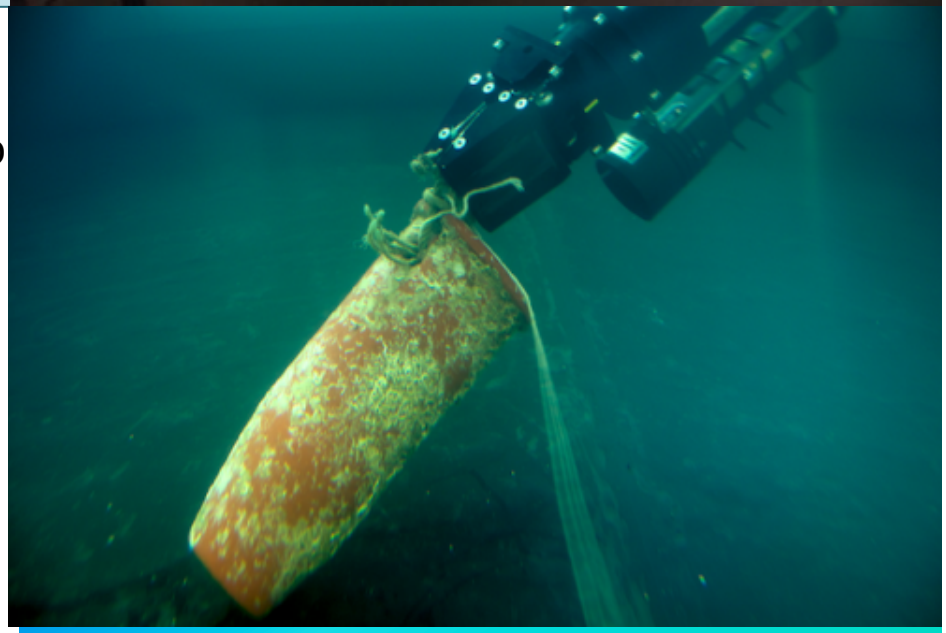
IRS LAB PRESENTATION

Improving robotic remote manipulation in smoky and underwater hazardous environments: Fingerprinting/ TDoA Localization, Network Protocols, and Image Compression



R. Marin, P. J. Sanz, V. Martí, J. Sales, D. Centelles, E. Rubino
Computer Science and Engineering Department
University of Jaume-I
{rmarin, sanzp, vmarti, salesj, al132071, rubino@uji.es}

IRS Lab
Interactive & Robotic Systems
UNIVERSITAT JAUME·I

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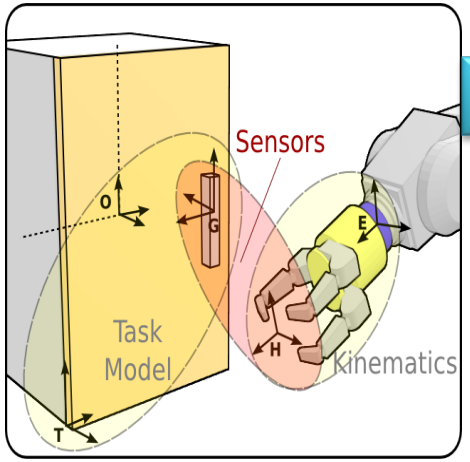

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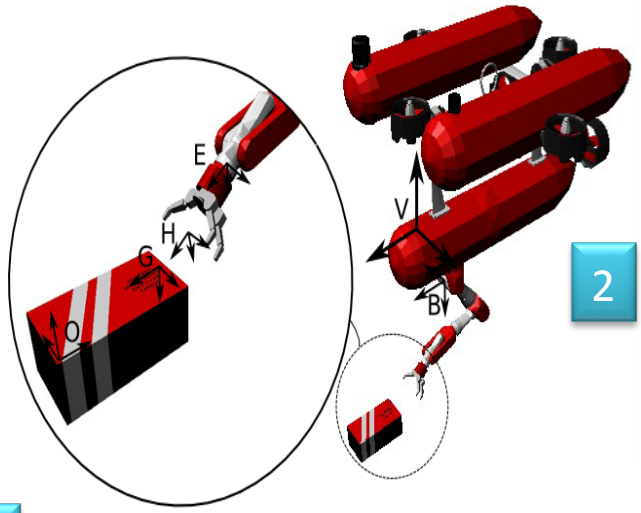

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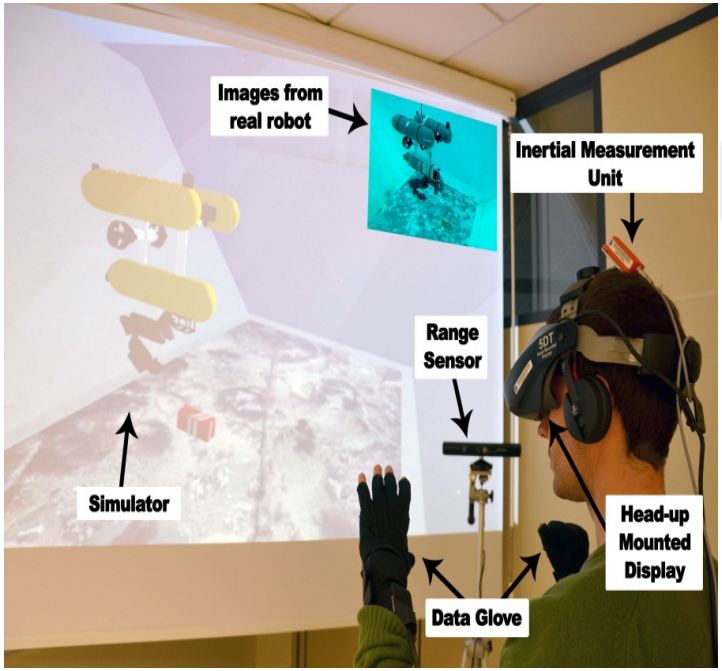

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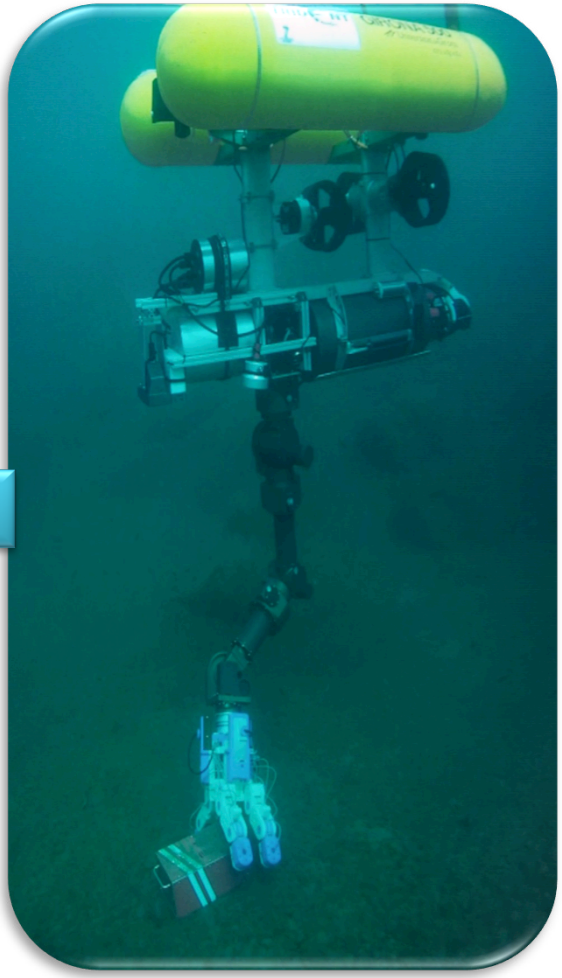

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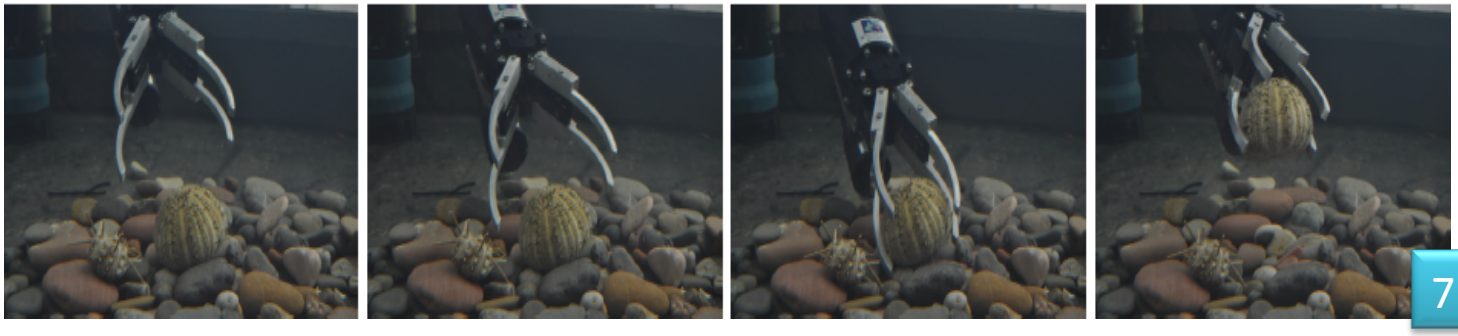

7

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J. Sales, Marín, R., Cervera, E., Rodríguez, S., and Perez, J., “Multi-Sensor Person Fellowing in Low-Visibility Scenarios”, Sensors, vol. 10, no. 12, p. 14, 2010.

Smoke density: 0%
Sonar: 2.2 m Laser: 2.0 m

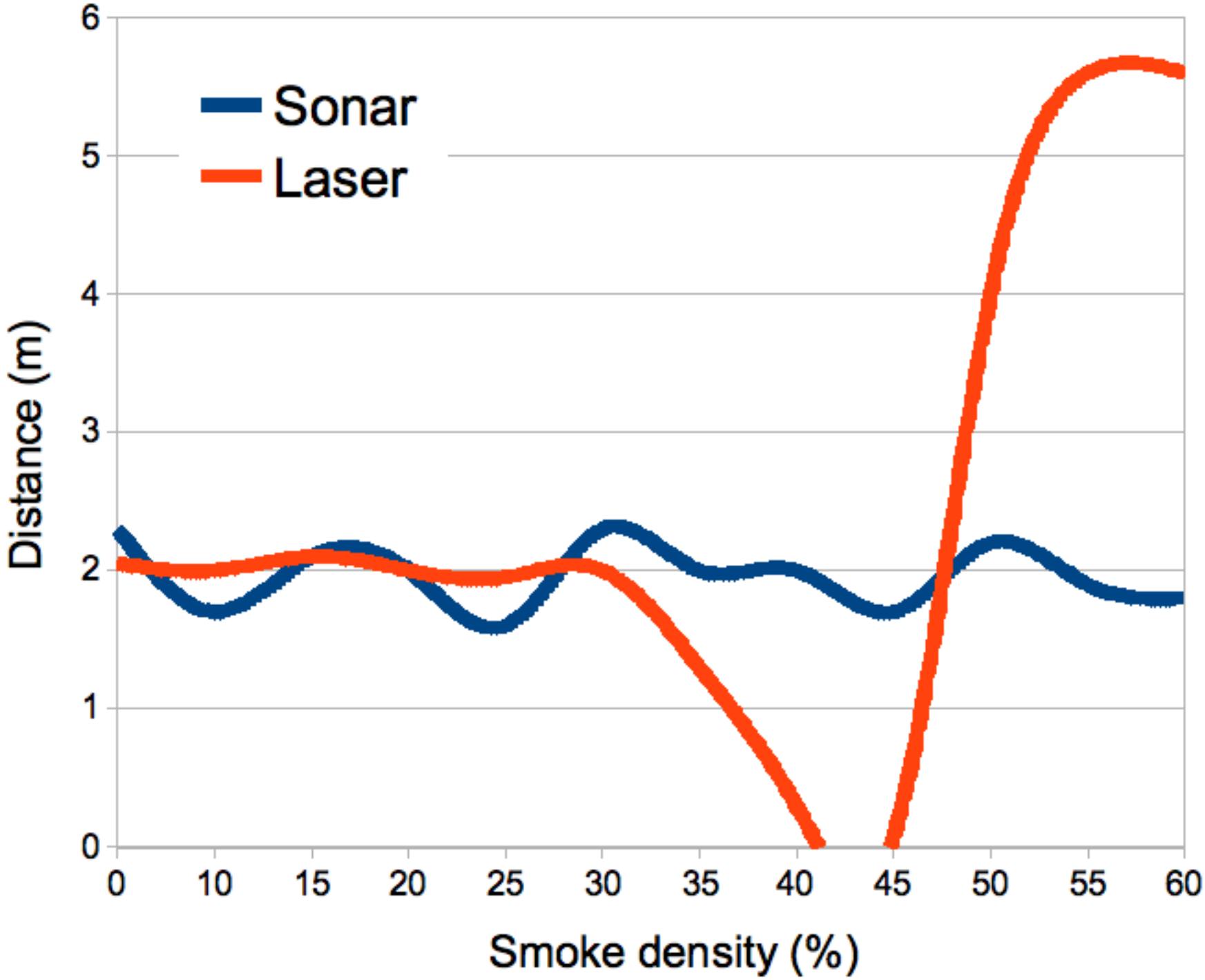
Smoke density: 16%
Sonar: 2.1 m Laser: 2.0 m

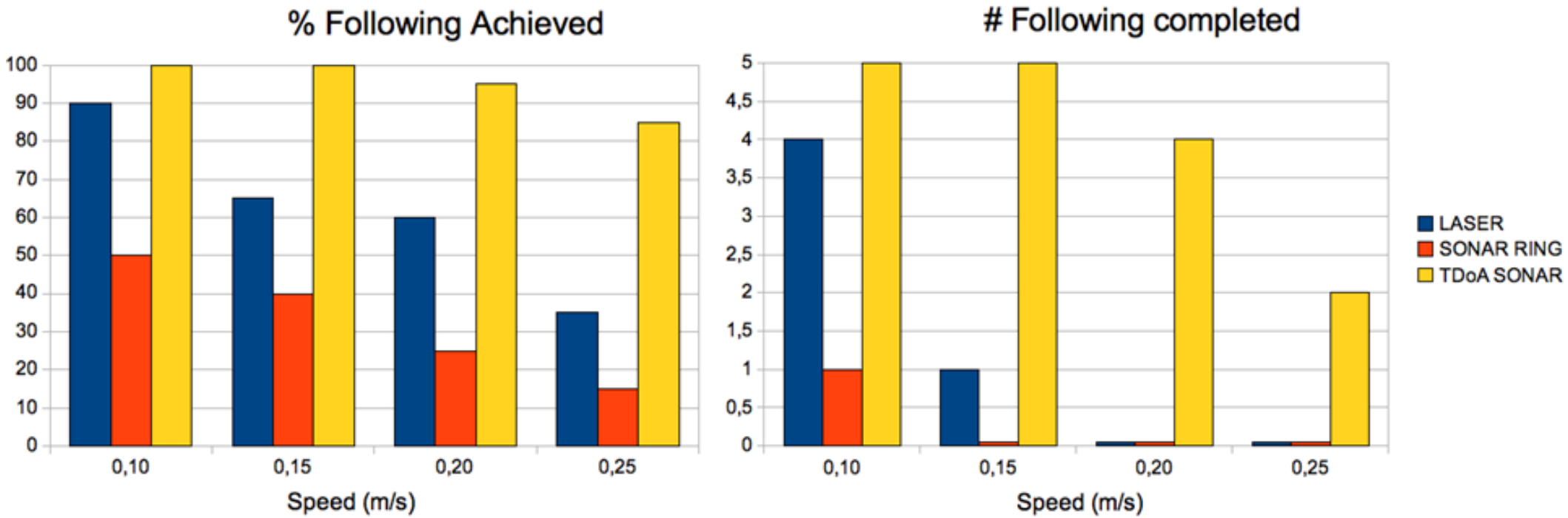
Smoke density: 20%
Sonar: 2.1 m Laser: 2.1 m

