Investigation of Radome Enclosed Antenna with Tilted Angles of 10º and 20º for Airborne Applications

Madiha Farasat, Yang Yang, *Senior Member, IEEE*
School of Electrical & data Engineering, Tech Lab
University of Technology Sydney, Australia
Madiha.Farasat@student.uts.edu.au; yang.yang-1@uts.edu.au

***Abstract*- Electromagnetic windows, called as Radome, are used to shield the antenna system. Antenna being a part of every microwave system needs more protection, particularly for applications where environmental effects are worse. Radome acts as a supporting structure for critical terrestrial antenna systems, airborne radar systems, and submarine antenna systems. This work discusses the design considerations, and particularly, tilted angles of the radome and their impact on antenna performance. Antenna performance is simulated with radome at different angles. Radome power transmission characteristics are simulated over antenna scan angle range.**

Keywords— Antenna, tilted Radome, high gain, airborne

I. INTRODUCTION

Primarily, the radomes are support structures for antennas from environmental loads. They must be capable of bearing the applied loads [1]. For ground applications, loads are mostly strong wind loading, while for underwater radomes, load is water pressure. For airborne radome, load is in the form of air drag. Radome for airborne application is tricky as the antenna systems are on aircrafts. Radome weight, size, and geometry are critical for airborne applications due to large environmental stresses [2].

II. RADOME DESIGN

The growing pressure for improvements in the performance of airborne antenna system places considerable demands on the design of Radome [3]. The purpose is to offer lower side lobes and boresight errors to ensure minimum degradation in antenna radiation patterns [4]. The geometry of a radome is selected in such a way that air drag is negligible if not zero. Long elliptical shape is considered to be ideal for airborne radome. There are many construction possibilities in the sandwich wall radome.

A-sandwich radome has very high strength to weight ratio, and its outstanding electrical performance at low incidence angle makes it an optimal choice for airborne applications [5]. We have to select low ε_r material for the core of radome that can meet airborne environmental and structural requirements. Rohacell is chosen as it's ε_r is 1.16. This core material is trendy in airborne industry for its structural and electrical properties. Radome skin is set as 0.5 mm thick quartz polycyanate having ε_r = 3.23. The skin material has high ε_r, which is required to increase the stiffness of the core [6]. The proposed radome and a horn antenna are modeled in HFSS for fullwave EM simulation to verify the design performance of overall structure and parameters of the radome.

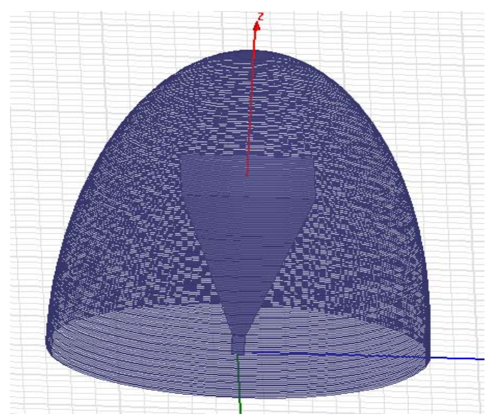

Fig. 1. Radome enclosed horn antenna

Performance of the horn antenna with the proposed radome and without a radome are compared in the following figure. The results show that radome loss is around 0.14 dB and boresight error is around 0.09 degrees.

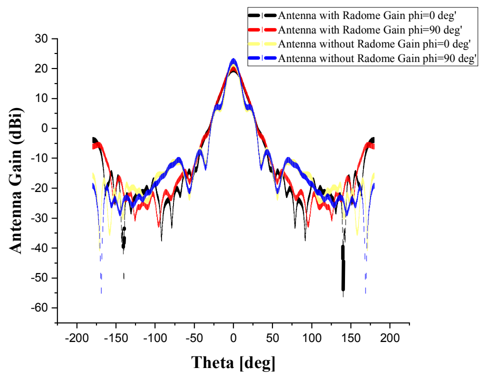

Fig. 2. Comparison of antenna gain with and without a radome (Insertion loss is 0.14 dB).

