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Future and Emerging Technologies
ICT-2007.8.5 Embodied Intelligence

Partnership

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www.octopus-project.eu

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Project Information

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Project Duration: *48 months*

Project Cost: *9.745.000 €*

EC contribution: *7.600.000 €*

7 partners from 5 countries

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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

SEVENTH FRAMEWORK PROGRAMME

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Objectives

The grand challenge of the OCTOPUS IP is investigating and understanding the principles that give rise to the octopus sensory-motor capabilities and incorporating them in new design approaches and ICT and robotics technologies to build an embodied artefact, based broadly on the anatomy of the 8-arm body of an octopus, and with similar performance in water, in terms of dexterity, speed, control, flexibility, and applicability.

Octopus vulgaris

What is special in octopus is that its body has **no rigid structures**. Thanks to this, the octopus can adapt the shape of its body to the environment and its whole body can be squeezed into very small apertures. The octopus presents the capability to **twist**, **elongate**, **bend in all directions its arms** and, despite of the lack of rigid skeletal support, can **vary their stiffness** to apply relatively high forces. The control of this **large number of degrees of freedom** is highly distributed and is simplified by the use of stereotyped movements. The arms are effectively used to locomote on the diverse substrates of the sea bottom and to reach, grasp and even manipulate objects with **unexpected dexterity**.

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Novel Design Principles and Technologies

OCTOPUS IP aims at deep analysis of the tissues and materials properties, the biomechanics, kinematics and dynamics modelling, and the study of the sensing system and control systems strategies and of the ways in which these octopus features affect relationships and interactions with the environment.

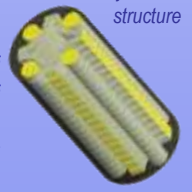
The anatomical, neuro-physiological and behavioural characteristics studied on the whole octopus will be applied to the design and development of the **8-arm robotic octopus-like artefact**.

The **distributed control system** of OCTOPUS envisages three levels: the **central behavioural architecture**; the **peripheral highly distributed sensory-motor control system** and the **mechanical ("embodied") intelligence**.

	ANIMAL	Functions:	ARTEFACT	
Central level	BRAIN	Scaling, adjusting and combining arm movements	BEHAVIOURAL ARCHITECTURE	From neuro-physiological & behavioural investigation
Peripheral level	ARM GANGLIA	Control of arm basic motion patterns	ARM CONTROL	From neuro-physiological investigation
Mechanical level	ARM TISSUES AND PASSIVE BIOMECHANICS	Reactive responses to environment	ARM MATERIALS & MECHANICAL PROPERTIES	From anatomical investigation

Distributed control system

The OCTOPUS system will present a **hierarchical system organization**, from materials (with a functional role in the design), to functional structural of the arm (composed almost entirely of tightly packed muscles organized into a special structure called **muscular hydrostat**).



Hydrostatic structure

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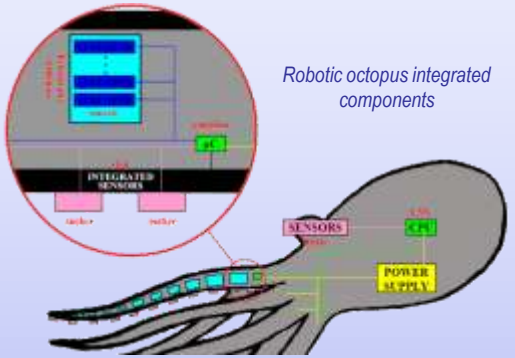
According to the principles of **biomechatronic design**, the different components of a system (actuators, sensors, materials) are designed from models of the reference biological system, in an **integrated** way.



Robotic octopus integrated components

Impact

OCTOPUS can be considered as a basic (scientific and technological) research project with an impact both in engineering and biology fields. **New science** and **new scientific** data will result from the focused research on the octopus, as well as from some of the experimental activities during the technological development phases. **New technology** and **new design principles** will come out in the form of prototypes, both for components and for an integrated system. The results expected from OCTOPUS will have an impact on academic researchers in engineering and biology and on the future development of ICT and robotics.

The final OCTOPUS artefact will be built with no use of rigid structures and show all the capabilities of an octopus. This can be used in exploration and monitoring tasks, for the capability to reach impracticable places, but also in maintenance or rescue tasks, because of the simultaneous manipulation capability.