Smoke density: 25%
Sonar: 2.2 m Laser: 1.9 m

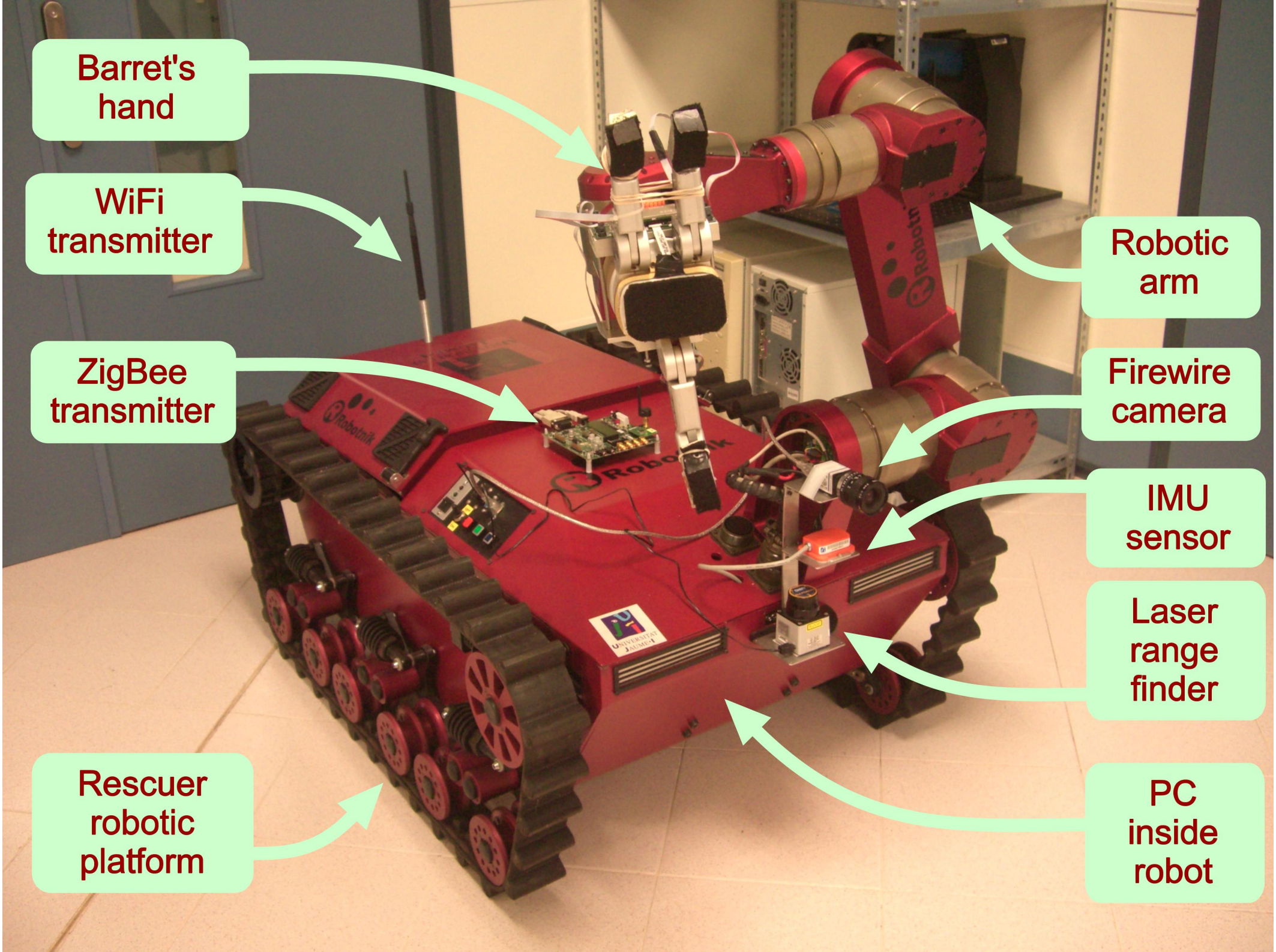
Smoke density: 35%
Sonar: 1.8 m Laser: 1.3 m

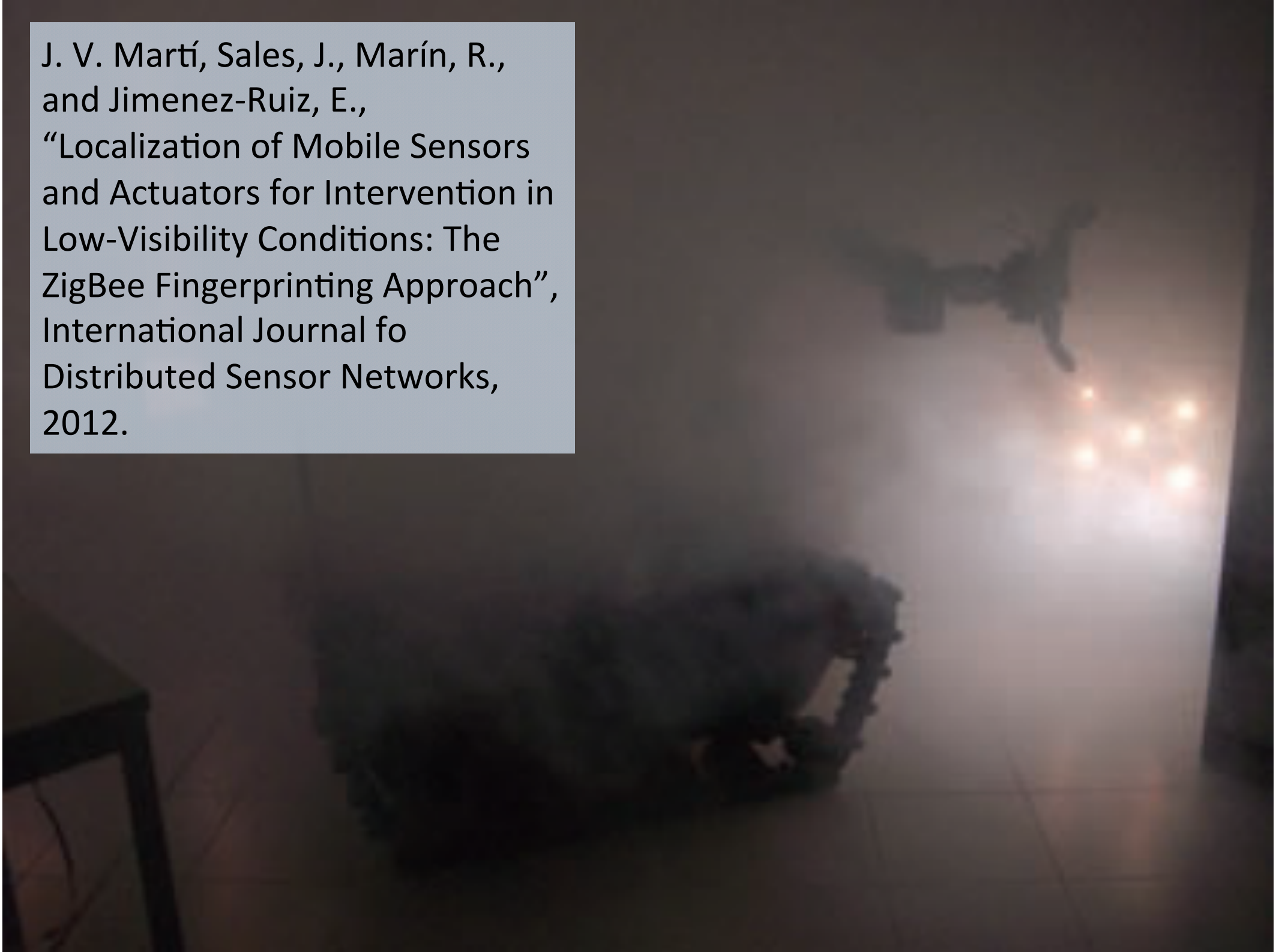
Smoke density: 45%
Sonar: 2.1 m Laser: 0.1 m


Sonar
Laser
Distance (m)
0
1
2
3
4
5
6
0
10
15
20
25
30
35
40
45
50
55
60
Smoke density (%)

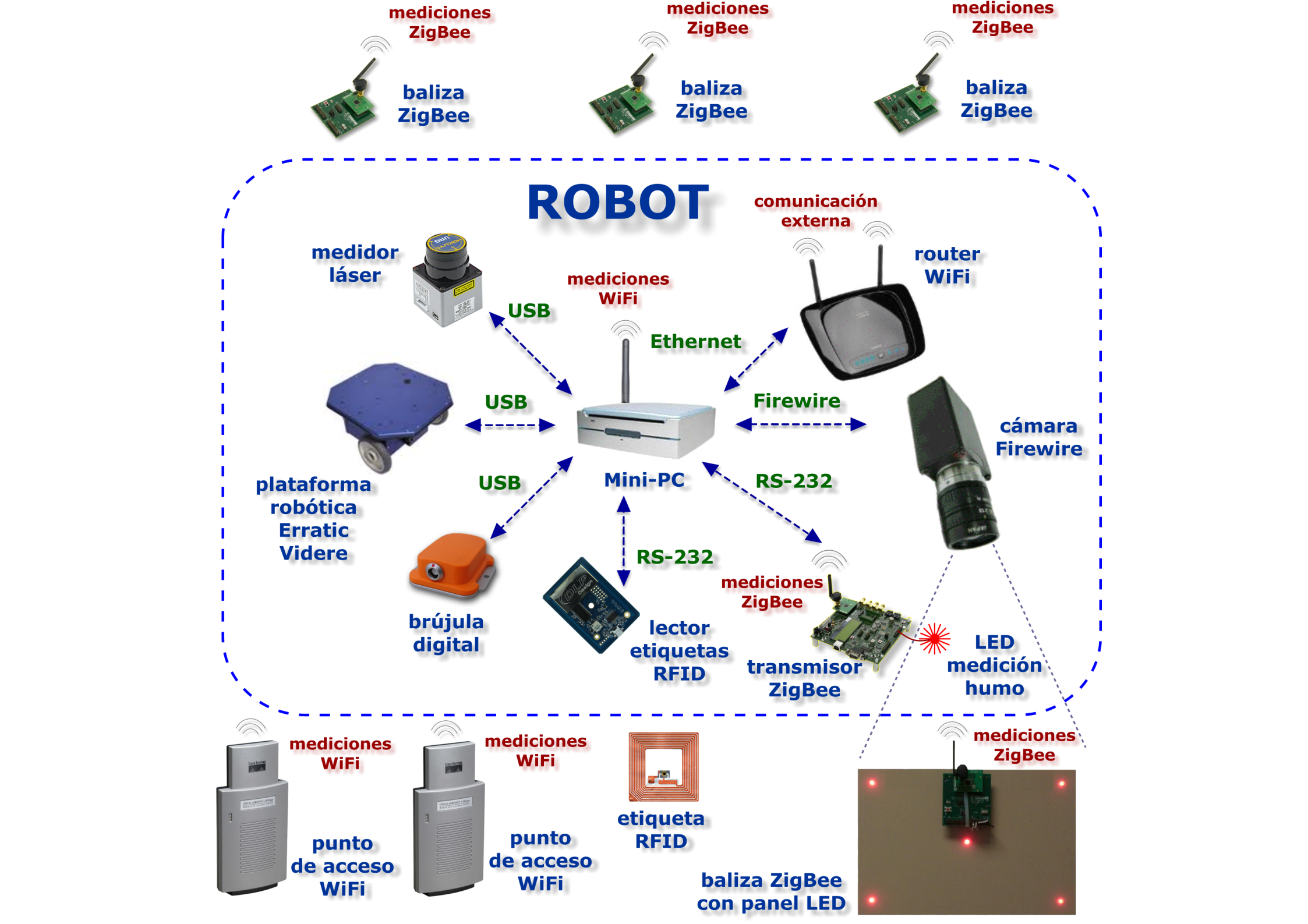

% Following Achieved
100
90
80
70
60
50
40
30
20
10
0
0,10
0,15
0,20
0,25
Speed (m/s)
Following completed
5
4,5
4
3,5
3
2,5
2
1,5
1
0,5
0
0,10
0,15
0,20
0,25
Speed (m/s)
LASER
SONAR RING
TDoA SONAR

J. V. Martí, Sales, J., Marín, R., and Jimenez-Ruiz, E., “Localization of Mobile Sensors and Actuators for Intervention in Low-Visibility Conditions: The ZigBee Fingerprinting Approach”, International Journal fo Distributed Sensor Networks, 2012.


Barret's hand
WiFi transmitter
ZigBee transmitter
Rescuer robotic platform
Robotic arm
Firewire camera
IMU sensor
Laser range finder
PC inside robot



J. V. Martí, Sales, J., Marín, R., and Jimenez-Ruiz, E., "Localization of Mobile Sensors and Actuators for Intervention in Low-Visibility Conditions: The ZigBee Fingerprinting Approach", International Journal fo Distributed Sensor Networks, 2012.


mediciones ZigBee
baliza ZigBee
mediciones ZigBee
baliza ZigBee
mediciones ZigBee
baliza ZigBee
ROBOT
comunicación externa
router WiFi
medidor láser
mediciones WiFi
USB
Ethernet
USB
Firewire
cámara Firewire
plataforma robótica Erratic Videre
USB
Mini-PC
RS-232
RS-232
brújula digital
lector etiquetas RFID
mediciones ZigBee
transmisor ZigBee
LED medición humo
mediciones WiFi
punto de acceso WiFi
mediciones WiFi
punto de acceso WiFi
etiqueta RFID
mediciones ZigBee
baliza ZigBee con panel LED

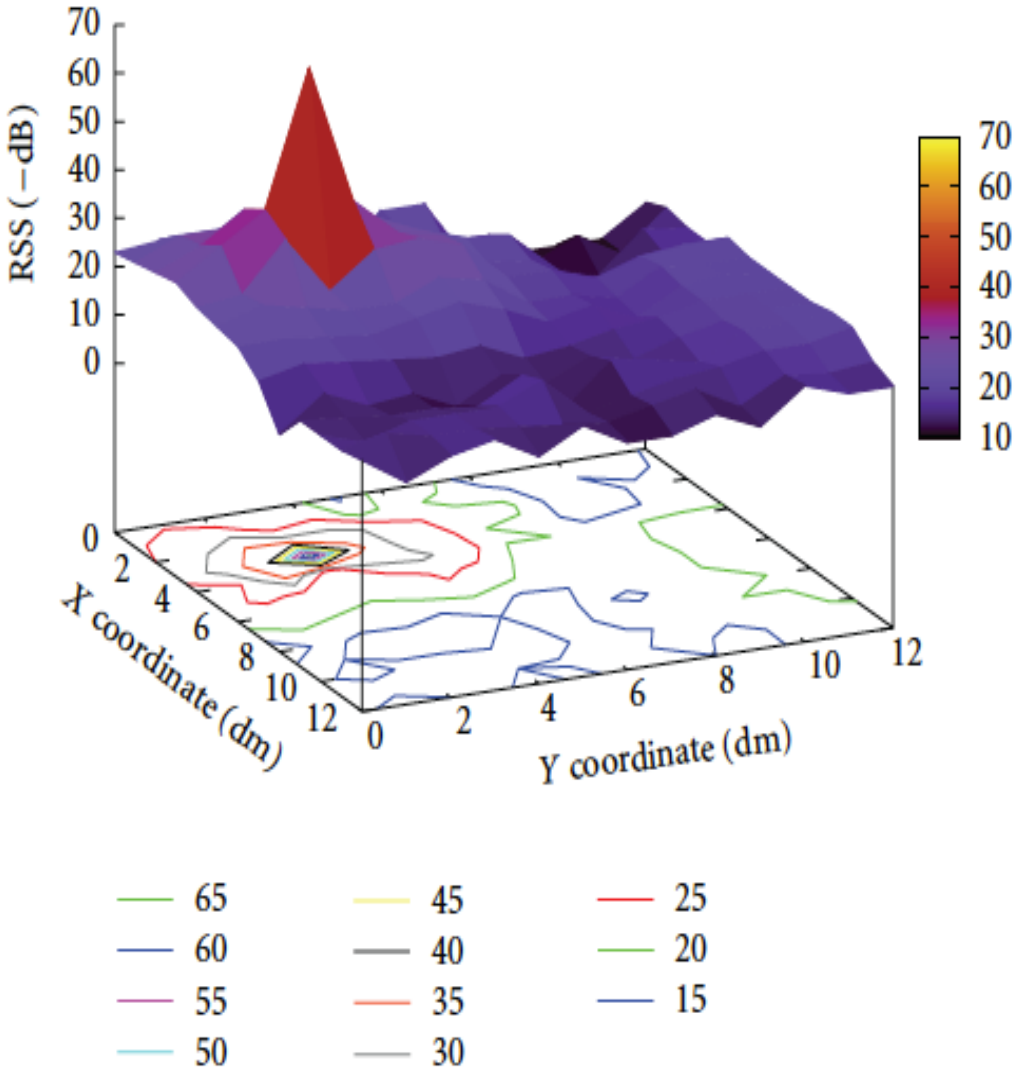


Figure 1: Signal strength distribution in an obstacle-free environment (outdoors).

