learning, interpreting, and adapting to the diver's behaviour and physical state

CADDY

Cognitive Autonomous Diving Buddy

SEVENTH FRAMEWORK PROGRAMME

http://www.caddy-fp7.eu/

Key facts:
FP7-ICT Cognitive Robotics STREP with 7 partners
EU contribution: €3,7 million
Duration: 36 months, starting 01/01/2014
Coordinator: UNIZG-FER

Consiglio Nazionale delle Ricerche

LISBOA

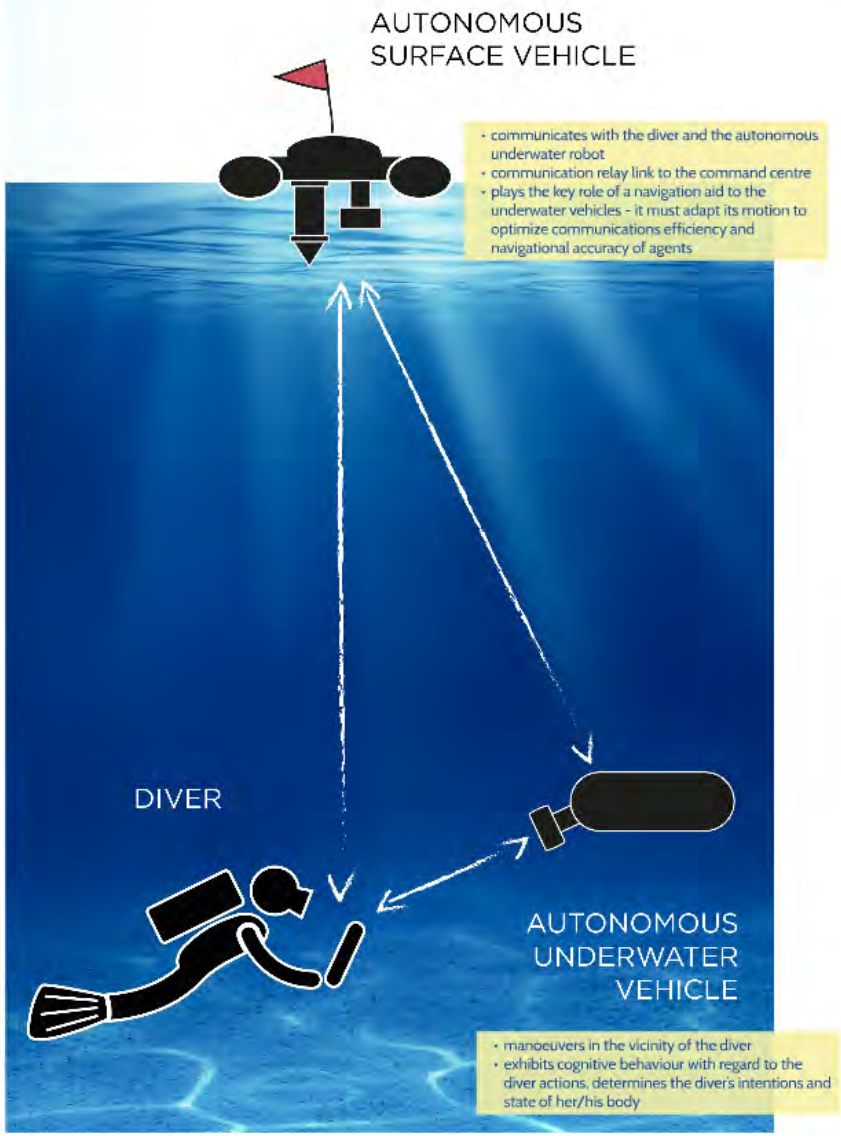
JACOBS UNIVERSITY

universität wien

Newcastle University

DAN EUROPE

- ~1 fix per second



What?

Set up symbiotic links between a human diver and a set of companion autonomous robots (underwater and surface).

How?

By developing a multicomponent, highly cognitive robotic system capable of learning, interpreting, and adapting to the diver's behaviour and physical state

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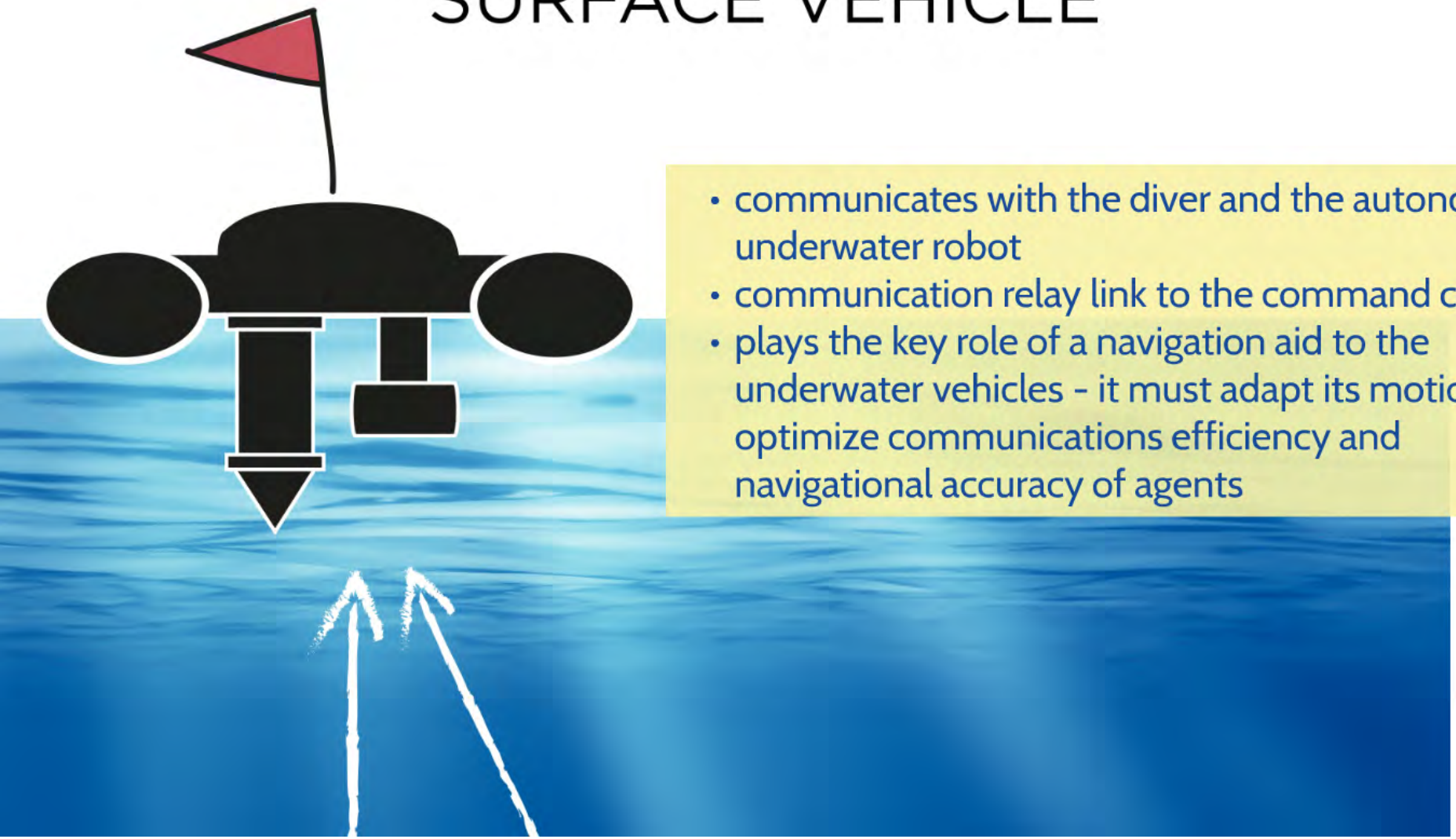
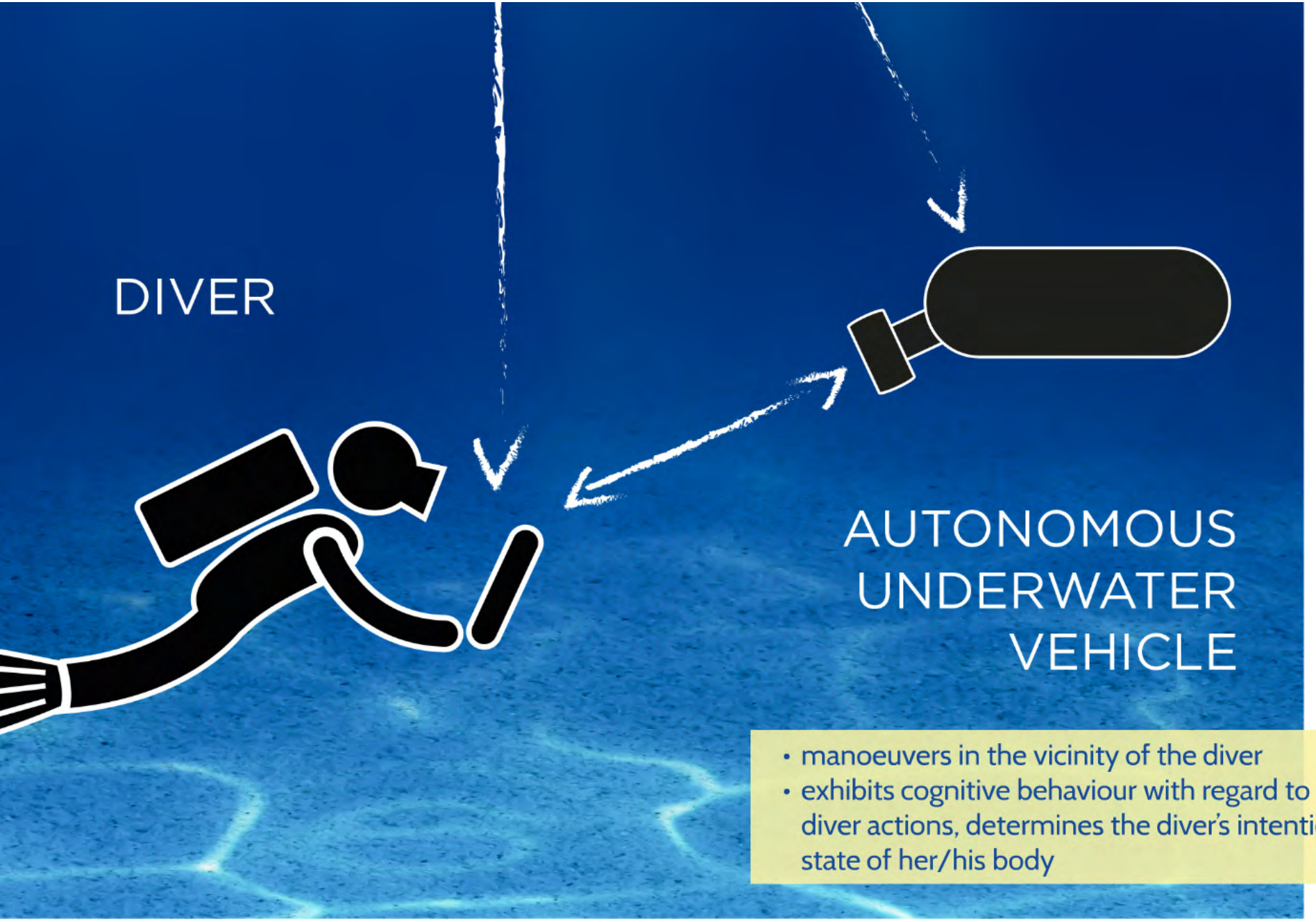
AUTONOMOUS SURFACE VEHICLE

