A Study of Radar Cross Section (RCS) Reduction Techniques

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Abstract – Radar cross section (RCS) reduction is important in stealth and military applications. In order to reduce RCS of these systems the RCS of antennas present in these systems must be reduced. There are many RCS reduction techniques available in literature. In this paper, a study of different RCS reduction techniques for antennas is presented.

Index Terms: Radar cross section, Antenna, stealth and military applications.

1. INTRODUCTION

The Radar Cross Section of an object means how much it is detectable with radar. So if the RCS of an object is more it will be more detectable. In stealth and military applications we would need to reduce the visibility of our vehicles or aircrafts by the enemy radar. In those cases we need to reduce the RCS. But in the case of these systems, antennas are the major contributors to the total RCS. And we should reduce the RCS of the antennas.

In literature there are many RCS reduction techniques available. In this paper some of these techniques are discussed. Section 2 discusses the different RCS reduction techniques and section 3 presents our conclusions.

2. DIFFERENT RCS REDUCTION TECHNIQUES

As we already discussed, antennas are one of the main contributors to the total RCS of a stealth system. So stealth system will not be useful unless its antennas have low RCS. But it is very difficult to design antennas with low RCS as well as good radiation performance because the RCS reduction in antennas is different from that of regular stealth systems.

The feed network of antenna is very important while we consider the RCS reduction of antenna because it controls the antenna scattering characteristics. If the antenna is fed by match loads there will be only structural mode scattering. But when the antenna is not fed by match loads there will be both structural mode scattering and antenna mode scattering which means a part of the energy will reflect back and reradiate to the space [1].

RCS can be reduced using different techniques. An aperture coupled antenna will provide better RCS reduction since its feed network is on the other side of the dielectric material. RCS can again be reduced using chip resistor load, ground slot and miniaturization [2]. Miniaturization and ground cut slots can also be applied for micro strip antenna to achieve low RCS and good radiation ability [3]. These techniques will reduce the resonance frequency and size of the antenna which results in RCS reduction. RCS of micro strip antennas can also be reduced by controlling the bias voltage across a varactor diode [4].The varactor diode whose capacitance can be reduced by increasing the reverse bias voltage is mounted between the patch and ground plane. And the monostatic RCS of the antenna can be varied by varying the bias voltage.

RCS of rectangular patch antenna can be reduced using distributed loading without compromising its gain [5]. Compared to lumped loading, distributed loading (using a narrow resistive strip placed around the periphery of the patch) can attain broadband RCS reduction without compromising the gain. Another RCS reduction technique for rectangular microstrip patch antenna is using the material effects [6]. By reducing the radiation efficiency of the conducting body or by minimising the currents in the radiative parts of the body, RCS can be reduced. RCS reduction for microstrip antenna can be achieved over a wide frequency range using a properly biased ferrite substrate [7]. This method needs only moderate values of bias field and RCS can be reduced by 20 to 40 dB. Use of frequency selective surfaces (FSS) can also be employed for reducing

the RCS of microstrip antenna effectively while preserving the radiation performance [8].

Another method for the reduction of RCS is the use of Radar Absorbing Material (RAM). A novel ultra-thin RAM using Sievenpiper high impedance ground plane (HIGP) is useful in RCS reduction [9]. An ultra-thin Electromagnetic Band Gap (EBG) RAM can reduce the monostatic backward RCS of asymmetric ridged waveguide slot antenna array [10]. Radar absorbing method can also be applied to reduce the RCS of patch array antenna without compromising the antenna performance [11].Bionics principle can be applied for RCS reduction of UWB antennas [12].

3. CONCLUSIONS

As we know reduction of RCS is very important in many applications like stealth and military platforms. A study of different radar cross section reduction techniques is performed. Commonly used methods are by using Radar Absorbing Material (RAM), ground cut slots, miniaturization, distributed loading, frequency selective loading etc. These methods provide RCS reduction for different antenna configurations. Based on our requirement or application we can select the suitable method.

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