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ADAPTIVE ARRAYS FOR AM AND FM SIGNALS.(U)
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This report describes progress under Naval Air Systems Command Contract N00019-77-C-0156 during the fourth quarterly period. Research on the problem of integrating adaptive arrays into conventional modulation systems is summarized.

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INTRODUCTION

This report describes progress under NASC Contract N00019-77-C-0156 during the fourth quarterly period. There are three areas of work under this contract. The first involves experimental tests of an adaptive array in an AM communication system. The second involves array experiments with an FM communication system. The third consists of theoretical studies of methods of integrating adaptive arrays into other types of conventional communication systems.

The AM and FM communication systems involve the addition of a binary phase switching modulation on conventional AM and FM signals. The purpose of this phase switching is to allow the array to distinguish between the desired signal and interference. Implementation of the system with this phase switching requires an IF delay lock loop for the AM system and a Costas loop and baseband delay lock loop for the FM system, in addition to other minor circuitry.

PROGRESS

During the final quarter of this program, work has been done in three areas, as described below.

1. Implementation and Testing of the AM System

The brassboard model of the delay lock loop used for reference signal generation has been completed and tested. Figure 1 shows a photograph of the completed delay lock loop and reference signal circuitry. This equipment has been added to the adaptive array processor, shown in Figure 2, and a variety of tests of array performance have been performed.

Figures 3-6 show typical experimental results. In these tests, a desired signal 3 dB above thermal noise arrives from broadside. A CW interference signal arrives from off broadside with a progressive 60° electrical phase shift between elements. Figure 3 shows the array output desired signal power, Figure 4 shows the array output interference power, and Figure 5 shows the array output thermal noise power, each as a function of the input interference power. Figure 6 shows the resulting output signal-to-interference-plus-noise ratio. These and other data will be the subject of a technical report on the AM system.

2. Studies on Dynamic Range

As a result of the experimental work on the AM system described above, a study is being done of dynamic range in the adaptive array. The purpose is to determine the optimum signal levels, allocation of loop gains, etc, to maximize dynamic range in an LMS adaptive array with practical equipment limitations (multiplier offset voltages, intermodulation distortion, etc.). A technical report will be prepared on this subject.

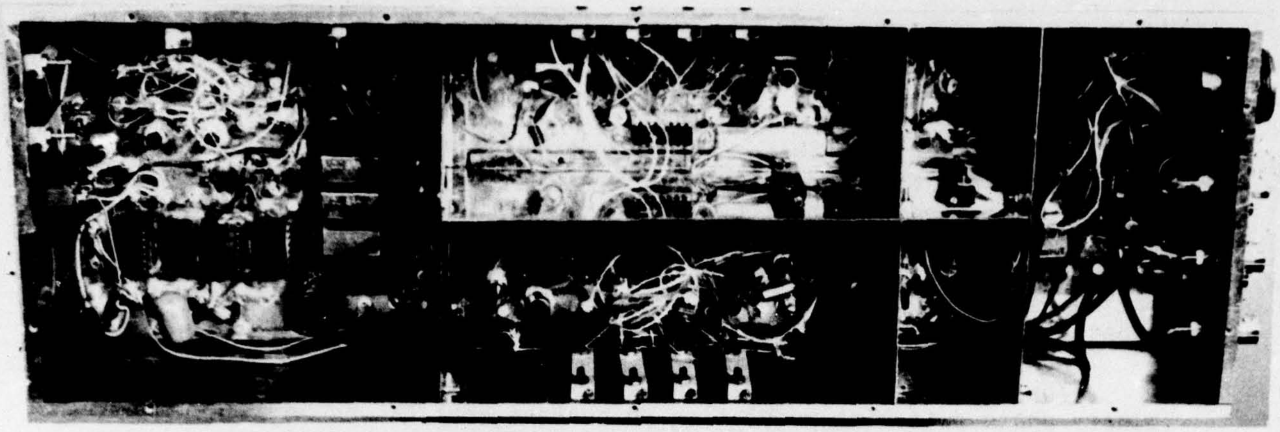

Figure 1. Reference signal generation circuitry.

