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Pandora
Persistently Autonomous Robots

Persistent Autonomy through Learning in Autonomous Underwater Vehicles

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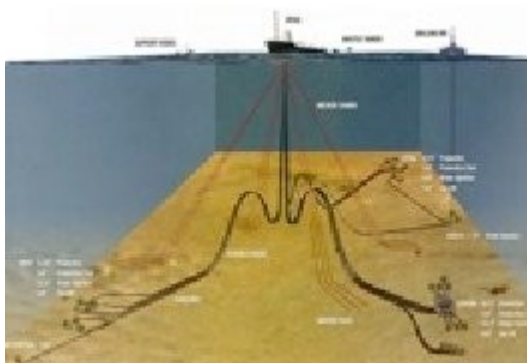
Persistently Autonomous AUVs

- Respond to system faults
- Generate their own missions when idle
- Adapt to unexpected environmental conditions

A PANDORA AUV constantly replans, continuously questions its assumptions, and adjusts its skills to fit its immediate environment.

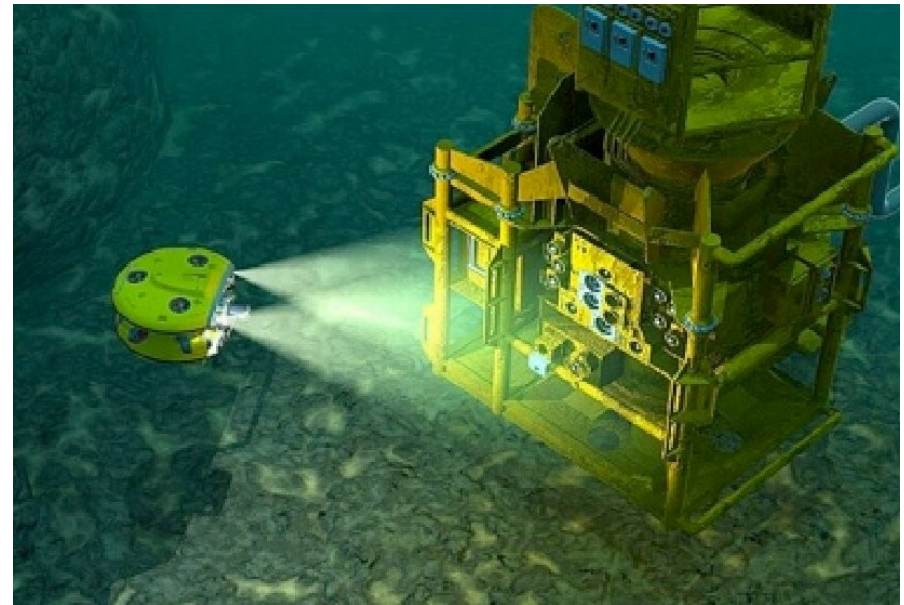
Persistently Autonomous AUVs

- Cost-effectively carry out more frequent inspection and repair
- Reduce the need for expensive ships
- Operate on extended periods (12-48 hours)



Domain challenges

- Noisy sensors
- Limited communications
- Finite energy
- Partially known environment
- Currents
- Reaction forces
- Object motion

