REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

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1. REPORT DATE *(DD-MM-YYYY)*
27-07-2020

2. REPORT TYPE
Technical Paper

3. DATES COVERED *(From - To)*
27-05-2020

4. TITLE AND SUBTITLE
Application of Kernel Density Estimation to Achieve Automated Near Real-Time Antenna Pattern Data Processing and Analysis in an Anechoic Chamber

5a. CONTRACT NUMBER
012100

5b. GRANT NUMBER
N/A

5c. PROGRAM ELEMENT NUMBER
N/A

6. AUTHOR(S)
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5d. PROJECT NUMBER
N/A

5e. TASK NUMBER
N/A

5f. WORK UNIT NUMBER
N/A

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) AND ADDRESS(ES)
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8. PERFORMING ORGANIZATION REPORT NUMBER
412TW-PA-20322

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
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10. SPONSOR/MONITOR'S ACRONYM(S)
N/A

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release A: distribution is unlimited.

13. SUPPLEMENTARY NOTES
N/A

14. ABSTRACT

The Benefield Anechoic Facility (BAF) at Edwards Air Force Base is the world's largest known anechoic chamber. Due to its unmatched size and complement of test equipment, the BAF hosts far-field pattern measurements at all azimuth angles and multiple simultaneous elevations of installed antennas on large aircraft across a frequency range of 0.1 – 18 GHz. Antenna tests at the BAF rapidly produce large quantities of data, which often require immediate analyses to allow system owners to make relevant improvements. Historically, the BAF had accomplished quality assurance manually. Today, the BAF team has developed scripts that use kernel density estimation and basic machine learning to automatically check incoming data for errors and highlight unusual results for review. During a 2019 test of over sixty installed antennas on a B-1B bomber, the BAF team used these scripts to produce calibrated, quality-assured antenna patterns in near real-time. Rapid processing brings deficiencies to the customer's attention fast enough to allow corrections to be applied and re-tested during the same test event – highly significant and valuable as aircraft and BAF schedule times are limited and may be a one-time opportunity to gather required data.

This paper explores the algorithm used to evaluate antenna patterns, as well as the expected characteristics of patterns that enable the selection of relevant data. Development and application of this algorithm found that using kernel density estimation to calculate the number of maxima in a pattern's distribution of gain values, then performing this recursively over only the main lobe, can identify problems such as incorrect switching, mismatched transmission lines, and multipath. Algorithm optimization was achieved using generated data, then verified by applying the algorithm to previous test data.

15. SUBJECT TERMS
Benefield Anechoic Facility, anechoic chamber, BAF, antenna measurements, patterns, antenna characterization, Kernel Density Estimation, KDE, Real-Time Antenna Pattern Data Processing, Analysis in an Anechoic Chamber, data quality assurance, data QA

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
Unclassified			None	8	Emily Mendoza
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			**19b. TELEPHONE NUMBER** *(include area code)*
Unclassified	Unclassified	Unclassified			661-277-8513