Compressed Sensing Application For Sparse Array Radar

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- MTD Based on Airship Linear Sparse Array
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- Side-looking 3D Imaging Based on Airborne Three-Aperture MMW SAR
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1. Introduction

- For MTD, the moving targets exist and the scene is sparse after clutter suppression by MTI processing. CS method can be chosen to reconstruct the locations of the moving targets.
- Because the essence of 3D imaging is imaging on the contour of targets, the targets only have a few scatterers and is sparse in an azimuth-range resolution cell. Therefore, the CS theory can be introduced in 3D imaging.
- Due to the random phase of each scattering cell, the compressibility of the continuous scene can hardly be expressed for SAR. For the multi-antenna observation structure SAR, the random phase of each scattering cell can be eliminated by signal interferometry reconstruction. The bandwidth of complex-valued SAR image can be reduced and the scene spectrum is sparse . So CS method can be used for 3D imaging of the cross-track sparse array side-looking SAR.
- Some signal and data processing results about CS for sparse array radar application are presented in this paper.

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2. MTD Based on Airship Linear Sparse Array

- **Because the volume of the airship is really huge, it is possible to achieve real aperture stationary targets imaging and MTD using large size linear sparse array antenna, and the array antenna can be placed outside of the airship.**

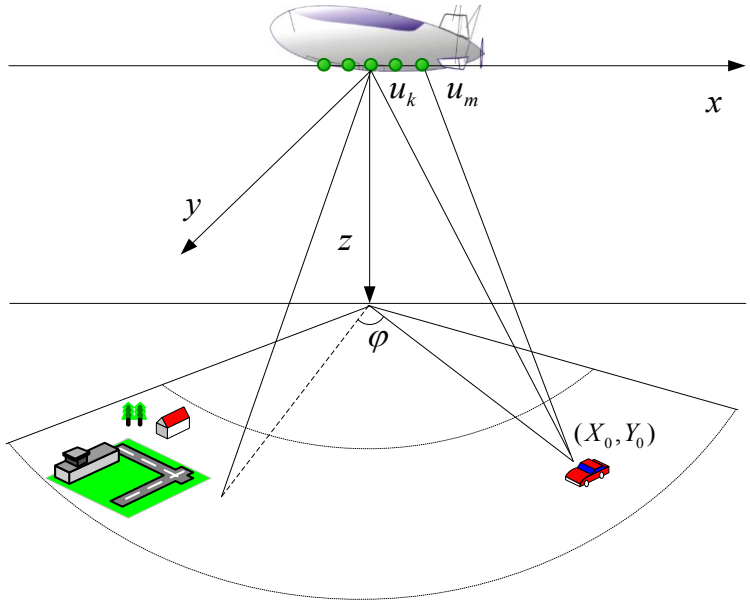

Fig.1 The signal model for airship linear sparse array radar

2. MTD Based on Airship Linear Sparse Array

- **Consider an airship radar system, The subarray beam could scan to expand the swath. By the simulated optimization algorithm, 28 subarrays (possessing 132 space positions) are used to obtain 263 equivalent phase centers (EPC). The subarray azimuth size is 0.6m, so the array length in azimuth direction is 79.2m.**