III. RADOME TILTED BY 10 AND 20 DEGREES

To verify the radome design and observe the impact of the scan angle on radome performance, the simulation was performed with a radome tilted by 10º and 20º, separately.

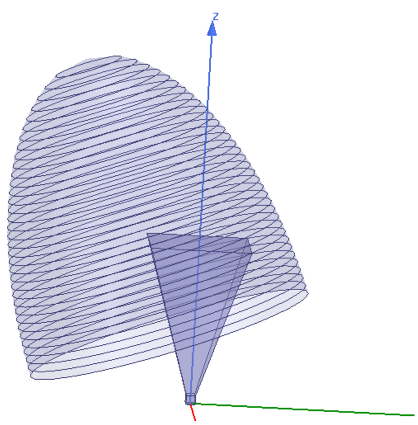

Fig.3. Antenna system with radome tilted

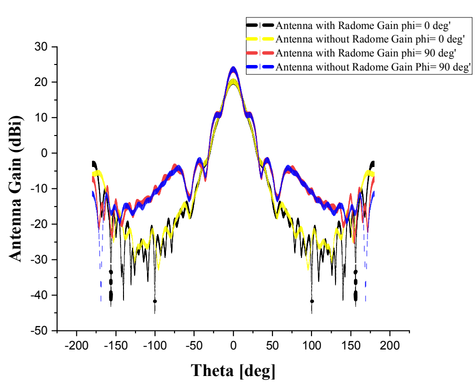

Fig.4. Comparison of gain patterns of an antenna with and without a radome after tilting radome 10º (Insertion loss is 0.1 dB).

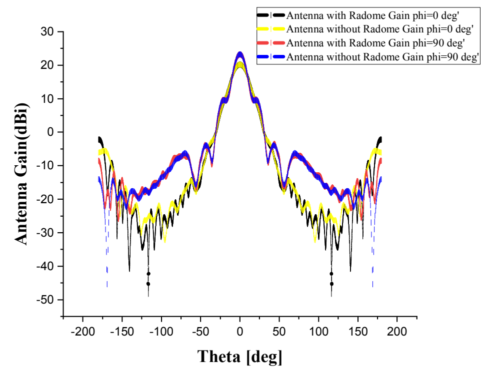

Fig.5. Comparison of gain patterns of an antenna with and without a radome after tilting radome 20º (Insertion loss is 0.04 dB).

Figs. 3 and 4 shows that radome insertion loss decreases with the increase of tilted angle from 0º to 20º. The reason is that the radome is a curved object. At 0 degree, the EM waves pass through the radome area with highest curvature. As the scan angle increases, the EM waves pass through less curved part of the radome.

IV. CONCLUSION

This research has been conducted for radome and related infrastructure design and development. The investigation of the tilted angles of the radome and its impact on antenna system performance is presented.

REFERENCES

[1] R. U. Nair and R. M. Jha, "Electromagnetic design and performance analysis of airborne radome trends and perspectives," *IEEE Antennas and Propagation Magazine*, vol. 56, no.4, Aug. 2014.

[2] F. Chen, Q. Shen, and L. Zhang, "Electromagnetic optimal design and preparation of broadband ceramic radome material with graded porous structure," *Prog. Electromagn. Res.*, vol. 105, pp. 445–461, 2010.

[3] D. J. Kozakoff, *Analysis of Radome Enclosed Antennas*. Norwood, MA, USA: Artech House, 1997.

[4] V. B. Yurchenko, A. Altintas, and A. I. Nosich, "Numerical optimization of a cylindrical reflector-in-radome antenna system," *IEEE Trans. Antennas Propag.*, vol. 47, no. 4, pp. 668–673, Apr. 1999.

[5] R. U. Nair and R. M. Jha, "Electromagnetic performance analysis of a novel monolithic radome for airborne applications," *IEEE Trans. Antennas Propag.*, vol. 57, no. 11, pp. 3664–3668, Nov. 2009.

[6] L. Zhou, Y. Pei, R. Zhang, and D. Fang, "Method for design of dual-band flat radome wall structure," *AIAA J.*, vol. 51, no. 12, pp. 2819–2822, 2013.