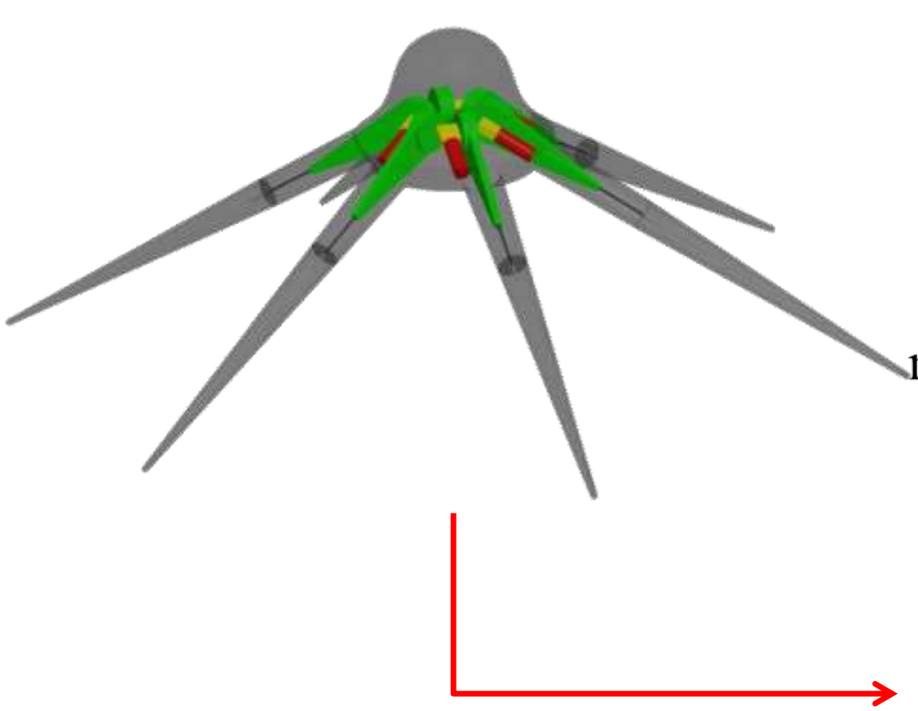

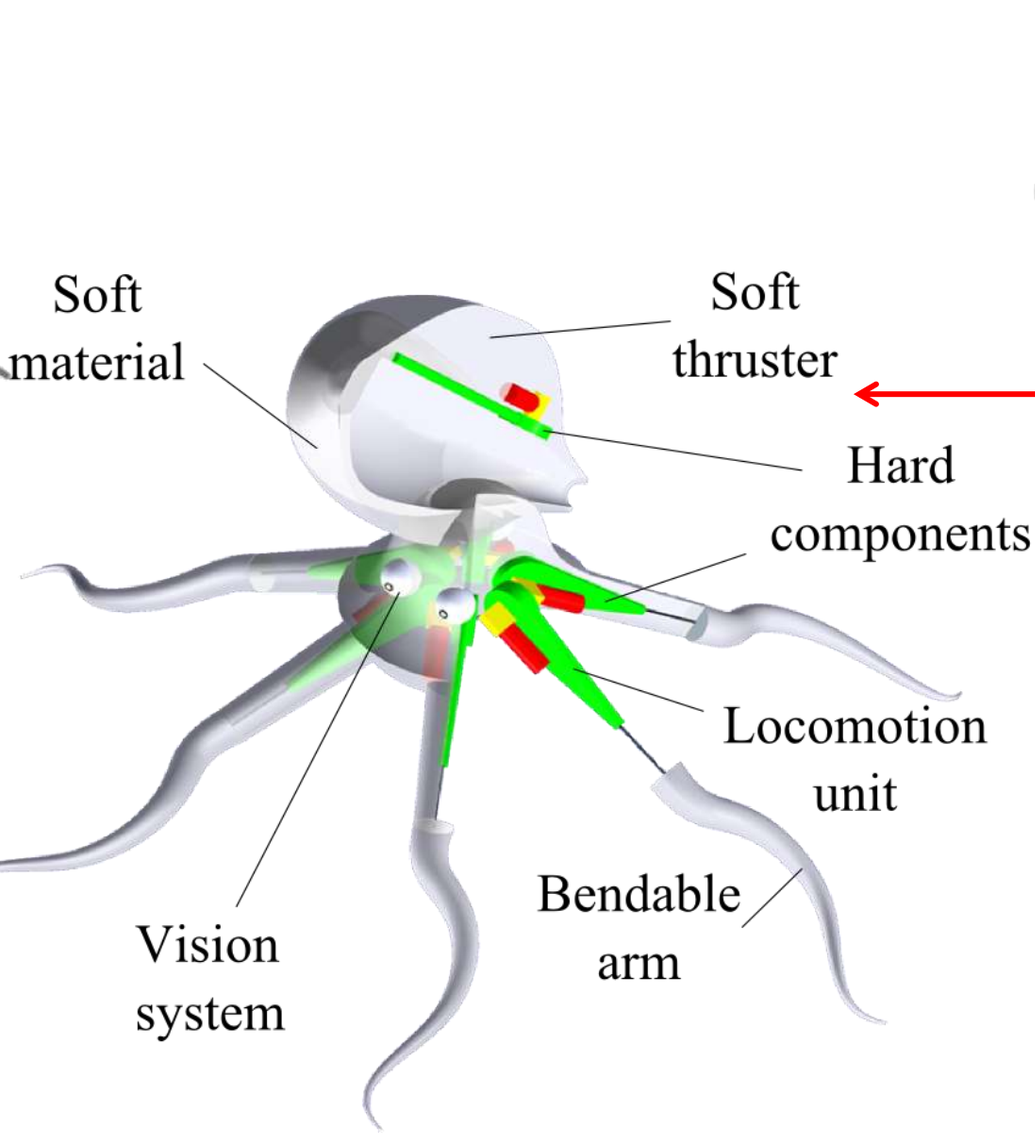

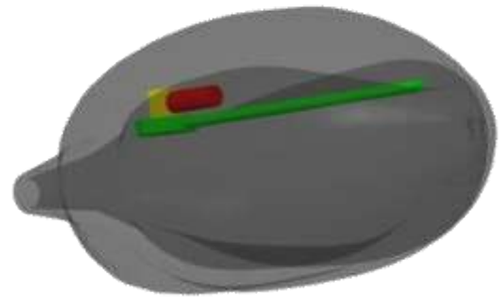

- Single continuum of rubber
- Cable driven transmission
- Standard DC motor actuation
- Natural waterproof insulation

