The DRL Underwater Sensor Network: Supporting Dual Communications, Sensing, and Mobility

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We propose to demonstrate the underwater sensor network hardware we designed, built, and deployed for perception, Communications, and control experiments in the ocean. The hardware consists of static sensor network nodes and mobile robots that are dually networked optically (for point-to-point transmission at 300kb/s and acoustically for broadcast communication over hundreds of meters range at 300b/s. We will demonstrate the results collected during experiments with this system in the ocean, in rivers, and in lakes.

The sensor nodes, which were developed in our lab, are shown in Figure 1. These nodes package communication, sensing, and computation in a cylindrical water-tight container of 6in diameter and 10in height. Each unit includes an acoustic modem we designed and developed. The system of sensor nodes is self-synchronizing and a distributed TDMA protocol. The system is capable of ranging and has a data rate of 300 b/s verified up to 300meters in fresh water and in the ocean. Each unit also includes an optical modem implemented using green light. The sensors in the unit include temperature, pressure, and camera with inputs for water chemistry sensors.

Because the nodes are light and small, they are easily deployed by manually throwing them overboard. Once deployed, the nodes are anchored with weights and form a static underwater network. This network self-localizes a range based 3D distributed localization algorithm [1].

Figure 1: A picture of some sensor nodes drying.

The underwater sensor network supports mobile nodes such as our underwater robot called the Autonomous Modular Optical Underwater Robot (AMOUR), shown in Figure 2. It is 11kg. with a maximum speed of 1m/s. It has a battery life of 5 hours.

Figure 2: A picture of AMOUR and some sensor nodes.

The robot has all of the capabilities of the sensor boxes as well as a more advanced camera system for use in local obstacle avoidance. One of the design goals of the robot was to be inexpensive, so it does not have an expensive inertial measurement unit (IMU). Instead we rely on the range measurements we obtain to the sensor nodes to determine its trajectory through the water

The job of the robot is to travel around and download data from the senor nodes. Additionally it gives the network dynamic sampling capabilities. If an event is happening of interest the robot can move to that area to provide denser sensor sampling. We envision having many robots in the final system to provide highly dynamic sampling and faster download of the data from the static nodes.

To be able to find the sensor nodes the robot must know precisely where it is at all times. A passive localization and tracking algorithm we developed [2] has been implemented on this sensor network system and used to localize and track the moving robot.

We have deployed the sensor nodes and the robot in the ocean (Moorea), in the river (Charles River) and in a lake (Otsego, NY) and collected extensive networking and localization data for this system. Our experiments verify the theoretical predictions. We will describe this data in great detail during our demonstration.

References

[1] David Moore, John Leonard, Daniela Rus, and Seth Teller. Robust distributed network localization with noisy range measurements. In *Proc. 2nd ACM SenSys*, pages 50–61, Baltimore, MD, November 2004.

[2] Carrick Detweiler, John Leonard, Daniela Rus, and Seth Teller. Passive mobile robot localization within a fixed beacon field. In *Proc. of the 2006 International Workshop on Algorithmic Foundations of Robotics*, New York, August 2006. Springer-Verlag.