“Blob” Tracking with Robotic Swarms

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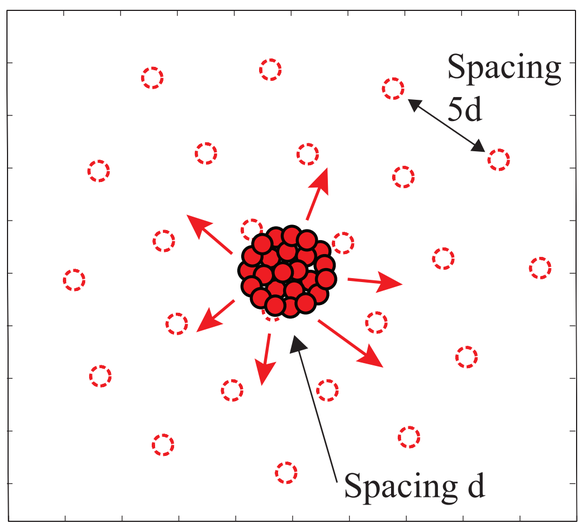
A swarm is a large group of vehicles that navigate autonomously using only near-neighbor communication. The objective of swarm management development is to enable multi-vehicle in-situ ocean samplers to characterize the shape, content, and evolution of ocean events in scales of interest from very small and quick (spills, run-off, etc.) to very large and slow (meso-scale temperature anomalies, i.e., El Nino, the “Blob”, etc.).

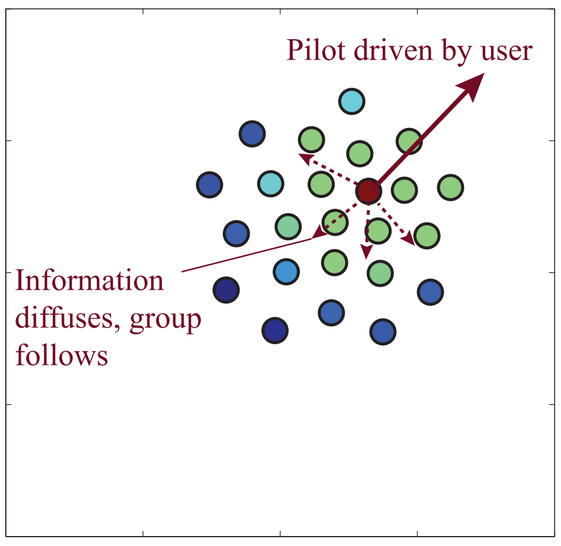
Towards adaptive in-situ measurement of time-varying phenomena, we present a swarm-robotics approach. We have developed an autopilot algorithm that allows a swarm to undertake three dynamic behaviors shown below on the left. The behaviors were implemented on a group comprising of about two dozen robotic model-scale boats as shown above. Below right, are simulations of edge-tracking using such swarms for tracking the Blob.

I. Tunable-Size Uniform Coverage



The swarm can change its size to the desired inter-neighbor spacing, changing the area of coverage. The individuals determine their new locations autonomously and adjust dynamically to changes in the number of vehicles.

