AD-A048 654 OHIO STATE UNIV COLUMBUS ELECTROSCIENCE LAB F/G 9/5
PATTERN PREDICTION OF WIRE ANTENNAS ON SATELLITE STRUCTURES.(U)
JAN 78 G A THIELE N00173-76-C-0395
UNCLASSIFIED ESL-784575-1 NL

| OF |
AD
A048654

END
DATE FILMED
2-78
DDC

FINAL REPORT - PATTERN PREDICTION OF WIRE ANTENNAS ON SATELLITE STRUCTURES

G. A. Thiele

The Ohio State University

ElectroScience Laboratory

Department of Electrical Engineering
Columbus, Ohio 43212

Final Report 784575-1

Contract N00173-76-C-0395

January 1978

Naval Research Laboratory
4555 Overlook Avenue
Washington, DC 20375

NOTICES

When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever, and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data, is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER (6) (9) Final rept. 1 Oct 76 - 1 Jan 78	2. GOVT ACCESSION NO. / 3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) FINAL REPORT, PATTERN PREDICTION OF WIRE ANTENNAS ON SATELLITE STRUCTURES.	5. TYPE OF REPORT & PERIOD COVERED Final Report 10/1/76 - 1/1/78
(14) ESL-784575-1	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) (10) G. A. Thiele	8. CONTRACT OR GRANT NUMBER(s) Contract N00173-76-C-0395 (15) new
9. PERFORMING ORGANIZATION NAME AND ADDRESS The Ohio State University ElectroScience Laboratory Department of Electrical Engineering Columbus, Ohio 43212	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Research Laboratory 4555 Overlook Avenue Washington, DC 20375	(11) 12. REPORT DATE January 1978 / 13. NUMBER OF PAGES 6
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) (12) 19p.	15. SECURITY CLASS. (of this report) / 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Antennas
Satellite
Moment Methods
Geometrical Theory of Diffraction

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A technique which combines the Method of Moments and the Geometrical Theory of Diffraction into a single Hybrid Technique is incorporated into a computer program for determining the performance of wire-type antennas on a planar satellite panel which is joined to other planar panels on each of its sides. The computer program, which is still undergoing revisions, is capable of handling up to five antennas on a single satellite metallic panel.

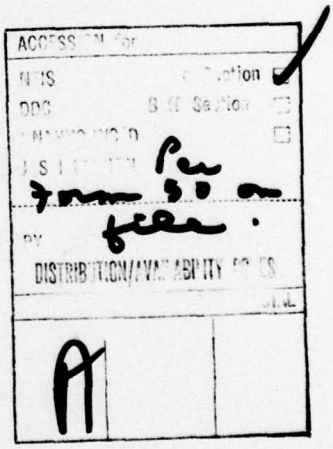
DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

402 261

TABLE OF CONTENTS



I. INTRODUCTION

Previous work done in connection with the present research program has utilized two modern computational methods in electromagnetics. The first technique is the Geometrical Theory of Diffraction, or GTD, which is most often used when an antenna radiates from a structure that is large in terms of the wavelength. The second technique is the Method of Moments which, for practical reasons based on computer storage, applies best to structures that are not large in terms of the wavelength.

A major innovation of the research performed in connection with the prediction of satellite antenna radiation patterns lies in the formal combination of the GTD and the moment method into a single computational method known as the Hybrid Technique [1]. This technique was used by Moore and Thiele [2] to investigate a turnstyle type antenna on a 24" x 24" satellite panel.

The computer program developed in connection with the turnstyle antenna investigation was limited to monopole type elements and pattern calculations in one plane only. Subsequent work described in [3] was concerned with the generalization of the theory and the incorporation of that theory into the computer program so that it could be used in the analysis and design of more general satellite antenna systems than previously possible.

The work done on this contract has been concerned with improvements in the computer program with the objective of making it user oriented. At the time of this final report, those improvements have not been attainable within the resources of this contractual effort.

