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
Improving the Information Content of Sonar Signals	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) **Raymond Fitzgerald,4409 Jensen Place,Fairfax,VA,22032**	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)**	**2**	

IMPROVING THE INFORMATION CONTENT OF SONAR SIGNALS

Raymond Fitzgerald
4409 Jensen Place
Fairfax, VA 22032
rfitzg@erols.com
Award #: N00014-94-1-0743

LONG-TERM GOALS

Improve the utility of the information obtained in remote sensing..

OBJECTIVES

Extract maximum information from given measurements. Develop remote sensing (i.e. measurement) systems from which more information can be extracted.

APPROACH

Develop parametric models for the physical phenomena involved in remote sensing. Develop techniques for optimizing the model parameters so as to maximize the information provided by the model. Test the extend the models and optimization procedures by application to laboratory, simulation and field data.

WORK COMPLETED

Analyzed the Matched Phase Noise Reduction technique (JASA, J. Comput. Physics) which claims to provide signal to noise improvements (100+ dB) that constitute a technology breakthrough.

Collaborated with the A. Parvulescu to publish a historic experimental scientific paper which demonstrates the ability of the ocean medium to support coherent information processing in both one-way and reciprocal transmissions.

Modeled the Doppler scattering of sound from a dissipating wake. A dissipating wake is a constant volume of water. The volume appears to move in the direction and at the speed of the vessel generating it, but the volume is composed of scattering centers that move in the opposite direction under the impulse provided by the vessel's propeller. The Doppler spectrum of scattered waves for this situation is unknown.

Developed improved technique for radar and sonar synthetic aperture imaging by reformulating in an approximation theoretic context. Synthetic aperture imaging is the coherent processing of active signals generated and received by moving sources and receivers and reflected from moving targets in order to extract target information.

Existing approaches formulate the problem in the contexts of detection theory (matched filter), integral transform theory (Fourier analysis), filter theory (inverse filter), or adaptive processing theory (generalized sidelobe canceller).

RESULTS

Rederived the Matched Phase Noise Reduction technique as a special case within a more general theory. Employed this general theory to analyze the properties of the new technique, to explain the original authors' errors in interpretation, and to demonstrate that the Matched Phase Noise Reduction technique does not provide the claimed increases in signal to noise ratio.

Demonstrated by analysis that the Doppler shift from a dissipating wake depends on the distance between scattering centers measured in wavelengths. For scattering centers much closer than a wavelength, the Doppler shift mirrors the forward velocity of the wake-generating ship; for scattering centers separated by more than a wavelength, the Doppler shift mirrors the backward velocity imparted to the scattering centers by the propeller. Thus, a broadband signal can in different parts of its spectrum contain simultaneously both up- and down-Doppler shifts from the same dissipating wake !

IMPACT/APPLICATION

.
Synthetic aperture imaging was reformulated as a problem in parametric estimation. That this technique is superior to other techniques is manifest, because the class of parameter models considered contains the models appearing in other approaches (detection theory, inverse filtering, adaptive processing, integral transforms) and because optimal parameter values are determined for this more general class of models.

RELATED WORK

Synthetic aperture sonar and radar are active areas of investigation. Most existing approaches are limited to stripmap, broadside, squinted, or spotlight modes of operation, are either transform domain or time domain methods, and are restricted in terms of bandwidth, platform speed and track. The new technique is applicable to all modes of operation (stripmap, broadside, squinted or spotlight modes), can be implemented in either the time or transform domain, applies to arbitrary bandwidth, platform speed and track, and treats monostatic as well as multistatic operations.

REFERENCES

R. Fitzgerald, "Matched-Phase Noise Reduction," J. Acoust. Soc. Am 99(3),1791-1794 (96)
A. Parvulescu, "Matched-signal ("MESS") processing by the ocean," J. Acoust. Soc. Am 98(2),943-960 (96)