Autonomy at the Surface: Oceanography through Robotics

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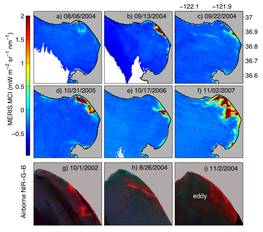
Objectives

Low-cost oceanography, e.g. surveys of

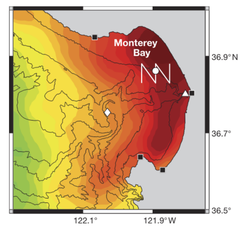
- the Oxygen Minimum Zone
- harmful algal blooms
- thin layers
- zooplankton
- open ocean eddies



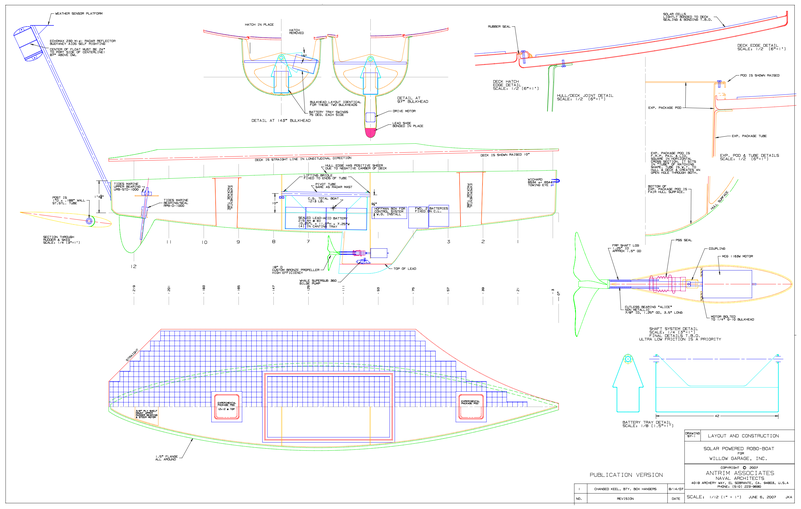
To further research through open-source as an autonomous research platform.

Explore distributed control across heterogenous vehicle fleets

Research carrier capabilities for rotary-wing aircraft.



Hardware



Onboard

- 3-axis mag, accel, gyro
- GlobalSat GPS
- Passive radar
- Water depth, temp, speed

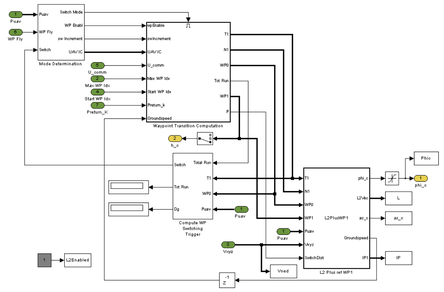
Capabilities

- >1kW solar charging power
- Mobile ballast for controlling roll
- Modular sensor payload
- Max cruising speed of 3.7 knots (4.3mph)
- Long-range wireless radio

Software

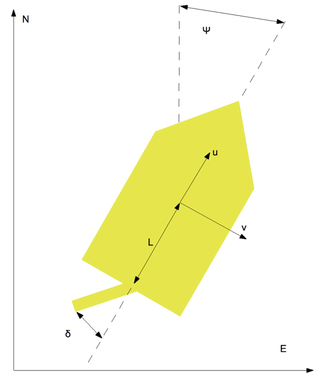
Software platform

- Control algorithms written in MATLAB, Simulink with C drivers provide integration with sensors
- Simulation, HIL, and live code from similar code base
- Fully open source and retargeteable



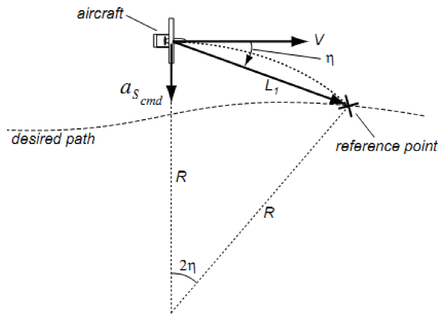
Simulation model

- Inverse-bicycle model
- Replicates environment down to the actuator level
- Augmented with 1st order dynamics determined from live tests

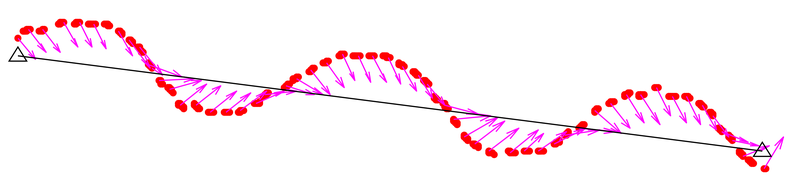


Controller

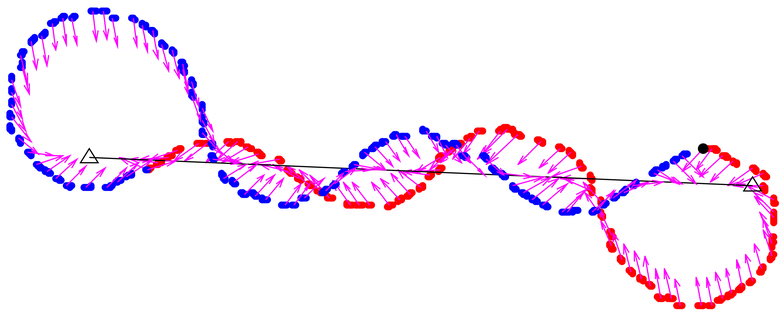
- Utilizes L2+ Guidance, a robust derivative of L1 control
- Look-ahead vector (L_1) determines intercept point along desired line trajectory
- Crosstrack and velocity PID loops provide path control



Results



First autonomous line-following test
Purple: desired heading
Black: desired path



Test of autonomous waypoint switching
Red: westward trajectory (initial point in black), Blue: eastward trajectory
Purple: desired heading, Black: desired path

Current Focus

- Improved vehicle model
- Complimentary filters for estimation of slow sensors (GPS)
- Integration of intertial measurement unit (IMU)
- Bi-directional remote command interface through the use of the open-source QGroundControl project already in use by SLUGS