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Envirobot RTD 2013

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Envirobot: A Bio-Inspired Environmental Monitoring Platform

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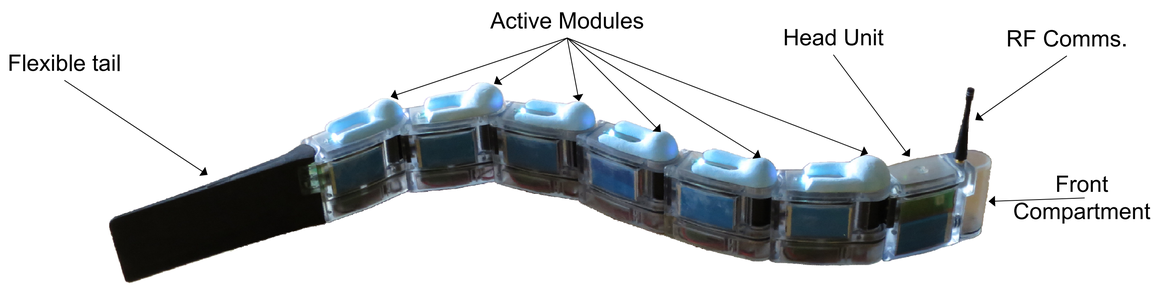
Abstract:

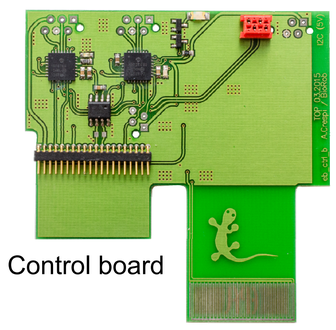
The Envirobot platform is based on existing segmented anguilliform AmphiBot III, but with important adaptations in terms of energy use and efficiency, sensory decision programming, and communication possibilities. To this end, Envirobot has been designed to have more endurance, flexible computational power, long range communication link, and versatile flexible environmental sensor integration. Its low-level control is powered by an ARM processor in the head unit and micro processors in each active module. On top of this, integration of an x86 based compute module enables versatile high level control methods and long range GPRS communication.

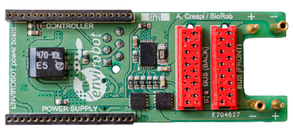
One of the main goals of the Envirobot project is to design and construct an **aquatic water sampling and water analysis robot**, which can either work in a **surveying mode** according to a predefined path, or in **autonavigation mode**, according to chemosensory and biological systems input; and that can store and/or communicate data analysis to an external observer. In autonomous surveying the robot will sample and analyze water bodies according to a predefined path and predefined number of waypoints. During autonavigation, the robots must guide its movements and sampling on the basis of the sensory input. Autonavigation is challenging but extremely interesting, since Envirobot would be able to track and follow gradients of chemical pollution in water bodies to find the source of pollution.

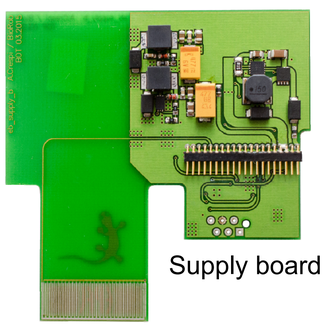
Envirobot with 7 Active Modules



Envirobot Active Modules


Control board

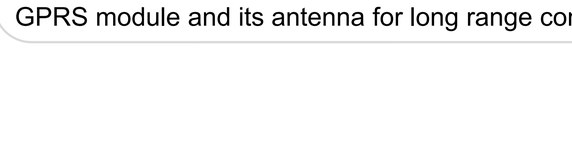

Power board


Supply board

Each active module includes a DC motor, step-down gearbox, absolute encoder, power board, supply board, and a control board with an integrated microcontroller for position/torque control of the motor. All the sensors connected to the modules are accessible through the CAN bus, which runs from the head module to the tail.

Envirobot Head Unit

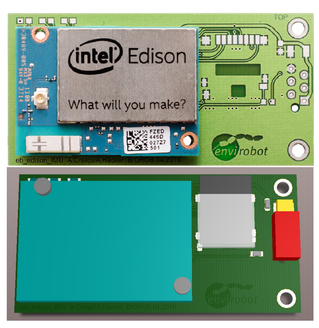
The head unit includes the main low-level controller of the Envirobot. Also, it communicates with the other modules through a CAN bus. It consists of a power board and supply board which is the same as the ones in active modules. Further, it contains the central control board and RF antenna.