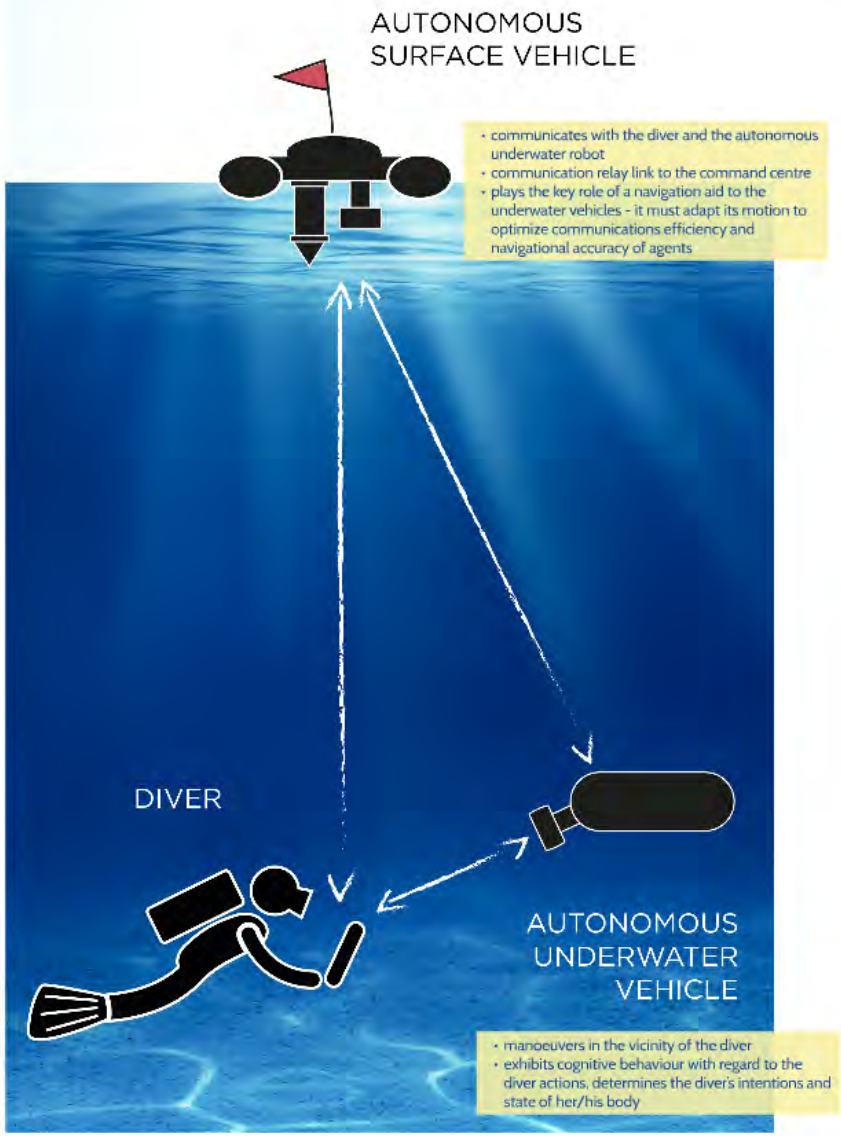


- communicates with the diver and the autonomous underwater robot
- communication relay link to the command centre
- plays the key role of a navigation aid to the underwater vehicles - it must adapt its motion to optimize communications efficiency and navigational accuracy of agents



- manoeuvers in the vicinity of the diver
- exhibits cognitive behaviour with regard to the diver actions, determines the diver's intentions and state of her/his body

- ~1 fix per second



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- guides (upon request) the diver from one spot to another, along a predefined search path,
- steers the diver safely to an appropriate point at the surface
- acts as an intelligent communication router in situations where the diver loses line-of-sight to the surface vessel.

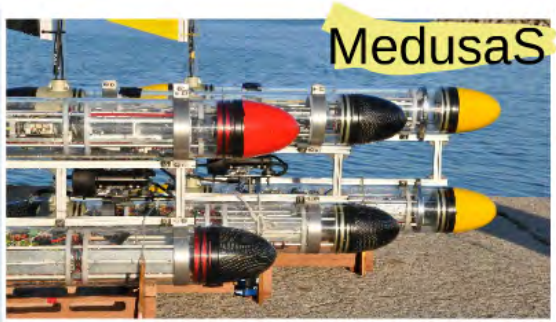
dive observer

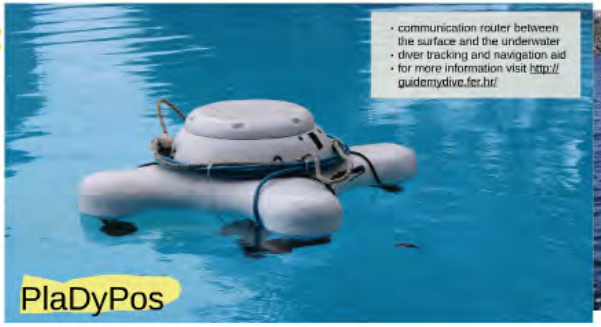
- observes the diver at all times
- interprets diver's behaviour and symbolic gestures communicated by the diver.
- manoeuvres safely around the diver in order to assume the best viewpoint for observation;

dive slave

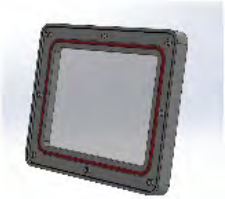
- hovers over a spot indicated by a laser beam and takes photos of the location
- follows the diver
- performs a mosaic of an indicated area,
- illuminates a site from different angles upon request from the diver,
- carries a payload with tools and equipment.

