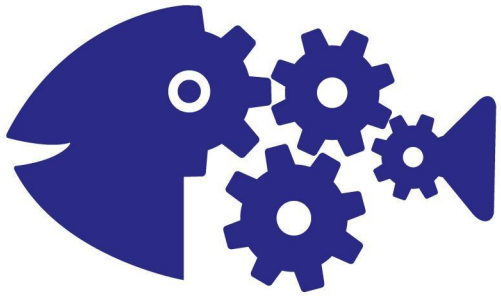


subCULTron

Subcultron

A learning, self-regulating, self-sustaining underwater society/culture of robots

Ronald Thenius

Artificial Life Lab - University of Graz

subCULTron

What is subCULTron about?

- Robots
- Underwater
- Swarms
- Using “Culture”

What is the “big vision”

“A swarm of robots, on and under the water has to operate in highly dynamic and complex environment (including humans), including adaptation to local conditions for long time measurement of environmental factors.

What are the topics of this talk?

- What is subCULTron, what is it about?
- What can we DO WITH the subCULTron system?
- Our Algorithms

What is subCULTron?

Facts:

EU funded project

Partners: 7

Involved Countries: 6

Involved Companies: 1

Duration: 48 month

Started at: 1.4.2015

Call: H2020-FETPROACT-2014

Budget: 4 Mio. Euro

Coordination: University of Graz

What is subCULTron?

What is subCULTron?

Objectives:

- Environmental monitoring of Venice Lagoon with the world's largest swarm of autonomous underwater robots.
- Novel bio-inspired robot designs, bio-inspired sensing & actuation.
- Energy efficiency, energy autonomy, and energy-harvesting.
- Long-term autonomy.
- Human society & ecosystem interact with a robotic society and vice versa.

What is the field of operation

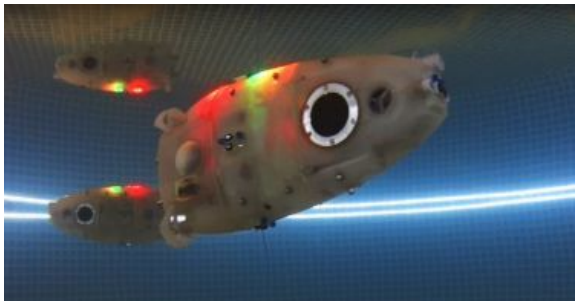
What is the field of operation

Who are the “players”?

There are **THREE** types of robots in the subCULTron swarm:

aPads inspired by Lilies

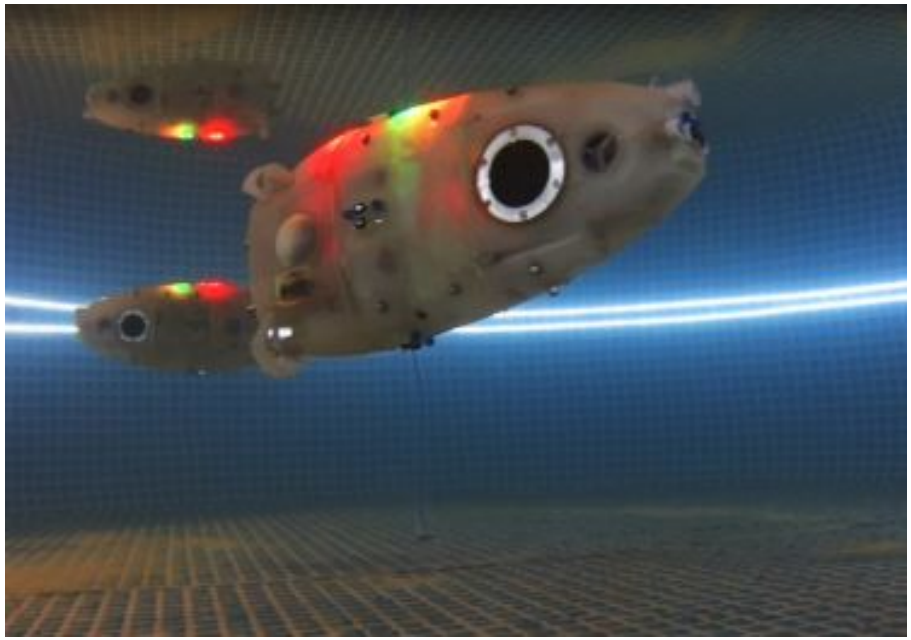
aFish inspired by Fish



aMussels inspired by clams

subCULTron

aFish



- Mobile
- Used for communication
- Used for localization
- Planned number of robots: 20

