MOTION MEASUREMENT ERRORS ANALYSIS FOR THE "ONE-ACTIVE" LASAR

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In recent years, the three dimensional (3D) imaging SAR has been researched as a hot field. Generally, the 3D imaging system can be classified into two types: the curved SAR (CSAR) [1-4] and the linear array SAR (LASAR) [5-6]. The CSAR obtains its 3D resolutions by designing a non-rectilinear flight trajectory of the antenna phase center (APC). The typical CSAR- circular SAR [3, 4], researched by ONERA, has been validated by the airborne SAR experiments. The typical LASAR system is the ARTINO (Airborne Radar for Three-dimensional Imaging and Nadir Observation), which is developed at FGAN-FHR. It uses a linear array antenna mounted in traverse direction to synthesize a visual 2D antenna array; combining with the pulse compression technique, the three dimensional resolutions are obtained. However, the data computational cost and the couple between receiver elements should be an inevitable problem for ARTINO. To improve the performance of the LASAR system, the "one-active" LASAR [7-8] system was studied by the 704-4 Lab. E. E. Dept. UESTC. The first ground experiments (section targets) have validated the feasibility of this "one-active" LASAR. Fig.1 is the geometry of the "one-active" LASAR. The first ground experiments are displayed in Fig.2.

For any SAR system, the SAR imaging quality should be an important aspect. The conventional SAR processor assumes that the locations of the radar sensors platform are known perfectly at every point in the flight path. In contrary, the radar sensors platform is always showing deviations from the ideal flight track due to the motion measurement errors (MMEs). Some of the influences to the SAR imaging quality have been researched in some former literatures [9]. While, most of these analysis are based on the 2D SAR system and only the vibration wings errors are discussed in literature [6] basing on the ARTINO system. Therefore the analysis of the 3D MMEs to the 3D SAR imaging system is presented in this paper.

Firstly, the principle of the "one-active" LASAR is presented in this paper and the first ground experimental results are displayed. The MMEs are introduced by three forms: the constant velocity errors and the constant accelerate errors in the along track (AT), the sine vibration errors in the cross track (CT) and the wings vibration errors in the vertical dimension (VD). To derive the system specifications that limit the defocus in the final 3D SAR image, one typically chooses to limit the magnitude of quadratic phase error (QPE) contributed by any one motion measurement error to be less than $\pi/4$ radians according to literature [10]. So we can obtain the 3D SAR system's maximum allowable MMEs in Table I.

To analyze the effect of the MMEs on the 3D SAR image, a simulation study was performed. The ambiguity functions (AF) of the point scatterer were portrayed to illustrate the impact of every error type. Fig. 3 to Fig. 7 are the simulation results.

From these simulation results we can find that the effects of any MMEs on the vertical dimension AF are trivial. However, the effects on the along track and cross track are notable. The constant velocity errors cause the main lobe broadening and the side lobe rising in both the along track and cross track, especially in the cross track. The constant accelerate errors have a little effect on 3D AF although the acceleration had achieved three times of the allowable MME. The high frequency sine vibration errors cause the main lobe broadening a little in both the along track and the cross track, but the low frequency sine vibration errors cause the main lobe broadening and the side lobe rising distinctly in the cross track. The vertical wings vibration errors have a serious effect on both the along track AF and the cross track AF. Obviously, the AF of both the along track and cross track will be defocused seriously if there are notable wings vibration errors.