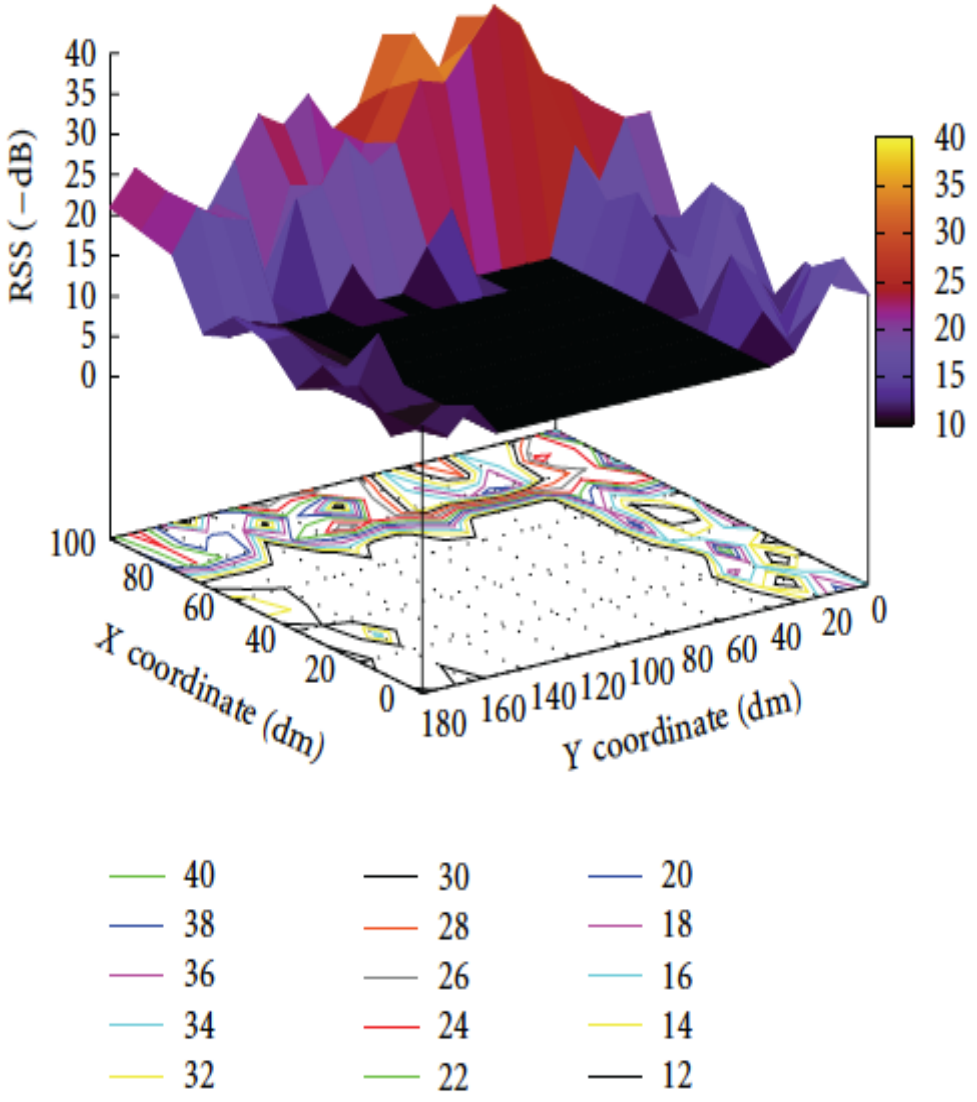
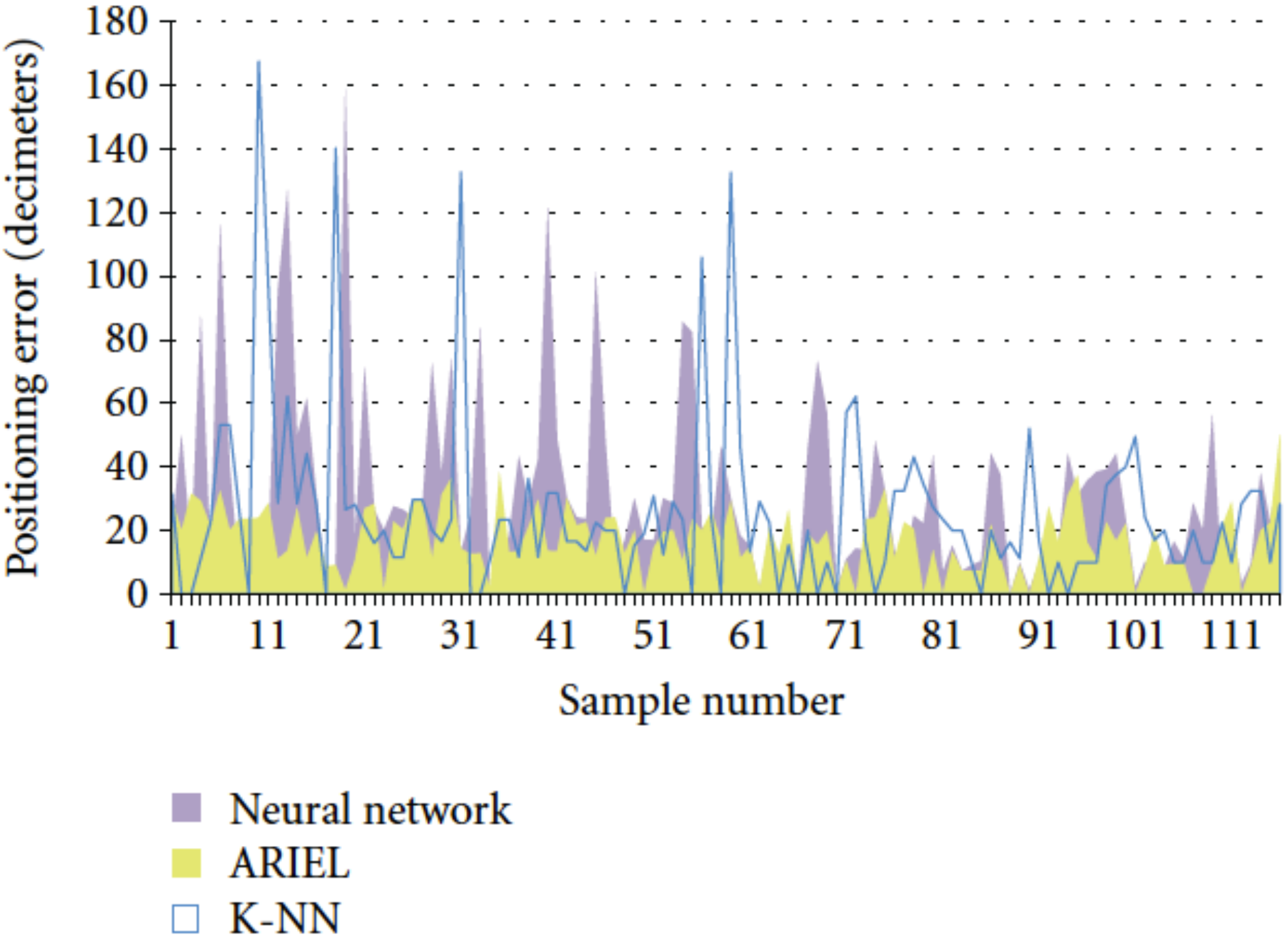
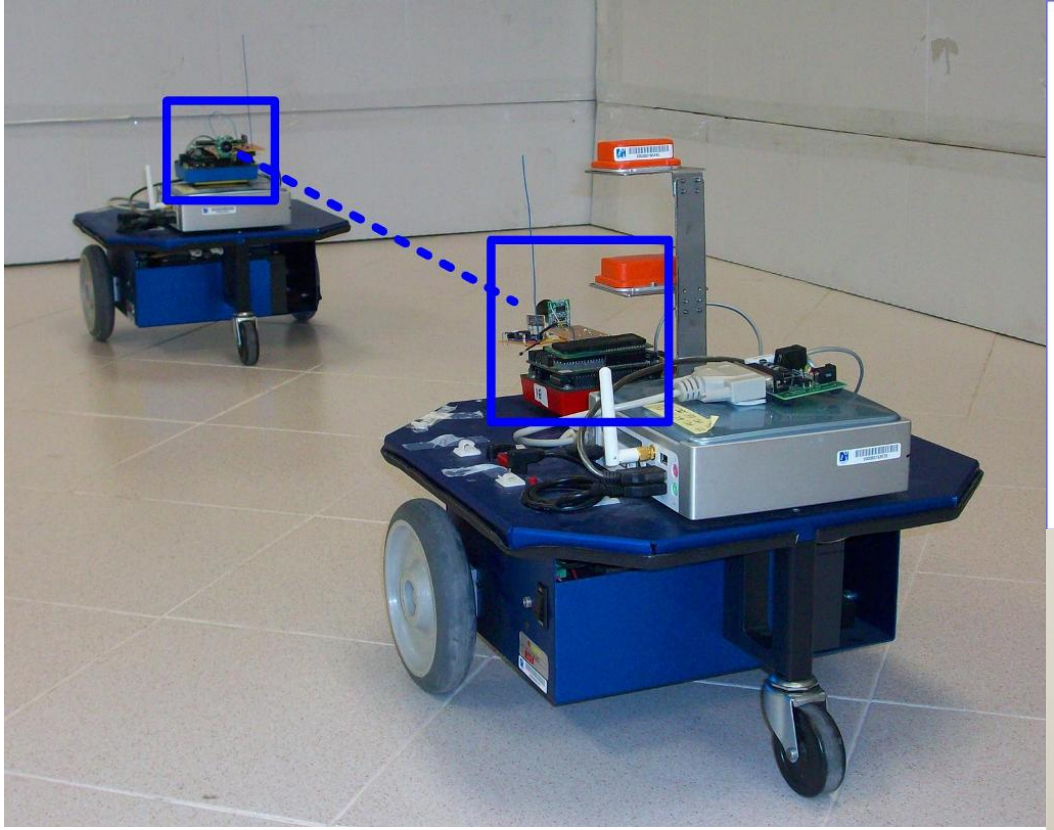
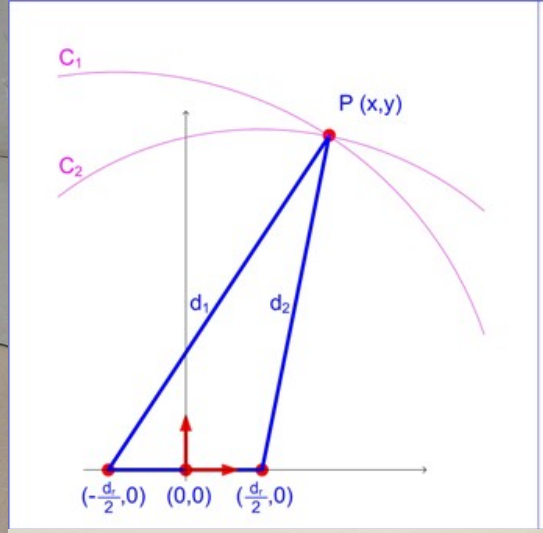
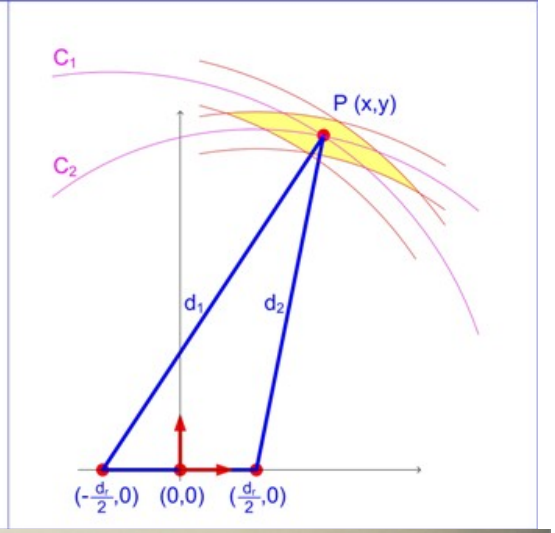


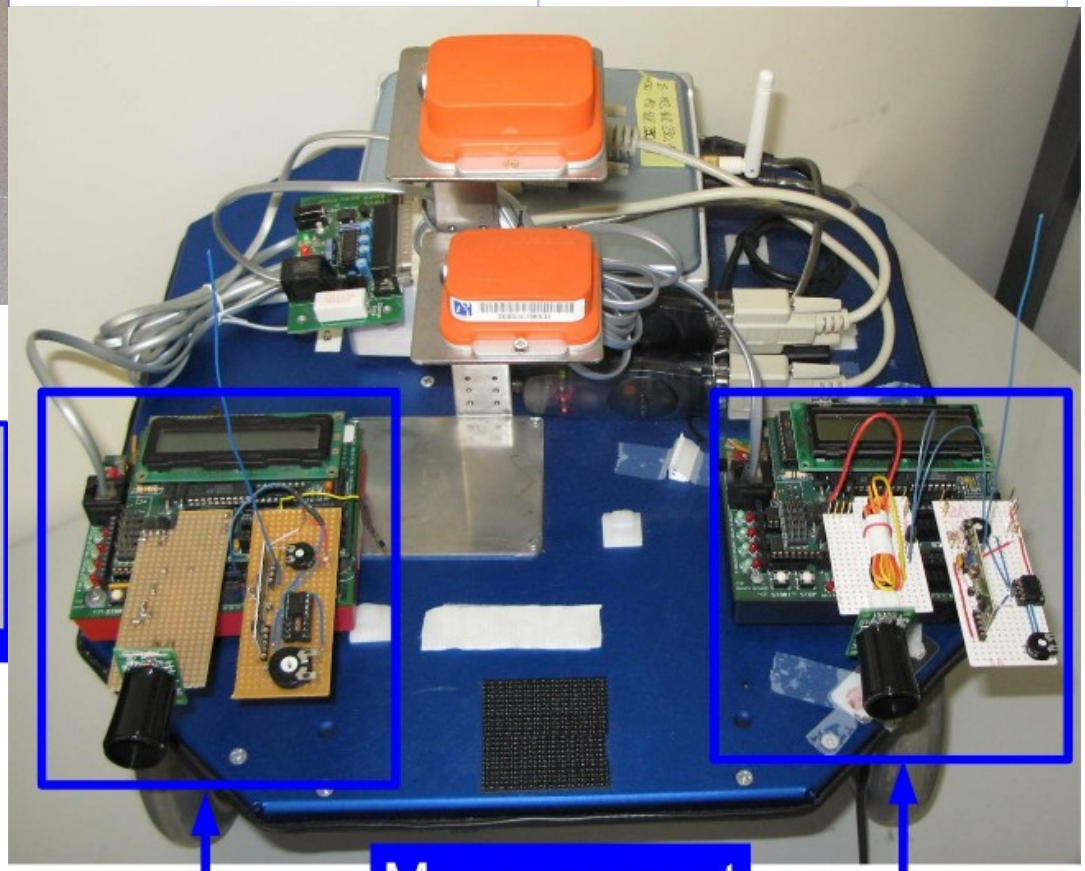
Figure 2: Signal strength distribution in an irregular environment (indoors).

