

A HYBRID SOLUTION TO THE RADIATION OF A PARABOLIC DISH ANTENNA

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1 INTRODUCTION

This paper presents the results of modeling a parabolic dish antenna radiation pattern. The antenna is a 27 x 72 inch non-circular parabolic dish. The feed consists of eight crossed sleeve dipoles mounted in an open box structure. In this work, two different computer codes were coupled in a "hybrid" fashion to produce results that compared quite well with measurements. Results will be presented for both the feed model and the system model and compared with measurements.

2 THE MODEL

The computer programs used in this effort were the Numerical Electromagnetic Code - Reflector Antenna Code (NECREF)[1] and the Electromagnetic Surface Patch (ESP) Code [2], both developed by The Ohio State University ElectroScience Laboratory. NECREF is a near and far field radiation calculator for reflector antennas with paraboloidal surfaces. The theoretical approach for computing the fields of the reflector antenna is based on a combination of Geometrical Theory of Diffraction (GTD) and Aperture Integration (AI) techniques. ESP is a method of moments solution for antenna and scattering problems. The program can solve radiation or scattering problems for geometries consisting of polygonal plates and wires. ESP was ideally suited for the feed calculations while NECREF was best suited for the reflector calculations. Thus the combination of the two codes provides an ideal approach for predicting the system (reflector and feed) radiation patterns.

3 RESULTS

Presented here are the sum and difference feed and system radiation patterns for vertical polarization. Figures 1 and 2 compare our estimated and measured sum and difference patterns for our feed model. These patterns were predicted using the ESP code. The agreement is excellent for the sum and difference patterns except for the back radiation regions. In each of these cases, the scattering from the feed is quite important. While we tried to model the exact antenna configuration, we could not model the minute details such as the feed thickness, finite plate conductivity, or dipole sleeves.

To get the system radiation patterns we simply coupled the feed data from ESP to the NECREF command structure. We modified ESP to provide the correct feed polarization for NECREF as defined by Ludwig [3]. Figures 3 and 4 show the system patterns. The agreement between the measured and predicted sum patterns is excellent in the main and near sidelobes, but degrades in the far out sidelobes. NECREF doesn't include higher order diffraction and

reflection terms. Inclusion of these terms may have improved the far out sidelobe predictions. We modeled the feed strut and feed blockage scattering; however, we found that including these terms made a minimal difference in the patterns. The comparison between the measured and predicted difference patterns is also excellent in the forward region but degrades in the far out side lobe regions. Again this may be due to the lack of higher order diffraction and reflector terms. These terms are quite important and may even dominate the lower radiation levels.

4 CONCLUSION

This paper demonstrates the accuracy obtainable by using a hybrid modeling approach to model a complex antenna problem. A low frequency (methods of moments) technique was used to model the feed while a high frequency (Geometrical Theory of Diffraction) technique was used to model the reflector. The results show that the hybrid approach can yield accurate predictions for a large, complex reflector antenna. These programs can be used by the system evaluator and the system designer for antenna design and emulation.

5 REFERENCES

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3. Ludwig, Arther C. "The Definition of Cross Polarization", IEEE Transactions on Antennas and Propagation, AP-21(1): 116-119, January 1973.