The first multi-locomotion prototype

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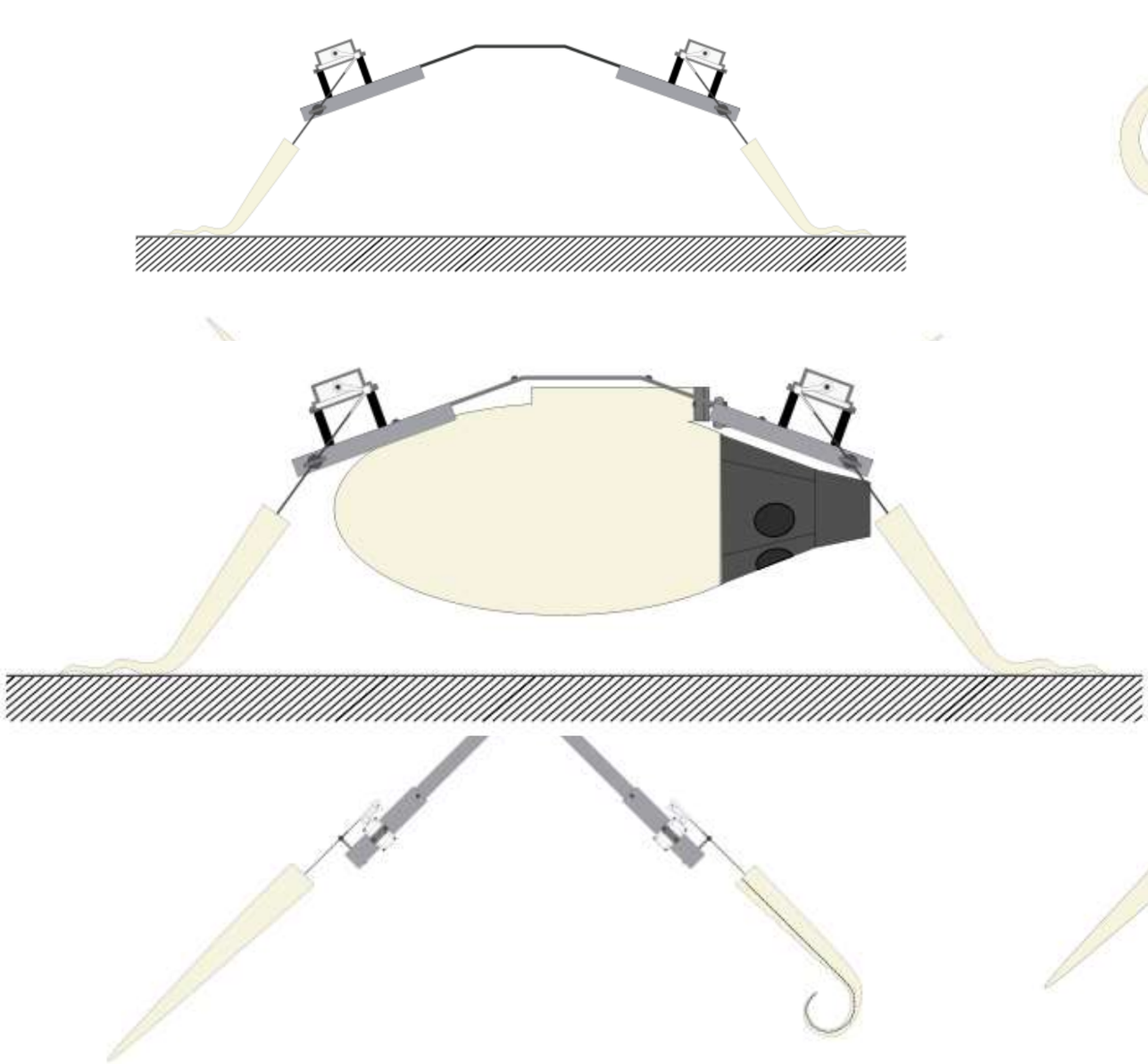

