Panel on Underwater Robotics – Porto Statement

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A meeting of the Panel on Underwater Robotics was held on November 5th, 2018 at the Reitoria da Universidade do Porto, Porto, Portugal. This was the day before the IEEE OES AUV2018 symposium held at the Universidade do Porto. During this meeting a facilitated workshop was held to:

a) Identify critical issues and themes in the field of underwater robotics for the next 5 – 20+ years; and,
b) Prioritize these issues based on importance and time horizon.

The raw data from the brainstorming identified the following themes and issues:

- Defence applications: policy and law; armed vehicles
- Data relay: autonomous surface vessels ASVs
- Data interfaces: jamming e.g. GPS, spoofs; common interfaces
- Using sea gliders: mobile transponders
- Mission simulation
- Long range vehicles, e.g. under ice, oil spill applications (satellite), buoys,
- Ice applications: low cost buoys for communications, recharge, position updates
- Underwater communication:
    - Quantum communication

    - Optical models
    - Acoustic low power low cost modems
- Releasable pods
- Biologgers
- Genomics in autonomous system + DNA sequencing
    - Energy storage/power: batteries; bio fuels; recharge; bio-fuels e.g. kelp
- Vehicle design/cost
    - Very big: filled with batteries, submarine size, 'Mother ships' for small vehicles
    - Very small : "Nano" size for surveillance, launch from drones
- Applications
    - Defence
    - Under ice, explore planets
    - Micro-plastic identification
    - Deep water oil & gas exploitation, decommissioning, monitoring, interventions, etc.
        - Common interfaces + training 5 year horizon
        - 6 months familiarisation needed to operate a small AUV
        - Losses at Launch and recovery
    - Hybrids
    - Autonomous maintenance/intervention task (AI) – no tether
    - Deep-open ocean fish farming: e.g. farm monitoring.
    - Biomimicry for propulsion
- Autonomy and artificial intelligence – future (>20 years)
    - What does autonomous mean?
    - Increase in autonomy applications e.g. mine intervention
    - Continuous monitoring: e.g. bio-fouling, persistent presence
    - Trusted autonomy
    - Restricted environments
    - Biofouling – e.g. Remora fish emulation
    - Study unknown ecosystems in deep ocean, e.g. thermal vents
- Water/air vehicle (e.g. Thunderbird like, flying fish, sea/water interface, breaching whales, fish
- Self-repair – regrow, e.g. losing a fin/propulsion/computer
- Multiple assets
- Docking/homing system development
- Autonomy for bio/fish/whale surveillance; military surveillance; persistent monitoring
- Increasing quietness of operation
- Sampling of environment, monitoring for coral releases + other sporadic bio-changes

These were prioritized in ranked order over two main time horizons:

Those achievable or likely to be achievable within the next five years:

1) AUV use in deep water oil and gas exploitation, decommissioning, monitoring, training of personnel
2) Development of autonomy, trusted autonomy and fault tolerance
3) Navigation issues resulting from jamming of GPS signals
4) Under-ice monitoring of oil spills
5) Larger vehicles, submersibles and ships operating fleets of smaller AUVs as "mother ships"

And less strongly in areas of:

6) Use of AUVs to study unknown ecosystems in the deep ocean
7) Multiple assets such as fleets and swarms
8) Under-ice buoys and docking stations for communications, recharge and positioning
9) Hybrid AUVs
10) Policy and law relating to uses for defence
11) Increasing the quietness of operations
12) Monitoring of “intruding” AUVs

Those “blue skies” ideas seen to reflect where the technology might develop in the 20+ years - time frame:

1) Developments in artificial intelligence applications for AUVs
2) Use of AUVs in remote environments such as under-ice and on planets
3) Step change developments in underwater communications (e.g. “quantum” methods)
4) Energy storage developments – bio-fuels, batteries

And less strongly in areas of:

5) AUVs as armed vehicles in defence
6) Air/water capable vehicles
7) Extended endurance
8) Ethical acceptance - synergies between private and public uses

A future meeting will propose how the Panel on Underwater Robotics can support/facilitate solutions to these issues.