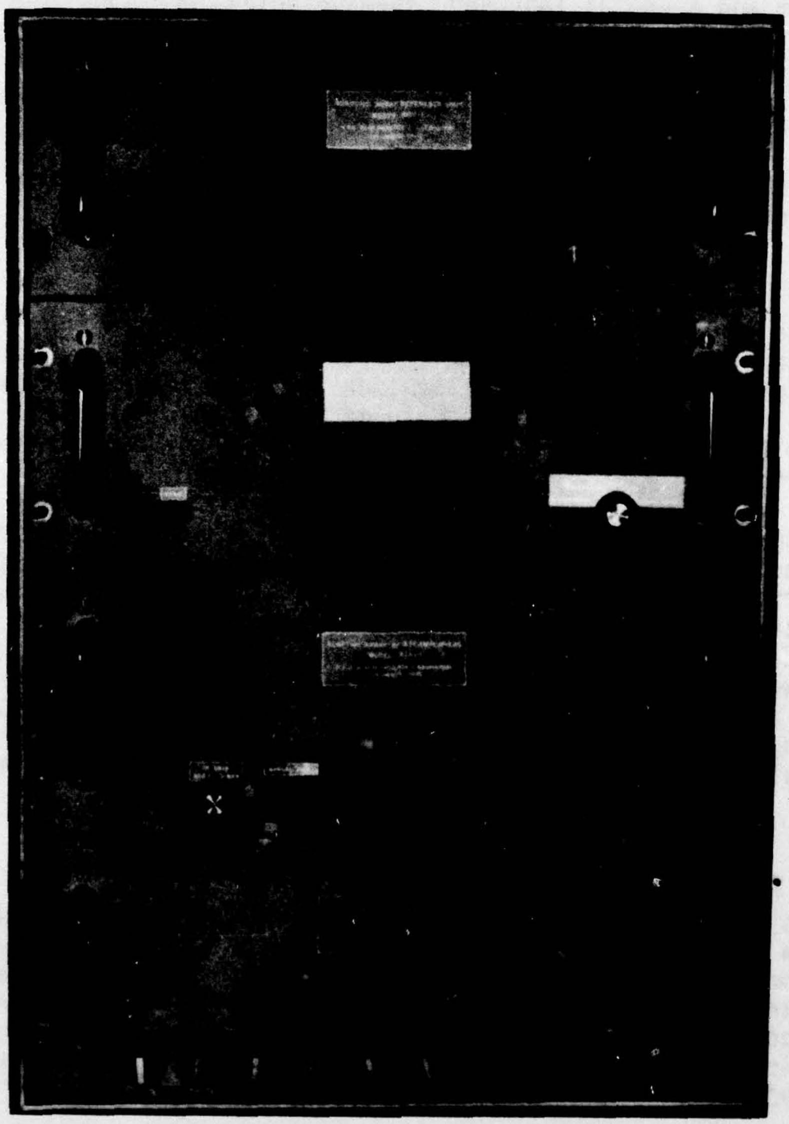

Figure 2. Adaptive array processor.

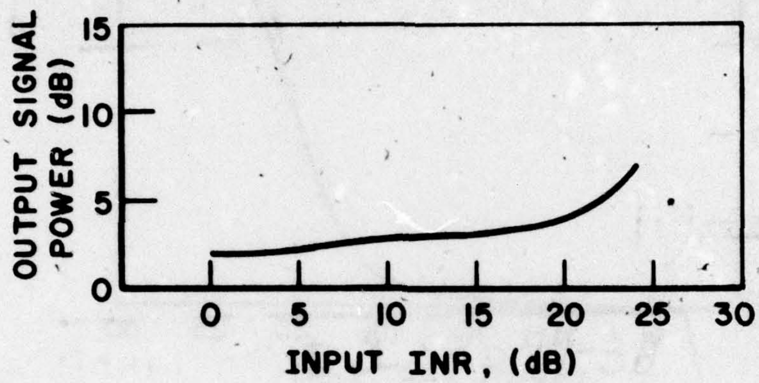

Figure 3. Output desired signal power.

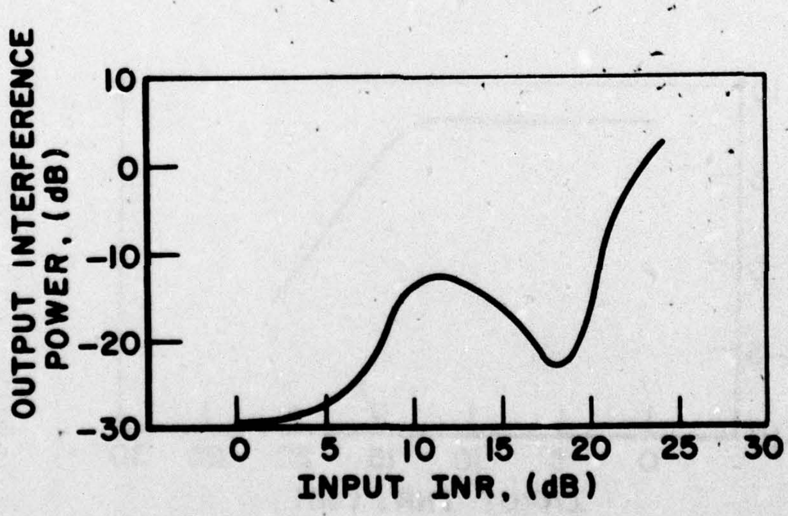

Figure 4. Output interference power.