II. AN EXAMPLE SATELLITE ANTENNA PROBLEM

Consider two quarter-wavelength monopoles inclined at an angle of 20° on a ground plane as shown in Figure 1. The θ-component of the far field pattern including diffraction by the 4 edges is shown in Figure 2a. These results were calculated by the computer program developed in connection with the present research program [1,2,3]. As a check on this calculation, Figure 2b shows the same pattern calculated by an independent computer program [3]. The agreement is seen to be quite good.

This example is typical of the kinds of satellite antenna problems that can be analyzed via computer simulation. The results are typical of the excellent agreement that can be obtained between calculations and experimental results.

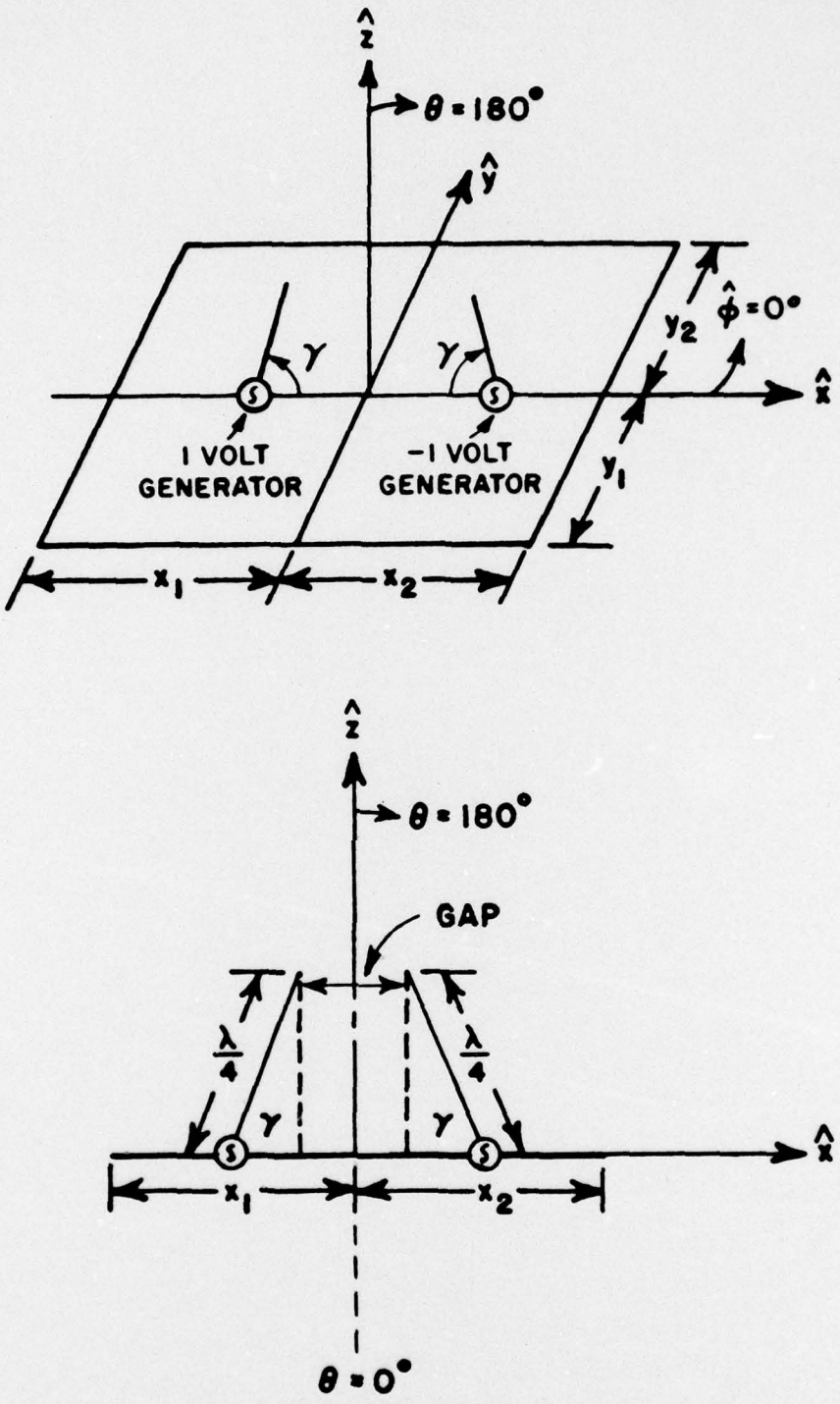
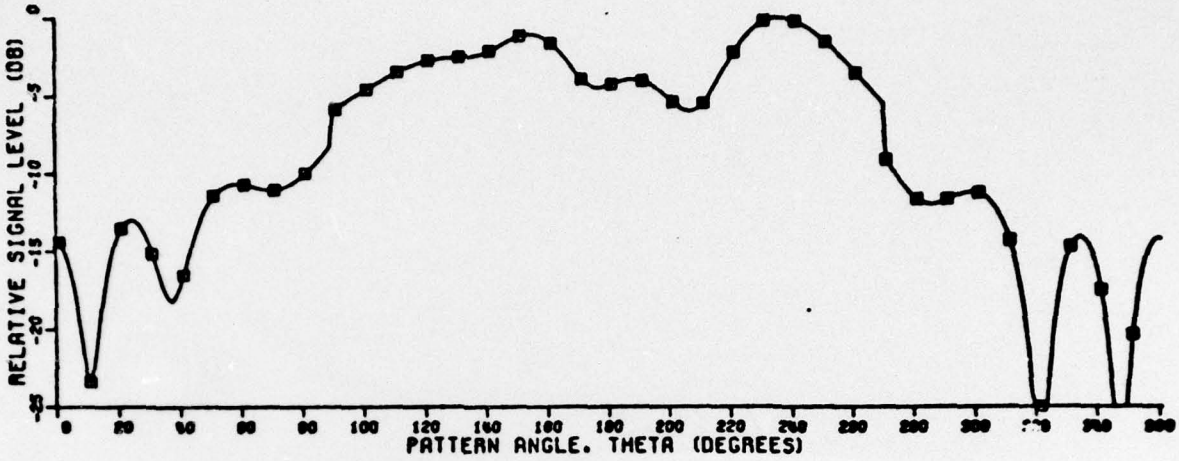
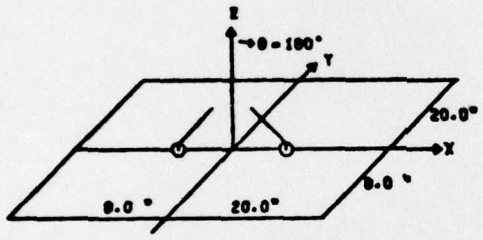