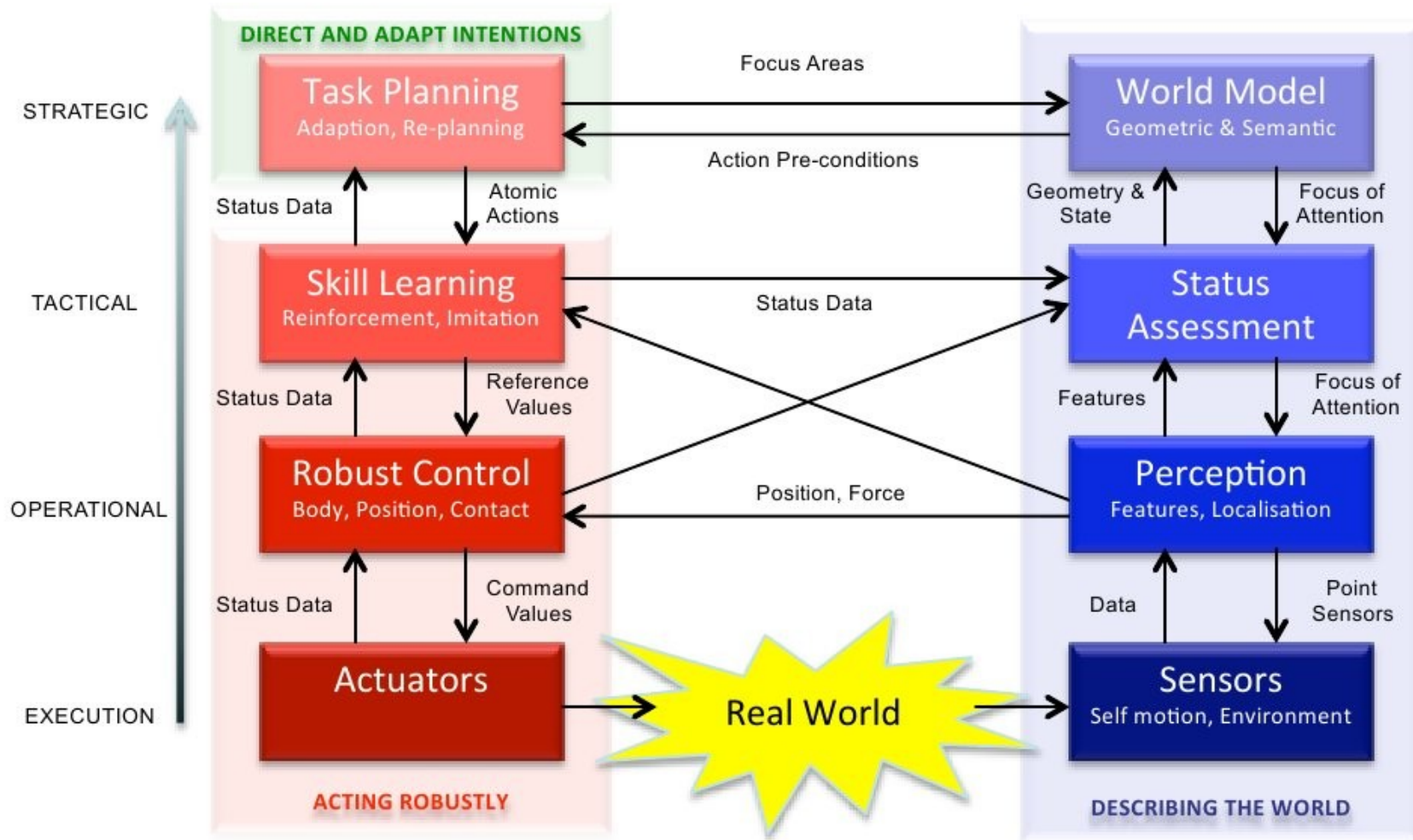


Partners

- Heriot-Watt Ocean Systems Lab
- Italian Institute of Technology – Advanced Robotics Dept.
- University of Girona – ViCOROB
- National Technical University of Athens – Control Systems Lab
- Kings College London

