Low Cost Modular Telemetry For Coastal Time-series Data

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Award #: N000149810816
http://dunkle.whoi.edu/webdata/LCT-Buoy/

LONG-TERM GOALS

The goal of this project is to develop and demonstrate a low-cost system for retrieving oceanographic data from instruments in the coastal ocean and delivering these data in near real time. This work is conducted under the National Ocean Partnership Program (NOPP) with Federal, State, Academic and private industry participation and funding.

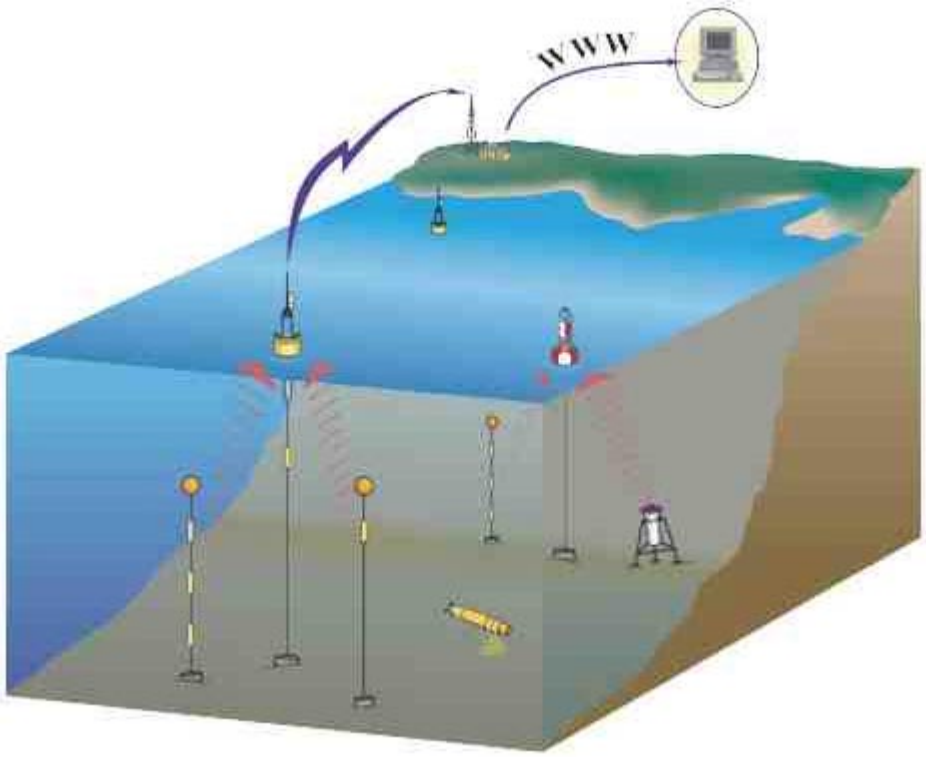
OBJECTIVES

The objective of this project is to develop and demonstrate a low-cost modular system for telemetering oceanographic data ashore. The system consists of 4 components: (1) a low-cost, medium bandwidth acoustic data link from oceanographic instruments below the surface to a surface buoy; (2) an acoustic modem/RF link to receive the acoustic transmissions and telemeter data to shore; (3) a buoy system for deployment of the acoustic modem/RF link, and (4) a system for distributing the data over the World Wide Web.

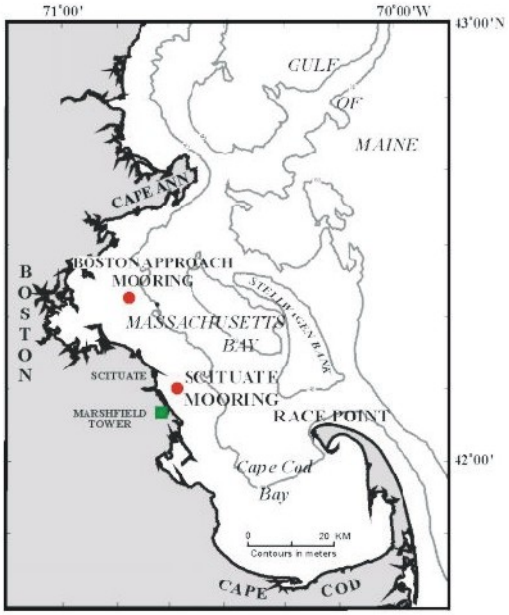
APPROACH

The approach is to use very low cost, low power acoustic transmitters which are capable of transmitting data from many sensors located on a mooring line or on the bottom in the vicinity of a surface buoy (figure 1). These acoustic transmitters are small, inexpensive, and low power, except during the brief