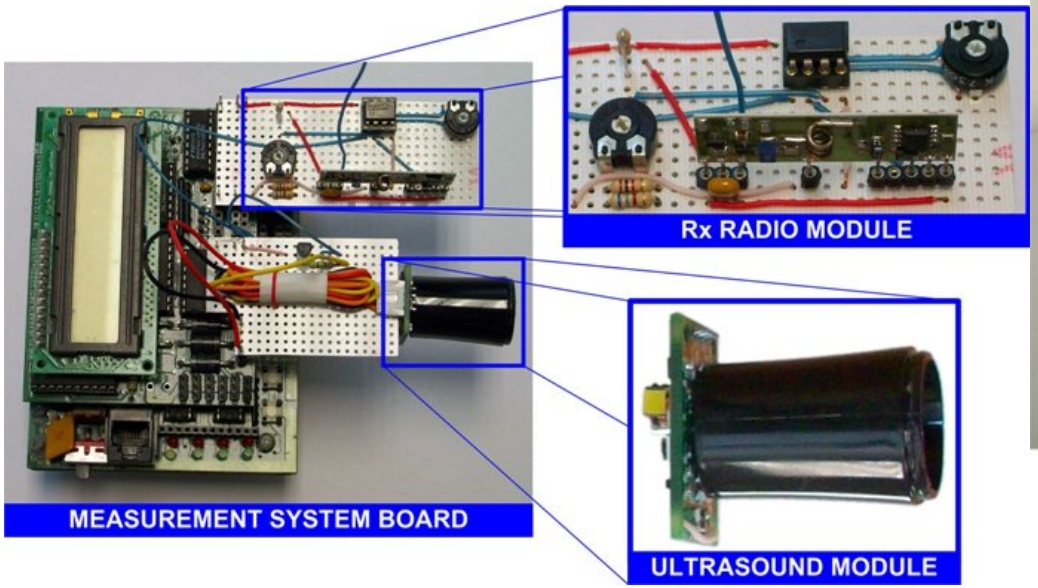

Positioning error (decimeters)
180
160
140
120
100
80
60
40
20
0
1
11
21
31
41
51
61
71
81
91
101
111
Sample number
Neural network
ARIEL
K-NN




C1
C2
P (x,y)
d1
d2
(-d/2,0)
(0,0)
(d/2,0)


C1
C2
P (x,y)
d1
d2
(-d/2,0)
(0,0)
(d/2,0)


Measurement Units


Rx RADIO MODULE
MEASUREMENT SYSTEM BOARD
ULTRASOUND MODULE

TRIDENT

Marine Robots and Dexterous Manipulation for Enabling Autonomous Underwater Multipurpose Intervention Missions

SEVENTH FRAMEWORK PROGRAMME

(ICT-248497)

TRIDENT – Marine Robots and Dexterous Manipulation for Enabling Autonomous Underwater Multipurpose Intervention Missions (2010-2013)

Universitat Jaume I de Castellón (Spain)
Dr. Pedro J. Sanz
Multisensory Based Manipulation Architecture

Universitat de Girona (Spain)
Dr. Pere Ridao
Navigation and Mapping

Universitat de les Illes Balears (Spain)
Dr. Gabriel Oliver
Visual/Acoustic Image Processing

Università di Bologna (Italy)
Dr. Claudio Melchiorri
Mechatronics System and Control

Università di Genova (Italy)
Prof. Giuseppe Casalino
Floating Manipulation

Instituto Superior Técnico (Portugal)
Dr. Carlos Silvestre
Single and Multiple Vehicles Control

Heriot Watt University (United Kingdom)
Dr. Yvan Petillot
Vehicles Intelligent Control Architecture

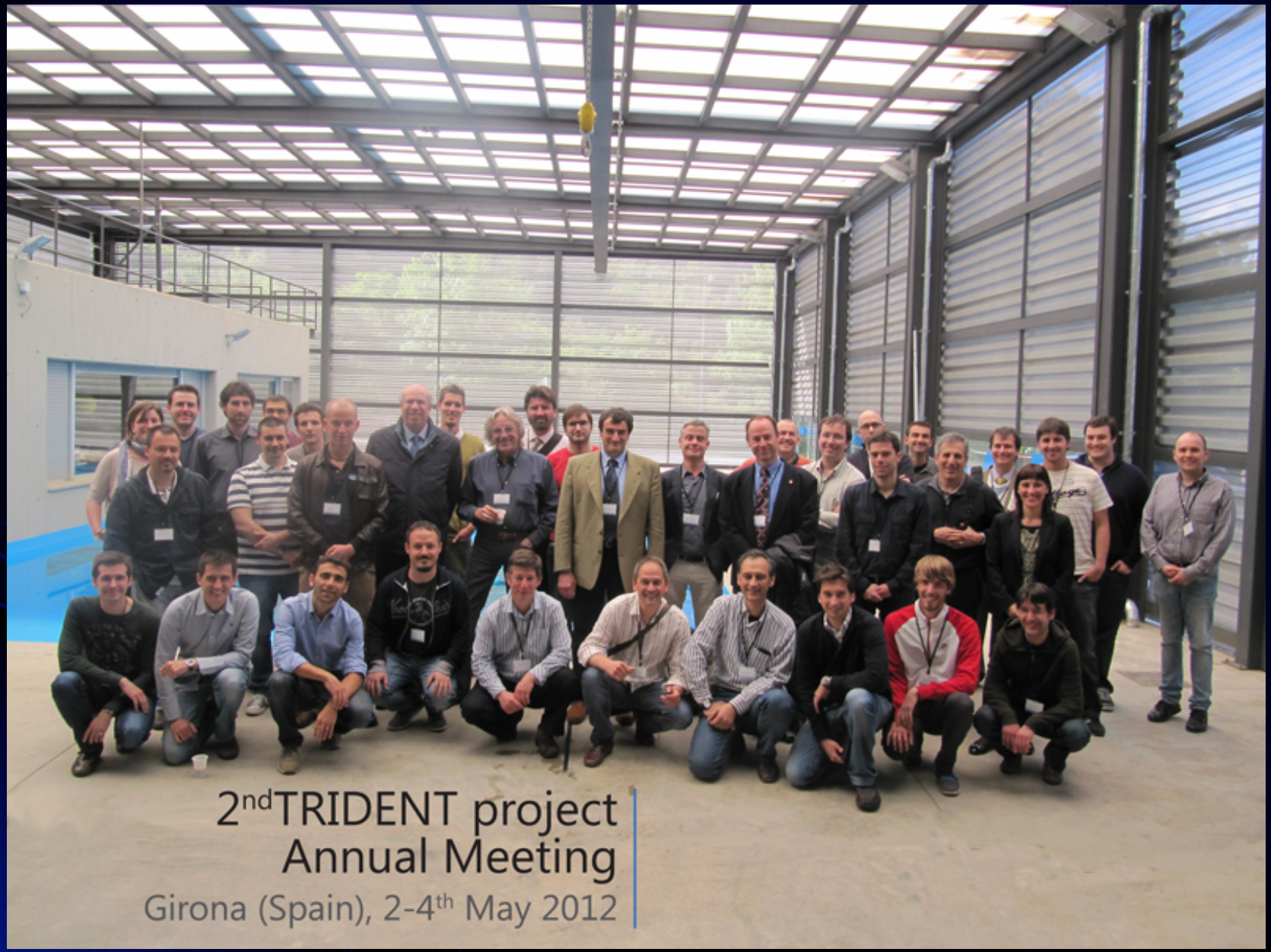
Graal Tech (Italy)
MSc. Andrea Caffaz.
Electromechanical design of the arm

TRIDENT

Marine Robots and Dexterous Manipulation for Enabling Autonomous Underwater Multipurpose Intervention Missions

SEVENTH FRAMEWORK PROGRAMME

(ICT-248497)

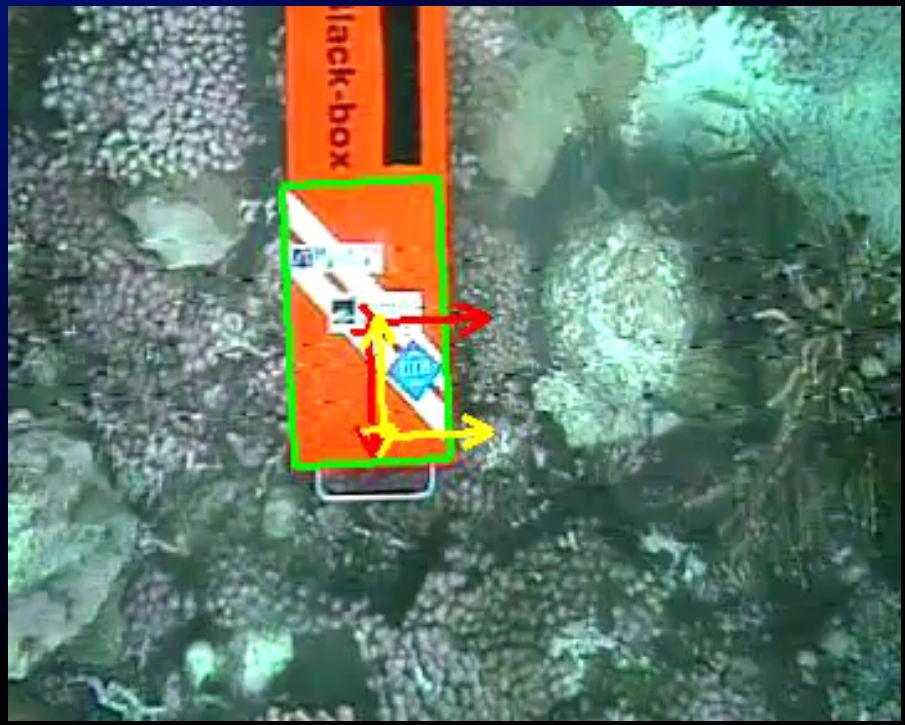


TRIDENT

Marine Robots and Dexterous Manipulation for Enabling Autonomous Underwater Multipurpose Intervention Missions

SEVENTH FRAMEWORK PROGRAMME

(ICT-248497)

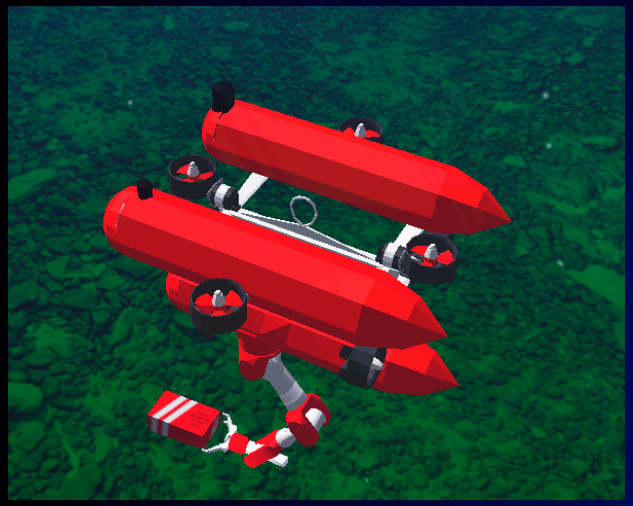


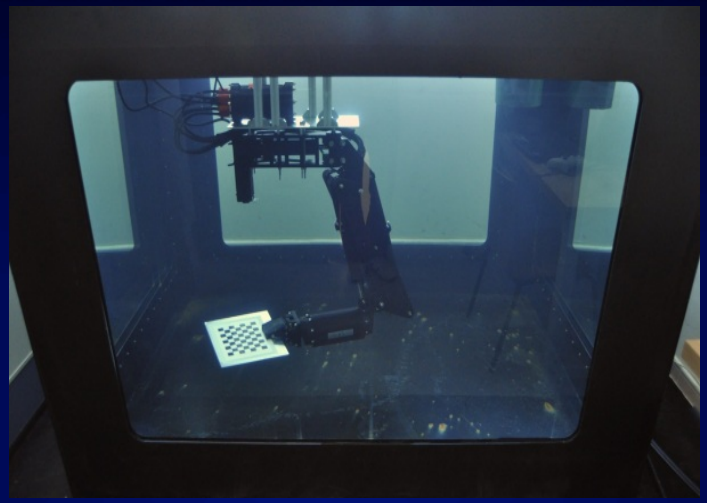
TRIDENT

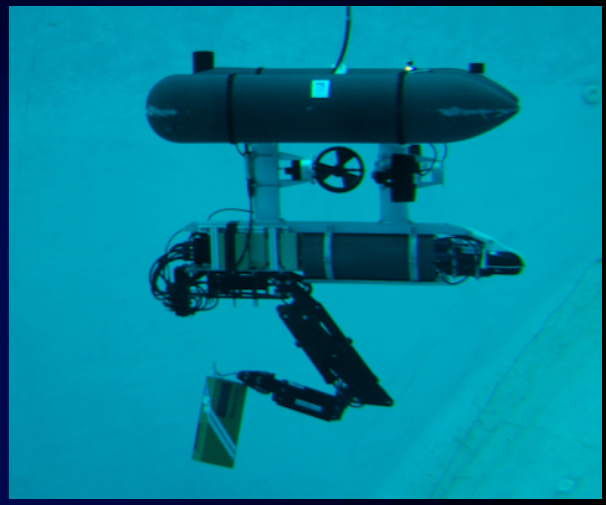
Marine Robots and Dexterous Manipulation for Enabling Autonomous Underwater Multipurpose Intervention Missions

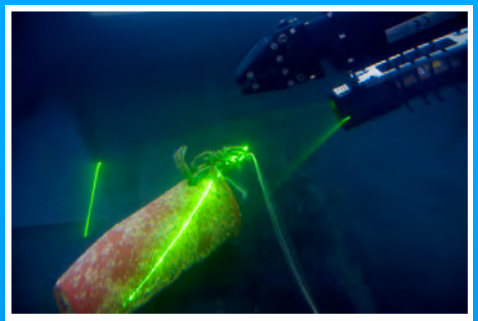
SEVENTH FRAMEWORK PROGRAMME

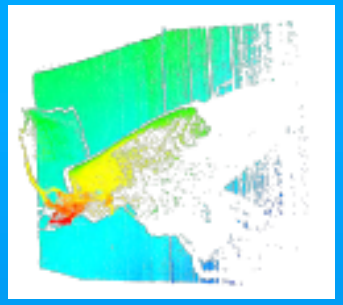
(ICT-248497)