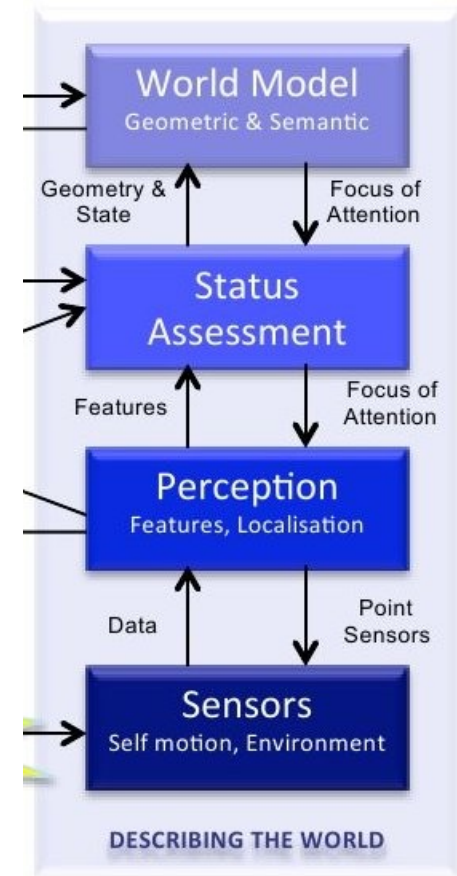


Themes



Describing the world

- Semantic descriptions of the world, agent and task
- Intrinsically uncertain
- Evolving
- Status assessment
- Attention focus
- Sensor failure detection



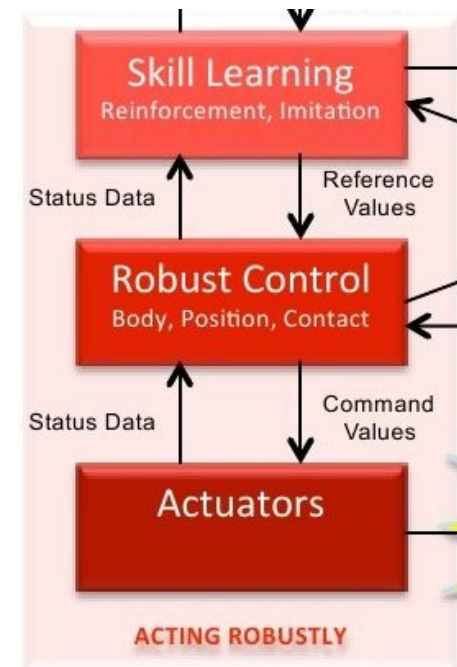
Direct and Adapting Intentions

- Set of mission goals
- Non-stationary environment: different sequences of actions to achieve the same goal
- Actions can fail, and how to recover from the failure is not obvious
- Sensing actions, parallel, temporal plans.
- Explicit models of uncertainty
- Model adaptation
- Hindsight plan repair