periods during which they burst. They operate in the 22-27 kHz band in a random access mode. The receive system, located at the surface buoy, consists of a Utility Acoustic Modem integrated directly with an RF telemetry link capable of providing high-reliability, medium bandwidth connection to shore. In this work a line-of-sight RF link, capable of operating over 6 - 20 miles, depending on the height of the shore-based receive station, is used for simplicity. Onshore, the data is distributed over the world wide web (http://dunkle.whoi.edu/webdata/LCT-Buoy/).



1: Conceptual picture of the low cost acoustic telemetry system for retrieving coastal times series date in near real time. Instruments are deployed near a surface buoy and transmit date to an acoustic modem mounted on the buoy. The data are immediately retransmitted to shore via radio frequency (RF) telemetry and further distributed over the World Wide Web (WWW). In principle, the data could also be received by ships in the vicinity. Sensors may be added or removed from the instrument array and the data are automatically added to the data stream without modification to the surface buoy. The target cost for the surface buoy, acoustic modem, and RF telemetry unit is $10,000. The low-cost telemetry and buoy system provides the potential for instrumented arrays capable of monitoring the coastal ocean on a variety of space and time scales and distributing the data over the WWW in a few minutes.



2: Location of moorings in Massachusetts Bay where the telemetry system is being tested. At the Scituate site, the surface link is installed on a research buoy (figure 3). At the Boston Site, the surface link is installed on a U.S. Coast Guard Navigation Buoy (figure 4). The telemetry link is located on a U.S. Coast Guard Tower in Marshfield.

The project is carried out as part of the National Ocean Partnership Program (NOPP). It is conducted cooperatively with the U.S. Geological Survey (USGS), Woods Hole Oceanographic Institution (WHOI), RD Instruments (RDI), the Massachusetts Water Resources Authority (MWRA), and the U.S. Coast Guard (USCG).

As proposed, the project involved 5 tasks:

Task 1: Acoustic and RF telemetry

Task 1a: Design low-cost transmit-only acoustic link (WHOI)

Task 1b: Design for the UAM/RF link (WHOI)

Task 1c: Low cost transmitter integrated with the ADCP (WHOI and RDI)

Task 2: Buoy deployment systems

Task 2a: Design low-cost surface mooring (WHOI)

Task 2b: Design system for deploying the UAM/RF link on a Coast Guard Buoy (USGS, USCG, WHOI)

Task 3: Distribution of data

Task 3a: Develop software to receive data from the RF link and distribute it in real time via the Web (WHOI, USGS)

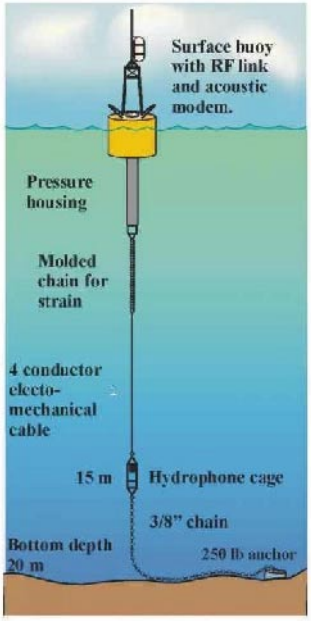
Task 3b: Distribute data over the Web during the field demonstration (WHOI, USGS)

Task 4: Demonstration

Task 4a: Demonstrate transmission of ADCP data from Scituate site (Figure 2) using a low-cost buoy (Figure 3) as the surface platform (WHOI, USGS, RDI)

Task 4b: Demonstrate transmission of ADCP data from long-term mooring utilizing Coast Guard Navigation buoy (Figure 4) as the surface platform (USGS, USCG, WHOI, RDI)

Task 5: Document results (WHOI, USGS, RDI)



3: This simple surface mooring combines an acoustic modem and a radio-frequency RF) modem to link insitu sensors to the shore. The mooring is small and lightweight and can be deployed from a small boat.

4: U.S. Coast Guard Boston Approach 'B' Buoy. The acoustic modem's hydrophone is suspended beneath the buoy and the radio antenna is mounted on the top of the buoy tower.