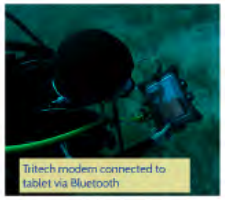
Surface segment





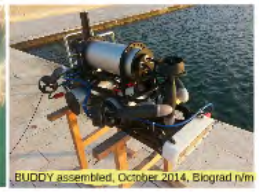
Linking the diver

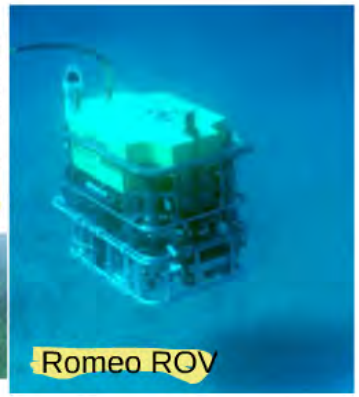


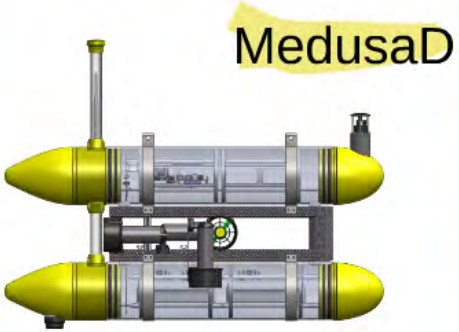


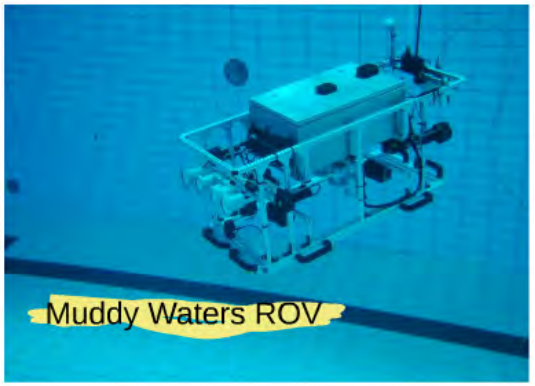
Underwater segment

Buddy AUV









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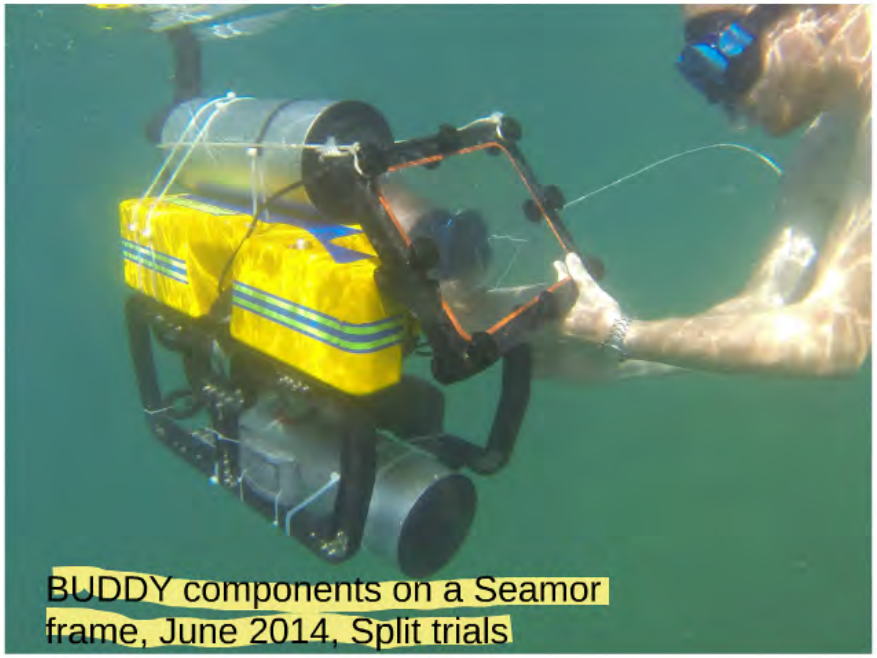
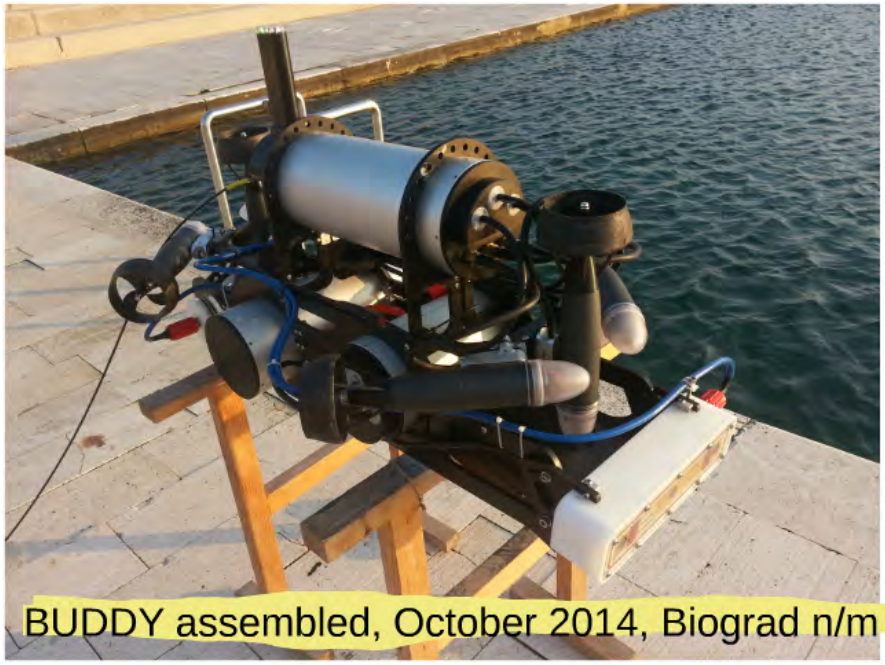
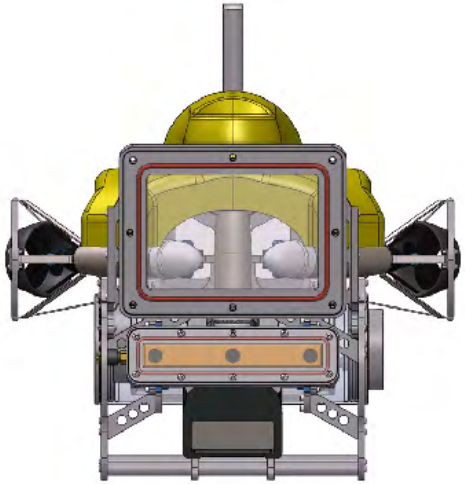
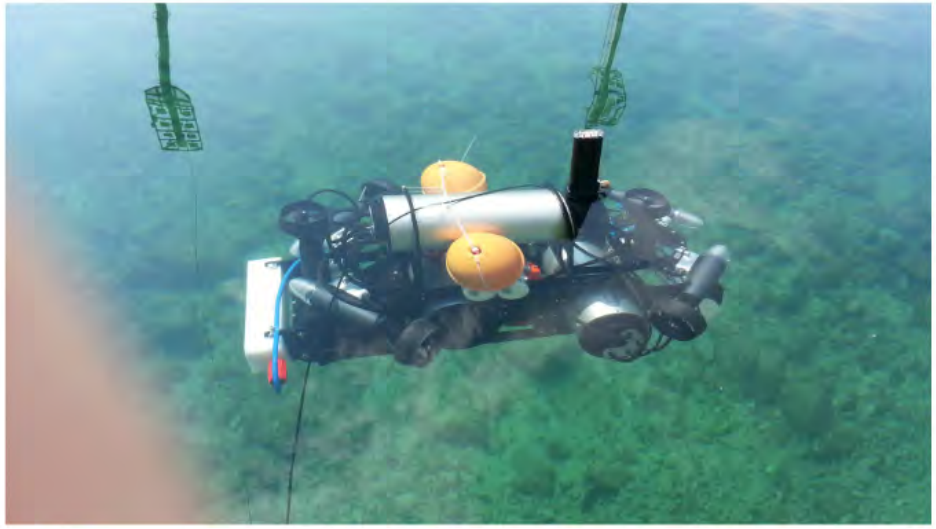