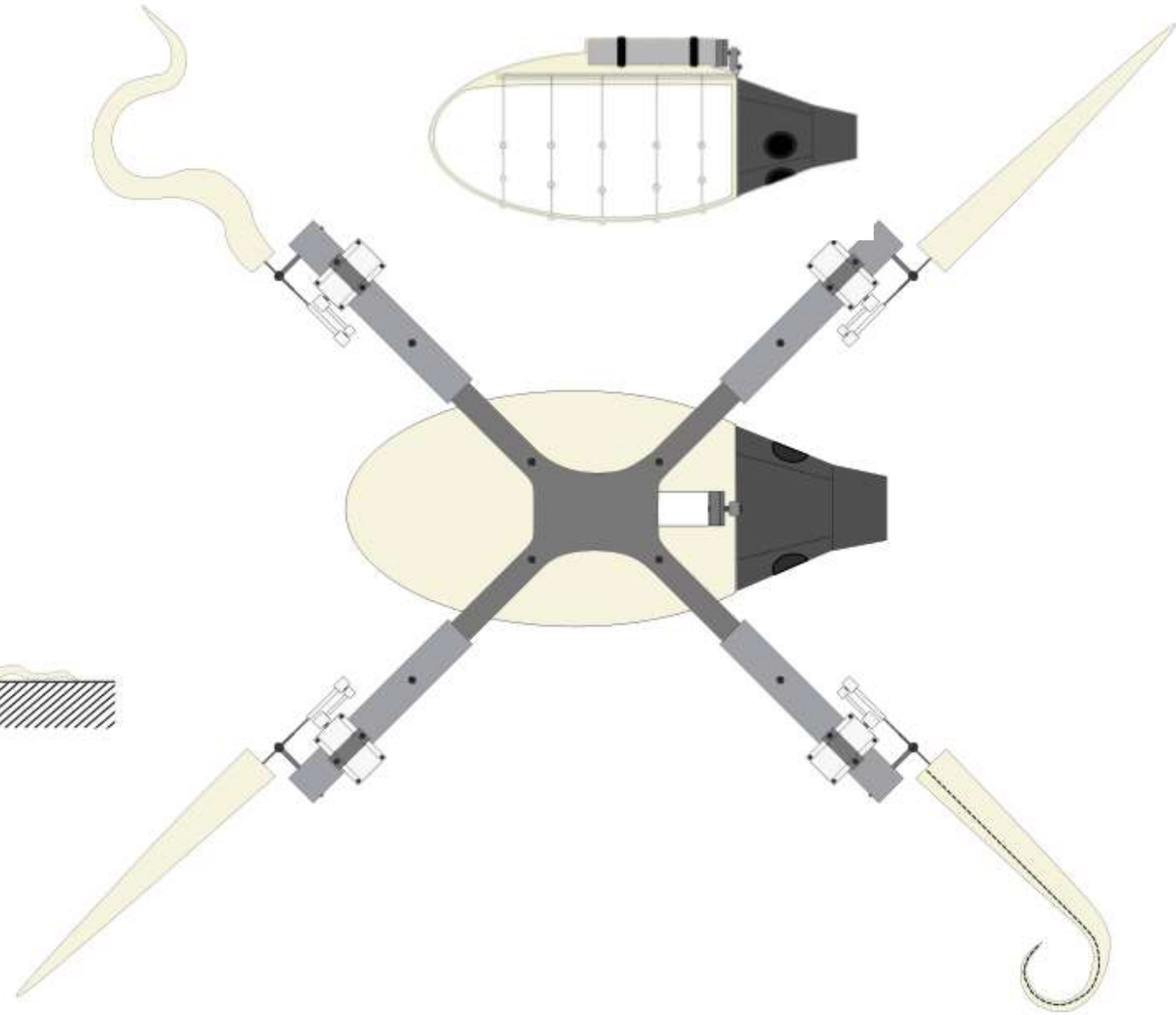

The first multi-locomotion prototype

