Title

Networked Robotic Sensor Platform Deployments for use in Coastal Environmental Assessment in Southern California

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Networked Robotic Sensor Platform Deployments for use in Coastal Environmental Assessment in Southern California

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Features of Slocum gliders, ASVs and Networked Buoys and Moorings for coastal observation

Slocum Gliders

+ Deep profiles (~100m)
+ Good endurance (~4 wks)
+ Collaborative robotic sensing
- Slow moving (<1km/hr)
- Iridium is expensive (>$2500)

Robotic boats

+ Ideal for lakes and marinas
+ Improves spatial coverage
+ Collaborative robotic sensing
- Limited range (<30km)
- Limited endurance (~8hrs)

Networked Sensor Buoys/Moorings

+ Constant presence with real-time web-streaming
+ More sophisticated sensing – larger sensors
- Samples a single location
- Difficult to re-deploy

Goals: Reduction of Iridium-usage; ASV Collaboration under Constraints; Online Data-streaming

Coastal radio-modem network

- **Develop a Freewave radio modem network**
  - Slocum gliders at surface communicate with shore-based Base stations using Freewave radios instead of Iridium whenever in range.
  - Network should support multiple gliders simultaneously to enable glider data-download and re-tasking of gliders.
  - Higher data-rates and reduced surface times improve power-consumption, reduce communication cost and enable easier access to data for re-tasking algorithms.

Multi-ASV collaboration

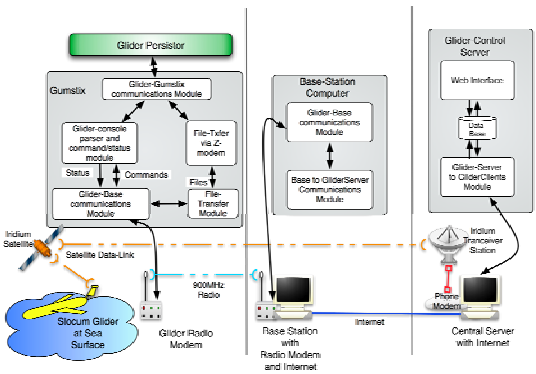
- **Develop controller for multi-robot collaboration under constraints**
  - Develop a hierarchical control scheme
  - Supervisory module commands elementary tasks
  - Behavior-based controller generates motion directives to achieve assigned task
  - Maneuvering controller follows motion directives
  - Perform static-obstacle avoidance
  - Perform target of visiting targets while maintaining inter-ASV wireless communication as constraint

Web-streaming of real-time data

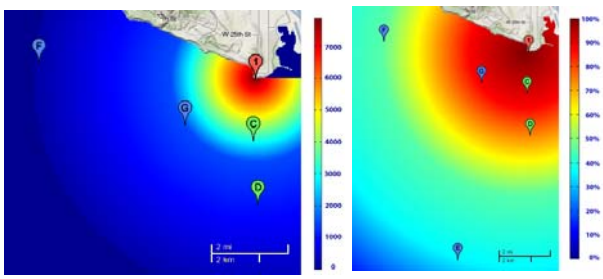
- **Online data-streaming from Redondo Beach and Marina Del Ray**
  - Network existing buoys and moorings to stream data to central server.
  - Configure and setup repeaters to provide access to remote buoys/moorings

Coastal Freewave network; Hierarchical Control Scheme for ASV; Data-streaming

Coastal network for Glider communication



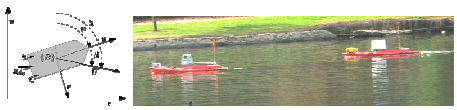
Block Diagram of Communication system for Gliders



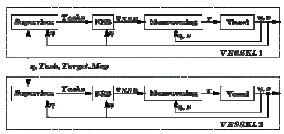
Interpolated File-Transfer rates in bytes/sec

Freewave Carrier-Detect On-Off Ratio

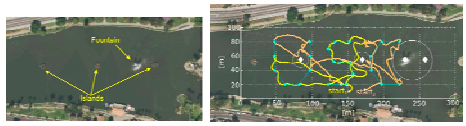
Multi-ASV collaboration under range-limited Communication constraints



ASV reference model and the Two vessels during the experiment

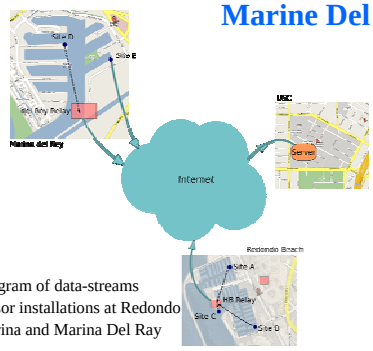


Control architecture for Two ASV team used for experiments



Obstacles in lake; Paths followed by both ASVs during experiments overlaid on a satellite map.

Online streaming of data from Redondo beach and Marine Del Ray



Block-diagram of data-streams From sensor installations at Redondo beach marina and Marina Del Ray

Plots of streamed data displayed on the NAMOS web-server

- Glider Mission Re-tasking successfully tested at range of 9.2km
- With compression, file transmission time improved 24x over Iridium
- Deployed a new centralized Glider Control Server with Mission-planning, updated Glider visualization, glider-console capability and file-transfers
- Glider status reports available at upto 20 km (E)
- Base-station hand-offs took place at location D