BUDDY components on a Seamor frame, June 2014, Split trials

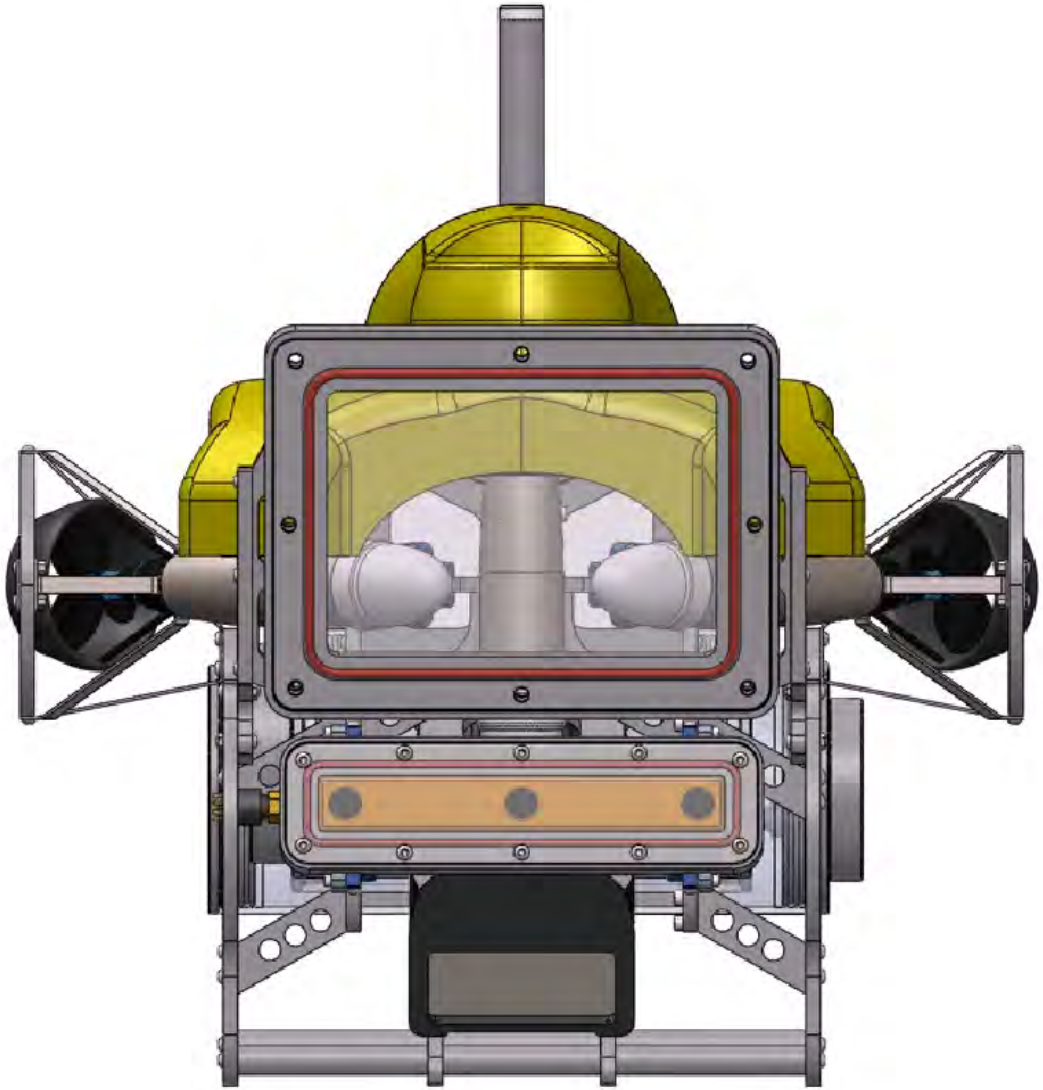


BUDDY assembled, October 2014, Biograd n/m

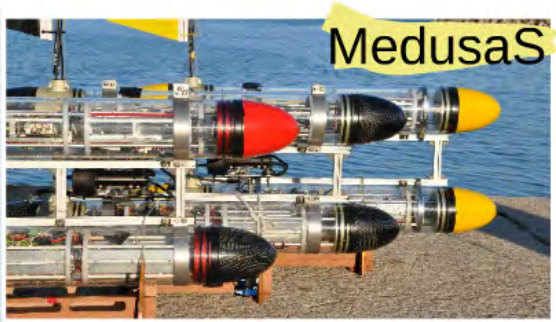


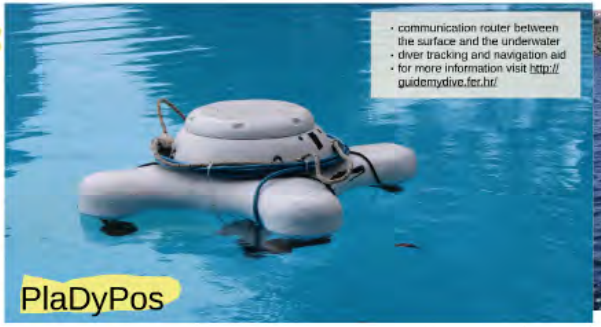


Frame, June 2014, Split trials

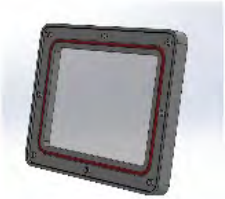


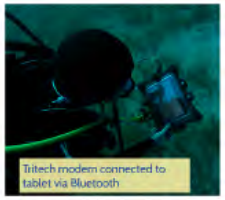
Surface segment





Linking the diver





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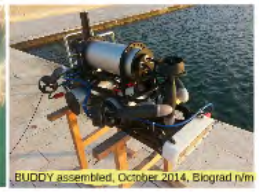
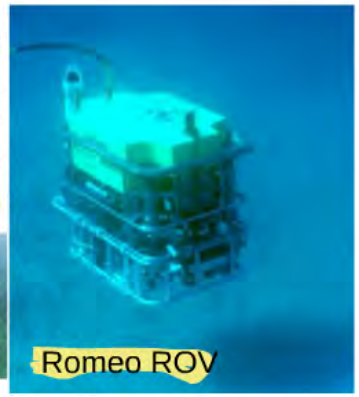
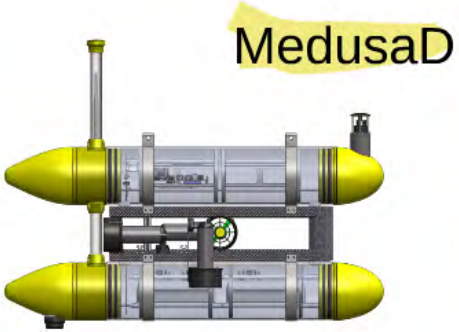
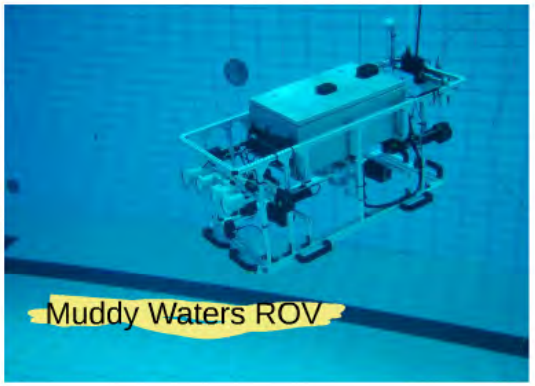








