AN AUTOMATED TEST SEQUENCER FOR HIGH VOLUME NEAR-FIELD MEASUREMENTS

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ABSTRACT

Test sequencing flexibility and high throughput are essential ingredients to a state-of-the-art near-field test range. This paper will discuss methods used by NSI to aid the operator through the near-field measurement process. The paper will describe NSI's expert system and customer applications of a unique test and processing sequencer developed by NSI for optimizing range measurement activities. The sequencer provides powerful control of the software functions including multiplexed measurements, data processing, and unattended test operations.

Keywords: Near-Field, Multiplexing, Expert System

1. INTRODUCTION

Experienced operators of automated antenna test ranges have always been required for yielding the best results available. The gap between test throughput with an experienced and a novice operator is usually large. Because of additional complexities involved with near-field measurements, the gap can be even greater. Some companies assign a key person to manage and operate each automated range, but in many cases this is not possible. Minimizing the learning curve required and increasing the confidence of achieving good results with less experienced operators are essential parts of NSI's software design philosophy. The software insulates the user from many of the complexities while still allowing access to advanced features and setup options.

2. NSI EXPERT SYSTEM

The near-field measurement process involves numerous test design decisions, scan parameter choices, and far-field processing options which can become quite intimidating for the inexperienced operator. Many technicians or engineers assigned to operate near-field ranges have little or no prior experience with near-field testing or even automated testing with computers. NSI has used an expert systems approach in its software to aid the operator in achieving proficiency in performing measurements on the test range. The system includes the following:

- Automatic Setup Of Scan Sizes And Densities
- Fault Warnings For Improper Test Setup
- Pre-Scan Confirmation Of Timing Used For Beam Multiplexing
- Fault Handling And Recovery During Measurements
- Automatic Setup Of Many Far-Field And Hologram Parameters

3. AUTOMATIC SCAN SETUP

For most basic near-field measurement applications, good results can be achieved through use of some simple rules. A general introduction to near-field measurements and discussion of some of the rules can be found in a book by one of the authors[(1)]. The operator is required to enter information on the antenna and the desired far-field angles, and the expert system then determines the remaining parameters.

~~Operator Entered Values:~~

? Antenna dimensions
? Antenna to probe spacing
? Desired far-field angles
? Test frequency and polarization

4. FAULT WARNING SYSTEM

The built-in fault system checks all vital operating parameters. These include scan parameters, hardware status, disk space availability and memory remaining. Parameters which fall outside of predetermined limits are flagged, typically by flashing in yellow the offending parameter. The operator is then presented with a set of fault recovery options.

As an example, if the expert system determines the scan size required for the entered far-field angles exceeds the capability of the scanner, the operator is given the option of:

1. Reducing the scan size and giving up some far-field angle range.
2. Moving the AUT closer to the probe.

5. PRE-SCAN MULTIPLEXING TEST

Once the operator has established the desired test scenario, the system can do a pre-scan beam multiplexing test at a single X-Y point to verify settling times for the source, receiver, and other devices are adequate. For the Hewlett Packard HP-8360 sources used with the HP-85309 external mixer system, this pre-scan confirmation will time the sources through use of the stop-sweep TTL line available on the unit. This takes some of the guess work out of the scan setup and can prevent problems which can occur for instance at band crossings. The operator can accept the recommended source dwell times based on the pre-scan test, or override the settings with his own. Figure 1 shows an example of the system timing display which provides confirmation that the multiplexing is working as expected. A real-time display of the amplitude and phase at each multiplexed point can also be inspected. During bi-directional scanning, the multiplexing list is scanned backwards on the reverse pass to keep all points spatially aligned on a regularly spaced grid for each beam.