Figure 1. (a) 3-diminsional geometry of two tilted monopoles on a finite ground plane.

(b) 2-diminsional geometry of two tilted monopoles on a finite ground plane.





MONOPOLES TILT AT 20.0 DEGREE

MONOPOLE LENGTH= 0.25 WAVELENGTHS

FREQUENCY= 1000 MHZ

GAP BETWEEN ANTENNAS TIPS= 0.2 INCHES

☐ PATTERN INCLUDING 4 EDGES DIFFRACTION

Figure 2a. E_θ pattern calculated by the hybrid technique.

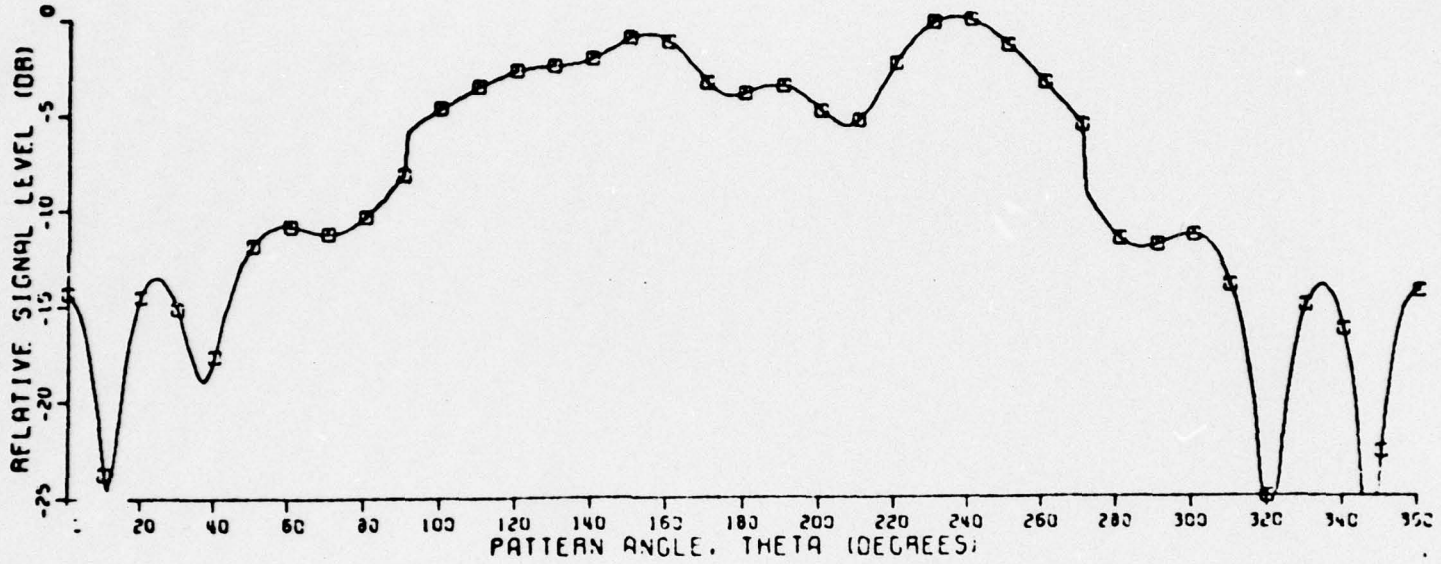


Figure 2b. E_θ pattern calculated by Burnside's GTD program.

III. SUMMARY AND RECOMMENDATIONS FOR FUTURE WORK

Antennas on satellites assume many different configurations. Many of these configurations are wire type antennas or can be modeled by wires. In addition to modeling the antennas themselves, the satellite body itself must also be modeled.

The work presented in [3] has shown how the modeling of both the antennas and satellite body can best be accomplished. The terms of interest that can be accurately calculated include impedance, radiation patterns, coupling between antennas, response of an antenna to another when the response antenna is loaded with a frequency sensitive device (filter), etc.

The computer program developed in connection with the work discussed herein is sufficiently flexible that it can be used in the design as well as analysis of satellite antenna systems. For example, the performance of an antenna in the presence of up to four other antennas of arbitrary wire geometry (e.g., helix) can be calculated as a function of frequency. The ultimate use made of such software depends in large part upon the degree to which the program is made user orientated. One possibility for the future is to make the program interactive through a visual (i.e., CRT) display.

Items which should be done to augment the satellite antenna analysis and design capability of the Navy include the following:

1) Finish the present effort to make the computer program user oriented.

2) Take the user oriented computer program to NRL and get it running at the NRL computer facility. It could then be used by NRL personnel in the batch processing mode.

3) Develop the computer program further for interactive use through a visual (i.e., CRT) display.

Theoretical and software work that has been done on this engineering program and on related preceding programs has evolved to a stage where its use by NRL personnel is almost immediate. The above suggested items of future work would take this theoretical and software work to its full conclusion.

REFERENCES

[1] T. H. Newhouse and G. A. Thiele, "A New Method for Combining the Method of Moments with the Geometrical Theory of Diffraction," Report 3468-4, March 1974, The Ohio State University ElectroScience Laboratory, Department of Electrical Engineering; prepared under Contract N00014-67-A-0018 for Office of Naval Research (Naval Research Laboratory).

[2] C. L. Moore, Jr. and G. A. Thiele, "Satellite Antenna Pattern Distortion Due to Ground Plane Edges," Report 4091-2, October 1975, The Ohio State University ElectroScience Laboratory, Department of Electrical Engineering; prepared under Contract N00014-75-C-0313 for Office of Naval Research (Naval Research Laboratory).

[3] G. K. Chan and G. A. Thiele, "Pattern Prediction of Antennas on a Flat Plate," Final Report 4091-4, March 1977, The Ohio State University ElectroScience Laboratory, Department of Electrical Engineering; prepared under Contract N00014-75-C-0313 for Office of Naval Research (Naval Research Laboratory). (AD A042330)