II. Pilot-Controlled Migration

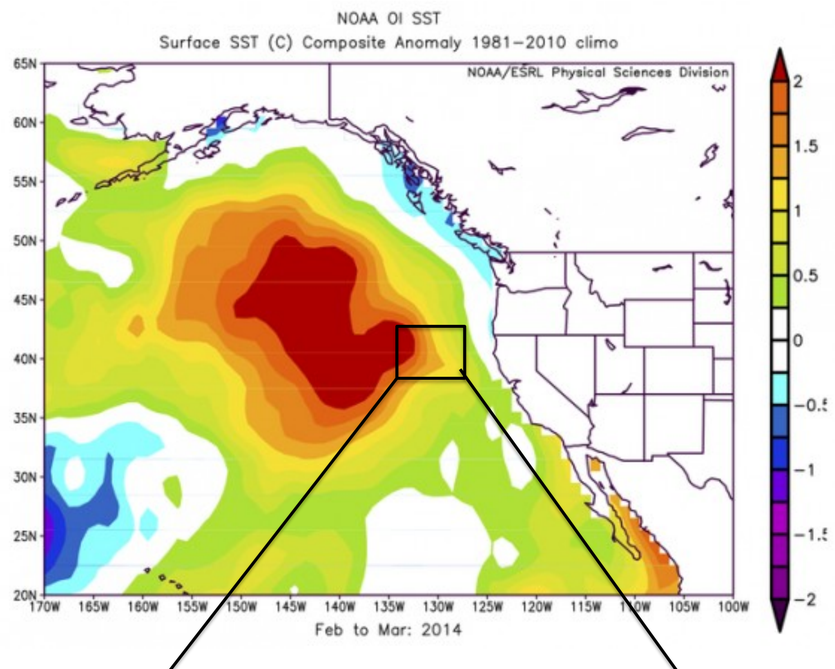


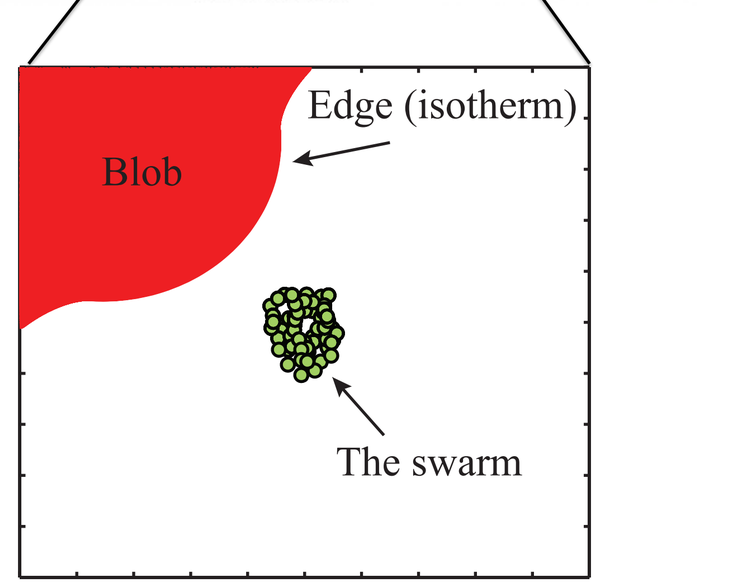
The swarm can be controlled by driving only one individual, that need not necessarily be in communication with all others. The group follows using “diffusion” of information.

III. Gradient-Tracking Migration

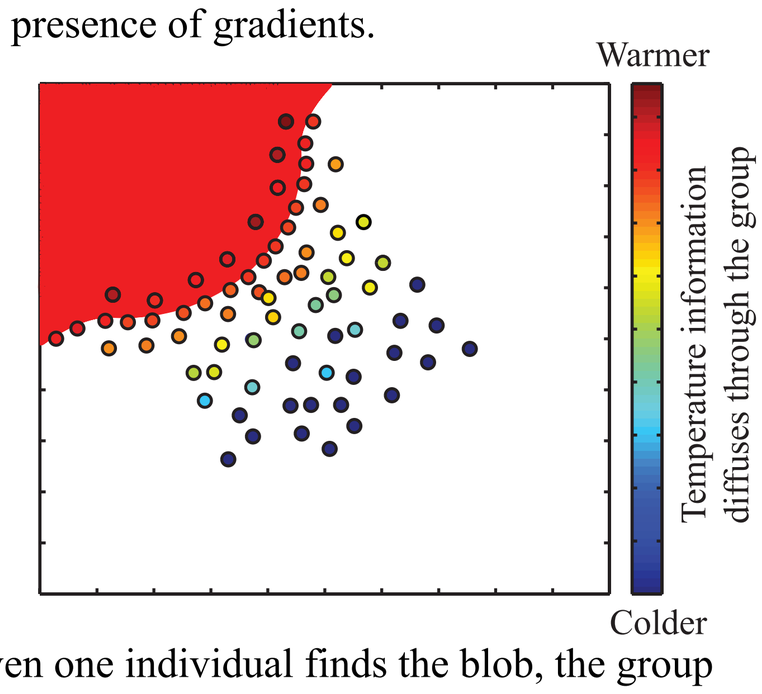
The swarm can also autonomously navigate based on measured environmental values. By responding to gradients thereof, it can identify hot spots, edges, and fronts.

Blob tracking





The swarm searches for the blob, by uniform spreading, piloted navigation, or by following the presence of gradients.



If even one individual finds the blob, the group spreads along the edge and adaptively tracks it.

Full paper available from the authors.
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