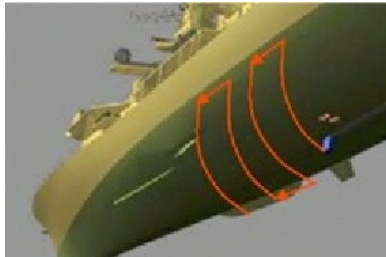
Acting Robustly

- Reactive control methods
- Adaptation through learning



Tasks

Structure inspection



Chain cleaning

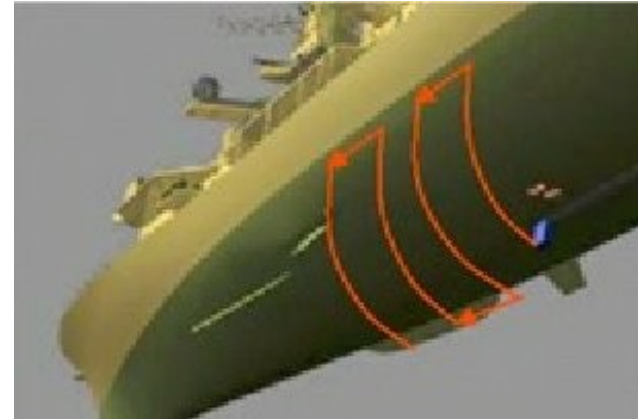


