Extended Abstract: Ocean-TUNE UCLA Testbed for Subsurface Current Mapping

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ABSTRACT

This documentation contains future plans for the Ocean-TUNE supported deployment at UCLA of an open testbed suite, accessible to the public. The testbed will consist of U/W sensors that flow with ocean currents and allow us to map them. The UCLA subsurface current mapping testbed will be deployed "on demand" in the coastal region of the Southern California Bight including Santa Monica Bay, San Pedro Channel and near Catalina Island. The proposed subsurface current measurements taken simultaneously from different locations will complement existing observations. Surface currents will be compared and correlated to subsurface currents.

Categories and Subject Descriptors

C.3 [**Special-purpose and application-based systems**]: Real-time and embedded systems

General Terms

Design, Experimentation

Keywords

underwater wireless networks, ocean testbed, acoustic communications

1. INTRODUCTION

Underwater sensor network have recently been proposed as a way to explore and observe the ocean with wide area coverage. Since the ocean is directly related to our daily life, monitoring the ocean has gained much attention. Underwater sensor networks can provide an efficient way to monitor the ocean e.g. water current, water temperature and eddies. To fulfill this requirement, we will deploy a permanent water monitoring Ocean-TUNE [1] testbed in a couple of years. The UCLA Ocean-TUNE testbed will be deployed in the coastal region of the Southern California Bight, more specifically, the regions of Santa Monica Bay, San Pedro Channel, and near Catalina Island. The area is chosen due to ongoing observations of small-scale oceanographic eddies and fronts (SubEx). This project will therefore significantly leverage these experiments by providing a technology for subsurface current measurements taken simultaneously at different locations within these features. These observations are currently lacking, but are essential for determining the kinetic energy and evolution of these features that are a key element of the ocean energy budget. The ongoing experiments will deliver high resolution sea surface and in situ temperature measurements that help to determine acoustic travel times. Surface current measurements will be used for comparison. Aerial sea surface temperature measurements taken from the plane used in SubEx will be used to identify a suitable deployment area. UCLA's research vessel will help with the deployment, tracking, and recovery of the sea field testbed. The UCLA testbed will consist of one surface buoy, three bottom nodes and two drifters (two drogues from UCSD [3]). All nodes (including buoys, bottom nodes, and drifters) will be equipped with high-speed OFDM acoustic modems. The drifters employed in this testbed will be used to conduct measurements of eddies and fronts, where an accurate flow-tomography of underwater currents and eddies obtained from drifters will well complement the data from the bottom nodes.

2. TESTBED ARCHITECTURE

The UCLA testbed consists of three Sonobuoys, a couple of Drogues and a Glider and all nodes are equipped with high-speed OFDM acoustic modems. Fig. 1 shows the locations which we plan to deploy in the future. The testbed will be deployed in Santa Monica Bay, San Pedro Channel and near Catalina Island and one location will be permanently deployed and accessible to the public. Fig. 2 shows a network topology of our testbed. The sonobuoys serve as acoustic positioning references and as data relays from sensors to support ship. The underwater drifters will be mobile. Therefore, localization [2, 4] must be supported in this testbed. In that reason, we will also test proposed localization schemes. We plan to test and evaluate two novel localization schemes in Ocean-TUNE, especially for mobile underwater wireless networks.

- *Dive 'N' Rise (DNR) Positioning*: in [2], we propose a positioning scheme, called Dive'N'Rise (DNR). The idea is to use DNR beacons (such as gliders and drogues) for localization. Randomly chosen beacons get their coordinates from GPS while floating above the water, then they dive into water. While sinking and rising, they broadcast their positions. Underwater nodes are localized by passively listening to DNR beacon messages which reduces the communication cost and the energy consumption.

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Figure 1: UCLA testbed locations

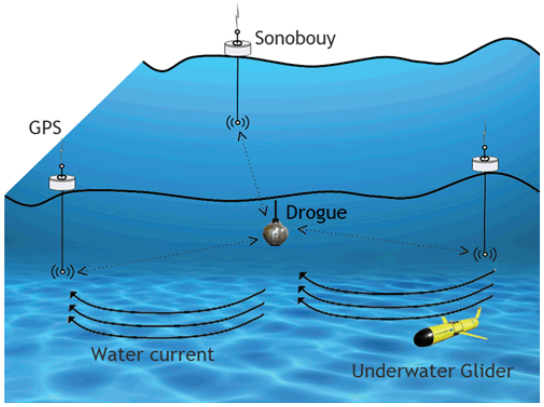

Figure 2: Ocean Tune Architecture (UCLA)

- *Network-based Localization*: in [4], we analyze various design choices to realize an efficient location service in a mobile underwater wireless network. We find that maintaining location information in a 2D plane is a good design choice. Given this, we propose a bio-inspired location service called a Phero-Trail location service protocol. In Phero-Trail, location information is stored in a 2D upper hull of a mobile underwater wireless network, and a mobile sink uses its trajectory (a pheromone trail of ants) projected to the 2D hull to maintain location information. This enables underwater nodes to efficiently locate a mobile sink.

Drogues and glider will monitor water current and eddies and deliver data to Sonobuoys via acoustic channel with OFDM modem. A permanent testbed that demonstrates the basic capabilities will be hosted by the UCLA Marina Aquatic Center in Marina del Rey (other suitable Southern California harbors are also being investigated). We plan to provide basic functionality of permanent testbed to be demoed in Summer 2013. The operational testbed is a "portable" testbed; it will be deployed in the ocean off the Catalina coast in conjunction with existing ocean current monitoring experiments. The full functionality of the proposed operational testbed is targeted for demonstration in Summer 2014.

3. EXPERIMENTATION PLAN

3.1 December, 2012

We plan to demonstrate OFDM communications link in Marina Del Rey between a sonobuoy and a bottom node. We may need to try in the UCLA pool first.

3.2 March, 2013

We will demonstrate Localization in Marina Del Rey and with three sonobuoys + one bottom node, which can be repositioned.

3.3 June, 2013

We plan to demonstrate Localization in Marina Del Rey and test with a glider.

3.4 August, 2013

We plan to demonstrate localization in the ocean with static buoys trailed bottom node or glider.

3.5 November 2013

We plan to demonstrate localization of glider. Static buoys will records Glider's position with timestamps. In addition, we will try to do preliminary under surface current mapping

3.6 Spring, 2014

We will test moving buoys experiments for longer traces. In this experiment, buoys move tracking the glider

3.7 Summer, 2014

We will demonstrate localization in Marina Del Rey both experimentation with single and multiple drogues positioning

3.8 Fall, 2014

Sub surface current mapping with multiple drogues

4. CONCLUSION

Ocean-TUNE is an open testbed suite which can be accessed by the public in the future. The UCLA testbed will be deployed in Santa Monica bay. Our goal is to monitor the ocean, and provide gathered important infomation in real-time. The ongoing experiments will deliver high resolution sea surface and in situ temperature measurements.

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5. REFERENCES

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