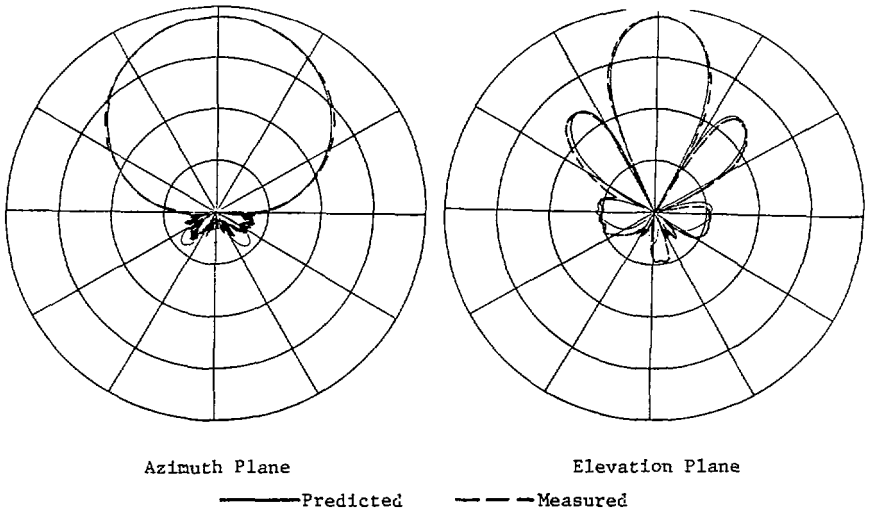


Figure 1. Feed Sum Patterns, Vertical Polarization

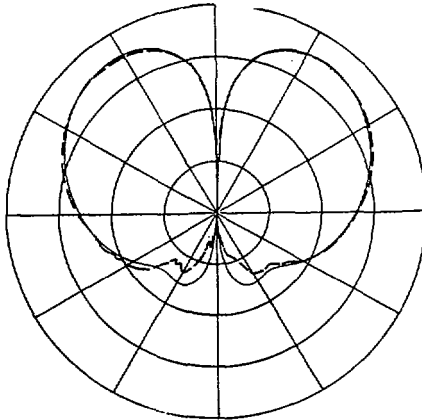


Figure 2. Feed Difference Pattern, Vertical Polarization

——— Predicted - - - Measured

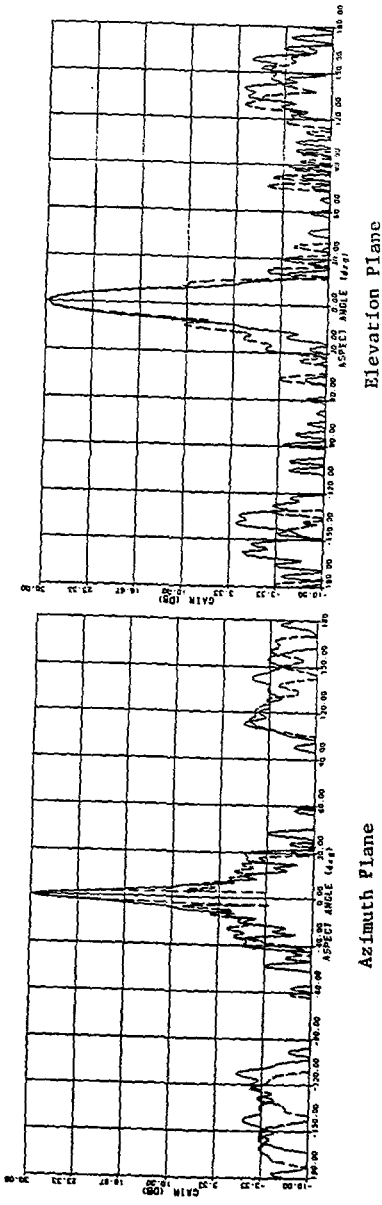


Figure 3. System Sum Patterns, Vertical Polarization

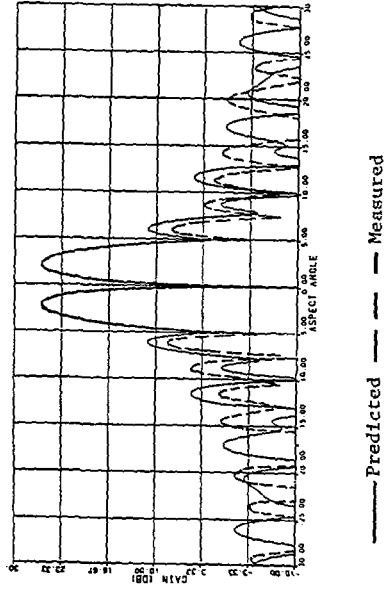


Figure 4. System Difference Pattern, Vertical Polarization