Valve turning

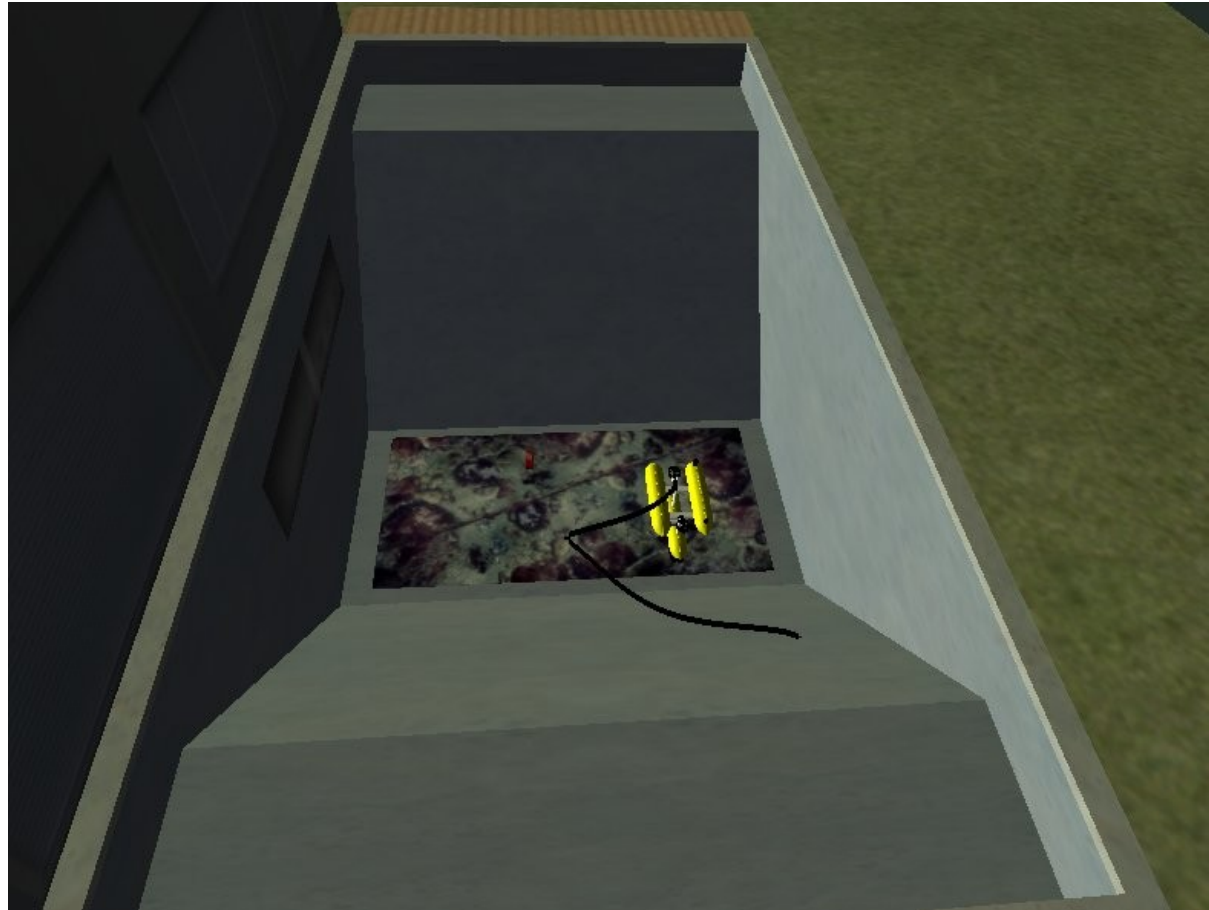


Structure inspection

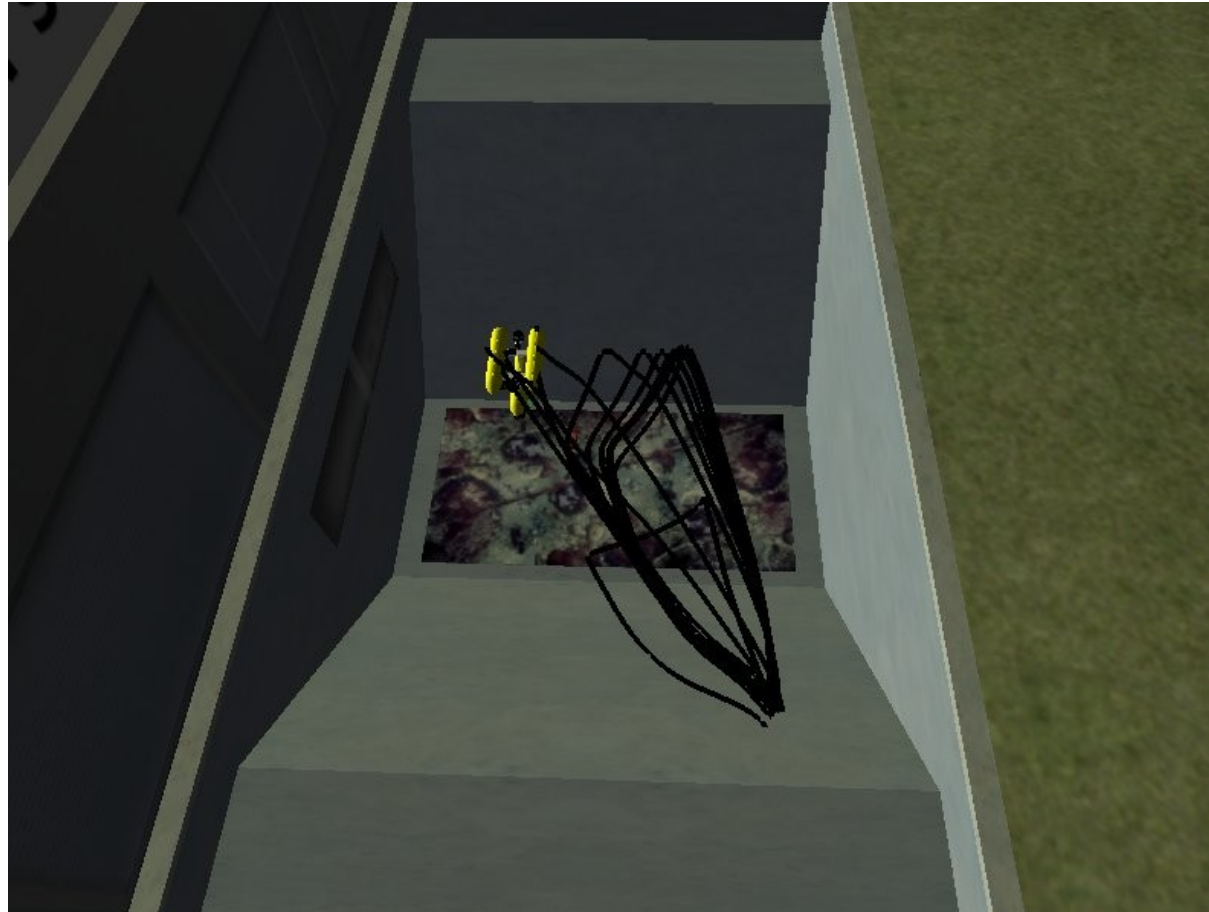
- Locate the structure
- Navigate
- Map the structure
- Clear data holidays



