Measurement of Polarimetric RCS Characteristics of Canonical Targets under GB-SAR Environment

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***Abstract*—This work presents a novel aspect for measurement and implementation of a radar cross section (RCS) using the polarimetric backscattered power under ground-based Synthetic Aperture Radar (GB-SAR) environment. Special attention is given to combine the GB-SAR principle with RCS measurement in order to determine the polarimetric backscatter characteristics of canonical targets along the azimuth direction. In this paper, the polarimetric measurement concept using GB-SAR environment for the movement of pyramidal horn antennas in the azimuthal direction are developed. The experimental results are presented with implementation of dihedral and trihedral corner reflectors. The results based on this methodology allow to generate the backscattered characteristics of canonical targets with reference to measurement geometry under GB-SAR environment. Consequently, the measurement concept and the experimental results can be used to determine and to identify the specific geometry of the objects in searching applications.**

***Keywords*—Radar Cross Section measurement, Scattered characteristic, Synthetic Aperture Radar**

I. Introduction

In general, a broad area imaging at high resolutions is necessary for various tasks such as environmental monitoring, earth-resource mapping, and surveillance military systems. These images are often acquired at night or during inclement weather. The synthetic aperture radar (SAR) systems have this capability and are widely used because they can provide the image data during both day and night without restriction of weather conditions as shown by [1] and [2]. The SAR systems take advantages of the long-range propagation characteristics of radar signals and the complex information processing capability of modern digital electronics to provide high resolution imagery. A SAR complements photographic and other optical imaging capabilities because it is not limited by the time of day or atmospheric conditions. Furthermore, it has unique responses of terrain and cultural targets to radar frequencies.

An interesting application of the SAR systems is the ground-based (GB)-SAR system as shown by [3], where the radar system is fixed on the ground or on the roof of a building for environment monitoring and disaster prevention. A SAR system makes an image by pointing a radar beam perpendicular to the motion vector, and then recording the radar echoes for digital signal processing as shown by [4]. The scattering property of any surfaces or objects can be explained using the radar cross section (RCS), which depends on various factors such as object geometry, frequency, and polarization.

The purpose of this paper focuses on the implementation of polarimetric RCS signatures of canonical targets to generate the backscattered characteristics of echo power. This paper also aims to show the effect of relative position changes between canonical target and radar sensor.

The organization in this paper are as follows. It begins with the theoretical background, which consists of the Synthetic Aperture Radar principle and the radar cross section's definition in Section II. Next, the measurement concept under GB-SAR environment and the canonical targets are described in Section III. In Section IV, the experimental results are presented and discussed. Finally, Section V concludes the measurement methodology and the applicability of this concept.

II. Background Theory

A. Synthetic Aperture Radar Principle

The Synthetic Aperture Radar (SAR) is a form of radar used to create images of objects, such as landscapes. These images can be either 2D or 3D representations of the object. The SAR uses the motion of a radar antenna over an observed area to provide finer spatial resolution than one obtained from the conventional beam-scanning radars. It has a geometry of a side-looking real-aperture radar and is carried on a platform moving in a straight line at constant altitude as shown by [5]. In other words, the SAR uses one antenna in time-multiplex manner. The different geometric positions of the antenna elements are result of the moving platform. The distance, which the SAR's antenna travels over a target until the radar pulses return, creates a large synthetic antenna aperture. This larger aperture allows the SAR system to create high resolution images with comparatively small physical antennas.

For a 2D SAR image, one of its dimension is called a range and is a measure of the line-of-sight distance from the radar to the target. Range measurement and its resolution are achieved in the SAR system in the same manner as most other radars. That is, a range is determined by measuring the time when a radar pulse is transmitted until the echo pulse from a target is received. Also, a range resolution is determined by the transmitted pulse width, i.e., a narrow pulse yields a finer range resolution. Another dimension of the image is called an