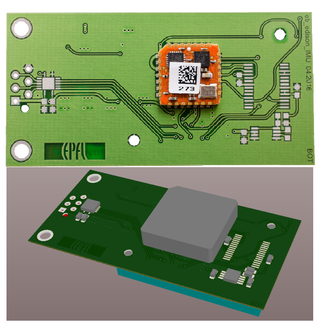
Central control board (front and back)

Supply board (front and back)

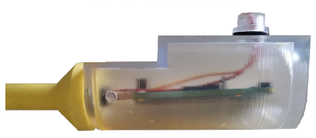
Envirobot Front Compartment



Top view of the compute board containing Intel Edison compute module


Bottom view of the compute board containing Attitude Heading Reference System (AHRS)

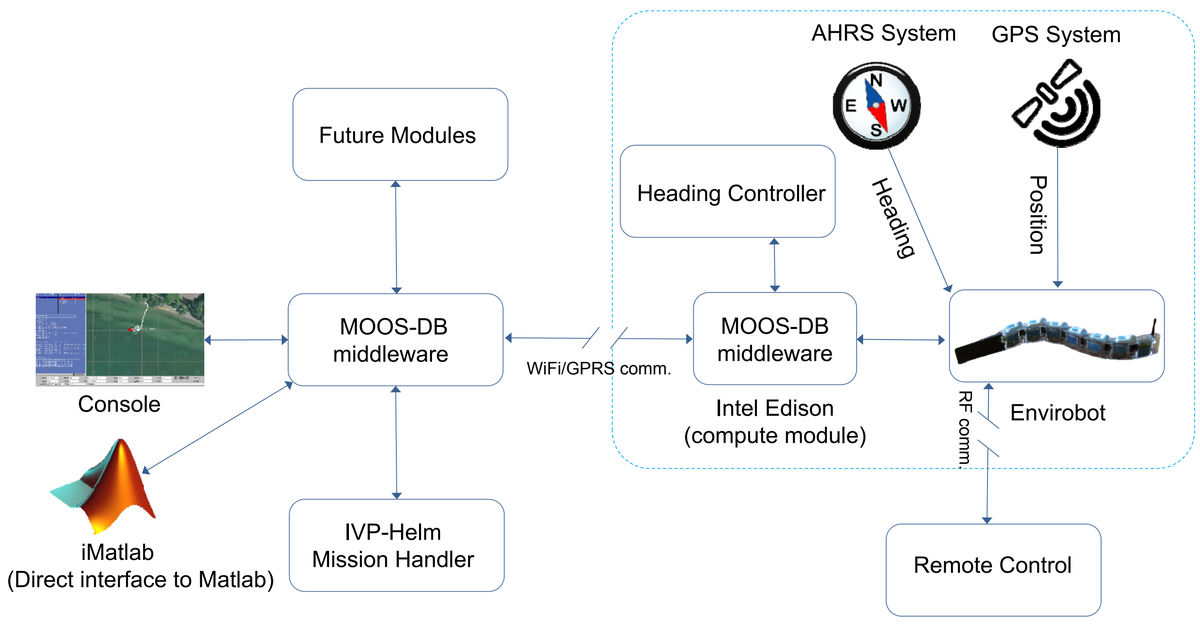

GPS antenna


Front compartment


GPS communication board

The Front compartment is dedicated to higher levels of control. It includes an AHRS, a compute module, GPS communication board, and GPS antenna. We also planned for future integration of GPRS module and its antenna for long range communication.