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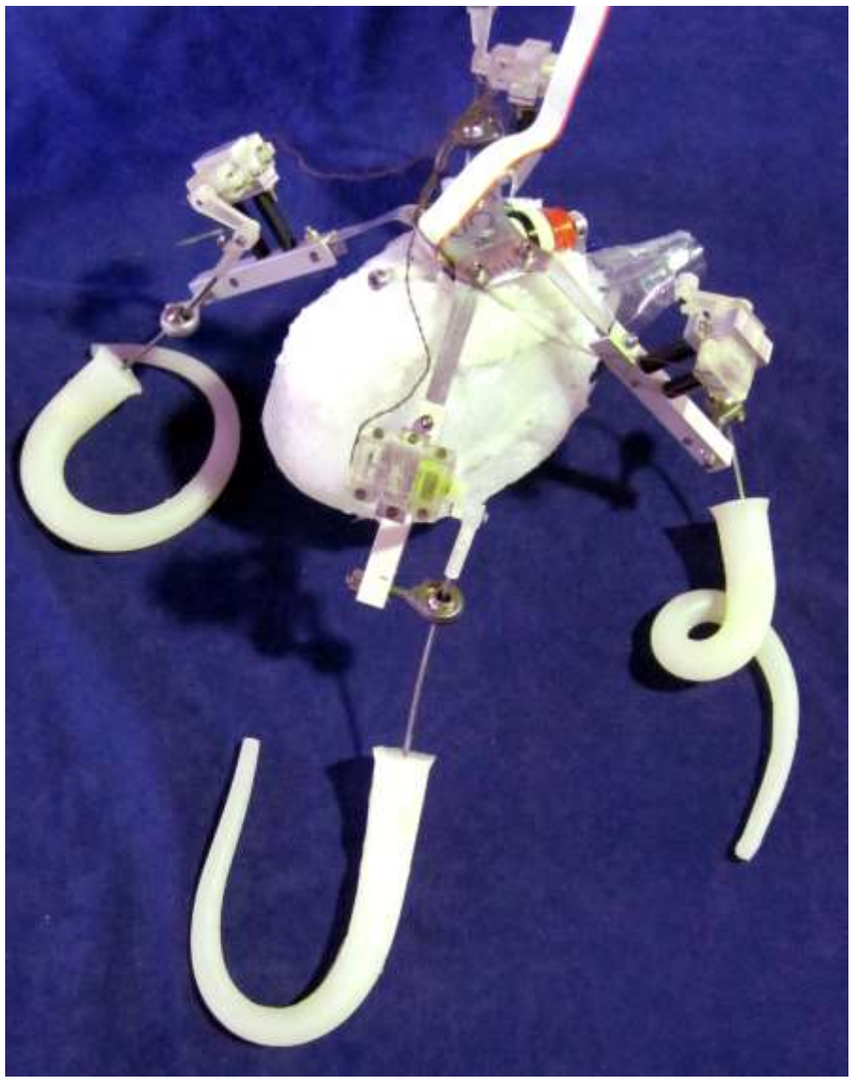

