An imaging method and the correction of distortion for Spaceborne-airborne Bistatic SAR

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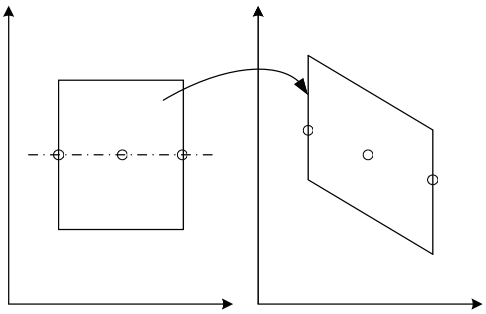
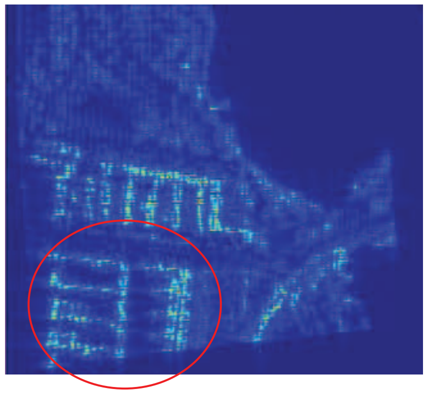
Abstract

Because of the great speed difference between the transmitter and the receiver of the spaceborne/airborne bistatic SAR (SA-BiSAR), the bistatic angle changes with time, which makes the geometric structure of the SAR system no longer invariant, so SA-BiSAR belongs to the translational-variant bistatic SAR. Because its multifreedom geometry, the concepts of Doppler frequency rate and Doppler Centroid do not exist anymore. So, traditional algorithms such as R-D algorithm can't be used. But during the course of researching, we found that by some simple modification, the range-Doppler can be used for SA-BiSAR imaging under specific circumstance. But the final image distort seriously and dissimilarly.

In order to solve this problem**,** this paper establishes the geometric model of the SA-BiSAR firstly, and then we use perfect square to transform the bistatic range history from the sum of two square roots into a mono-square root: $R(t_m) \approx 2\sqrt{R_0^2 + \left(V_{eq}t_m - \frac{x_0}{2}\beta\right)^2 + \alpha}$

Based on that, we derived the formula of the modified RD algorithm, by which we can get well focused but some distortions results.

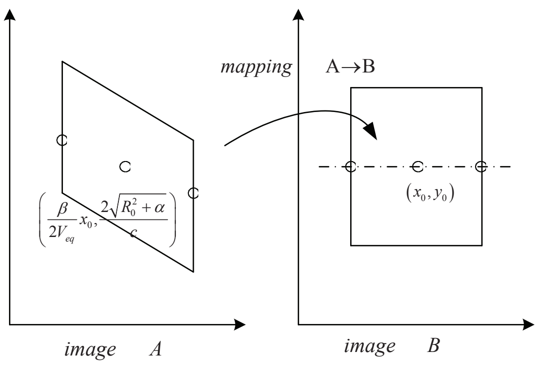
Using R-D for bistatic SAR imaging, the directions of two axes of imaging space correspond to the composition vector of the angle velocity of T/R platform and the composition vector of the radar sight respectively. It is obviously that for translational-variant bistatic SAR the two axes of the SAR image are non-orthogonal. For imaging algorithm, that means transforming the data from a rectangular coordinate system to a non-orthogonal coordinate system, which is the main cause of the image distortion. That is to say, we need to find a relationship between the image before correction (which is denoted as image A) and the real image (denoted as image B). Then a correction method for bistatic SAR distortion named Inverse-Projection .Then based on the analysis to cause the image distortion, a correction method for bistatic SAR distortion named Inverse-Projection is brought up. The simulation results demonstrate that this method can work well for spaceborne/airborne configuration.

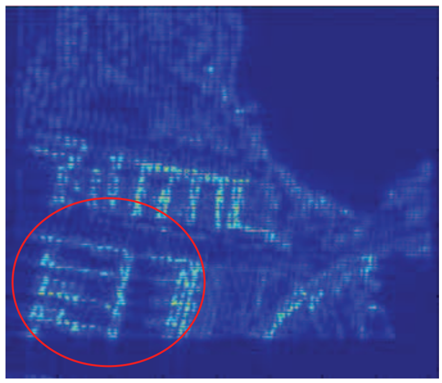
 

The essence of Inverse-Projection is to find the mapping from image A to image B. By deriving, we can get the relationship between image A and image B:

$$\begin{cases} x_0' = \dfrac{2V_{eref}}{\beta\left(x_{ref}, y_{ref}\right)} \cdot t_m = x_0 V_{eref} \beta\left(x_0, y_0\right) / V_e \beta\left(x_{ref}, y_{ref}\right) \\ r = t \cdot c = 2\sqrt{R_0^{\ 2} + \alpha} \end{cases}$$

Where $\beta\left(x_{ref}, y_{ref}\right)$ is the β of reference point. V_{eref} is the equivalent velocity of reference point. It is obvious that, except reference point, all the other points' azimuth positions are unreal, i.e. $x_0' \neq x_0$. Our aim is to transform point (x_0', r) into (x_0, y_0) by this expression. Finally we can get the correct image.





CONCLUSION

The modified RD algorithm can be used for SA-BiSAR imaging when the platforms move in parallel tracks, but there will be some distortion. A correction method for bistatic SAR distortion named Inverse-Projection is brought up. The simulation result demonstrates that the method is. But this method has its own disadvantages, for example, the large calculation and the slow process. Setting the whole scene into different small parts can be an improvement, which can improve the efficiency of correction. And when the platforms move with non-parallel tracks, the correction formulations should be re-derived.

[1] Y. L. Neo, F. H. Wong, and I. G. Cumming, "Processing of azimuth-invariant bistatic SAR data using the range Doppler algorithm," IEEE Trans. Geosci. Remote Sens., vol. 46, no. 1, pp. 14–21, Jan. 2008.

[2] Shi jun; Zhang Xiaoling; Yang Jianyu; "Translational variant bistatic SAR signal space-time feature and processing method" Geoscience and Remote Sensing Symposium, 2007. IGARSS 2007. IEEE International 23-28 July 2007 Page(s):2140 – 2143