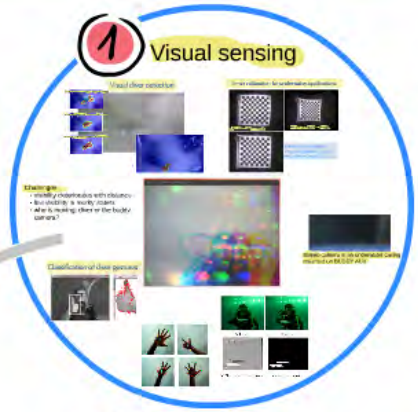
Tank tests

- USBL fix repeatability assessed (<< 1 deg).
- Range repeatability <10cm.
- ~1 fix per second

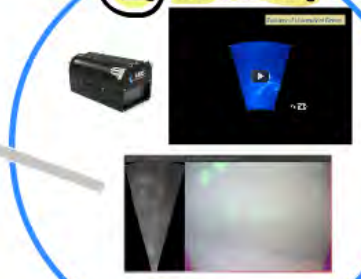
WP2
Seeing the diver

recognition of hand gestures
diver pose estimation
ego-motion compensation
wireless DiverNet transmission
Remote sensing fusion

1 Visual sensing



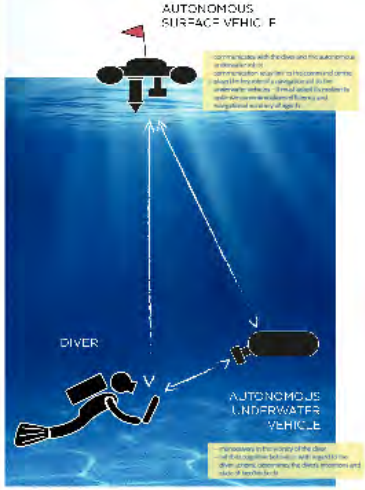
2 Sonar sensing



Challenges
- low quality data
- low nar beam width

3 DiverNet

Challenges
- wireless transmission to the surface
- low bandwidth



Trials in Caska
Island Pag, Croatia
May 2014

Trials in Y-40 pool
Padova, Italy
June 2014

1. Emotional breathing

Caddian,

Trials in Caska, Island of Pag, Croatia, May 2014

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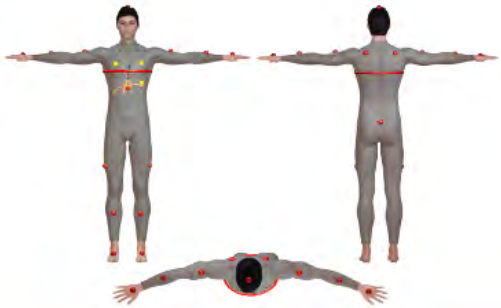
3 DiverNet



Challenges

- wireless transmission to the surface
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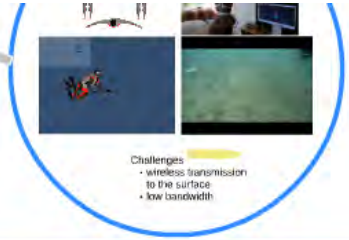
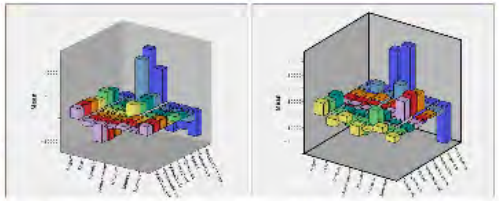
Seeing the diver



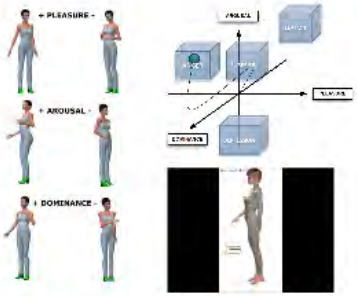
1. Emotional breathing



Parameters	Anger	Fear	Disgust	Amusement	Sadness	Surprise
Respiration rate	→	→	↑	↑	→	→
Resp. Turbulence	↓	→	↑	↑	→	→
Heart rate	↓	→	↓	→	→	↓
Heart Turbulence	→	→	↑	↑	→	→

2. Breathing through regulator

3. Internal states and posture

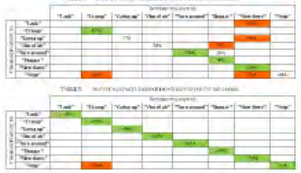


Caddian, the diver-robot language

"I follow you" (i.e. You lead) ↔ A I F Y ∀

SYNTAX	A	I	F	Y	∀
GESTURES					
SEMANTICS	I follow you				

Recognition of hand gestures



WP3 Understanding the diver

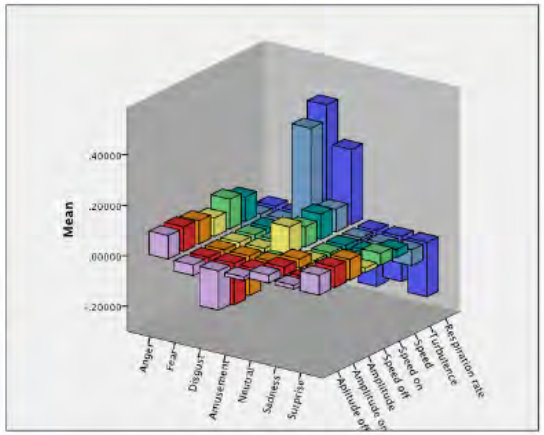
adaptive interpretation of diver behaviour

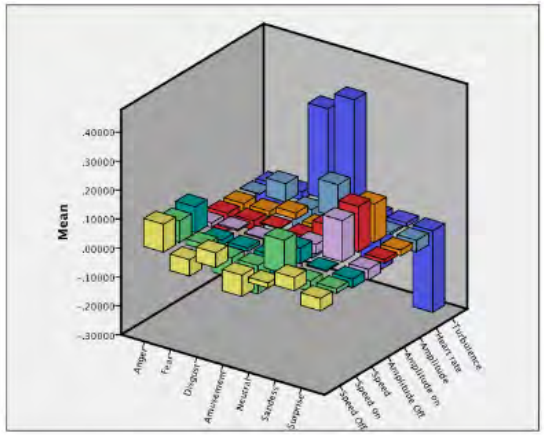
emotional breathing

cognition-based mission (re)planner

symbolic language interpreter

1. Emotional breathing





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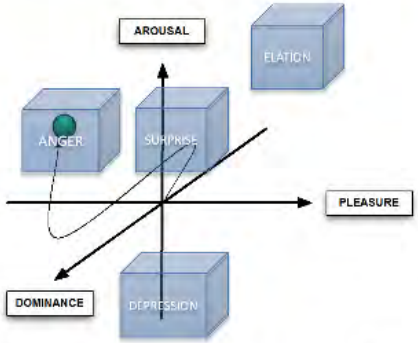


Cado

SYNTAX
GESTURE
SEMANT

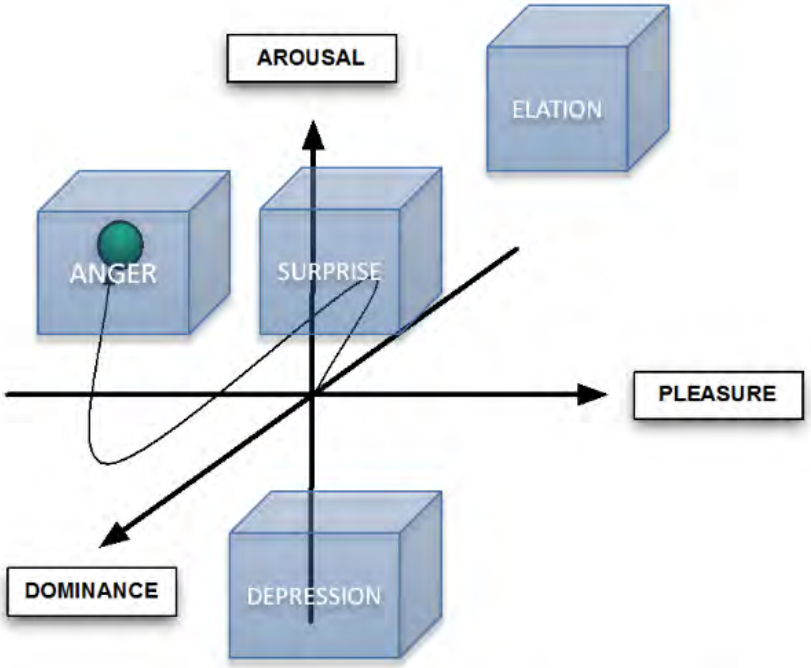
R
g

WP3

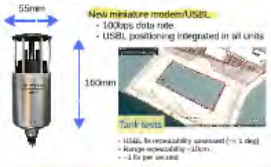
p_-1_a_-1_d_-1
Department of
Anthropology

or

3. Internal states and posture



WP1
ulticomponent system



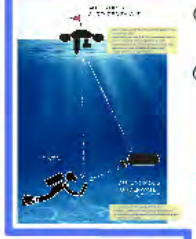
New miniature modem/USBL
- 100bps data rate
- USBL positioning integrated in all units

