AD-A127 257   ADVANCED ADAPTIVE ANTENNA TECHNIQUES(U) OHIO STATE UNIV COLUMBUS ELECTROSCIENCE LAB R T COMPTON JAN 83 ESL-714505-2 N00019-82-C-0190   1/1

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The Ohio State University

ADVANCED ADAPTIVE ANTENNA TECHNIQUES

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Quarterly Report 714505-2

Contract N00019-82-C-0190

December 1982

Naval Air Systems Command
Washington, D.C. 20361

NOTICES

50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO.	2. AD-A123 357	3. Recipient's Accession No
4. Title and Subtitle ADVANCED ADAPTIVE ANTENNA TECHNIQUES			5. Report Date January 1983
			6.
7. Author(s) R.T. Compton, Jr.			8. Performing Organization Rept. No ESL 714505-2
9. Performing Organization Name and Address The Ohio State University ElectroScience Laboratory Department of Electrical Engineering Columbus, Ohio 43212			10. Project/Task/Work Unit No 11. Contract(C) or Grant(G) No (C) (G) N00019-82-C-0190
12. Sponsoring Organization Name and Address Naval Air Systems Command Washington, D.C. 20361			13. Type of Report & Period Covered Quarterly Report
			14.
15. Supplementary Notes			

16. Abstract (Limit 200 words)

This report describes progress under Naval Air Systems Command Contract N00019-82-C-0190 during the first quarterly period. Research on the behavior of adaptive arrays with frequency-hopped signals is summarized.

17. Document Analysis a. Descriptors

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report)	21. No of Pages
APPROVED FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED	Unclassified	3
	20. Security Class (This Page) Unclassified	22. Price

(See ANSI-Z39.18) See Instructions on Reverse OPTIONAL FORM 272 (4-77) (Formerly NTIS-35) Department of Commerce

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I. INTRODUCTION

This report describes progress under Naval Air Systems Command Contract N00019-82-C-0190 for the first quarterly period. This contract involves research in two areas: (1) the effectiveness of adaptive arrays with frequency hopped signals, and (2) the performance of adaptive arrays based on the Frost algorithm [1].

During the first quarter of this contract, we have concentrated on the use of adaptive arrays in frequency hopped systems. Our progress is described below.

II. PROGRESS

During the first quarter we have formulated the equations necessary to determine array performance when the array is used with a frequency hopped desired signal. In the initial model, we assume the desired signal is frequency hopped but not otherwise modulated. The array processing dehops the signals behind the elements but before the LMS weighting. The reference signal is assumed correlated with the desired signal after dehopping. Initially we are considering CW interference.

The weight behavior for this type of problem can be obtained analytically, because the covariance matrix is constant on each hop interval. The hopping pattern is assumed to be periodic. By taking advantage of the periodicity, we can calculate the array weights at the beginning of each hop interval and then determine the complete weight transients during each interval. From the weights, everything else can be calculated: desired signal modulation, array patterns and output signal-to-interference-plus-noise ratio (SINR). The technique used here is similar to that used with pulsed jamming under an earlier contract [2].

During this quarter, computer programs have been developed to calculate array performance based on the above method. For a given set of signal parameters, these programs calculate the weight behavior over the hopping period, the desired signal modulation, the array patterns at specific times and the output SINR versus time. At the end of the first quarterly period, we are in the process of checking out and debugging these programs.

III. REPORTS PUBLISHED

During the first quarter, a technical report was published on the effects of modulated jamming on the LMS array. This report is based on work done during the previous contract (N00019-81-C-0093). The report presents an analytical method for determining the effect of an envelope modulated jammer on an LMS array. This method is a generalization of the technique developed earlier for jamming with sinusoidal envelope modulation[3]. The method allows one to handle jamming with an arbitrary periodic envelope modulation. The only restriction is that the jammer bandwidth must be small compared to its carrier frequency.

IV. PLANS FOR NEXT QUARTER

During the next quarter we plan to continue our work on the effects of frequency hopping on the LMS adaptive array. The computer programs mentioned above will be completed and performance curves run.

During the next quarter, we will also publish an additional technical report on modulated jamming (also based on last year's contract). This report will describe a method we have found for analyzing the effects of jamming with phase modulation.

V. FINANCIAL

As of August 31, 1982, a total of $15,716.93 has been expended and an additional $1,124.50 has been committed but not yet paid, leaving $23,158.57 available from the initial funding of $40,000. (This contract is incrementally funded in two $40,000. amounts.)

VI. REFERENCES

[1] O.L. Frost, III, "An Algorithm for Linearly Constrained Adaptive Array Processing," Proceedings of the IEEE, Vol. 60, No. 8 (August 1972), p. 926.

[2] R.T. Compton, Jr., "The Effect of a Pulsed Interference Signal on an Adaptive Array," IEEE Transactions on Aerospace and Electronic Systems, Vol. AES-18, No. 3 (May 1982), p. 297.

[3] A.S. Al-Ruwais and R.T. Compton, Jr., "Adaptive Arrary Behavior with Sinusoidal Envelope Modulated Jamming," Report 713603-5, March 1982, The Ohio State University ElectroScience Laboratory, Columbus, Ohio; prepared under Contract N00019-81-C-0093 for Naval Air Systems Command.