INVESTIGATION ON MOVING TARGET DETECTION AND VELOCITY ESTIMATION WITH TRIPLE-CHANNEL MIMO-SAR

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1. INTRODUCTION

Triple-Channel SAR system is applicable to detect moving target and estimate velocity by using the Displaced Phase Center Antenna (DPCA) and interferometry method. However, this traditional approach will induce the blind velocity and velocity ambiguity. To overcome these shortcomings, several systems have been proposed [1][2]. All of these systems require adding more antennas with which the complexity of the system is increased. Without additional antennas, this paper proposes a Triple-Channel Multi-Input Multi-Output SAR (Triple-Channel MIMO-SAR) system[3], by employing a DPCA and interferometry method based on Matched Fourier Transform (MFT), which can be utilized for moving target detection without blind velocity, range velocity estimation without ambiguity and accurate azimuth velocity estimation.

The mechanism of moving target detection and velocity estimation with Triple-Channel MIMO-SAR system is presented in section 2. Besides, the DPCA and interferometry method based on MFT for Triple-Channel MIMO-SAR system is presented as well. In section 3, computer simulation results illustrate the effectiveness.

2. MOVING TARGET DETECTION AND VELOCITY ESTIMATION

2.1. Mechanism of Triple-Channel MIMO-SAR system

In this section, a Triple-Channel MIMO-SAR system is proposed which works in the mode of two-input three-output. In this system, two antennas are assigned to transmit Linear Frequency Modulated (LFM) signals which are orthogonal in frequency domain. Therefore, the signal received from each antenna consists of two orthogonal signals, which can be separated by pass-band filter. Via this pre-filter process on each received signal, six signals (separated into two groups by frequency) are obtained.

The signals of two groups are processed by the DPCA and interferometry method based on MFT. The blind velocity and velocity ambiguity can be resolved by combining detection and estimation results of two groups. The flowchart is presented in this section.

2.2. Analysis of the moving target detection and velocity estimation

As the blind velocity is related to the working frequency, the blind velocity can be identified through comparing the detection results of different working frequency groups. When the blind velocity is identified in one of the group, the other without blind velocity can be chosen for detection. The expressions to resolve the blind velocity are presented in this section.

The velocity ambiguity is caused by the Doppler frequency wrapping modulo Pulse Repetition Frequency (PRF), and the Doppler frequency is related to the working frequency as well. On the basis of velocity ambiguity identified via a discriminant with regard to working frequencies, the velocity without ambiguity can be recomputed by figuring out the unwrapped Doppler frequencies. The discriminant and expressions are also presented. Moreover, the azimuth velocity can be calculated by the Doppler frequency modulated rate estimated after the MFT. The expression is presented as well.

3. EXPERIMENT

The echo signals of Triple-Channel MIMO-SAR including clutter, four point-like moving targets and noise are simulated. To validate the proposed method, every moving target's velocity is set to be blind or ambiguous under at least one working frequency. By simulation, the targets' velocities and their corresponding estimators are shown, which illustrate the effectiveness of the DPCA and interferometry method based on MFT for Tripple-Channel MIMO-SAR.

4. CONCLUSIONS

Triple-Channel MIMO-SAR is proposed for the moving target detection and velocity estimation, in order to detect moving target without blind velocity, estimate velocity without ambiguity. Mechanism of moving target detection and velocity estimation with Triple-Channel MIMO-SAR system is presented. A DPCA and interferometry method based on MFT is presented. The validity of this method is verified by simulation results.

5. REFERENCES

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