AOSN MURI: COMMUNICATION SOFTWARE FOR THE UTILITY ACOUSTIC MODEM

David Brady, 402 Dana, Electrical and Computer Engineering Department
Northeastern University, Boston, MA 02115
Email: brady@cdsp.neu.edu

Dr. James Preisig, Department of Applied Ocean Physics and Engineering, MS # 11
Woods Hole Oceanographic Institution, Woods Hole, MA 02543
Email: jpreisig@whoi.edu

Co-PIs: Dr. Mark Johnson(WHOI)
Program #: ONR-322 OM/AOSN N00014-95-1-1316

LONG-TERM GOALS

To create and demonstrate a reactive survey system, capable of long-term unattended deployments in harsh environments. We refer to such a system as an Autonomous Ocean Sampling Network (AOSN). An integral part of this effort is the development, design, and implementation of both hardware and software for a Utility Acoustic Modem (UAM), which permits 2-way communications between survey vehicles and researchers. The effort described in this report pertains to UAM software development.

OBJECTIVES

This project focuses on the design and implementation of modem software which tailors the channel symbol rate to worst-case environmental conditions. In early implementation phases, the environmental parameters would be determined by a human operator and downloaded into the modem before deployment. Eventually, these parameters would be determined as part of a handshaking session between modems as part of link initialization.

APPROACH

The environmental parameters which determine the channel symbol rate include: maximum channel delay spread, maximum Doppler shift and spread, transmission bandwidth, center frequency and error-correcting code rate. From these parameters, a frequency grid and tone gating window are established for a noncoherent, coded, binary, slow-frequency-hopped spread spectrum system. The communication link is designed to provide reliable communications for all channel conditions which are no more severe than those characterized by the environmental parameters. These parameters remain constant for the duration of the communication session, which consists of an arbitrary number of packets. A session may be terminated and a new session negotiated, should channel conditions degrade or improve.

When expected worst-case environmental conditions permit and operational requirements require a data rate which is higher than that afforded by the noncoherent scheme, the noncoherent modulation and demodulation scheme will be replaced by successively more complex coherent schemes to provide the desired data rate consistent with maintaining robust communications.

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
30 SEP 1997		**00-00-1997 to 00-00-1997**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
AOSN MURI: Communication Software for the Utility Acoustic Modem	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Northeastern University,Department of Electrical and Computer Engineering,Boston,MA,02115**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**Same as Report (SAR)**	**3**	

WORK COMPLETED

--Physical layer noncoherent algorithm designed
-- Medium-access layer algorithm designed
-- MATLAB implementation of physical layer completed
--MATLAB implementation of medium-access layer completed
-- A MATLAB simulation of link operation has been accomplished
-- A C-code implementation of the physical layer algorithm is completed
-- A C-code implementation of the medium-access layer is completed
-- In-water testing of the transmitting modem C-code is completed
-- Successful demodulation of physical layer low-rate signals in rapidly varying shallow water environment using MATLAB implementation.
-- In-water testing of the receiver modem C-code is in progress

RESULTS

The physical layer and medium-access layer software have been designed. MATLAB implementations of the transmitter and receiver software have been completed and tested on simulated data. C-code implementations of the transmitter and receiver software are complete and have been compiled for the UAM microprocessor. The transmitting modem software has been tested in ocean deployments, using off-line demodulation via the MATLAB receiver code. Testing of the receiving modem C-code is currently in progress.

MATLAB simulations of long-memory, time-varying, underwater acoustic channels have shown that the proposed link can provide reliable communications in the jammed environment surrounding the survey vehicles. The MATLAB script files served as a template for a C-port of this communication software. The C-code was designed to run in real time on the modem microprocessor. In water tests of the transmission portion of the C-code (and off-line MATLAB demodulation) has yielded reliable communications as well. Pending successful tests of the receiving modem C-code, this code will serve as the kernel of a fully autonomous communication link.

IMPACT/APPLICATIONS

A reliable, fully autonomous, 2-way communication link is necessary for real-time monitoring/surveying of the water column. It is anticipated that a pool of UAMs, currently under construction at WHOI, will serve as a means for low-delay message forwarding between oceanographic instrumentation and a centralized database.

TRANSITIONS

In the short term, the UAM will serve as a means to communication between the Odyssey and mooring stations or a research vessel. Transitions to other projects will occur once the operation success of this modem is confirmed in the Lab Sea and upcoming demonstrations.

RELATED PROJECTS

This project is part of the Multidisciplinary University Research Initiative: "Real-Time Oceanography with Autonomous Ocean Sampling Networks: A Center for Excellence"

REFERENCES