Simulation of the PARSAX Dual-Channel FMCW Polarimetric Agile Radar System

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Abstract—**Polarimetric agile radar can be used to estimate all elements of the polarization-dependent backscattering matrix (BSM) simultaneously. Stringent requirements, such as amplitude and phase matching between channels, cross-channel isolation and polarization isolation, for a dual-channel polarimetric agile radar system have to be investigated. The radar system simulation is a practical and effective approach to evaluate these requirements. This paper presents the modelling and simulation of the dual-channel FMCW polarimetric agile radar system by using Agilent Advanced Design System (ADS) simulation software. The paper focuses on investigating the limitations of cross-channel isolation and estimating the error of BSM components in polarimetric agile radar system simulations.**

I. Introduction

Polarimetric radar is widely used to reveal more details of the polarimetric behavior of radar targets in recent years. There are two schemes which can be exploited in dual-channel polarimetric radar system design: the polarization diversity scheme and the polarization agility scheme [1]. In the polarization diversity scheme the polarization states are switched alternately between horizontal and vertical polarizations on transmission while both polarizations are received simultaneously on reception. In the polarization agility scheme both polarization states are transmitted and received simultaneously.

For polarization diversity the full polarization-dependent BSM can only be measured in a sequence of two sweeps, while for polarization agility the BSM can be measured in a single sweep. There are some advantages and disadvantages for the polarization diversity as well as the polarization agility schemes. On the one hand, for non-stationary targets with a correlation time equal or shorter than the sweep repetition time, the error in the measured BSM for the polarization diversity scheme will get increasingly larger than this error in the polarization agility scheme. On the other hand, the requirements for cross-channel isolation in the polarization diversity scheme are less stringent than that in the polarization agility scheme.

The radar system, which consists of a dual-channel transmitter and a dual-channel receiver, can be used to measure the full polarization-dependent BSM in a single sweep. Such type of radar is under development in the International Research Centre for Telecommunications and Radar (IRCTR) in the framework of a Netherlands Technology Foundation (STW) project, entitled: Polarimetric Agile Radar in S- And X-band (PARSAX) [2].

There are some stringent requirements for the hardware needed in the polarization agility scheme, such as amplitude and phase matching between channels, cross-channel isolation, polarization isolation, phase non-linearity etc. This paper presents the modelling and simulation of the dual-channel FMCW polarimetric agile radar system by using ADS simulation software, which is a practical and effective approach to evaluate these requirements. The optimal design of the PARSAX radar system with respect to amplitude and phase matching between channels has been conducted in [3]. This paper focuses on investigating the limitations of cross-channel isolation and estimating the errors in BSM components by using the whole PARSAX radar system simulation.

The organization of the paper is as follows. The modelling of the PARSAX dual-channel FMCW polarimetric agile radar system, including the modelling of each part of the radar system, is presented in Section II. After depicting the main specifications and simulation results of the PARSAX radar, the limitations of cross-channel isolation and the errors in BSM components are investigated in detail in Section III. Conclusions are drawn in Section IV.

II. Modelling the PARSAX Radar

Fig. 1 shows the block diagram used for simulation of the PARSAX dual-channel polarimetric agile radar system. The modelling of the PARSAX radar consists of the modelling of a dual-channel arbitrary waveform generator (AWG), the modelling of a dual-channel transmitter sub-system, the modelling of the propagation channels and target, the modelling of a dual-channel receiver sub-system and the modelling of a four-channel digital signal processor (DSP).

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