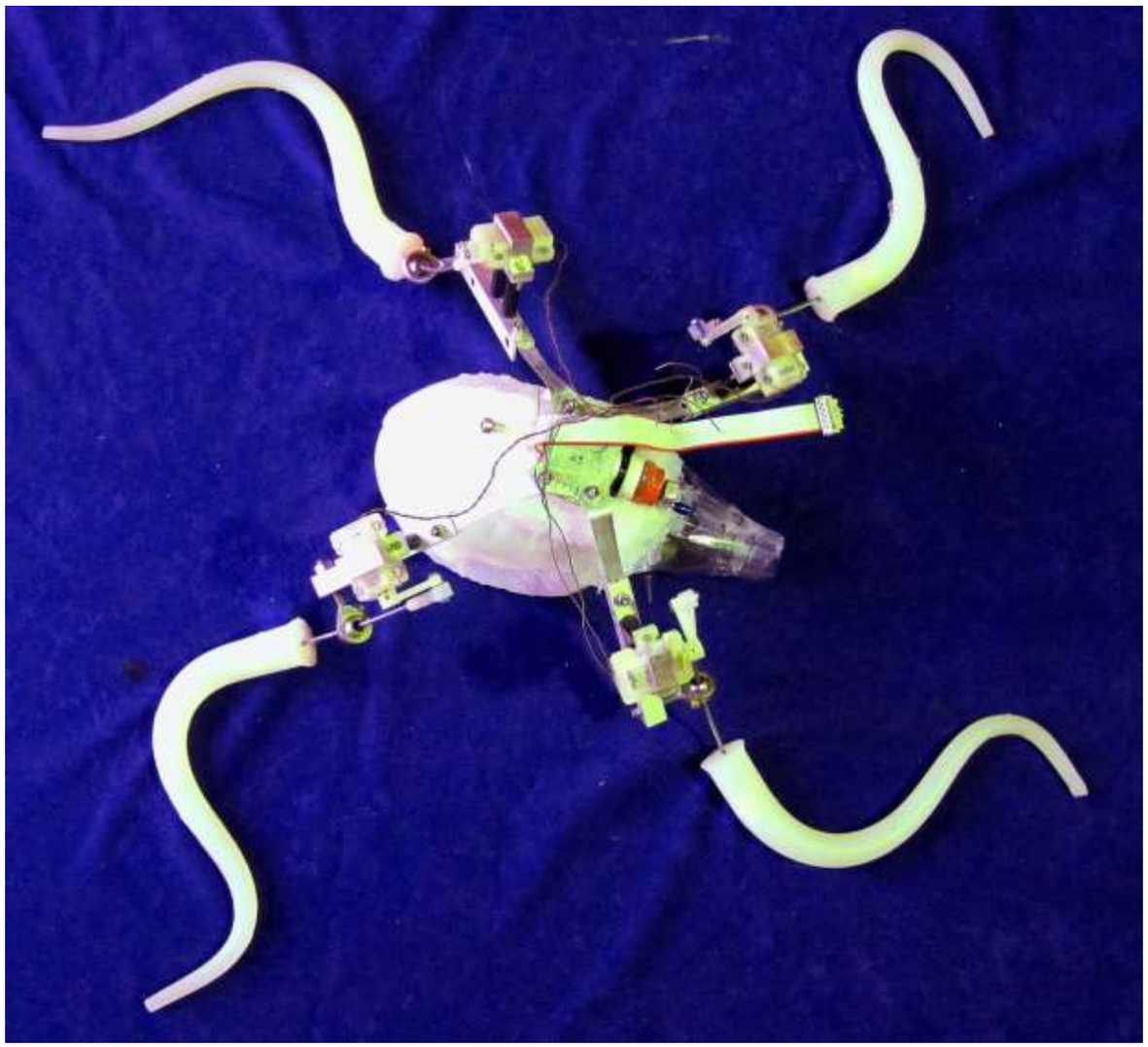

The first multi-locomotion prototype