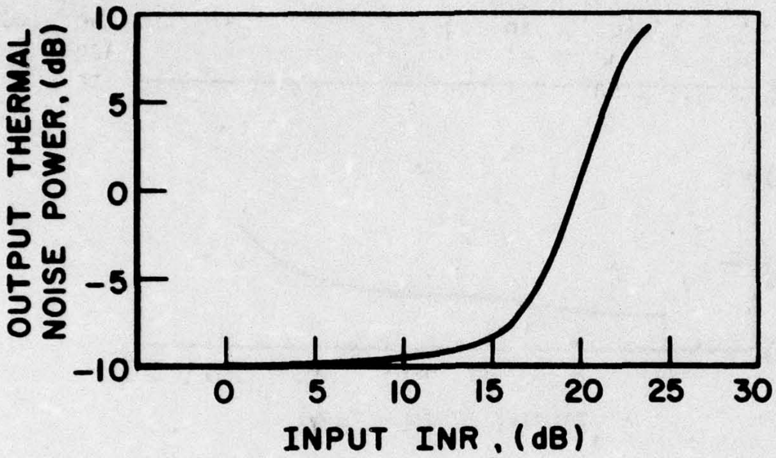

Figure 5. Output thermal noise power.

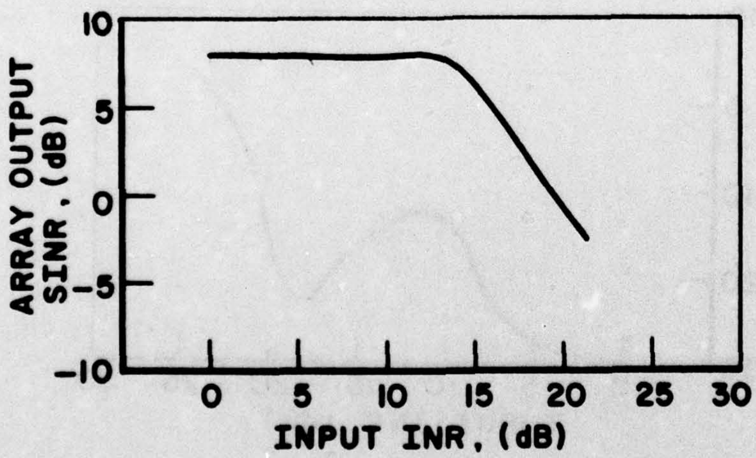

Figure 6. Output signal-to-interference-plus-noise ratio.

3. Implementation of the FM System

Design work has been started on an FM reference signal generation system. This system operates as shown in Figure 7. A baseband delay lock loop is interleaved with a phase lock loop in such a way that both code timing and FM frequency can be acquired. The lockup procedure is to slew the delay lock loop slowly enough that the phase lock loop, which has a wide bandwidth, can acquire frequency during the time interval when the incoming and local codes are synchronized. Acquisition of frequency by the VCO then allows the delay lock loop to latch.

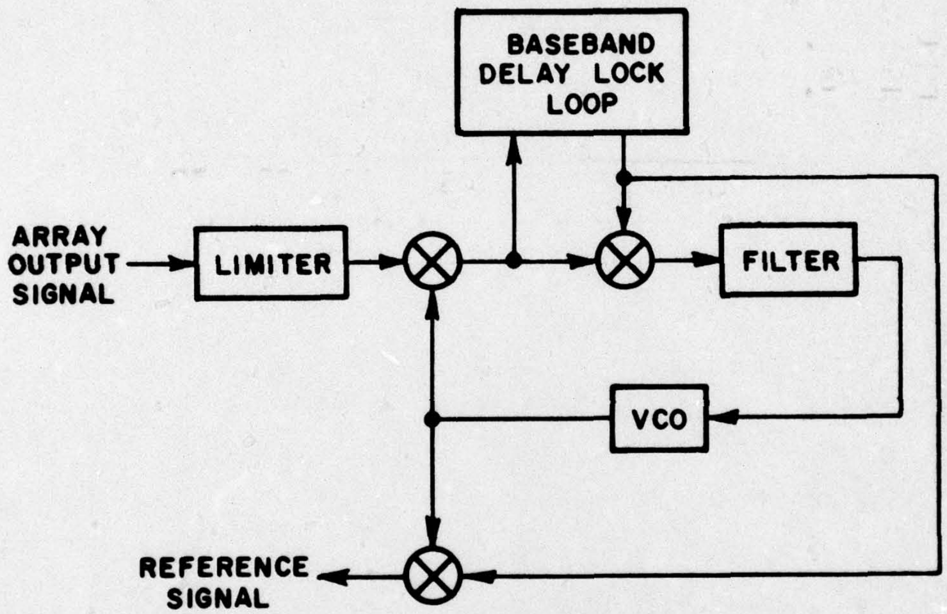

Figure 7. FM reference signal generation.

PLANS FOR NEXT QUARTER

Measurements of the performance of the AM system will be completed during the next quarter, and the results will be documented. Also, design work on the FM reference signal generation circuitry will be continued. Finally, a report on system dynamic range will be published.