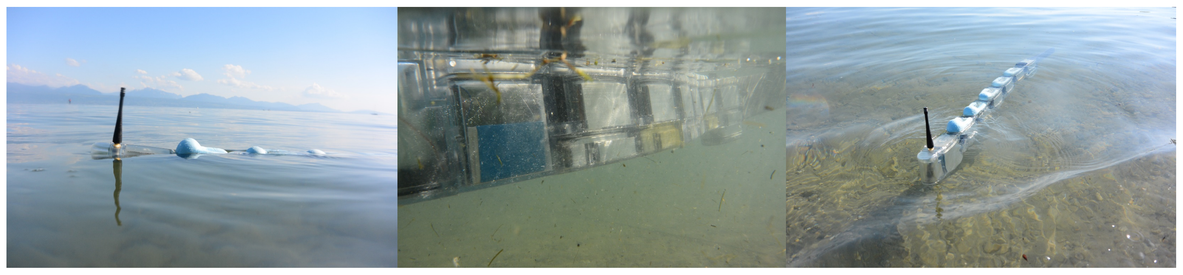
Architecture of Envirobot Platform



In the current structure we consider two MOOS-DB middlewares, one on the Envirobot and one on the computer running the console. Any new feature can be added to the platform by defining a new software module interrogating with MOOS-DB middleware. The modules can be developed in Matlab for fast prototyping, and after further development and module stabilization, it will be implemented on the Envirobot, increasing its autonomy capabilities.

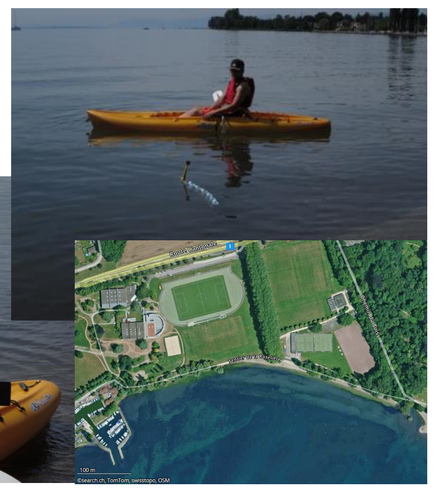
Envirobot First Test in the Lake Geneva

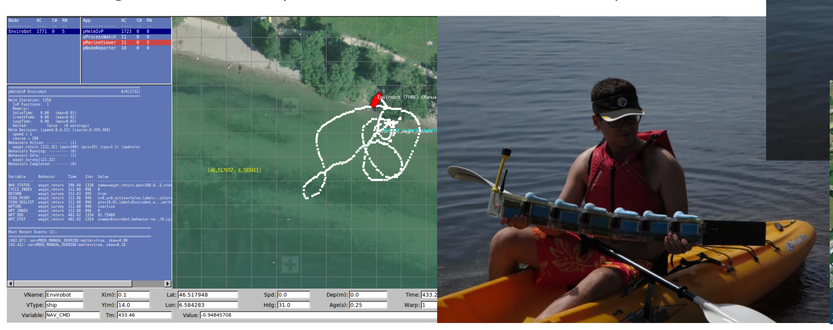
- **May 18, 2015**
- At the Lake Geneva, St-Sulpice, EPFL-UNIL sport center



Envirobot First Autonomous Trial in the Lake Geneva

- **August 27, 2015**
- At the Lake Geneva, St-Sulpice, EPFL-UNIL sport center
- Software integration test, GPS stability test, RF range of communication test, and mission control test.
- Travelled distance 302[m], average speed 0.87[m/s], and running time 05':48'' (screenshot of console below).

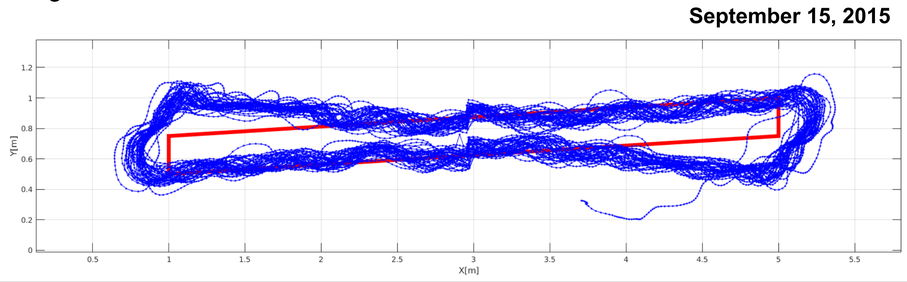




Autonomous Surveying

Autonomous surveying was tested in the indoor swimming pool using a path following algorithm and AmphiBot III (due to small dimensions of the pool). The result was a consistent path following behaviour of about 40 rounds in the pool with travelled distance of 324[m], average speed 0.32[m/s], and total running time 16':50''.

September 15, 2015



Future Directions

Future experimental tests include going to waypoint for water sample acquisition and autonomous surveying for mapping a predefined area with integrated sensors, such as conductivity, temperature, pH, and/or biological sensors. We also plan to conduct endurance tests of Envirobot. Last but not least is implementation and execution of autonomous pollution source seeking on the Envirobot.