Tank tests

Visual sensing

Sonar sensing

DiverNet



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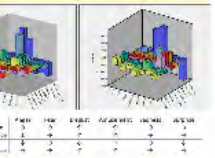

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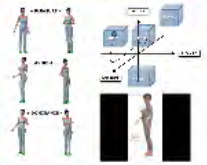

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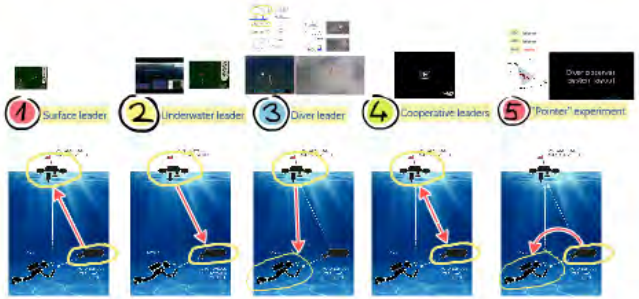
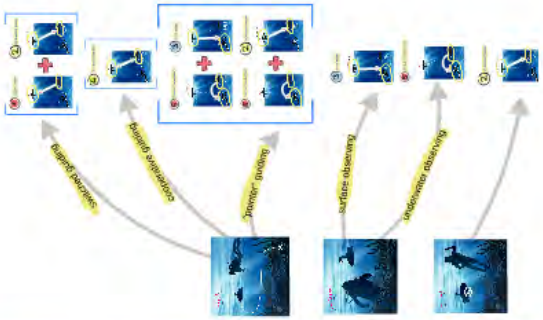
SYNTAX	A	I	F	Y	V
GESTURES					
SEMANTICS	I follow you				

Recognition of hand gestures

WP4
Diver-robot cooperation and control

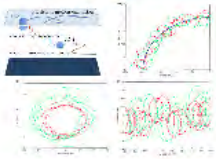
Cooperative control and optimal formation keeping





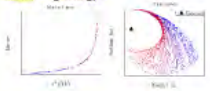
Cooperative distributed navigation and localization

Range-based Navigation

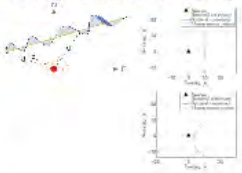


Range-based target localization

Minimizing energy



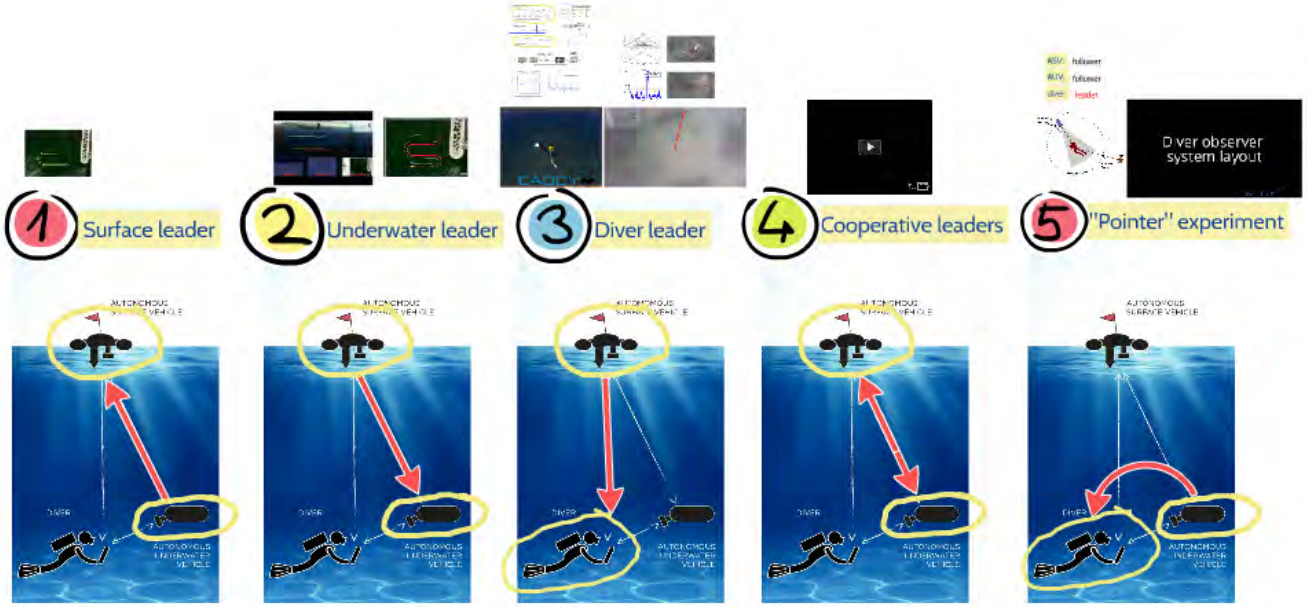
Minimizing deviation from nominal trajectory