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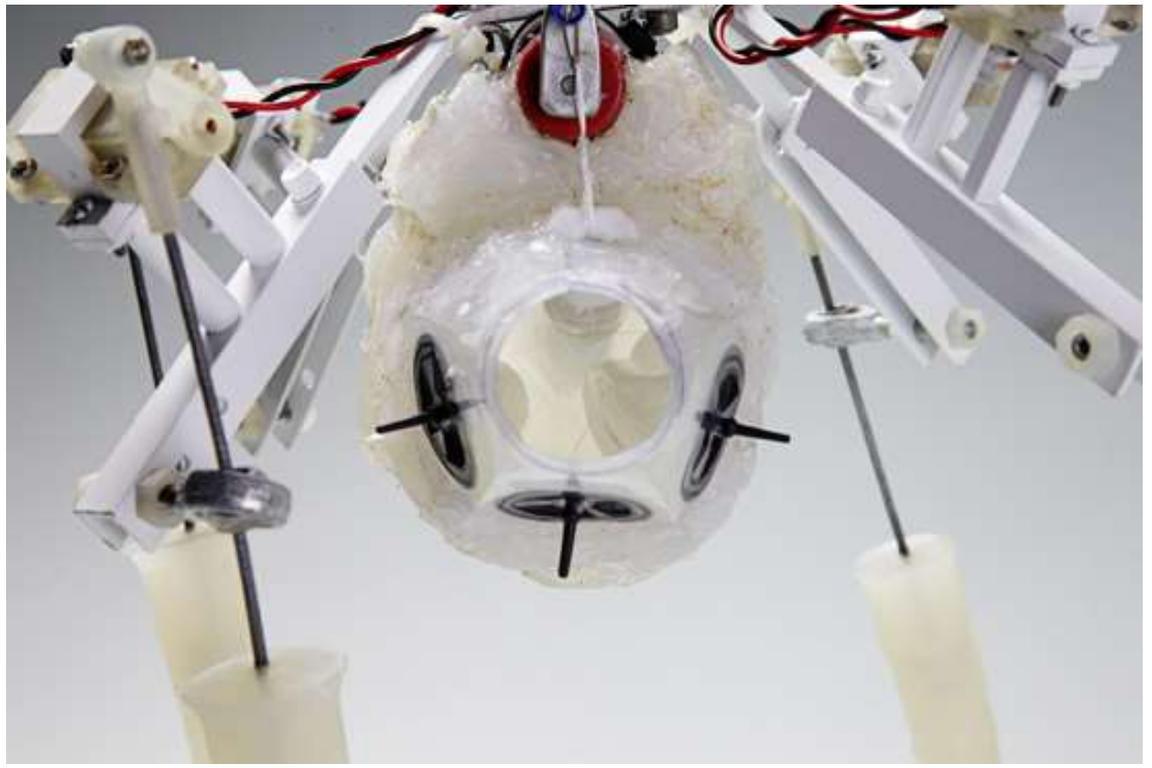