Structure inspection

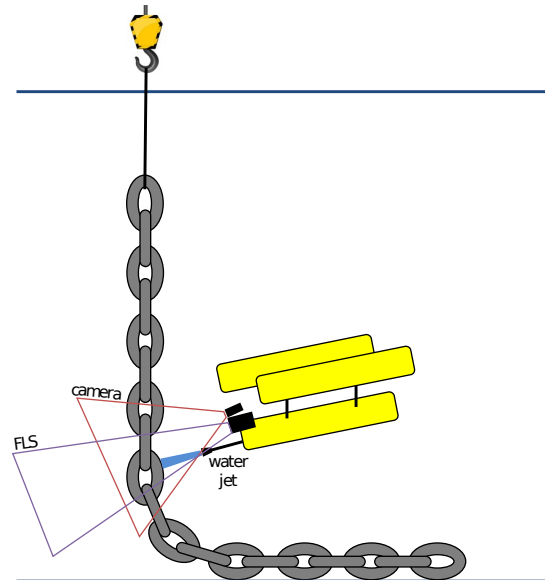


Structure inspection



Chain cleaning

- The AUV is equipped with a water jet
 - Locate the correct anchor chain
 - Remove marine growth
 - Revisit the chain and bring back a video inspection
-
- Visibility, currents, ...

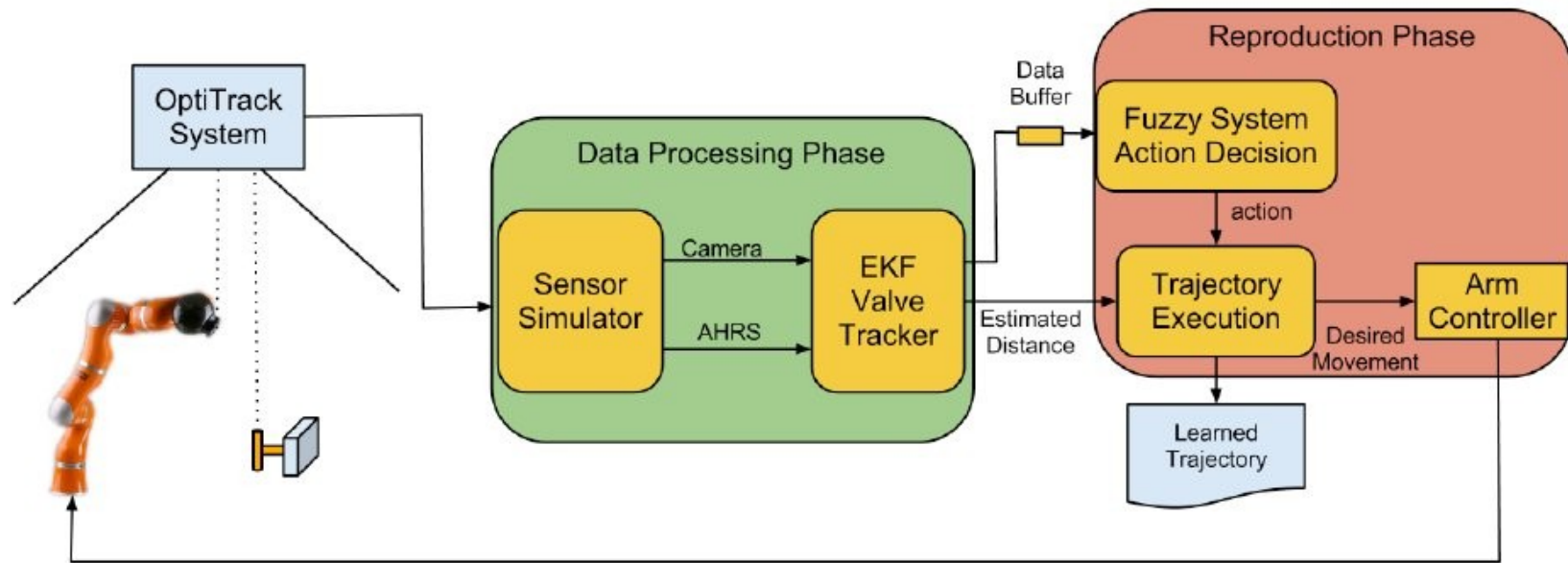


Valve turning

- The AUV is equipped with a robot arm
- Locate and navigate to the panel
- Locate the correct valve
- Identify its state
- Turn it if necessary
- Counteract reaction forces with thruster...
- ... without breaking the valve



Valve turning



Valve turning