aPad

- Powerful
- Solar cells
- Radio Communication
- Planned number of robots: 5

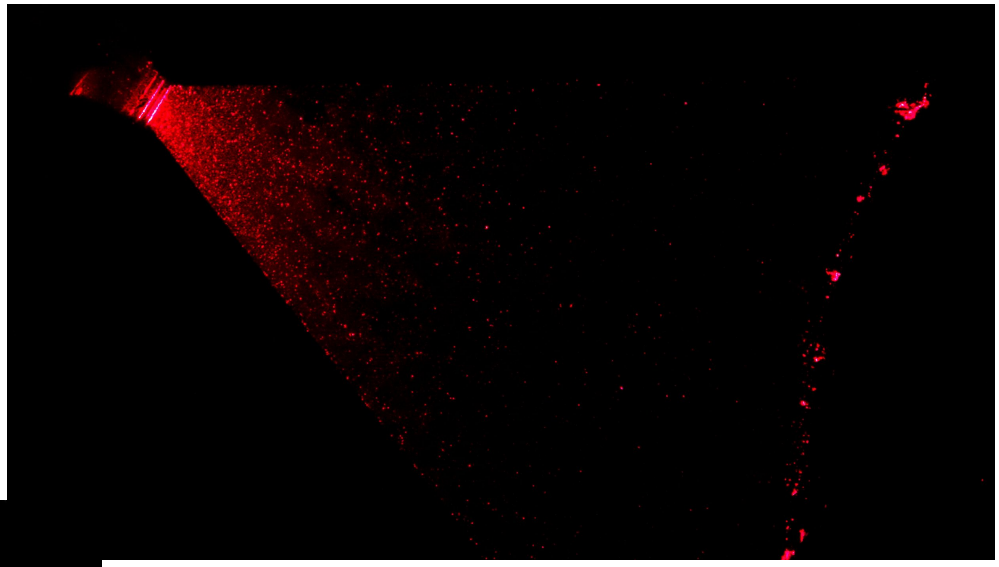
aMussel

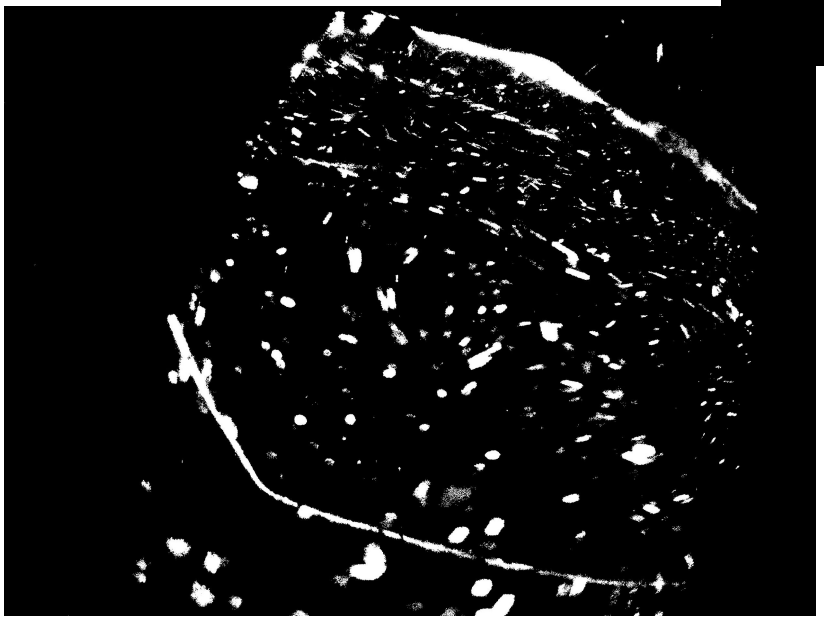
- Very long runtime
- Many sensors
- Passive movement
- Electric sense
- Near field communication
- Energy harvesting
- Planned number of robots: 120

aMussel

- **Sensors:**
- Depth
- Temperature
- Turbidity
- Impedance spectroscopy
- Electric sense
- Camera with light
- Camera with laser

aMussel - Laser





What can we DO WITH the subCULTron system?

We plan to “use”* the subCULTron swarm for several tasks, but my most prefered ones are:

*in our case better: “test”

Reference measurements

- Measure from Satellite
- Deliver reference measurements

Reference measurements

12.8.2017, 12:35:04
Need: 32 measurements
Need: turbidity, temperature, algae-status

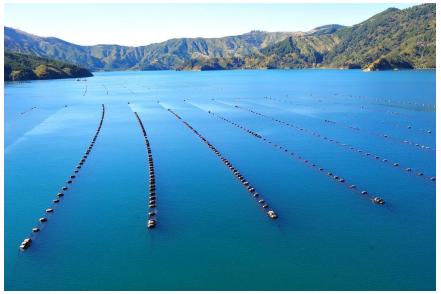
Reference measurements

Reference measurements

What are the tasks - the "Musselfarm-Scenario"

What are the tasks - The “Mussel Farm-Scenario”

- Observe lifeforms (fish)
- Record environmental data
- Do not interfere with structures
- Operate under relatively strong water current conditions



What are the tasks - “Drift-n-Measure”-Scenario

“Environmental-Based Drift-Movement”
Use tide-based water movements, combined with online available weather data to organise drift movements.

“Warp-Measurement”:
In short sequence: dive, measure, re-surface, synchronize...