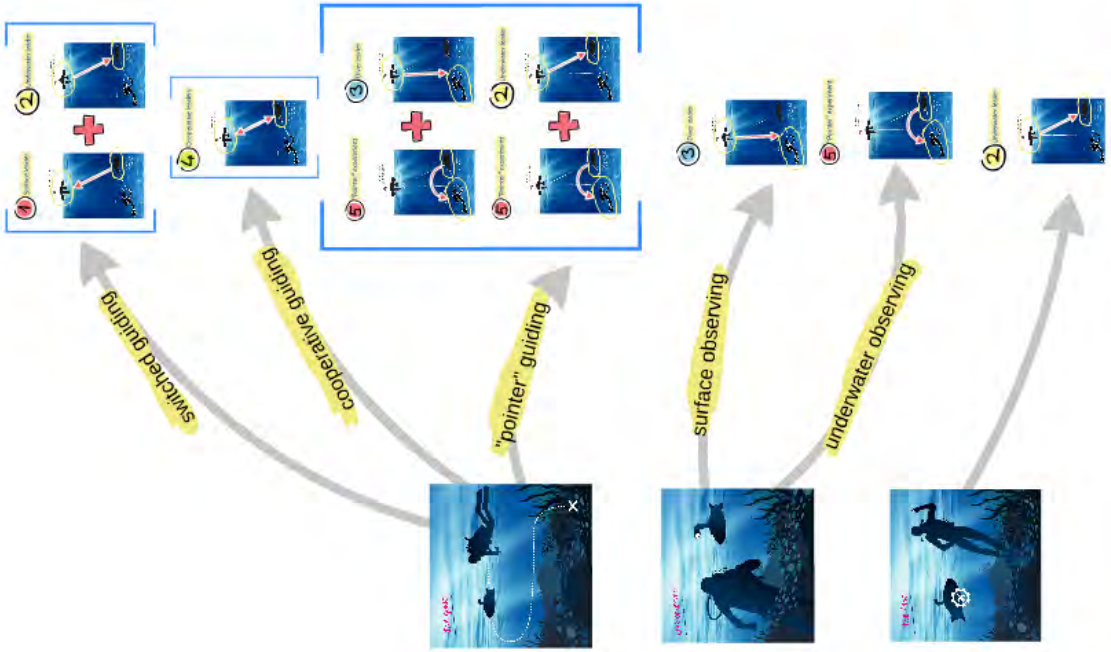


Extremum seeking

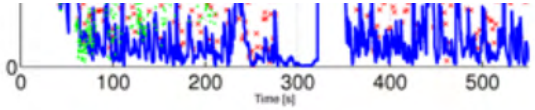
http://www.caddy-fp7.eu/

Cooperative control and optimal formation keeping





UWSim
CADDY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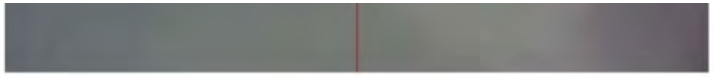
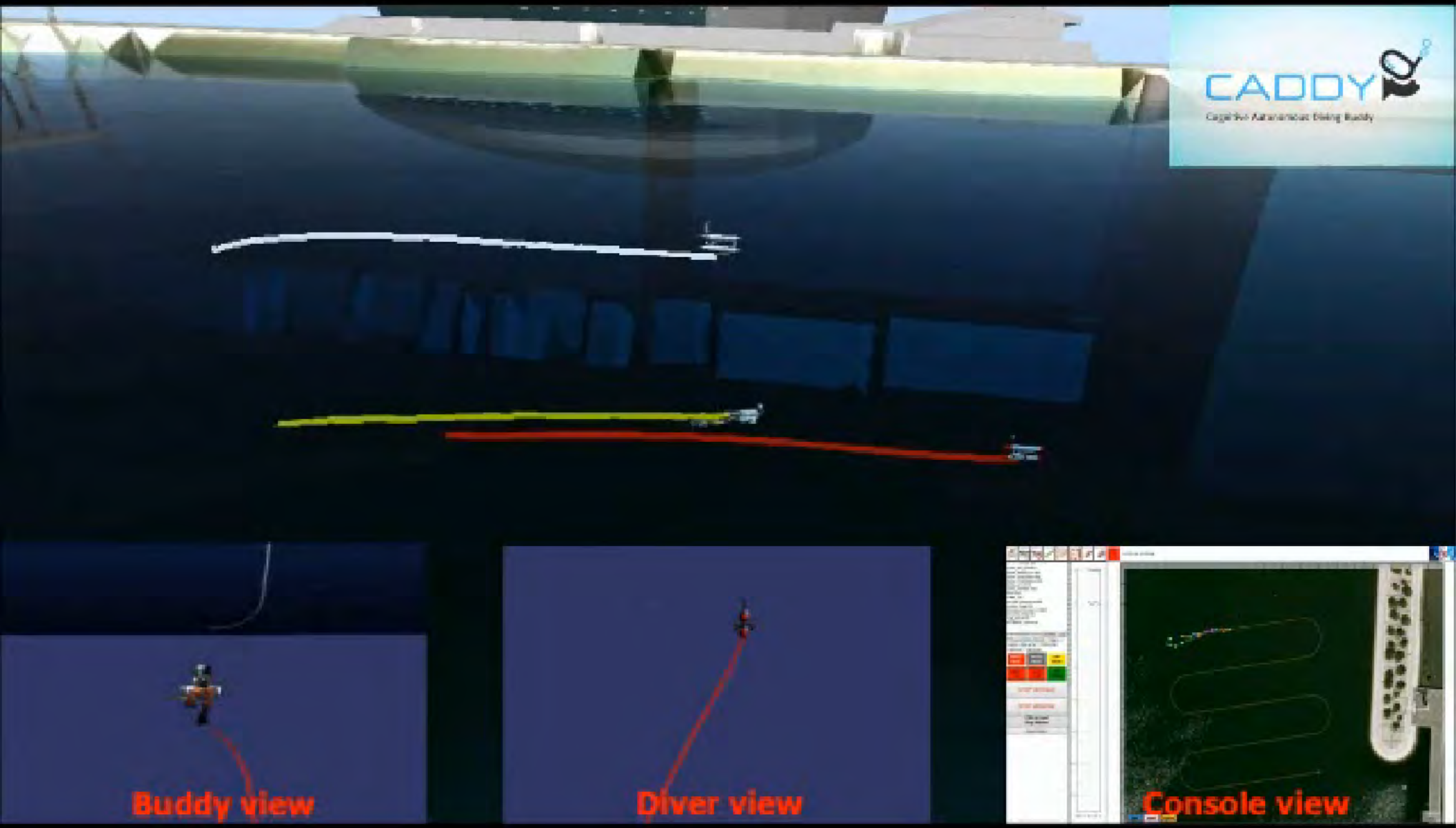
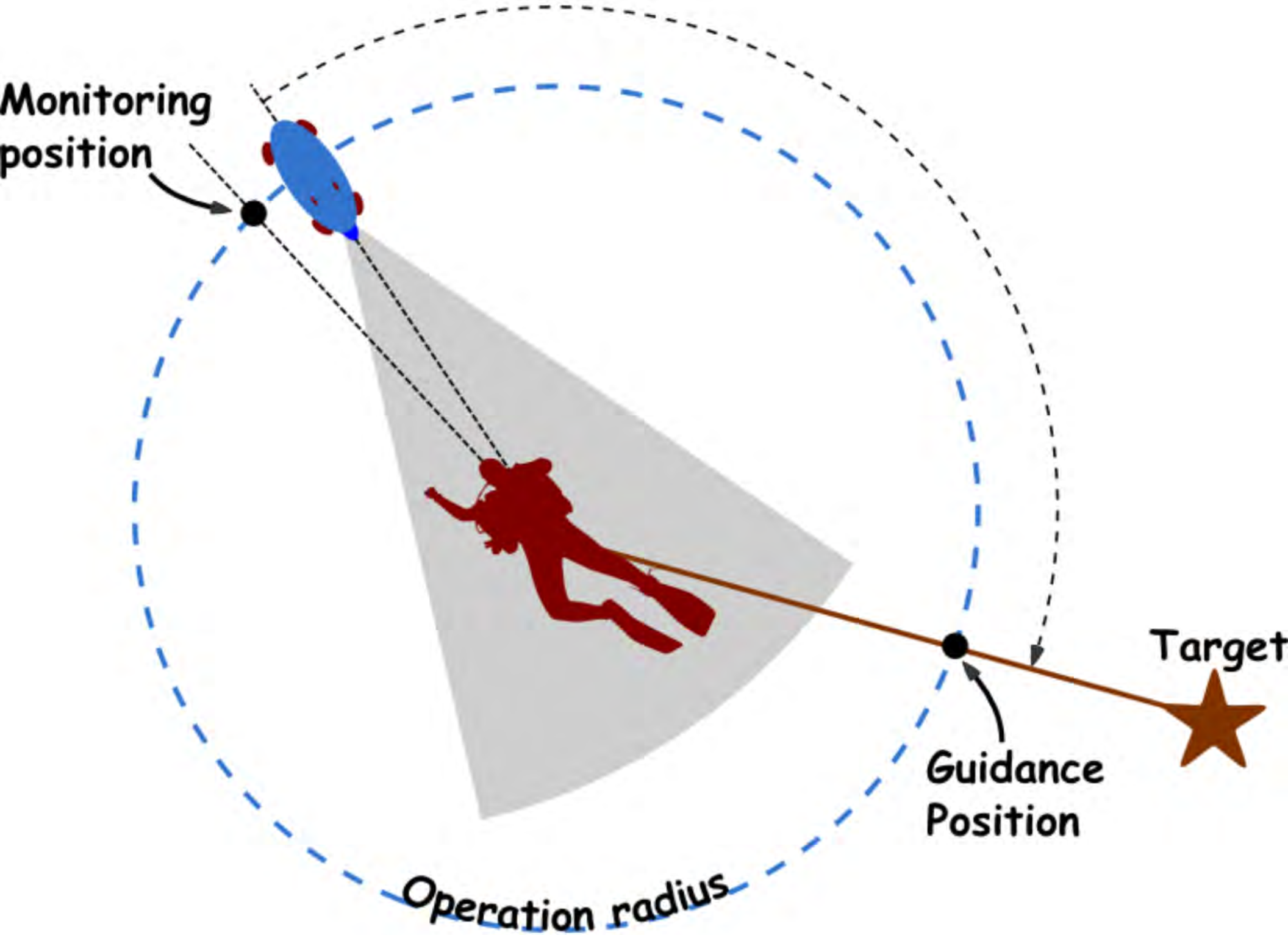
500
Time [s]