The first multi-locomotion prototype

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Tank testing

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crawl-swim cycles over plain terrain

crawl-swim cycles while holding object

Deployment testing

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from a harbour inside a marina

from a boat in open waters

Test at sea

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crawling over the sea floor

Advantages of Soft ROVs

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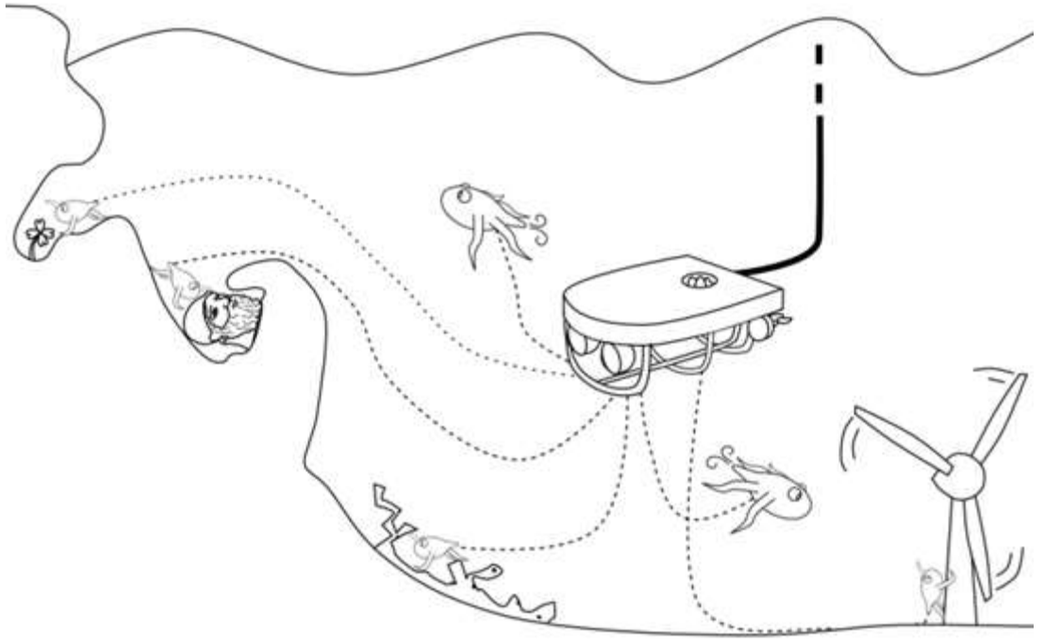
	PoseiDRONE (Soft)	**Traditional Robots (Hard)**
Safe Distance (human and/or environment)	Low (can move over surfaces or objects)	High (must avoid contact)
Control Strategy	Simple (simplified by bioinspired design)	Complex (fine control to avoid impact damage)
Docking/Deployment Systems	Simple (low risk of loss or damage)	Complex (high risk of loss or damage)
Load Capacity	Low (related to body deformations)	High (related to robot design)
Noise Pollution	Low (noise reduced by the soft mean)	High (propeller low frequencies loud hiss)
Water-Proof Insulation	Simple (intrinsic waterproof insulation)	Complex (frequent maintainment required)
Working Environments/Conditions	Complex (work in confined space)	Simple (require open space)

Conclusions

- PoseiDRONE is the first example of a soft robot (80% in volume of silicone) with crawling, swimming and manipulation ability to ever venture in the open water;
- Will the "soft approach" have what it takes to win over traditional robotics in such a forbidding scenario as the offshore industry?