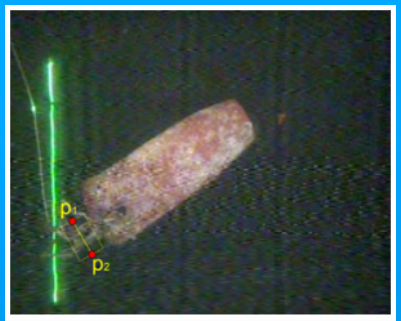


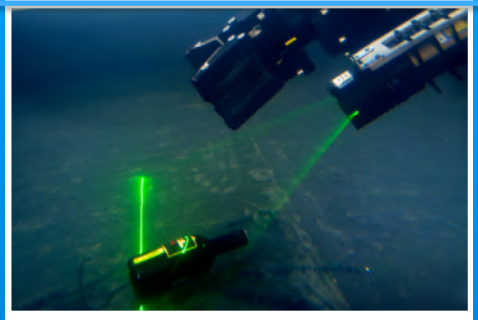


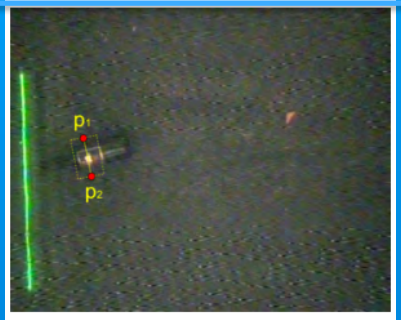




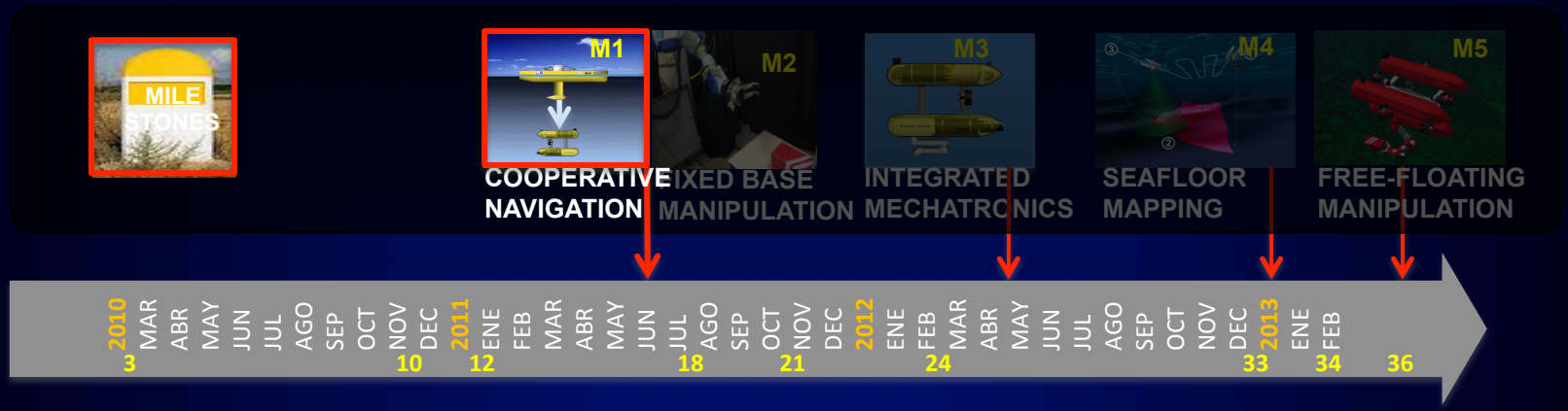






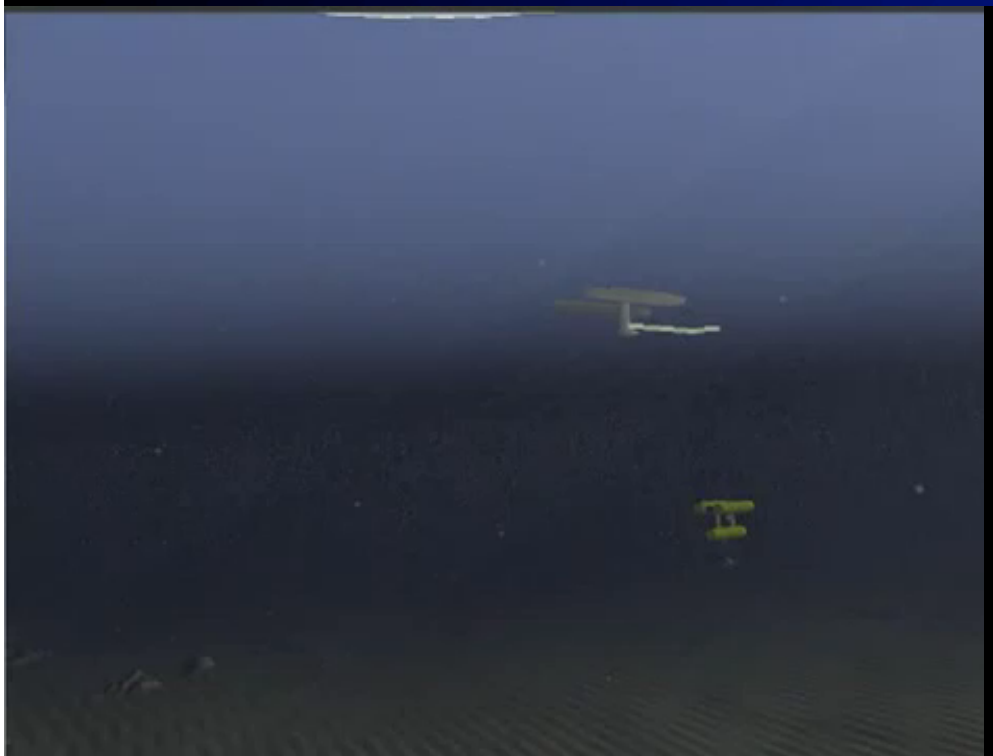


M1 Cooperative Navigation



UWSim HIL Simulation 2011

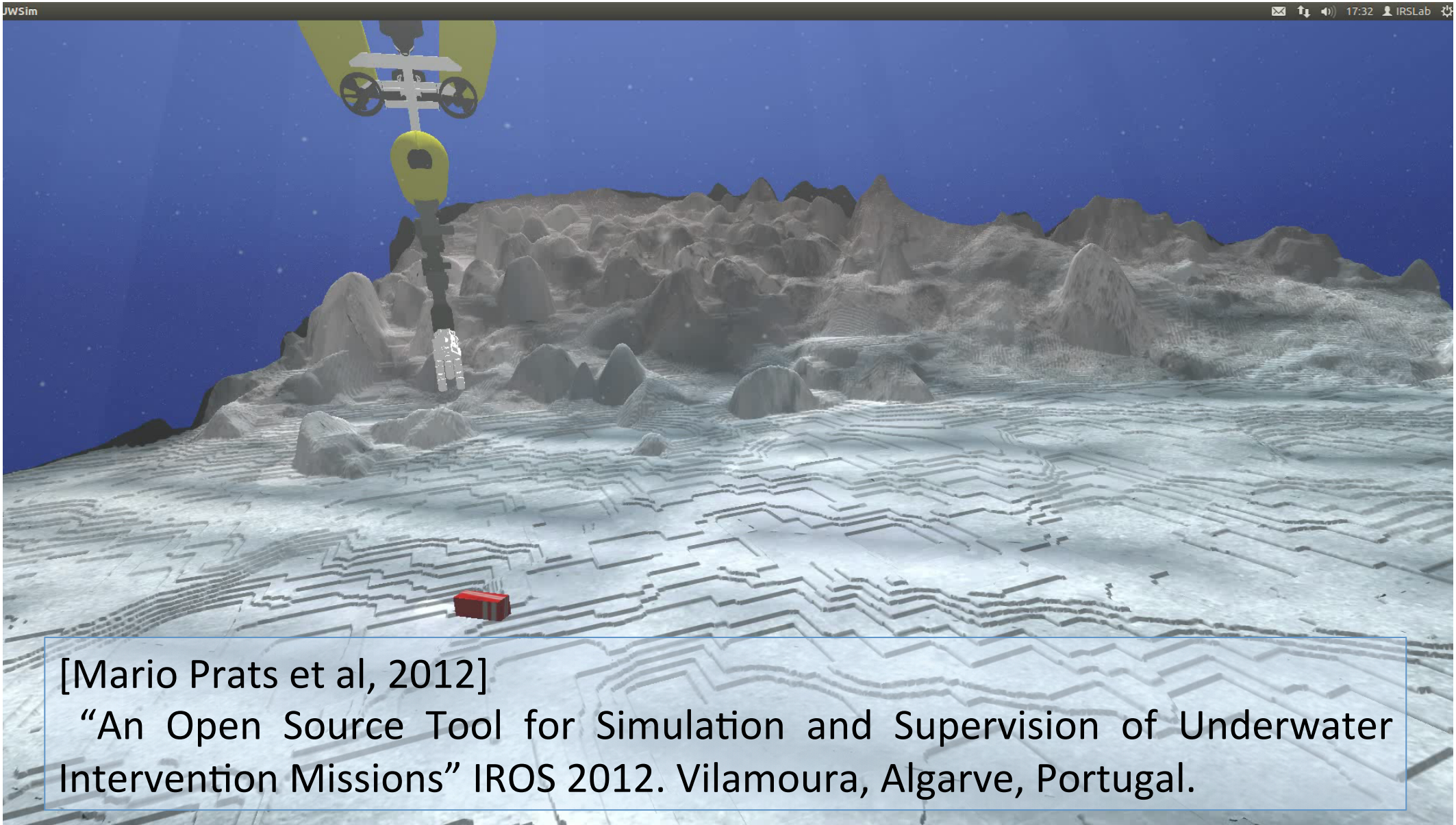
Soller 2012



Field experiments are hard

TRIDENT
Marine Robots and Dexterous Manipulation for Enabling Autonomous Underwater Multipurpose Intervention Missions
SEVENTH FRAMEWORK PROGRAMME
(ICT-248497)

UWSim: Underwater Simulator http://www.irs.uji.es/uwsim



[Mario Prats et al, 2012]
"An Open Source Tool for Simulation and Supervision of Underwater Intervention Missions" IROS 2012. Vilamoura, Algarve, Portugal.

Main Goals

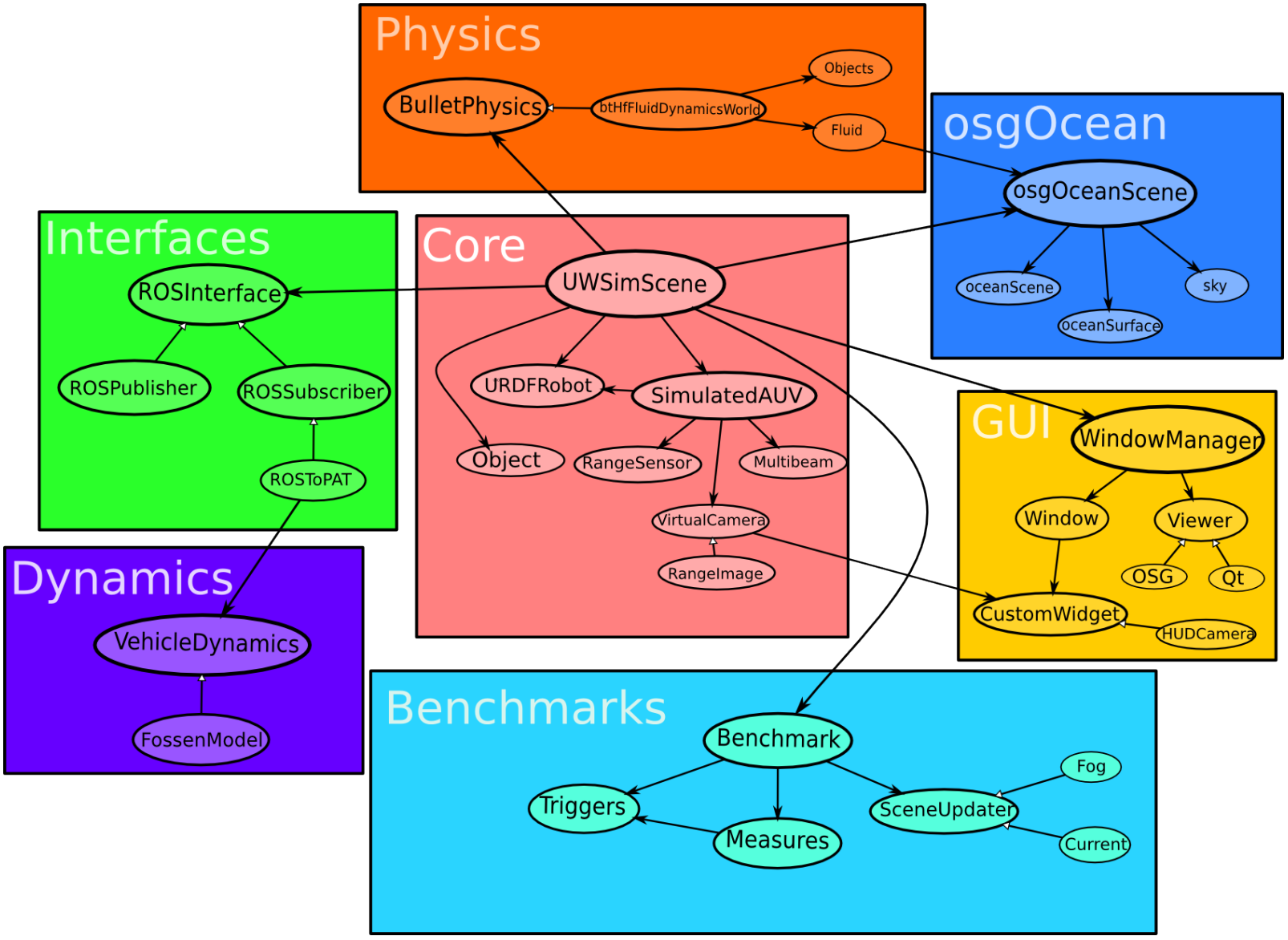
- To be easily integrable with existing control architectures. Control algorithms are external to the simulator that in many cases just works as a visualization of the output computed by external algorithms.

- To be general and easily extendible. Abstract interfaces are provided for adding new vehicles, manipulators, etc. Support for widgets is also provided.

- To include support for underwater manipulators, thus allowing simulating underwater intervention missions. Kinematic chains can be created and controlled.

- To be visually realistic, and to allow the configuration of several parameters such as water color, visibility, floating particles, etc.

Software Architecture



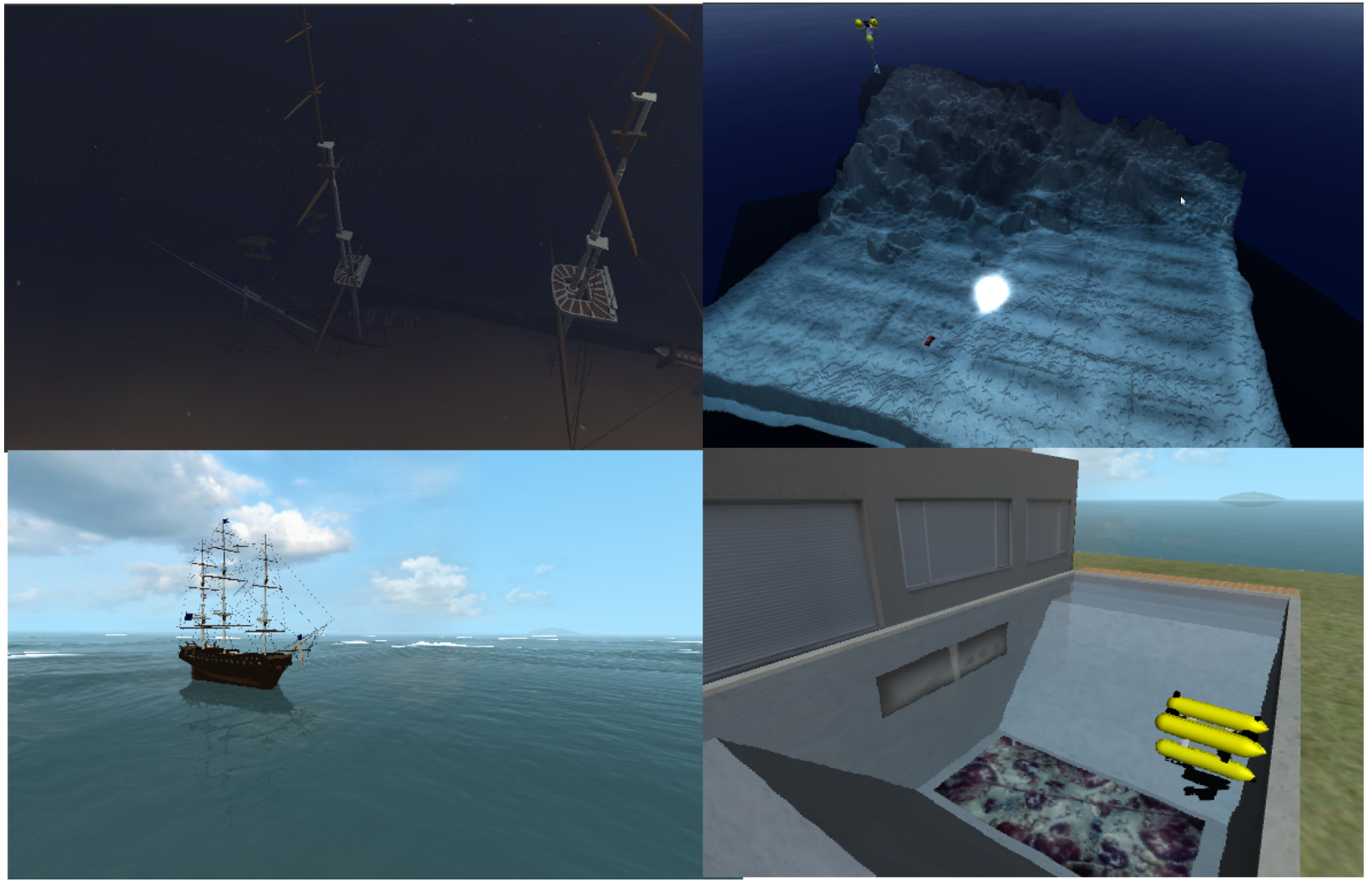
Main Features-1

- Configurable scenarios: The complete scene can be configured with an XML tag.
- Multiple robots support: Robots are described using URDF format.
- Simulated sensors: Up to ten different types of sensors can be simulated such as cameras, range sensor, IMU, GPS; and some more coming soon, for instance structured light projector or USBL.
- Network Interfaces: All sensors can be interfaced using ROS, allowing the use of Matlab, Simulink, etc., to control vehicles.

Main Features-2

- Physics: Simulation of contacts is supported by osgBullet and water physics is on experimental state.
- Dynamics: UWSim allows the dynamic simulation of rigid body motion, by using a state-space dynamic model in terms of state variables representing body linear and angular velocities and positions.
- Widgets: Customizable widgets can be added to the main window.
- Multi-resolution terrain: Terrain models can be loaded as standard objects, even though they can be composed of complex meshes with multi-resolution textures generated externally from bathymetry and imagery.

