The SeaSlug: An Autonomous Ocean Surface Vessel

Bryant Mairs, Ren E. Curry, Gabriel H. Elkaim
bwmairs, rcurry, elkaim@ucsc.edu
University of California, Santa Cruz
The SeaSlug
Control Algorithms
Mission Results
Architecture
Architecture
Systems Overview

[Diagram of a system overview showing connections between components on a 12V Rail and a 24V Rail. Components include Power Sensor, IMU CANode, Primary CANode, Wind/Air Sensor, GPS, Speed/Temp/Depth, Rudder CANode, Propeller Motor, ACS300, Power CANode, 2035, and Rudder Motor.]
The CANode
Simulation Environment

- Recorded Telemetry
- Controller
- Environment & Vehicle Model
- MATLAB
- C Compiler
- Autopilot Hardware
- MATLAB
- Environment & Vehicle Model
- HIL Simulation

Simulation
The SeaSlug
Control Algorithms
Mission Results
- Pursuit-guidance
- Look-ahead time
  \[ L_2 = V_g T^* \]
L_2^+ Mode Switching

\[ \min \left( \frac{e_N}{\tan(\gamma_{\text{max}})} \cdot M^* |L_2| \right) \]
Intercept Angle
Inverse Bicycle Model

\[
\dot{\psi} = -\frac{v_{w_x} \tan \delta_r}{L}
\]
Inverse Bicycle Model
\[ \delta = - \arctan \frac{a_{cmd} L}{|V_g| V_{wx}} \]
Compensating for Slow Yaw Rates

\[ L_2^+ \alpha_{cmd} \rightarrow + \rightarrow \text{To Rudder Angle} \rightarrow \delta_{cmd} \rightarrow \text{SeaSlug} \rightarrow \text{GPS} \rightarrow \text{IMU} \]

\[ K_{\psi} \rightarrow \dot{\psi} \]
Compensating for Slow Yaw Rates

The diagram shows the relationship between cross-track error (in meters) and along-track distance (in meters) for different yaw rates. The lines represent different values of KDotPsi: 0.0, 0.5, 1.0, and 1.5. As the along-track distance increases, the cross-track error decreases significantly, indicating effective compensation for slow yaw rates.
\[ P_{center} = P_{gps} - P_{offset} \]
\[ V_{center} = V_{gps} - V_{induced} \]
\[ P_{offset}^{n} = \overset{b \rightarrow n}{R} (\psi) \cdot \begin{bmatrix} -2.709 \\ -0.155 \\ 0 \end{bmatrix} \]

\[ V_{\text{induced}}^{n} = \overset{b \rightarrow n}{R} (\psi) \cdot (\overset{b}{\Omega} \times \begin{bmatrix} -2.709 \\ -0.155 \\ 0 \end{bmatrix}) \]
GPS Offset Correction
The SeaSlug
Control Algorithms
Ocean Testing
Open-ocean Repeatability Tests
**Open-ocean Repeatability Tests**

<table>
<thead>
<tr>
<th></th>
<th>Mean (m)</th>
<th>Std. Dev. (m)</th>
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<tbody>
<tr>
<td>Trapezoid (run 1)</td>
<td>0.12</td>
<td>0.96</td>
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<tr>
<td>Trapezoid (run 2)</td>
<td>0.05</td>
<td>0.82</td>
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<tr>
<td>Bowtie (run 1)</td>
<td>-0.06</td>
<td>1.02</td>
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<tr>
<td>Bowtie (run 2)</td>
<td>0.05</td>
<td>0.88</td>
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</tbody>
</table>
Algal Bloom Data
Algal Bloom Performance
Oceanographic Sensors
Front Detection Data

**TEMPERATURE [°C]**

**SALINITY [PSS-78]**
Front Detection Performance

![Graphs showing alongtrack distance vs. error and density distribution of crosstrack error.](image)
Questions?