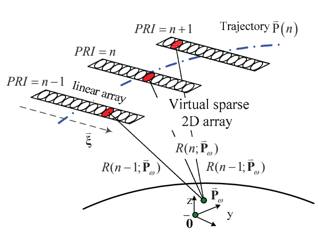

Fig.1 Geometry of the "one-active" LASAR

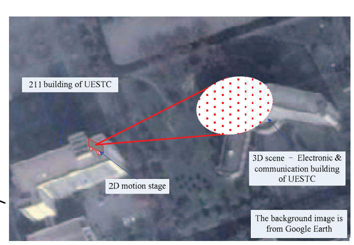

Fig.2 (a) schematic diagram of "one-active" LASAR

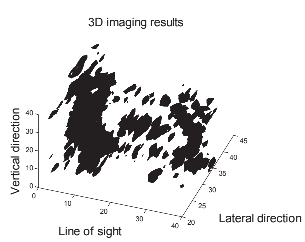

Fig.2 (b) 3D imaging results

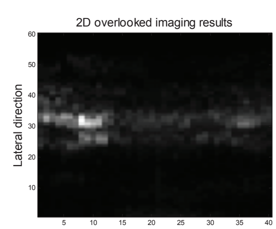

Fig.2 (c) 2D overlooked imaging results

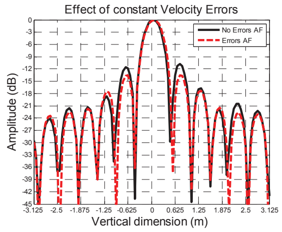

Fig.3 (a) AF with constant velocity errors in VD

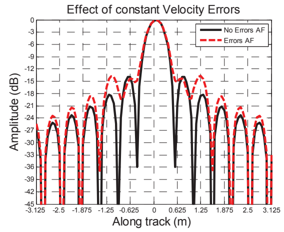

Fig.3 (b) AF with constant velocity errors in AT

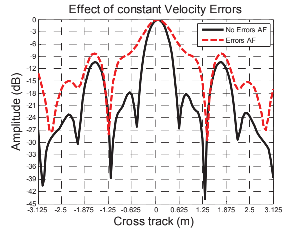

Fig.3 (c) AF with constant velocity errors in CT

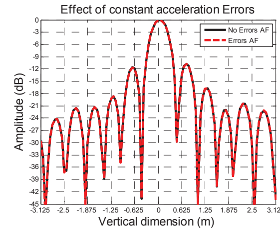

Fig.4 (a) AF with constant accelerate errors in VD

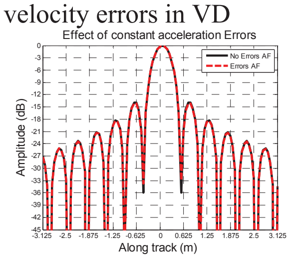

Fig.4 (b) AF with constant accelerate errors in AT

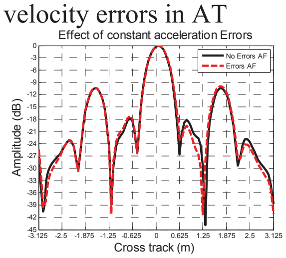

Fig.4 (c) AF with constant accelerate errors in CT

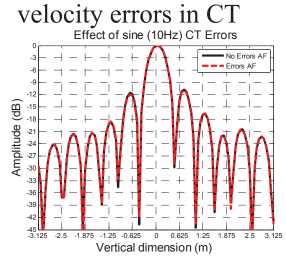

Fig.5 (a) AF with sine vibration errors in VD

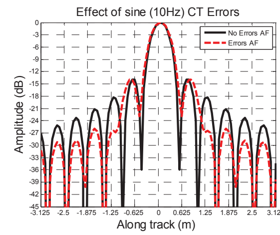

Fig.5 (b) AF with sine vibration errors in AT

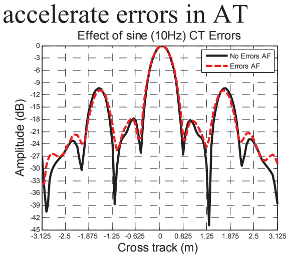

Fig.5 (c) AF with sine vibration errors in CT

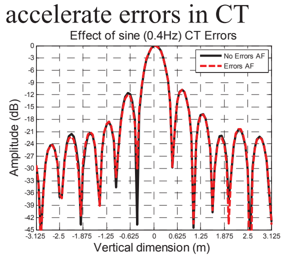

Fig.6 (a) AF with sine vibration errors in VD

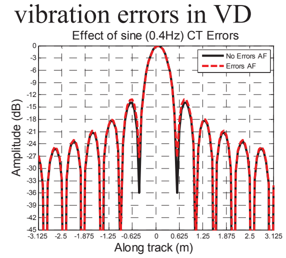

Fig.6 (b) AF with sine vibration errors in AT

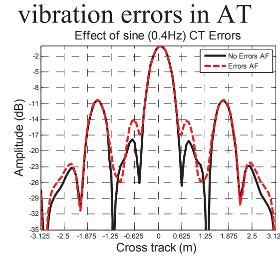

Fig.6 (c) AF with sine vibration errors in CT

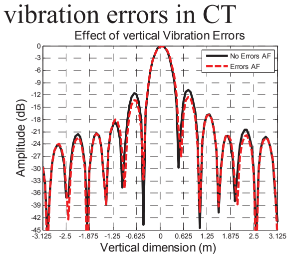

Fig.7 (a) AF with vertical vibration errors in VD

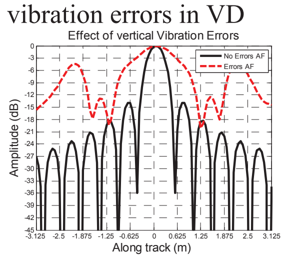

Fig.7 (b) AF with vertical vibration errors in AT

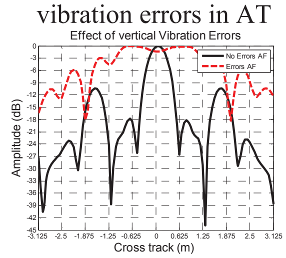

Fig.7 (c) AF with vertical vibration errors in CT

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