Configurable scenarios



Multiple robots

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Marine Robots and Dexterous Manipulation for Enabling Autonomous Underwater Multipurpose Intervention Missions

SEVENTH FRAMEWORK PROGRAMME

(ICT-248497)

Surface Vehicles

Surface Vehicles

Sensor simulation

- Virtual cameras
- DVL, IMU, GPS
- Joint encoders
- Range sensors (sonar)

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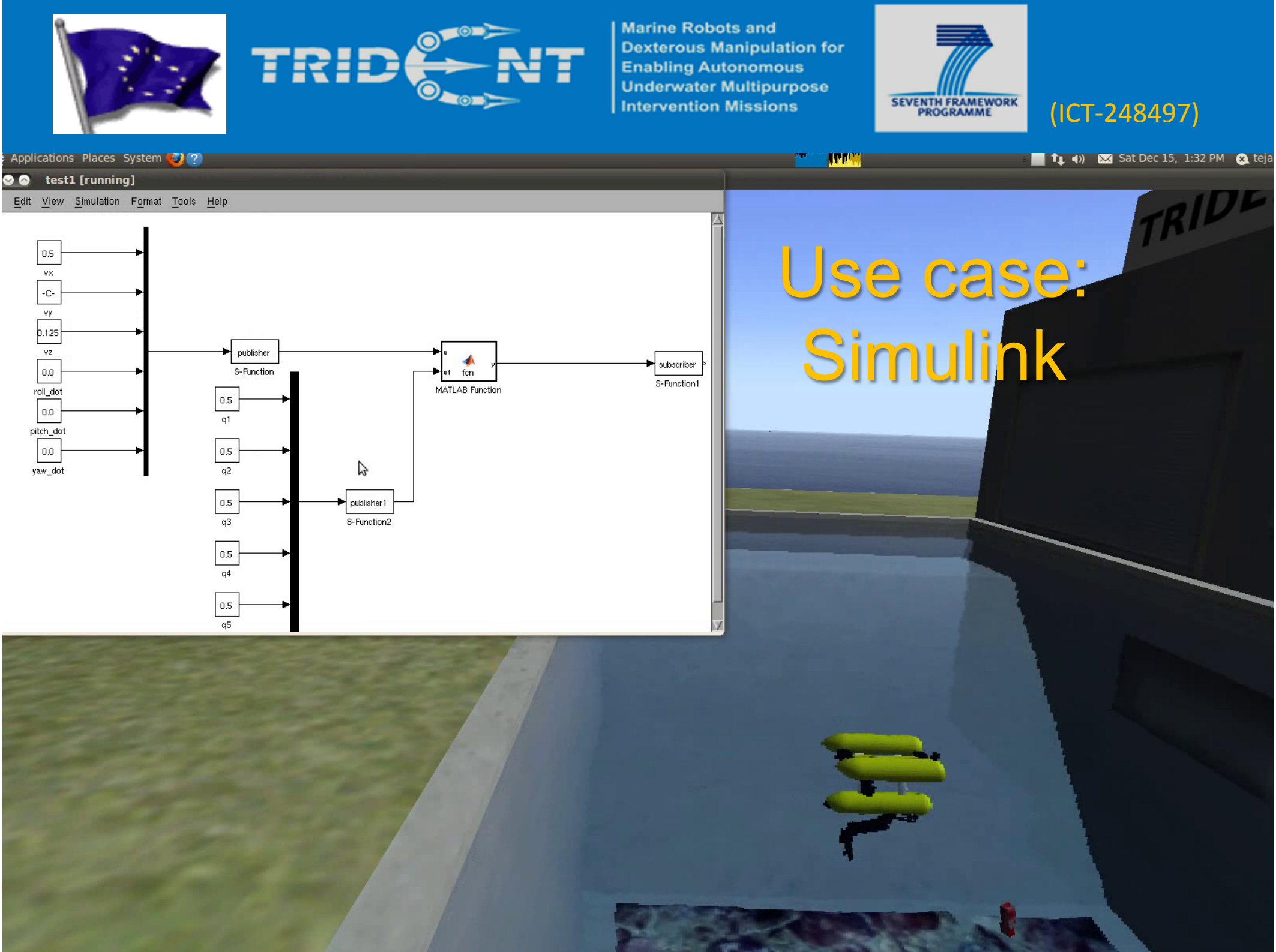
Marine Robots and Dexterous Manipulation for Enabling Autonomous Underwater Multipurpose Intervention Missions

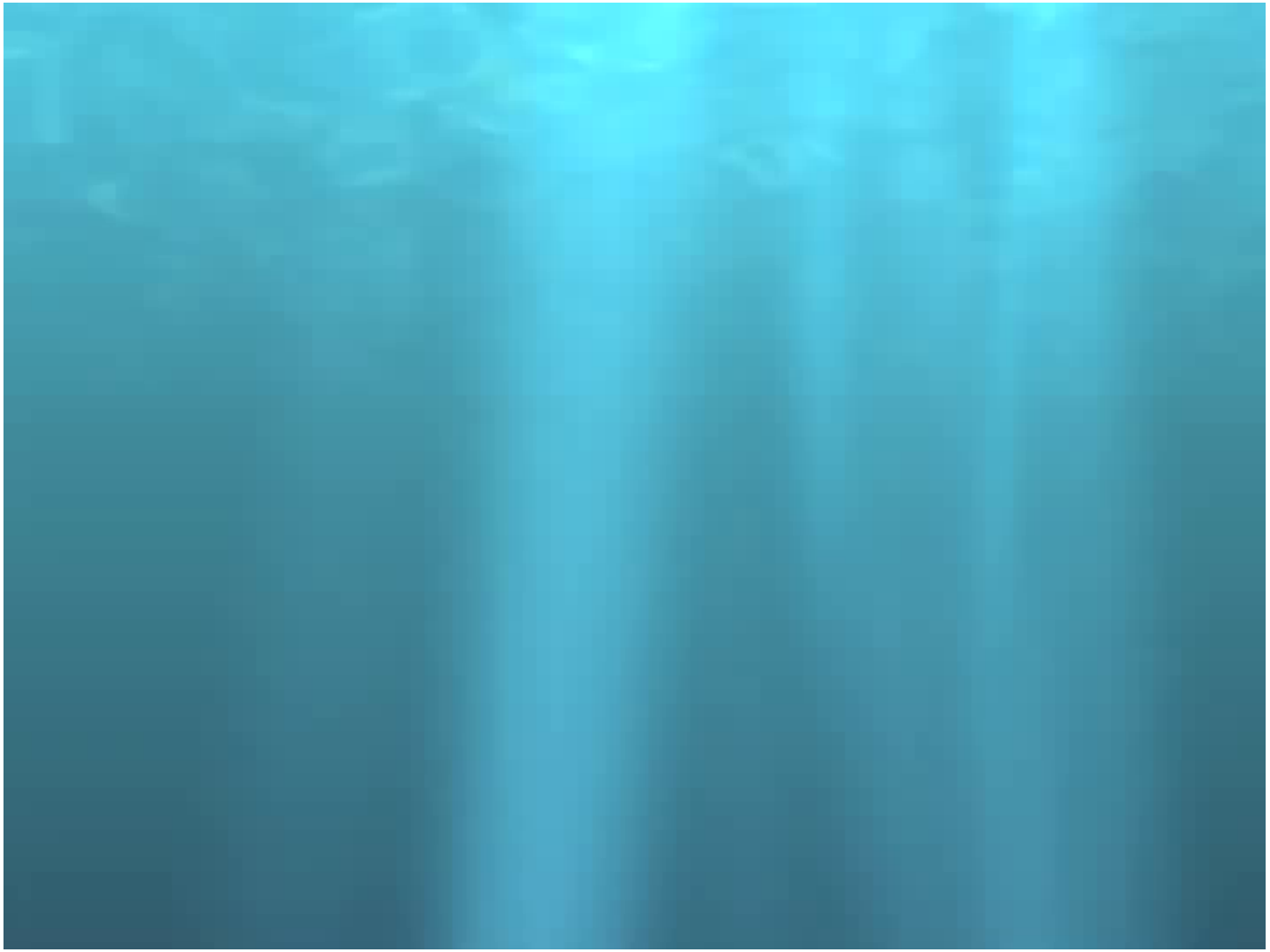
SEVENTH FRAMEWORK PROGRAMME

(ICT-248497)

ROS Interface

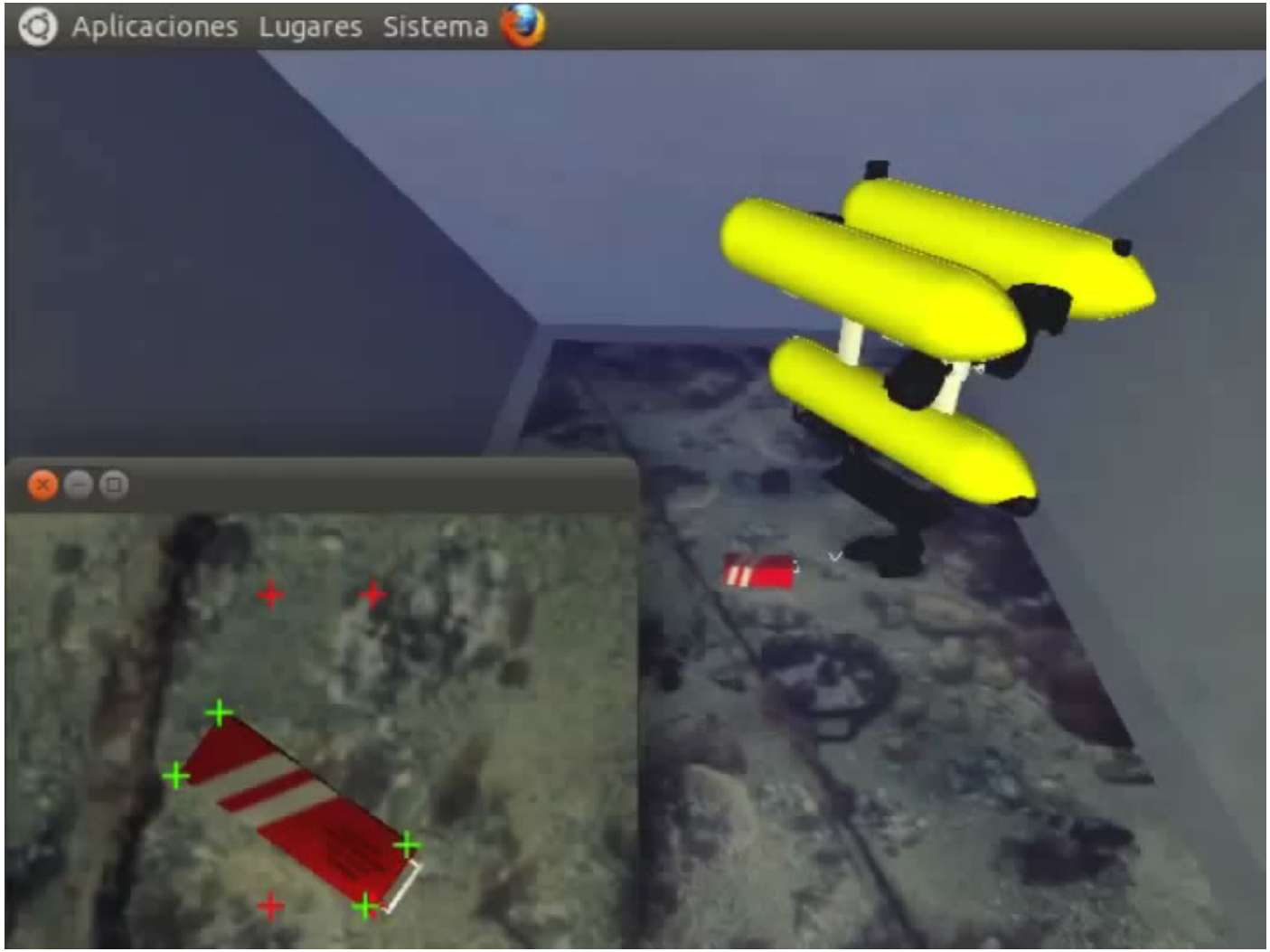
- nav_msgs/Odometry
- sensor_msgs/JointState
- sensor_msgs/Image
- sensor_msgs/Range
- sensor_msgs/Imu
- geometry_msgs/Pose
- geometry_msgs/Twist


TRIDENT
Marine Robots and Dexterous Manipulation for Enabling Autonomous Underwater Multipurpose Intervention Missions
SEVENTH FRAMEWORK PROGRAMME
(ICT-248497)
Applications Places System
Sat Dec 15, 1:32 PM
test1 [running]
Edit View Simulation Format Tools Help
0.5
vx
-C-
vy
0.125
vz
0.0
roll_dot
0.0
pitch_dot
0.0
yaw_dot
publisher
S-Function
0.5
q1
0.5
q2
0.5
q3
0.5
q4
0.5
q5
publisher1
S-Function2
u
u1
fcn
y
MATLAB Function
subscriber
S-Function1
Use case:
Simulink

