# P R E S S  R E L E A S E

## European scientists build up a society of autonomous underwater robots for environmental monitoring of the Venice Lagoon

**The recently launched EU scientific project „subCULTron“ is on its way to create new standards in underwater environmental monitoring. The Venice Lagoon is the target area of the novel and also world's largest autonomous underwater robot swarm,finally consisting of120 robots of three different types, currently developed by an international team of scientists from Austria, Italy, Croatia, France, Belgium and Germany. The goal is to monitor the Venice Lagoon and its surrounding water body. The swarm approach makes it possible to gain a never before collected variety of data in parallel,which is expected to give new insights in the interplay of ecology, industry, and tourism of the Venice Lagoon that can helpin conservation of the region.**

**First prototypes of the subCULTron robot swarmand first experiments can be watched from October 15th to October 16that EXPO 2015 location in Venice.**

Monitoring the ocean concerning pollution, ecology and climate change effects is a costly, complex and elaborate task. An interdisciplinary team of European scientists is on the way to break new ground in this field. Within the EU funded project subCULTron theywork on establishing the world's largest intelligent underwater monitoring system that coordinates, communicates and collects data autonomously. The scientistsare designing a swarm of autonomous underwater vehicles, consisting of three different types of robots, each of them specialized for a certain task, called“aFish”, “aMussels”and “aPads”(detailed information in: „How is the subCULTron swarm working?“). These three robot types aren't controlled by humans, they communicate and interact via bio-inspired algorithms in an autonomous way.

### Why was the Venice Lagoon chosen as target area for experiments?

The Venice Lagoon was chosen as experimental area, because this region and its underwater world offers an enormous biological and ecological variety that is strongly influenced by industry, inhabitants and tourism. Experiments with the subCULTron autonomous underwater swarm will take place in the channels of Venice, in the surrounding salt marshes and in a mussel farm nearby. In total, a huge number of different data from different habitats with various influences can be collected and be analysed by scientists afterwards. Collected data (e.g. water quality) will also be published on google maps for the public. This waysocietycan directly profit from the information gained by the subCULTron swarm. In this way a feedback loop between human society and the autonomous robot society will be established.Decisions of humans, based on information provided by the swarm, will in turn influence future data collection of the swarm. As the Venice Lagoon is known to be in danger of being strongly affected by climate change, collecting as much data as possible from different areas can help to get a better understanding of the multilayer interplay of human influences on the water body of the Venice Lagoon.Thiscan also help to find ways to defend the world heritage from future threats.

## Why using an autonomous swarm for sea monitoring and how does it work?

To set up a close-knit environmental monitoring system in the Venice Lagoon, the scientists decided to follow a swarm approach with autonomous communication among the robots, because such systems are known to be very robust, flexible, and scalable especially in unpredictably changing environments. Another advantage of developing a self-organizing robot society is that the single robots can be cheap and small compared to conventional underwater robots.This makes it possible to built a fleet consisting of about 120 robots to enlarge the data collection area.

The subCULTron swarm is going to consist of three different robot types, that are designed and developed especially for the project and that represent cutting edge technology and software: **a**rtificial**M**ussels(aMussels) are novel autonomous robots that sit on the ground after being deployed in the water to collect various data over a long time, establishing a specifically designed sensory network this way. When necessary, they will also be able to move as a group, exploiting given energy sources, e.g., turbulences or water currents. **A**rtificial**F**ish (aFish) are fast and agile underwater robots that are used to monitor the ground and to search for given targets. They also bridge communication between aMussels and**a**rtificial**P**ads (aPads). Such aPads are robots that float on the water surface, inspired by lilypads on a pond. They complete the communication chain from aMussels on the seabed via aFish to aPads and finally to the scientists in the lab. All three different robot types are planned to run efficiently concerning energy for a certain time by using advanced energy harvesting techniques established by the project team.

## Bio-inspirationis a key methodin hardware and softwaredesign

Bio-inspired communication:Bio-inspiration is used for hardware and software-design of the robot fleet. The fleet communicates via bio-inspired algorithms that are derived from social insects like honeybees or by slime molds or fish, because these natural systems also work without a central unit of control, which makes these systemsresilienteven if single robots fail. Bio-inspired algorithms make it possible that the swarm as a whole is aware of the inner state of all swarm members and that it also can make decisions collectively, what is very important in fast changing environments like the Venice Lagoon, where nature has to deal with a lot of different influences from humansociety.

