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Effects of Pulse Interference on ASR Video Processing Modes

FEDERAL AVIATION ADMINISTRATION

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Project Plan



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1. INTRODUCTION.

1.1 PURPOSE.

The purpose of this project is to investigate the abilities of the various Federal Aviation Administration (FAA) airport surveillance radar (ASR) processors to reject or suppress nonsynchronous interference, particularly that from S-Band weather radars.

1.2 BACKGROUND.

The 2700 to 2900 megahertz (MHz) frequency band is becoming increasingly crowded as additional S-Band radars are placed into operation by the Department of Defense, Department of Commerce, and the FAA. This crowding has led to concern that the performance of the FAA ASR's are being degraded. Of particular concern is the interference caused by the National Weather Service (NWS) radars which have the capability of operating with wide (4 microseconds (μ s)) transmitter pulse widths. Also, with the development of the next generation weather radar (NEXRAD) by the FAA, the U.S. Air Force, and NWS, additional crowding is expected.

In response to this concern, the FAA Systems Research and Development Service has requested that the FAA Technical Center perform an engineering evaluation of the possible deleterious effects of nonsynchronous interference on the performance of FAA ASR systems.

1.3 DESCRIPTION OF EQUIPMENT.

The Technical Center's Terminal Facility for Automated Systems Testing (TFAST) ASR-8 radar system and the Terminal Radar Beacon Test Facility (TRBTF) ASR-7 will be used for project testing. These systems will be configured to represent operation at a typical FAA terminal radar facility for data collection. Test equipment will be used to generate the desired interference signals and to measure system responses described in the following sections.

In addition to these tests, the interference rejection capability of a prototype moving target detector (MTD) presently installed at the TRBTF for operation in conjunction with the facility ASR-7 will be determined.

2. TEST DESIGN.

The nonsynchronous interference test signal generated by test equipment will be introduced into the radar through the radiofrequency (RF) directional coupler. The radar will be connected to dummy load. A test signal will be varied incrementally in pulse width from 0.5 to 4 μ s, and in pulse repetition frequency (PRF) from 100 to 1200 pulses per second. Various combinations of these two parameters to be used as test inputs to be recorded are shown in figure 1. The test sequence will be repeated for each of the radar systems' various video processing modes listed in this section. As data are taken, trends in the data will be noted to determine if all PRF/pulse combinations need to be individually examined. The capability of the various processing modes to eliminate the nonsynchronous

interference will be measured by using a counter to determine the number of interference pulses present at the output of the processor under test. These data will be recorded on data collection tables. The MTD system will also be tested for the combination of pulse widths and PRF combinations listed in figure 1.

FIGURE 1. PULSE INTERFERENCE TESTS

<u>Test</u>	<u>Pulse</u>		<u>Width</u>			<u>Comment</u>
	<u>0.5 μs</u>	<u>1 μs</u>	<u>2 μs</u>	<u>3 μs</u>	<u>4 μs</u>	
100						
200						
400						
600						
800						
1000						
1200						

The ASR-7 and ASR-8 will each be tested in the normal, enhanced normal, normal log fast time constant (FTC), enhanced normal log-FTC, moving target indicator (MTI), enhanced MTI, MTI log-FTC, and enhanced MTI log-FTC modes of operation.

The MTD processor will be tested in two additional modes.

a. With the radar connected to the dummy load, the test signal will be set to a nonsynchronous PRF (600 hertz (Hz)) and its amplitude varied from receiver noise level to receiver limit level. This test will determine if the basic MTD interference algorithm, which is based on an amplitude comparison principle, is effective in eliminating the interference. This test will be repeated for the different pulse widths shown in figure 1. Data will be collected using the MTD's nine-track magnetic recorder.

b. With the MTD operating with the ASR-7 in operating configuration (transmitter on and coupled to the antenna), the effects of the resulting ground clutter signals on the performance of the interference elimination algorithm will be investigated. For this test a limit level interference signal will be set to a PRF of 600 Hz, and the results on system performance will be noted on the MTD Megatek maintenance display. Target counts and interference patterns (relationships to known ground clutter) will be recorded on tape for subsequent analysis.

The MTD data tapes will be analyzed using the Technical Center Honeywell computer system and existing MTD analysis software. The MTD software provides counts of primitive target information and target reports. Range, azimuth, and strength data

are provided for each target signal. This information can be analyzed to determine the location of interference signals, which are displayed as target outputs with respect to clutter areas. Patterns and counts of interference generated MTD output signals will be reproduced using the Honeywell computer system in conjunction with a Tektronix 4014 graphics display and hard copy unit.

2.1 TEST DATA ANALYSIS.

From the data tabulated in the preceding tests, it will be determined (by evaluating the percentage of input interference pulses which become output targets) whether there are test parameters (pulse width or PRF) or combinations of parameters which will result in interference not being rejected by the processors being tested. If so, an analysis will be made of the processor parameter settings to determine those which provide optimum (100 percent) interference rejection. As the parameter settings are optimized or equipment modifications are developed, if necessary, the data runs and analysis will be repeated until correct operation is obtained. A summary matrix for the data collection/analysis is given in table 1.

3. RECOMMENDATIONS.

Based on the preceding tests and analysis, recommendations will be made (if nonsynchronous interferences is determined to be a problem) toward implementation of a new processor alignment procedure, equipment modifications, or new operational guidelines. These guidelines would deal with the necessity of maintaining PRF separation, etc., between radar systems in geographical proximity to each other. MTD processing algorithm will be proposed to prevent interference over-clutter-signals from being outputted as targets.

4. SCHEDULE.

Project Plan Complete	1/82
Tests Completed	8/82
Final Report	9/82

5. RESOURCES.

Manpower	1/2 MY
TFAST	60 hours
TRBTF	60 hours
Honeywell Computer	10 hours
Contract Dollars	None

TABLE 1. SUMMARY OF DATA COLLECTION/ANALYSIS

<u>Processor/Mode Being Tested for Interference Rejection Capability</u>	<u>Data Collected (also see figure 1) Real Time Data Except as Noted</u>		<u>Data Analysis (calculation of percentage of interference pulses rejected)</u>	
	<u>Number of Interference Pulses</u>		<u>No Rejection Baseline Data</u>	<u>100% Rejection (adjust processor parameters to obtain 100%)</u>
<u>ASR-7 and ASR-8</u>	<u>Input</u>	<u>Output</u>		
Normal	X	X	X	
Enhanced Normal	X	X		X
Normal Log/FTC	X	X	X	
Enhanced Normal Log FTC	X	X		X
MTI Video	X	X	X	
Enhanced MTI	X	X		X
MTI Log-FTC	X	X	X	
Enhanced MTI Log FTC	X	X		X
<u>MTD</u>				
Standard Operating Configuration	X	X		X
Interference Amplitude Dependence Test	X	X		X
Interference/Clutter Dependence Test	X	X ¹		X ²

¹System output data to be recorded on 9-track magnetic tape for off-line geographical (clutter area) dependence analysis.

²Radar coverage area display to be reproduced, using the Honeywell computer, to show areas of clutter/interference nonrejection.