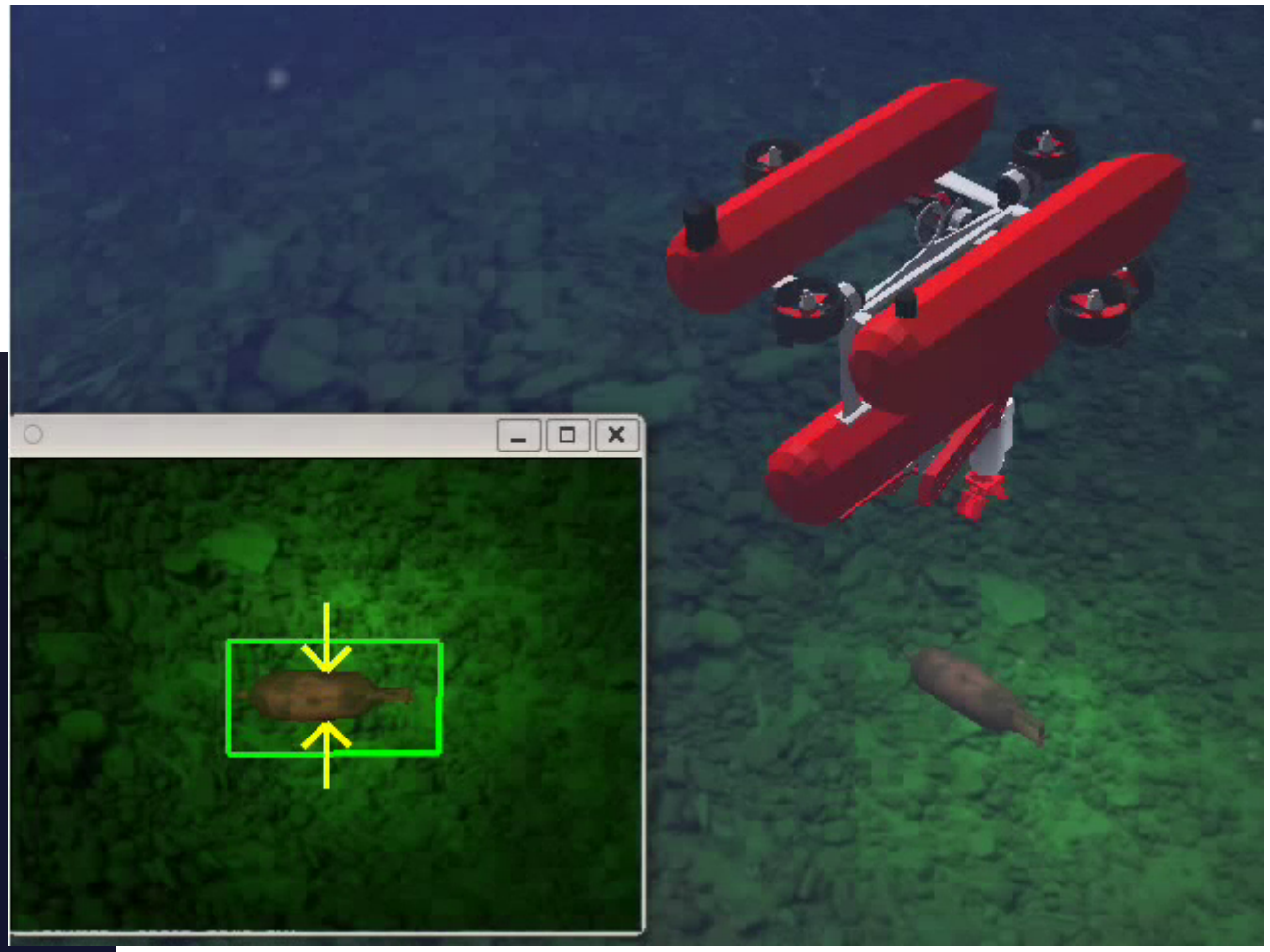


Use case: Vision

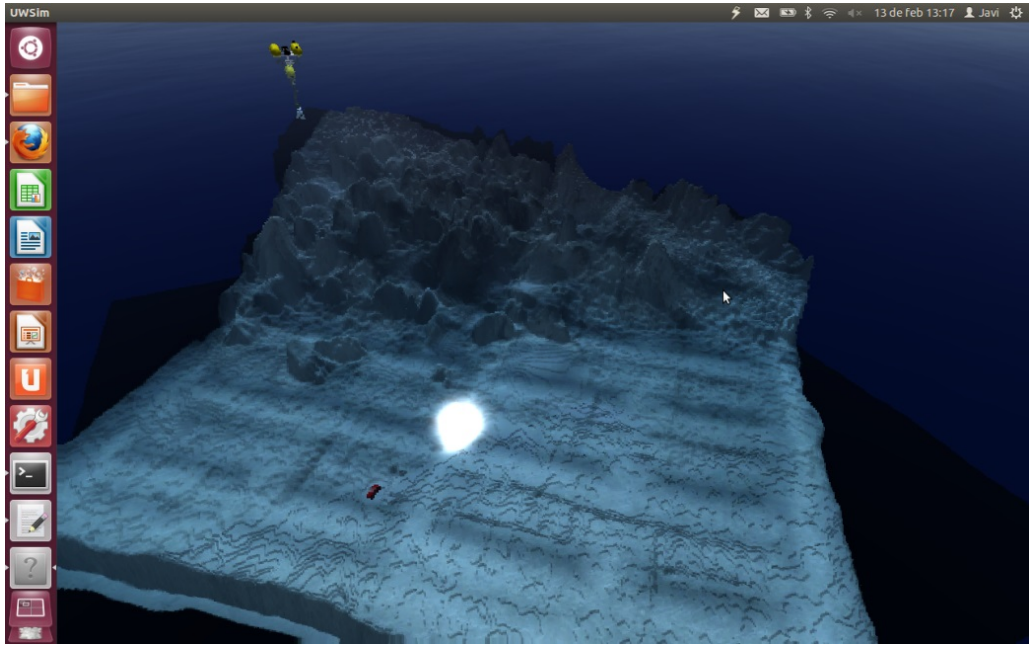
Use case: autonomous control

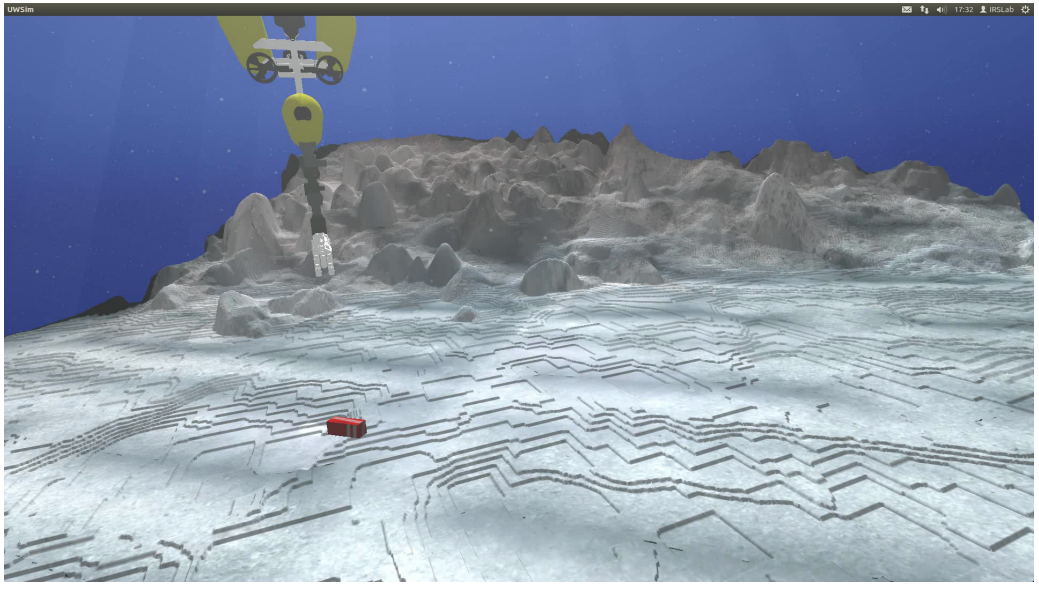


Use case: grasping

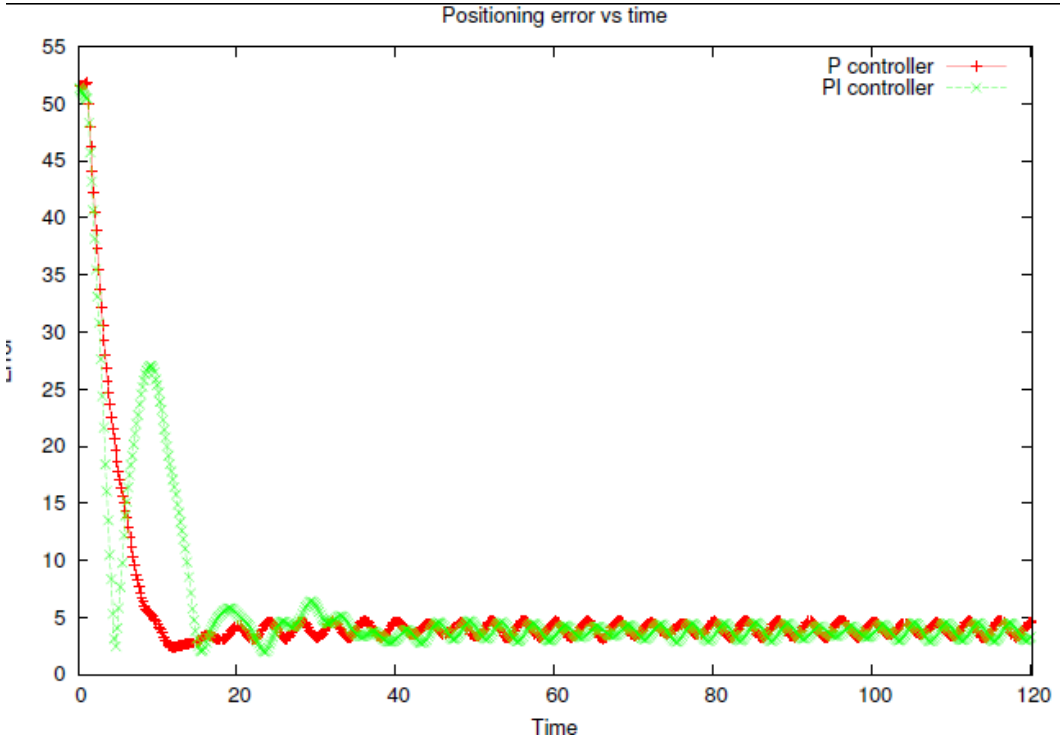


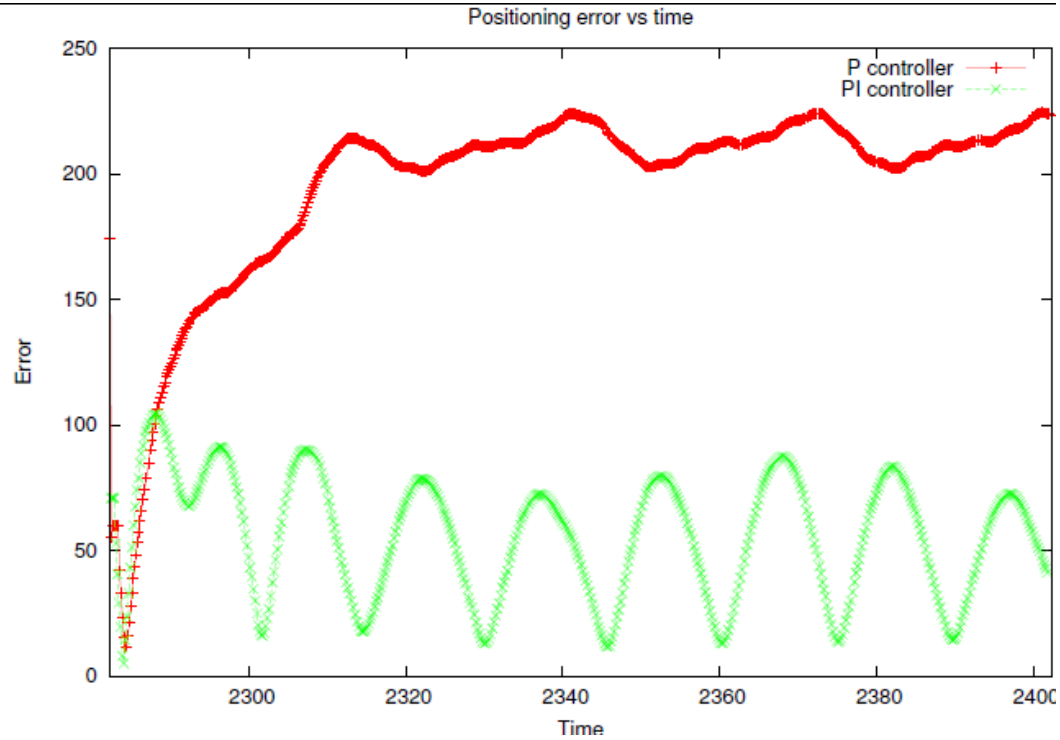
Use case: online visualization





Use case: Benchmarking



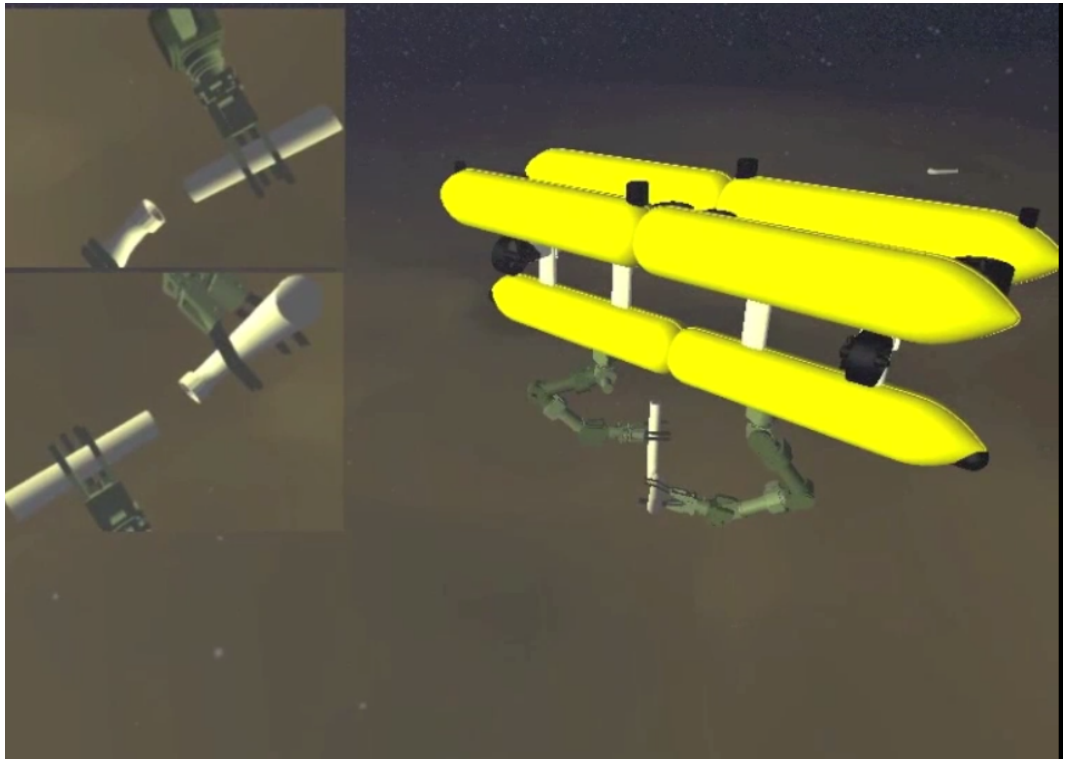


e.g. comparing two different positioning control algorithms on a increasing underwater current scene and measuring speeds, distances and covered terrain on real logged interventions

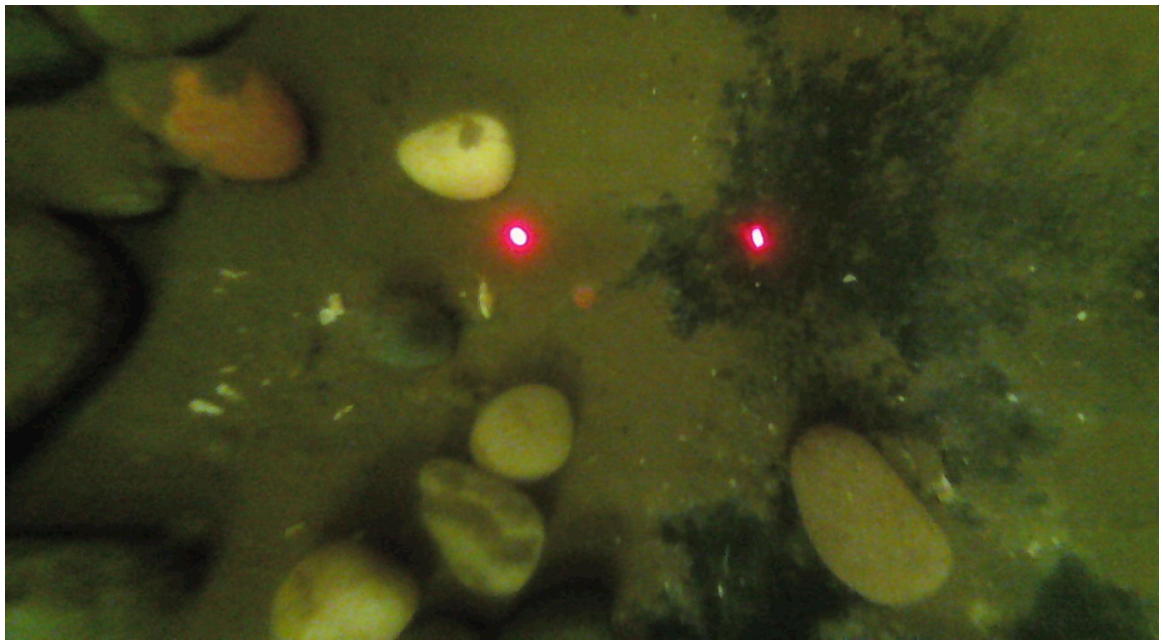
Ongoing Research

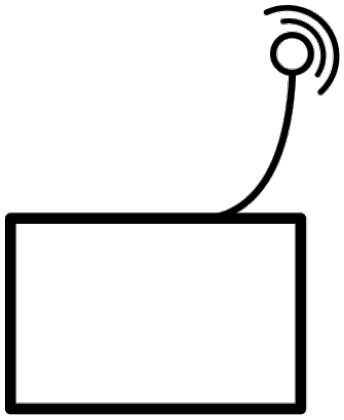
Promoted by FP7-MORPH Project, following the guidelines of Jacobs University and, in cooperation with UJI University (FP7-TRIDENT Project), a useful "comparison among simulators" has been addressed.