Come and see our posters…

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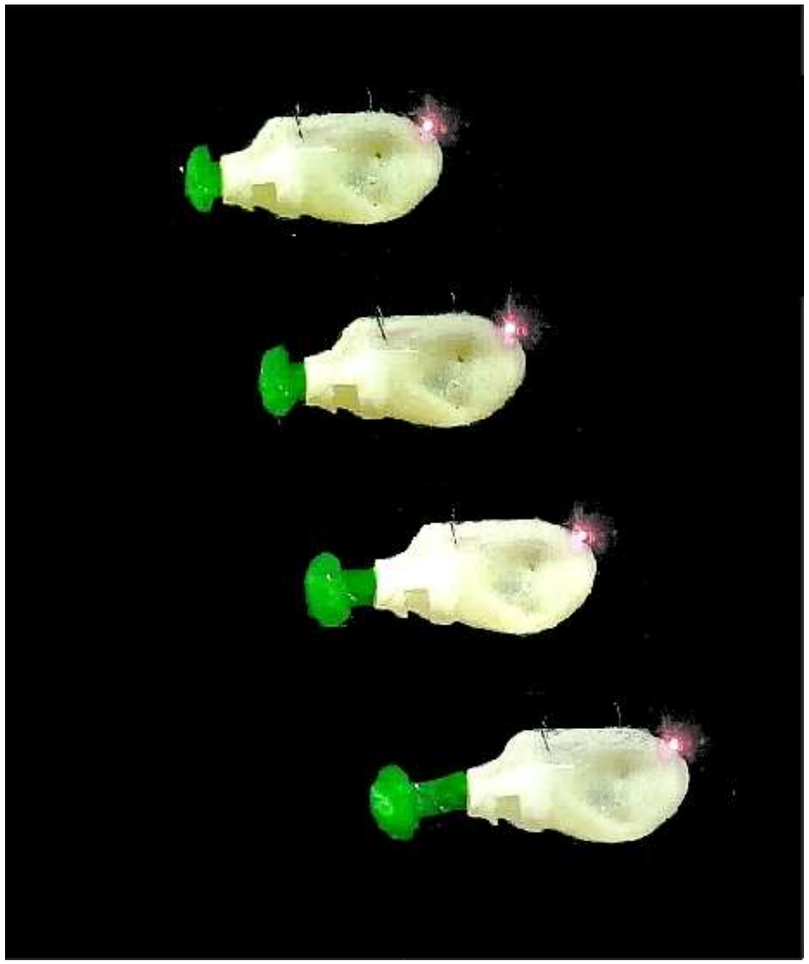
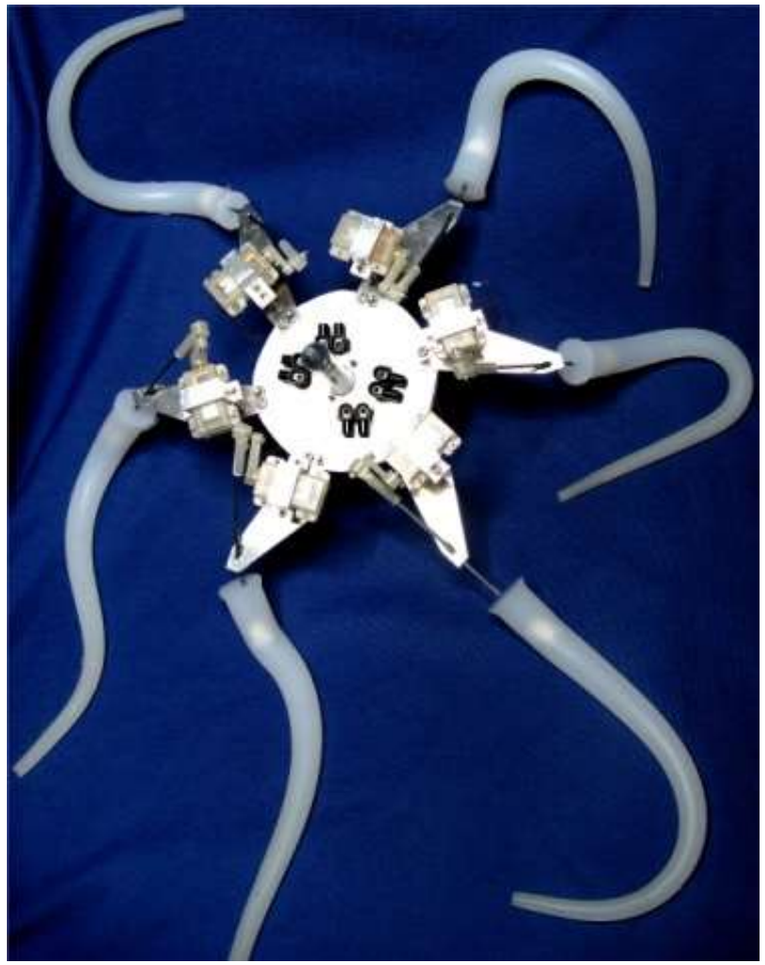


A soft, bioinspired pulsed-jet propelled underwater robot

Control strategies for soft robots

Geometrically exact modeling for soft robots



The bioinspiration design paradigm for legged soft robots