CADDY


CADDY
Cognitive Autonomous Diving Buddy
Buddy view
Diver view
Console view

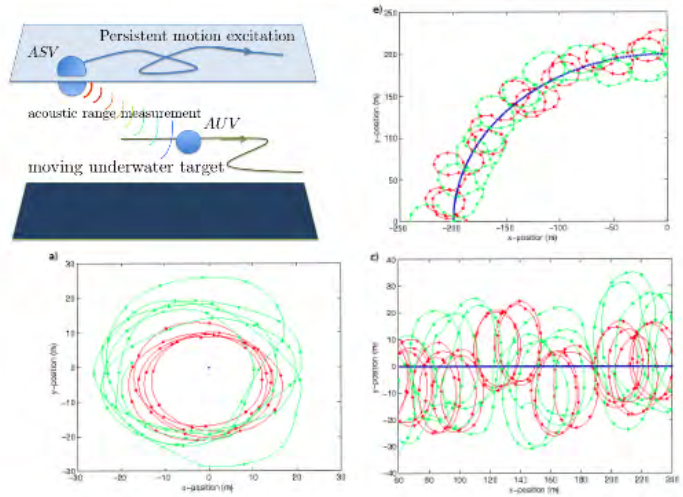

Monitoring position
Target
Guidance Position
Operation radius

Diver observer system layout

CADDY

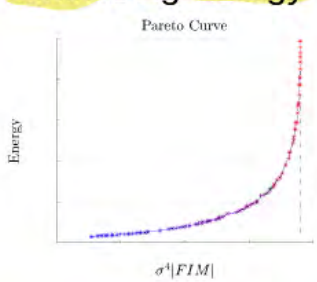
Cooperative distributed navigation and localization

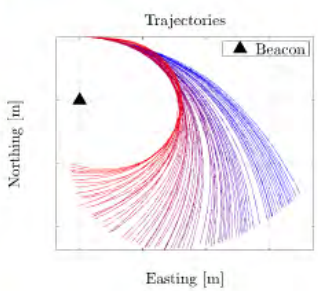
Range-based Navigation



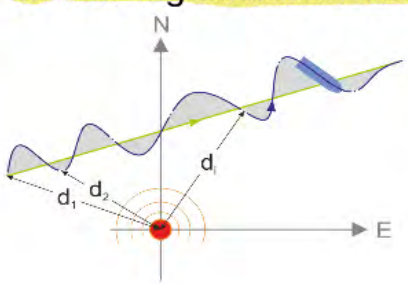
Range-based target localization

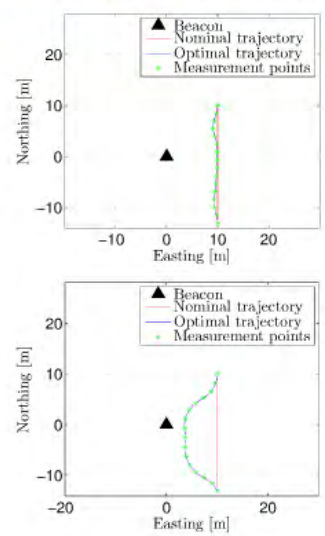
Minimizing energy



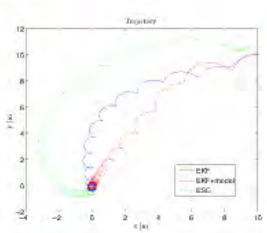


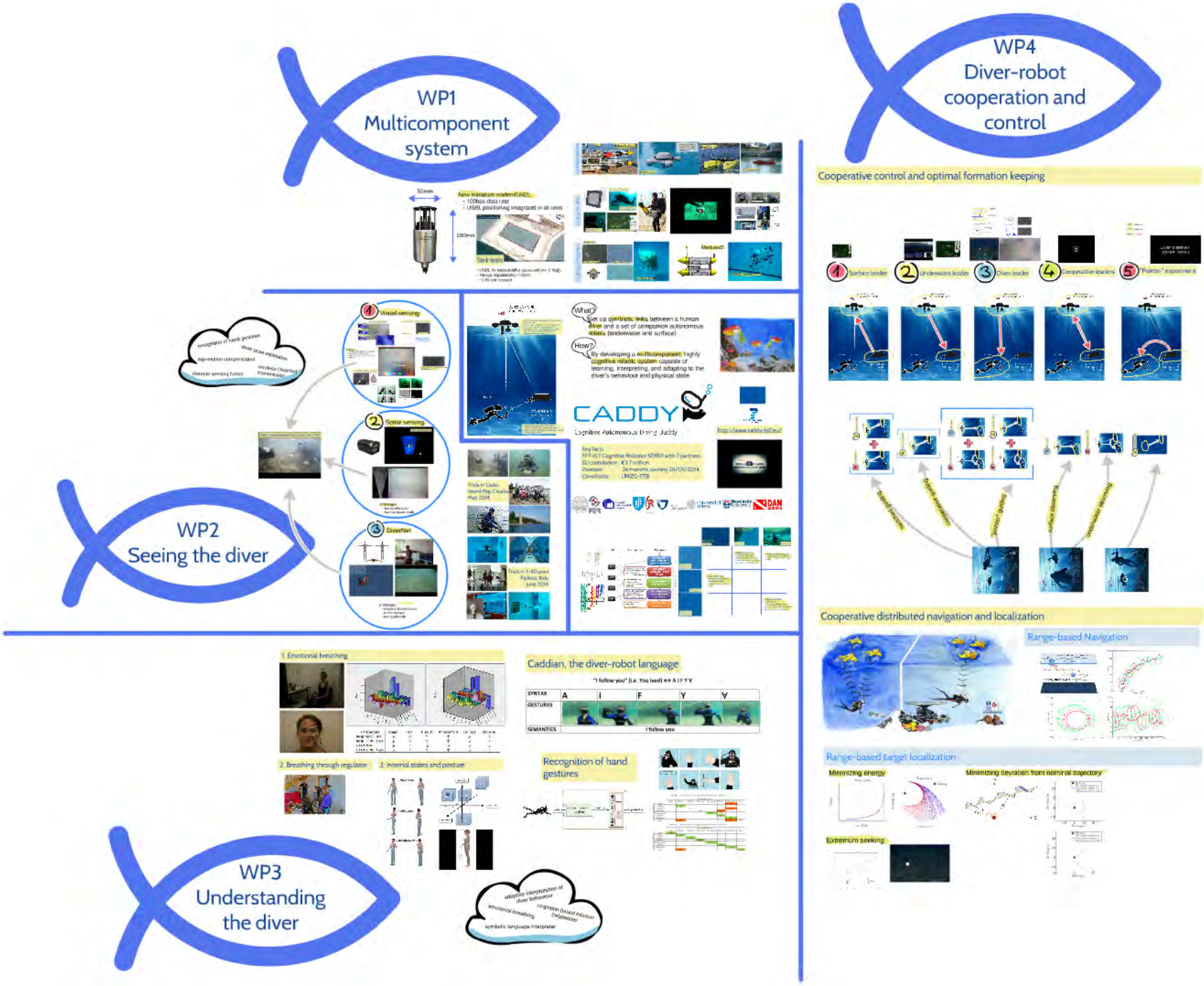
Minimizing deviation from nominal trajectory





Extremum seeking




WP1
Multicomponent system
55mm
160mm
Tank tests
WP2
Seeing the diver
1 Visual sensing
2 Sonar sensing
3 DiverNet
What?
Set up symbiotic links between a human diver and a set of companion autonomous robots (underwater and surface).
How?
By developing a multicomponent, highly cognitive robotic system capable of learning, interpreting, and adapting to the diver's behaviour and physical state
CADDY
Cognitive Autonomous Diving Buddy
WP3
Understanding the diver
1. Emotional breathing
2. Breathing through regulator
3. Internal states and posture
Caddian, the diver-robot language
"I follow you" (i.e. You lead) ⇔ A I F Y ∀
SYNTAX
GESTURES
SEMANTICS
I follow you
Recognition of hand gestures
WP4
Diver-robot cooperation and control
Cooperative control and optimal formation keeping
1 Surface leader
2 Underwater leader
3 Diver leader
4 Cooperative leaders
5 "Painter" experiment
Cooperative distributed navigation and localization
Range-based Navigation
Range-based target localization
Minimizing energy
Minimizing deviation from nominal trajectory
Extremum seeking

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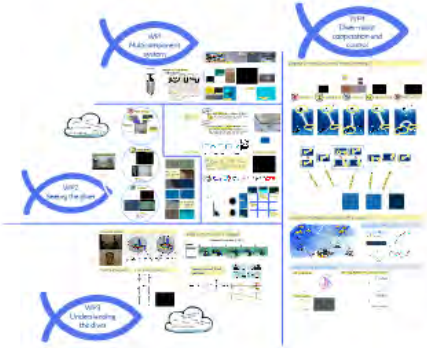
CADDY FP7 project



Thank you!