The Future

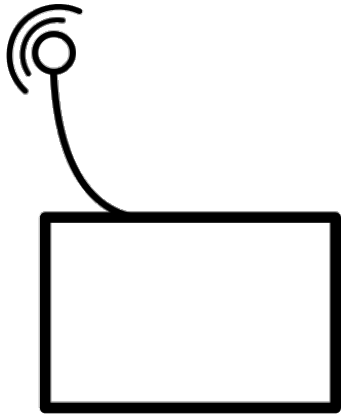


Use case: Image Compression and Transmission over RF Constrained Links (Rubino PhD Thesis)





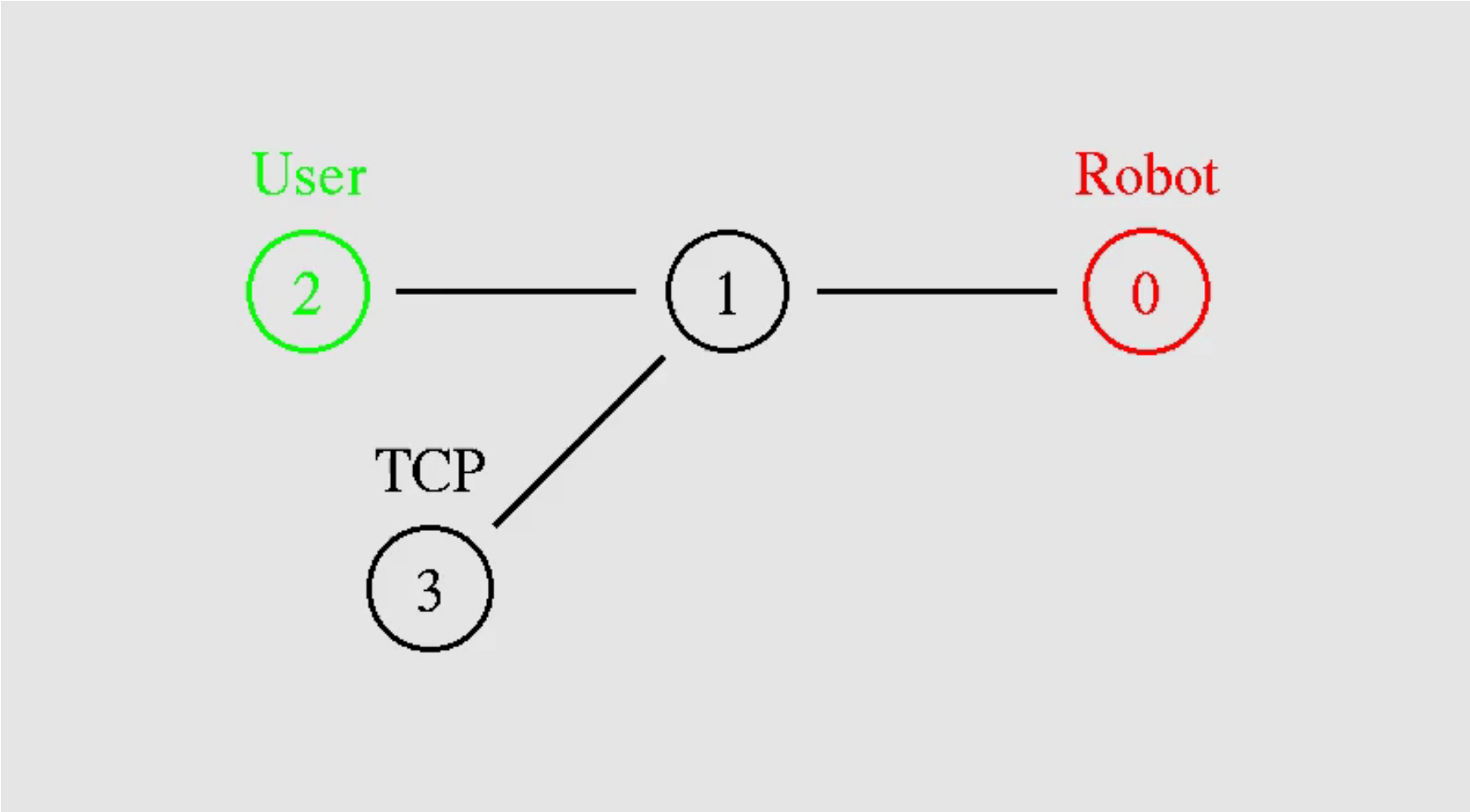
UHF transmission rate of **1.9 KB/s** with a **simple one-way protocol for testing image transmission**. Eduardo Rubino's compression algorithm, for **on-demand image size and resolution**



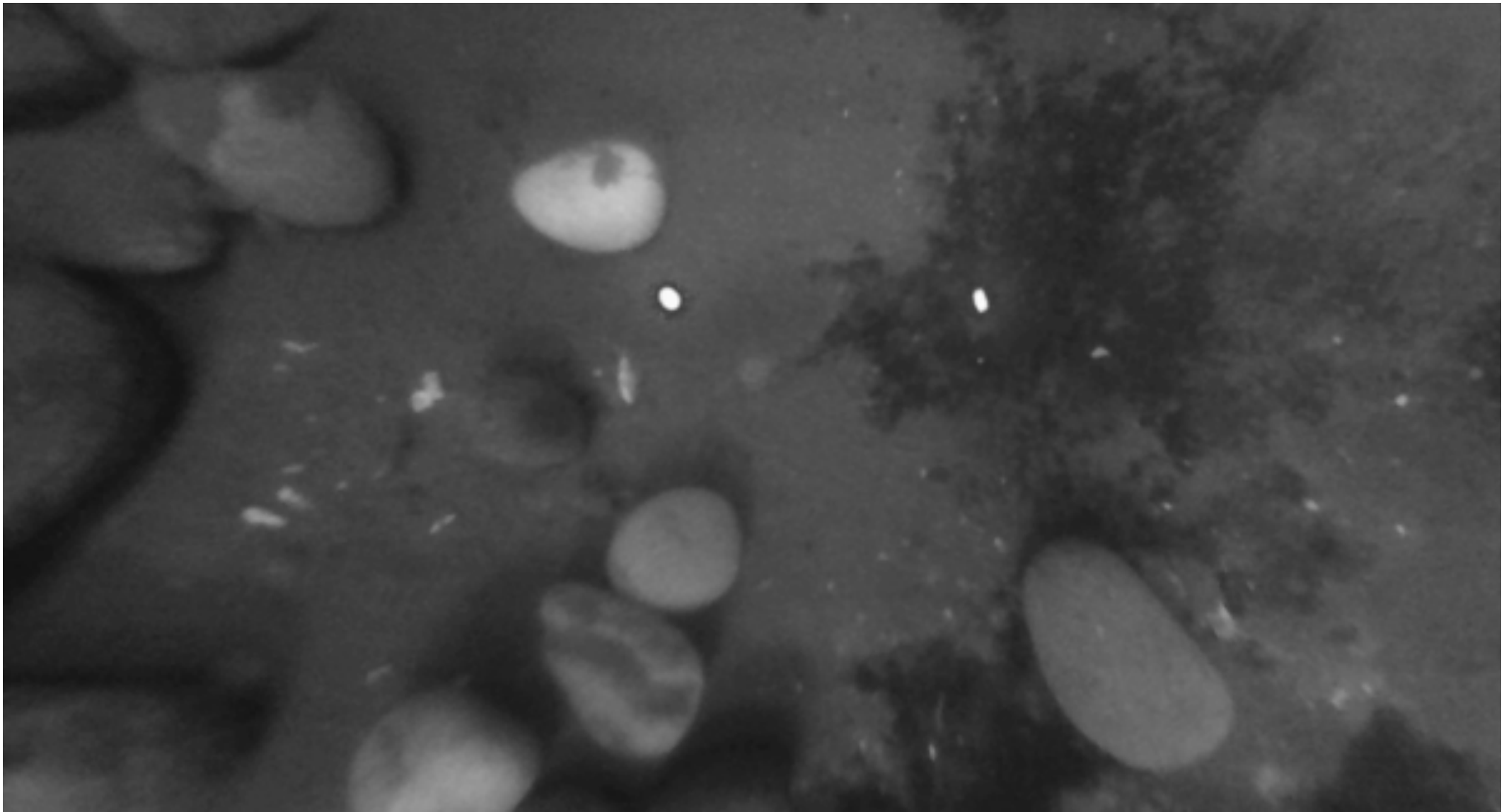
Network Protooclos for Bilateral Teleoperation and Robotic MANET Networks (Centelles PhD Thesis)

Raúl Wirz González, Jorge Sales Gil, Raúl Marín Prades, Enric Cervera Mateu, Ulf Witkowski, José Vicente Martí Avilés, Leonardo Nomdedeu Calvente. End-to-End Congestion Control Protocols for Robot Swarms using Ad-hoc Wireless Networks. Robotics for Risky Interventions and Surveillance of the Environment

R. Wirz, Marín, R., Ferre, M., Barrio, J., Claver, J. M., and Ortego, J., "Bidirectional Transport Protocol for Teleoperated Robots", IEE Transactions on Industrial Electronics, vol. 56, no. 9, p. 10, 2009.

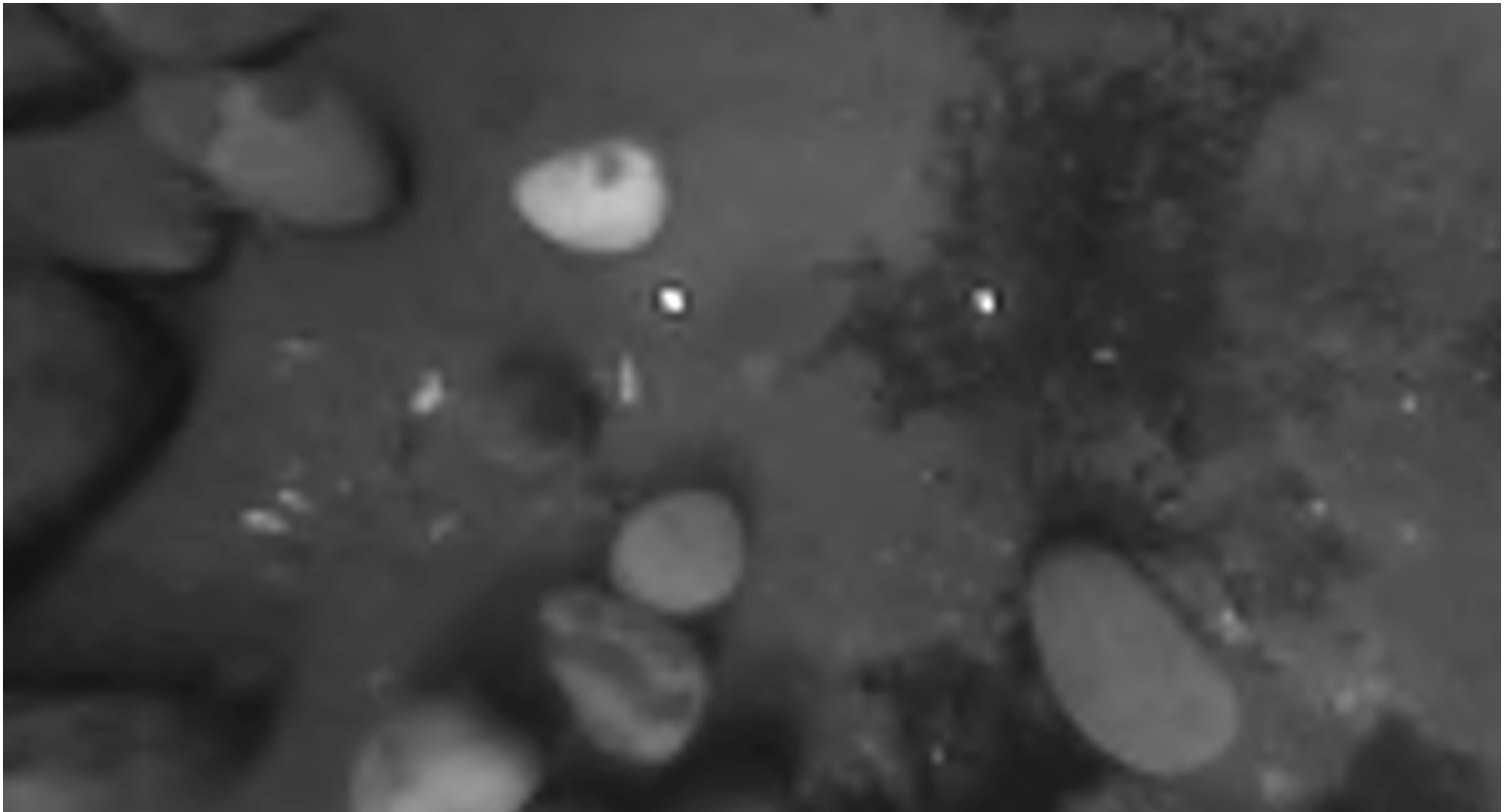


Original Image taken from Undewater Remote Operated Vehicle at IRS Lab (600x 325 pixels. **195 KB**)

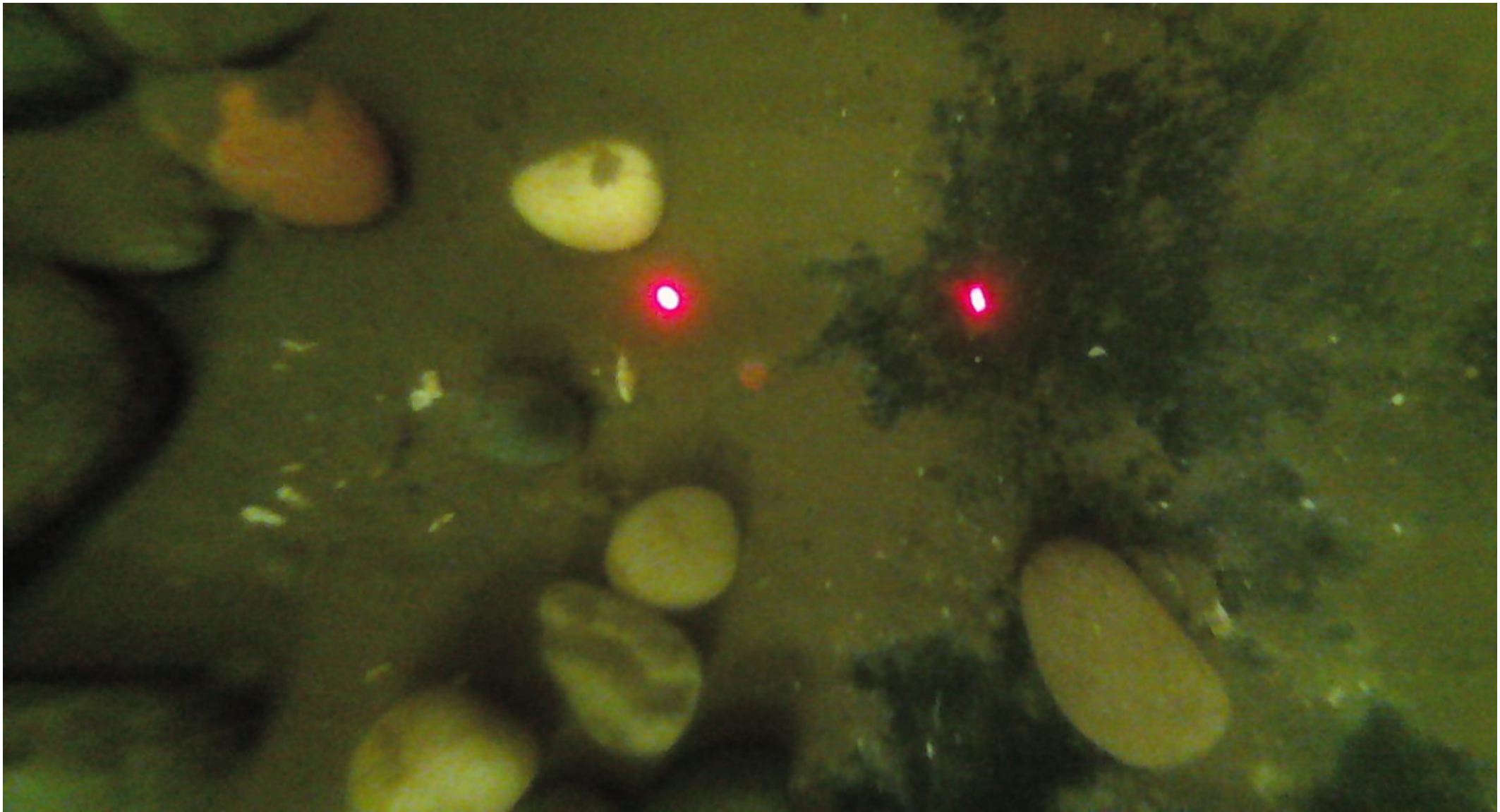


Original Image taken from Undewater Remote Operated Vehicle at IRS Lab (600x 325 pixels. **1.9 KB**).

Succesful transmission at 1Hz



Original Image taken from Undewater Remote Operated Vehicle at IRS Lab (1200 x 650 pixels)



Compressed Image taken from Undewater Remote Operated Vehicle at IRS Lab (1200 x 650 pixels – **3047 bytes**) Transmission Experiments Pending

Compressed Image taken from Undewater Remote Operated Vehicle at IRS Lab (1200 x 650 pixels - **975 bytes**) Transmission Experiments Pending

Thank you