WORK COMPLETED

Design and construction of the telemetry system has been completed and several field deployments have been conducted. Testing is ongoing at both the Scituate and Boston sites. The LCT development has not yet been completed, but we hope to complete this work in the first quarter of 2001. A prototype of the Internet based data collection and display system has been developed and can be viewed on the project web site.

RESULTS

- The acoustically linked coastal telemetry concept has been demonstrated in prototype form in Massachusetts Bay. The moored surface buoys and other hardware have been developed and are proving to be robust and easy to use. To date, the Scituate mooring has been deployed for more than six months without any mooring related problems. The mooring line includes a 6-conductor electromechanical cable with special terminations and strain relief at the surface, so this reliability record is worth noting.

- Design and construction of the low-cost transmitter (LCT) required two years, longer than expected. As a result, the field trials to date have used Utility Acoustic Modems (UAM) in place of the LCTs. Prototype LCT's are now being tested on the ULTRAMOOR [1] experiment offshore of Bermuda. We plan to substitute LCTs for the present UAMs on the ADCPs early next year.

- Rather than build the LCTs into the ADCPs, it was decided to use the modems as stand-alone modules that could be plugged into existing instruments. This increased the flexibility of the LCT without complicating the logistics of the ADCP deployment. It also allowed us to increase the size of the modem battery pack, which is needed to provide the endurance required for the operational system.

- The telemetry system on the stand-alone research buoy was successfully tested at the Scituate site (25 m water depth) twice during the spring of 2000 and is presently operating. Multipath problems caused higher than expected acoustic error rates. As part of the planned follow-on work, we will use a lower carrier frequency, a modified frequency-hopping table, and improve our shore-side processing routines to improve data quality.

- The telemetry system was tested on the USCG Boston Approach Buoy in the summer of 2000. An electronic failure shortened this test. The system was re-deployed in September 2000. A robust and modular system was developed for deploying instrumentation on Coast Guard navigation buoys. This system included an over-the-side mount for the subsurface hydrophone as well as deployment of instrument housings on the buoy and RF antennas on the buoy tower.

- A real-time data processing and display capability was developed and is available via the project web site. Refinements to this page are ongoing. http://dunkle.whoi.edu/webdata/LCT-Buoy/

- The goal of developing a low cost modular telemetry capability for coastal applications has been achieved. Our proposal had a stated goal to develop an easy to use, reliable buoy and telemetry system that costs about $10,000. Our best estimate of the actual costs break down as follows: Buoy with light, radar reflector and all metal parts- $6018 (materials and labor). Mooring including E/M cable, anchor and hydrophone- $1948 (materials and labor). RF telemetry including RF modem, UHF radio and battery- $2240 (materials and labor). Acoustic modem- $4040 (materials and labor). The total telemetry mooring cost is thus about $15,000 including the labor to fabricate all of the mechanical and electrical systems. The direct materials cost is about $7500.

IMPACT/APPLICATIONS

The development of the low cost telemetry system has the potential to provide observations from distributed arrays with multiple sensors on a wide variety of spatial scales. Such observations are needed to resolve key processes, for ocean prediction, to aid in developing optimal sampling strategies (particularly for coupled physical and biological studies), and for long-term monitoring.

TRANSITIONS

There has been considerable interest in this telemetry system, and it is being utilized by several other investigators.

- The telemetry system is being further refined and tested in the field during the period 2000-2001 by the U.S. Geological Survey, in continued cooperation with WHOI, USCG, MWRA and RDI at both the Scituate and Boston sites. During this period, we plan to use a lower carrier frequency, a modified frequency-hopping table, and improve our shore-side processing routines to improve data quality.

- This technology is being transitioned to NAVOCEANO to be used in the Gulf of Mexico on a project being funded by NAVOCEANO through ONR (Acoustically Linked Communications Buoys for Gulf Coast ADCP Measurements, PI- D. Frye, Grant No. N00014-94-1-0346).

- The technology was used by S. Ramp (Naval Post-Graduate School) to telemeter ADCP data to shore in real time during the MOOS Upper-Water-Column Science Experiment (MUSE)[2].

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[1] Frye, D., D. Peters, N. Hogg and C. Wunsch, ULTRAMOOR: A 5-year current meter mooring, Proc. Oceans' 2000, Providence, RI, Vol. 2, pp. 1097-1102, Sept. 2000.

[2] http://www.mbari.org/MUSE/

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