Algorithms

- Big Variety:
  - “TopDown” controlled: aPad does the “thinking”
  - Homogenous Control for heterogeneous robot swarm
  - “Bottom up” controlled

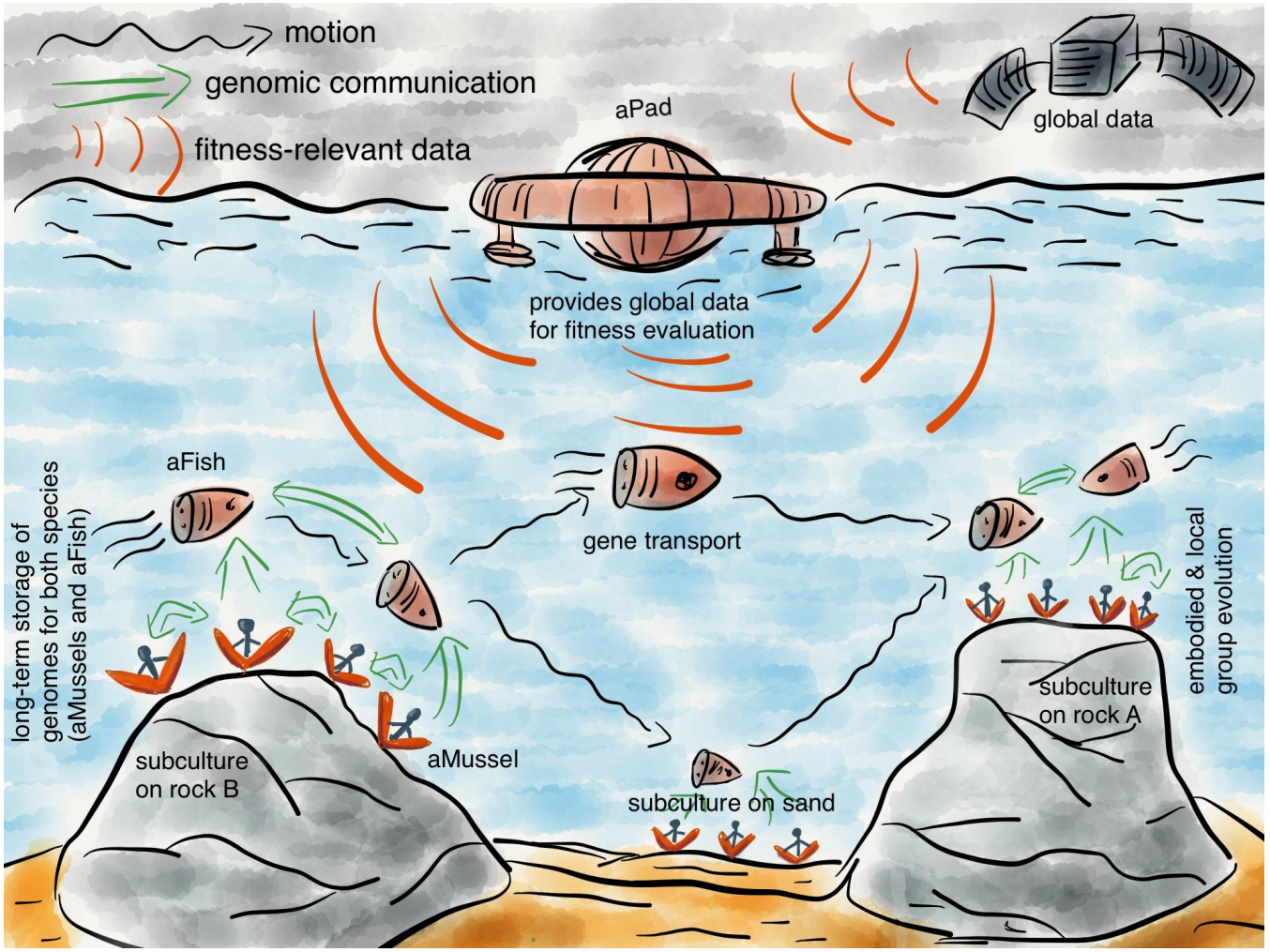
“TopDown” controlled

- aPads controls actions of the swarm
- aMussels are sensor nodes moved by the aPad
- aFish function as mobile sensor network

“Bottom-Up” controlled

- aMussels form network, that decides what to do.
- aPads are “used” by the swarm
- aFish function as communication vector
- very bioinspired

Culture?


motion
genomic communication
fitness-relevant data
aPad
global data
provides global data
for fitness evaluation
aFish
gene transport
long-term storage of
genomes for both species
(aMussels and aFish)
embodied & local
group evolution
subculture
on rock A
subculture
on rock B
aMussel
subculture on sand

Culture!

- Subgroups of agents adapt to a given situation
- Newcomers can easily adapt to local situation
- Mobile agents carry information from one subgroup to other
- Advantages behaviors are developed in sub-swarms and stored there

Conclusion

- subCULTron is a project that develops a swarm of underwater robots
- The subCULTron swarm will operate in Venice
- In subCULTron the concept of “Culture” as tool to increase efficiency is tested in robot swarms
- subCULTron is a robot swarm hardware platform for different applications in shallow water

Thank you