Bio-inspired hardware design: aFish are inspired by real fish what makes the robots fast, agile and deep diving. aPads are inspired by lilypads:Additionally to floating on the water surface they are also able to react to natural circumstances like lightsources by changing the direction of their “leaves” that are equipped with solar panels to gain energy. aMussels are considered to become a totally new type of underwater robot. Their design is on the one hand inspired by real mussels:aMussels will be equipped with a self-protecting shell, and have a shape that makes it possible that aMussels can sit on the ground to collect data as well as they can move to different places by intentionally using given energy sources like e.g.,water turbulences.

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## What novelknowledge will the subCULTron swarm system produce?

For the region: With subCULTron the world's largest intelligentautonomous underwater monitoring system that consists of about 120 robots will be established. This swarm will not only be able to collect data from the seabed, it will also be able to autonomously choose where to collect these data and which data is needed. By following the "swarm approach", the area where data is collected can be widenedenormouslycompared to other state-of-the-art robots, because the subCULTron system works with rather cheap hardware:Thiswill allow to deploy large numbers of such robots in the water body. In consequence,human society will be able to gain needed data from environmental monitoring in largeamounts and from a largearea in a new, unique and cheaper way than before by using thedeveloped artificial robotic society.These data can be needed for abetter understanding of how industry, inhabitants, tourism and the natural water flora and fauna in the Venice Lagoon interact. By analysing these interactions positive and negative influences can be identified and necessary actions to protect the region can be effectually set.

For underwater technology: By constructing new cutting edge robots, the technology community will gain significant benefit in testing novel sensor-actuator concepts and by implementing energy harvesting technology. Also new technologies to communicate underwater,e.g., by using an electric field for robot-to-robot communication,open up novelpossibilities for underwater technology. Additionally, new systems for energy autonomy will be developed. The project aims to pave the way for industry to build up large fleets of underwater vehicle swarms for different issues from monitoring to harvesting and mining.

For ecology and biology:Not only technology and industry will profit from the project, but also biologists and ecologists will benefit from it:The analysis of the performance of the bio-inspired mechanisms on the robots will help biologists in interpreting the natural sources of inspiration. Ecologists will be able to gain new insights about the interplay of natural habitats, human interventions and the feedbacks between these two domains by utilizing the data collected by the subCULTron robots.

## Watch the first subCULTron prototypes work at EXPO 2015 in Venice

At the EXPO 2015 location in Venice, it isthe first time – since the launching ofthe project in April 2015 – that press and audience can get insights how the subCULTron project operates. From October 15th to October 16th2015 a dozen of scientists willlive demonstrate first robot prototypes in small pool experiments.

## You can find us at:

**When:** 15th to 16th Oct. 2015
**venue:** AQUAE VENICE 2015 Pavillion
**adresse:** Via Galileo Ferraris, 5 , Venezia Marghera
**link:** (http://www.aquae2015.org/where/?lang=en)

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**subCULTron factsheet:**

**Budget:** 4 millions(Euro)

**Duration:** 48 month (April 2015- March 2019)

**Team:**

- **Artificial Life Lab der University of Graz (Austria):** Project-coordination , bioinspiration
- **Scuola Superiore Sant'Anna (Italy):**Hardware developement
- **Faculty of Electrical Engineering and Computing, University of Zagreb (Croatia)**: Hardware developement
- **Université libre de Bruxelles (Belgium):**Controller development, Software development
- **CORILA - Consorzio per il coordinamento delle ricerche inerenti al sistema lagunare di Venezia (Italy):** Interface with Venice scientists and infrastructure
- **ARMINES (France):**Underwater sensory and communication
- **Cybertronica Research, Industriepartner (Germany):**Hardware developement and sensory systems.

**Links:**
http://www.subcultron.eu
http://zool33.uni-graz.at/artlife/subCULTron

The project subCULTron is a follow-up from the project EU-„CoCoRo“ which was lately rated „excellent“ by an international reviewer-team of the European Commission in late 2014. For more information about CoCoRo, its challenges and its achievements, please visit:

http://cocoro.uni-graz.at/drupal/
https://goo.gl/duQgfS

**Funding scheme:**
This project is funded in the FET-PROACTIVEscheme of the EU FET unit (Future and Emerging Technologies):

**http://ec.europa.eu/programmes/horizon2020/en/h2020-section/future-and-emerging-technologies**

**https://ec.europa.eu/digital-agenda/en/fet-proactive**

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(subCULTron scenery image is available for reprint in press with non-exclusive copyright)