Automated long-term oceanography by an autonomous surface vessel

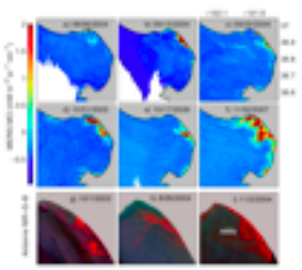
Bryant Mairs, Ren Curry, Ji-wung Choi, Gabriel Elkaim
bwmairs, rcurry, jwchoi, elkaim @soe.ucsc.edu

UC SANTA CRUZ

Baskin Engineering UC SANTA CRUZ

Objectives

Low-cost oceanography, e.g. surveys of
- the Oxygen Minimum Zone
- harmful algal blooms
- thin layers
- zooplankton
- open ocean eddies

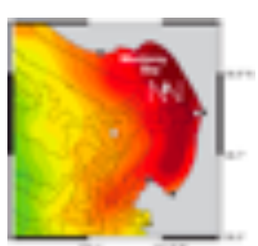


Time-lapse survey of an algal bloom

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



Ocean chlorophyll survey

Hardware

Onboard sensor payload
- 3-axis mag/accel/gyro
- Parallax GPS
- Passive Radar
- Water depth/temp/speed

Capabilities
- >1kW solar charging power
- Extensible sensor payload
- Cruising speed of 6 knots
- Long-range wireless radio

Control

Software Platform
- MATLAB/Simulink
- Sim+HIL+Code generation without substantial code change
- Open source controller

Low-level Control
- L2+ Guidance based on L2 control
- Look-a-head vector (L2) used to determine intercept point
- Crosstrack and velocity PID loops provide path control

High-level Control
- T-REX, created by MBARI
- Uses event-based reasoning
- Reactive to dynamic conditions
- Tested in live environments

Simulink diagram of navigation control logic

T-REX Functional Layers

Future Work

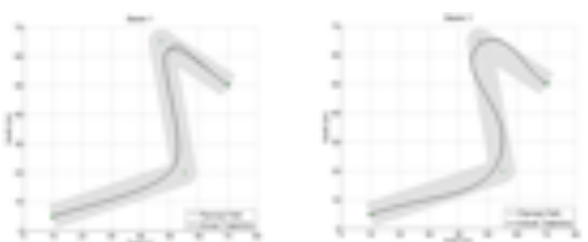
For complete autonomy:

- Complete systems integration
- Remote control & override
- Autonomous controller

Further refinements:

Improved Path Planner
- Based on Bezier-defined paths
- Adaptive to mobile obstacles
- Integrated constraint resolution

Sensor Pod Integration
- Integrate modular sensor pods into onboard power and communications
- Integrate sensor output into onboard reasoning engine



Generated paths using variations of Bezier-based planner

Multi-vehicle Control
- An extension to T-REX
- Supports a mix of aerial, surface, and underwater vehicles
- Invariant to communication reliability