Nearfield Systems Inc Scan timing display

#	Delay msec	Total msec	Probe pol –	AUT beam –	Frequency GHz	Y axis in
0	8.078	9.973	1.000	1.000	14.000	0.040
1	0.100	11.968	2.000	1.000	14.000	0.048
2	0.100	13.963	1.000	2.000	14.000	0.056
3	0.100	15.957	2.000	2.000	14.000	0.064
4	0.100	17.952	1.000	3.000	14.000	0.072
5	0.100	19.947	2.000	3.000	14.000	0.080
6	0.100	21.941	1.000	4.000	14.000	0.088
7	0.100	23.936	2.000	4.000	14.000	0.096
8	8.078	33.909	1.000	1.000	14.250	0.136
9	0.100	35.904	2.000	1.000	14.250	0.144
10	0.100	37.899	1.000	2.000	14.250	0.152
11	0.100	39.893	2.000	2.000	14.250	0.160
12	0.100	41.888	1.000	3.000	14.250	0.168
13	0.100	43.883	2.000	3.000	14.250	0.176
14	0.100	45.877	1.000	4.000	14.250	0.184
15	0.100	47.872	2.000	4.000	14.250	0.191

Figure 1 - Beam Multiplexing Setup

Extensive use of color is made in this display to highlight when devices change states or when parameters exceed acceptable boundaries. If the pre-scan test identifies a problem with the test setup, the operator is presented with a set of options appropriate for the fault. For instance, if the time available between major near-field grid points (typically 1/2 ?) is not sufficient for the multiplexed beams desired, the expert system recommends the following options:

1. Reduce the scanner speed
2. Increase the sample spacing
3. Reduce number of beams or frequencies
4. Reduce receiver averaging
5. Reduce receiver or source settling times

6. AUTOMATED TEST SEQUENCER

Even with the automatic scan setup procedures and fault analysis software, the process can be somewhat complicated. Multiple keystrokes are required to progress from the test design menu, to the data acquisition sequence, and finally the data processing routines. Keystroke errors or inattention to details can in some cases lead to test or processing problems. NSI's test sequencer can eliminate these problems by automating the entire sequence, in addition to allowing numerous sequences to be cascaded. The sequencer has been used most recently by Space Systems / Loral in their recent development testing of a large satellite antenna system. This system is described in a companion paper[(2)].

NSI's near-field measurement system at Space

Systems / Loral has the capability to multiplex 80 switch and frequency configurations while taking data on the fly at speeds up to 17 inches per second. The data is typically taken for 2 polarizations, 4 antenna beams, and 10 frequencies. Processing a single principal-polarization gain contour for each beam would yield over 40 plots. The sequencer has the capability to easily process this vast amount of data with simple keystrokes.

The order of test steps is typically as follows:

1. Establish test objectives
2. Set up acquisition parameters
3. Acquire data
4. Select beam and frequency for processing
5. Transform, probe correct, and plot data
6. Transfer data to off-line computers for further data reduction steps

The sequencer steps can be set up by an experienced operator familiar with the test objectives. Less experienced operators can then repeat the process using a small number of keystrokes, with consistent results. The sequencer can also be used to run long test sequences without the need for operator attention. Extended shift or overnight testing can greatly increase the productivity of a near-field range. Unattended operations can be quite practical when adequate reliability of the test range has been established. Planar near-field ranges offer the additional advantage that the antenna under test is not in motion during the test.

Figure 2 shows a simple sequence set up to acquire a near-field data set and process and plot far-field contour plot, 3D plot, and E and H cuts. A more complicated sequence could include processing multiplexed data sets or data from multiple files. The sequencer steps can be set for data acquisition, far-field processing and plotting, holographic diagnostics, and can even include programming commands to allow the process to be highly customized by experienced users.

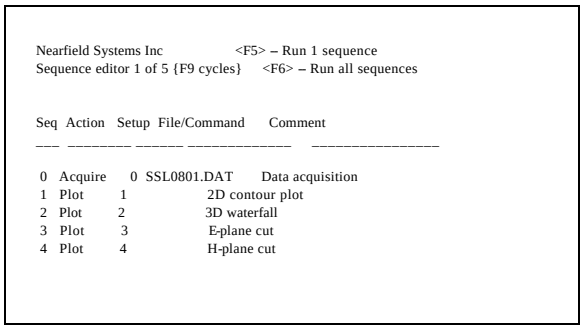

Figure 2 - Test sequencer setup

7. SUMMARY

The NSI expert system and automated test sequencer have been described above and can provide significant gains in test efficiency. Less experienced operators can become proficient at achieving good results with a minimum of training. The test sequencer can help make repetitive tests more systematic and consistent. Its benefits include the ability to maximize range throughput with minimal operator intervention. It reduces errors in the measurement process and yields high confidence in the results.

REFERENCES

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