

Research on the Relationship between Satellite Attitude Stability and Interferometric Performance

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1. Introduction

As the first distributed SAR system, TanDEM-X will be launched later this year. It will cooperate with TerraSAR-X to obtain the first batch of distributed interferometric data to validate the feasibility of the system. The most important task it will take in space is to obtain the global DEM, so the interferometric performance of the system should be carefully estimated. This paper discusses the relationship between the stability of the satellite attitude and the interferometric performance of a distributed satellite SAR system. In single SAR satellite system, attitude stability is a very important parameter in the platform designing process because of the effect of attitude jitter on the spaceborne SAR image qualities. In the distributed satellite SAR system, the problem is much more complicated.

2. Associated Modeling

Based on full reference to the mathematical model of the single SAR satellite attitude jitter, through the detailed analysis on the principle of the satellite platform in a distributed satellite SAR system, this paper gives out the mathematical model of the attitude jitter in a distributed satellite SAR system. The model is the theoretical basis for the analysis in this paper.

3. Precision Analysis

Based on the paired-echo distortion theory, this part derives the expression of impulse response function for attitude jitter and puts forward a quantitative analysis method on the relationship between the satellite attitude jitter and the interferometric performance of a distributed satellite SAR system.

Analysis in this part will include the following sections:

- ① The relationship between the SAR imaging quality and the attitude jitter in pitch and yaw direction

This section mathematically derives the fact that there will be more than one pair of echo on the image of the spaceborne SAR system, when attitude jitter exists. The expression of impulse response function after

imaging processing is given in several cases. Furthermore the content is discussed about the position it appears and the peak ratio, etc.

② The relationship between the SAR imaging quality and the attitude jitter in roll direction

The analysis in this section is similar to section ①. The difference is that the attitude jitter in roll is reflected in range direction.

③ The relationship between the SAR imaging quality and the interferometric performance

Through the analysis on the point target response, the relationship expression between the SAR imaging quality and the correlation coefficient is given. And then through the correlation coefficient, its impact on the interferometric performance is given.

④ The binding relationship between the attitude jitter and interferometric performance

Summing up the sections talked above, the binding relationship expression between the interferometric performance and the attitude jitter in 3-axis is given. The formula has great reference value to the integrated parameter design in a distributed satellite SAR system.

4. Simulation

Based on theoretical analysis, in order to verify the correctness of the analysis in this paper, computer simulation is made in several cases. The content includes the paired echo caused by attitude jitter in 3 directions, the impact curve between the SAR imaging quality and the interferometric performance. On this basis, using computer simulation, the impact curve between the interferometric performance and the attitude jitter in 3-axes is given. The curve has great reference value to integrated parameter design in a distributed SAR system.

5. Conclusion

Through the analysis on the attitude jitter in distributed SAR system, the binding relationship expression between the interferometric performance and the attitude jitter in 3-axes is given. Through computer simulation, this paper gives out the impact curve between the interferometric performance and the attitude jitter. The analysis in this paper provides an important theoretical basis to the integrated analysis and design in a distributed SAR system.