Serafina

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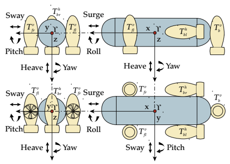
What?

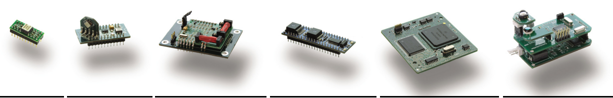
The *Serafina* project introduces schools of small autonomous vehicles to the underwater world. While each individual submersible might be equipped with a different set of sensors, they all share a common communication system. This enables them to organize the school as a single entity (distributed control), to disperse locally sensed data to many submersibles (e.g. for the purpose of sensor data fusion), and to grow or shrink the current school.

Why?

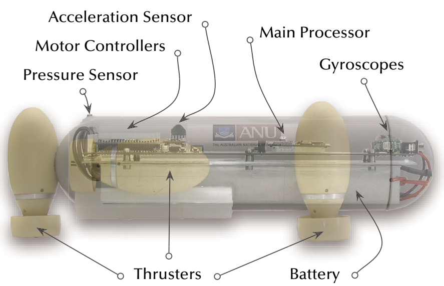
First: why small? In the case that the obvious limitation in payload does not pose a problem, a small submersible enjoys many advantages. Easy handling (no winch, no crane, etc.), great robustness at reasonable costs, low (or no) threat to operators and environment, enhanced flexibility and speed of deployment.

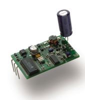


The list of benefits of the *Serafina* project can be broken down to the commercial application side, the perspectives of scientific exploration, and the gain for the artifact producing sciences (like us).

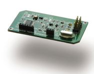


Gyroscope (1 of 3 axes) | Acceleration sensor (2 axes) | Compass | Motor controller (2 of 5 axes) | Main CPU module (MPC555) | Optical communication module





Ultrasound transceiver



Long wave radio transceiver

End-user applications:

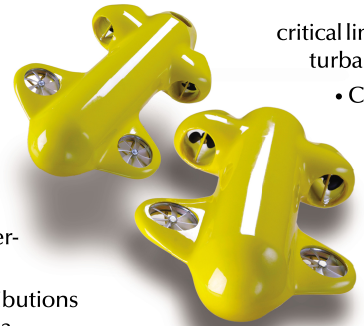
- Searching, exploration, mapping, …
- Monitoring, inspection.

Scientific exploration:

- Exploration of unknown territory and marine life.
- Seeking biochemical distributions and geological phenomena.

Science and Engineering:

- Open and dynamic environments.
  ☞ the environment is fast and unpredictable.
- Real autonomy required.
  ☞ remote control is not an option.
- Distributed control is put to a crucial test.
- Distributed scheduling and communication under low-range and low-bandwidth constraints
- Sensor data fusion



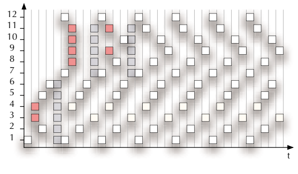
Problems!

The hard and thrilling issues exposed and addressed in the *Serafina* project:

- Establishment of an **effective and robust distributed communication system**, which enables the submersibles to stay informed, controlled and most of all: together!
- Establishment of a **distributed control schema**, which solves the given group navigation task effectively (energy is always a critical limitation under water) and robustly (disturbances are strong and unpredictable).
- Combine multiple, distributed position-related sensor readings into a common position ☞ **Localization**.
- Perform a given task autonomously over hours or days and make it back to base.

Solutions!

Every part of the project can only be just touched upon here, so you might like to take the time, asking one of us for the details, and/or look up our publications.



Dynamical, distributed omnicast schedule

Communication

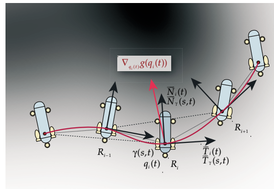
Sensor modalities for communication purposes currently include long-wave radio, optical, and acoustical channels. They all have limited ranges, but different bandwidths and other critical characteristics. Local schedules are built dynamically to optimize omnicast communication.

Localization

By combining optical posture and range estimation with active and passive wide-band acoustical data as well as depth readings, imprecise local measurements converge to a common understanding of position, posture, and swarm constellation.

Control

Distributed, robust swarm control has been developed based on curvature-driven curve evolution theory. Robust adaptation of larger swarms to isoclines of environmental fields could be established (simulated).



Formation motion

Mechatronics

Hulls, *thrusters*, *micro-controllers*, *converters*, *sensors*, *communication buses*, and *software architectures* are constructed and maintained. Most components are extremely miniaturized, but still manufactured out of standard components. Current sensing modalities include:

- Accelerometers and Gyroscopes
- Pressure (depth reading and leakage detection)
- Optical sensors and transmitters
- Acoustics (active and passive wide-band)
- Magnetic sensing (compass)
- Radio (long-wave)
- Chemical, biological, photos, videos, small samples, … (application required sensing)

from here …

you can get the most recent *state* of the project (including publications and videos) on the *Serafina* web-site:

http://serafina.com.au/

Contact the scientific team:

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Info about the products:

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