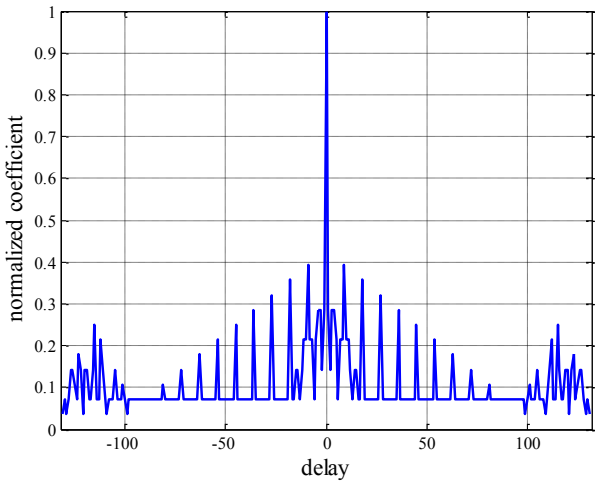

Fig.2 Correlation coefficient of a linear sparse array

2. MTD Based on Airship Linear Sparse Array

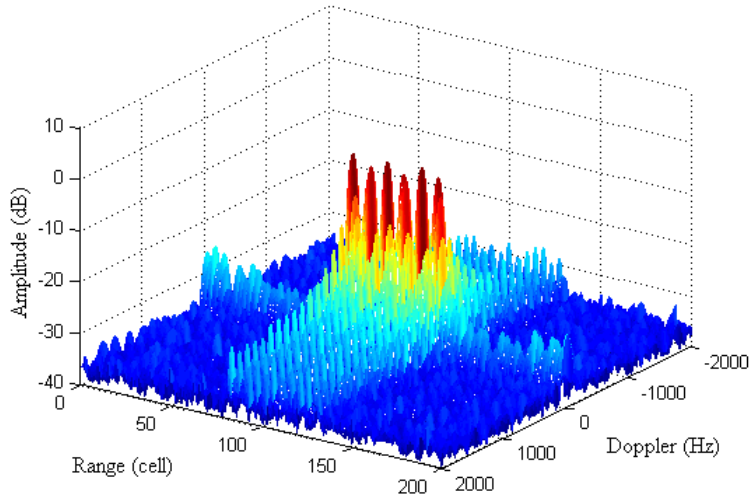

Fig.3 Range-Doppler signal before MTI

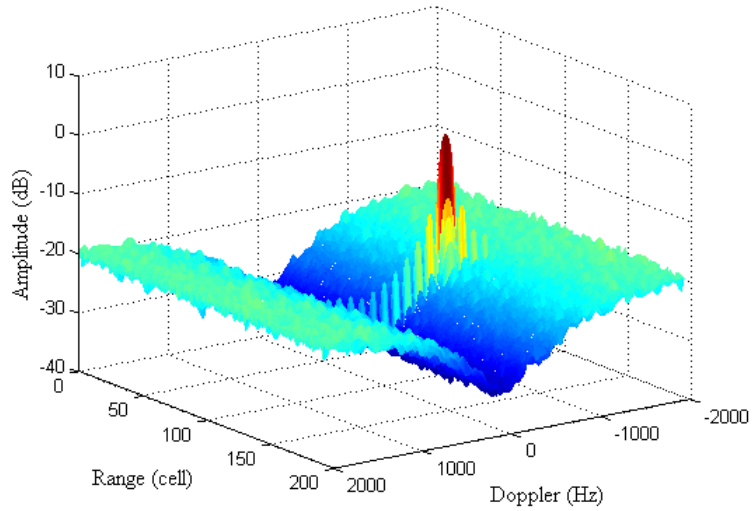

Fig.4 Range-Doppler signal after MTI

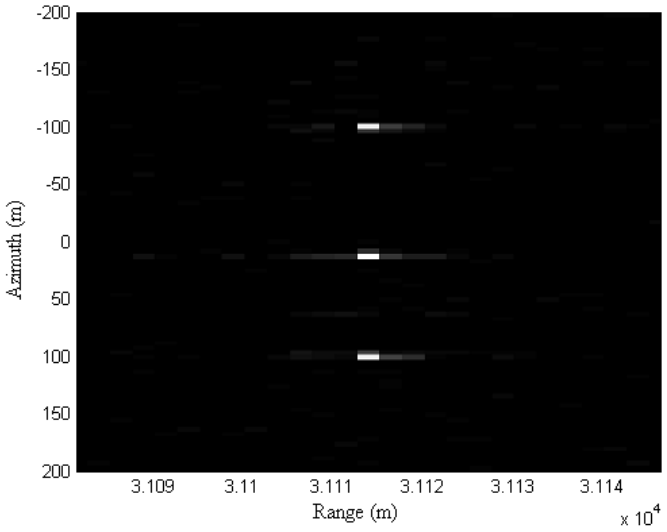

Fig.5 3 moving targets CS reconstruction in the same Range-Doppler cell

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3. MTD Based on Airship Conformal Sparse Array

- **Based on the concept of conformal antenna, the sparse array antenna could be embedded in the body of the airship, becoming a part of the system. The stationary targets imaging can be achieved by back projection (BP) algorithm**

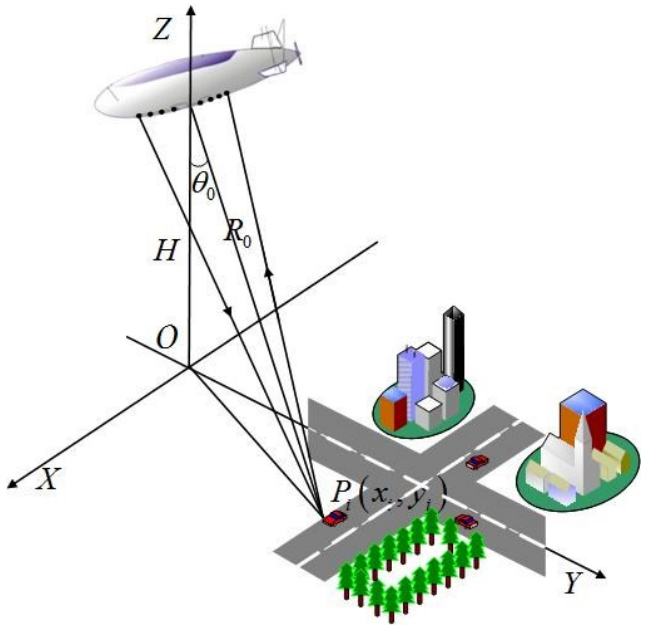


Fig.6 The signal model for airship conformal sparse array radar

3. MTD Based on Airship Conformal Sparse Array

- For every range cell data, in which the moving targets exist, reconstruct the azimuth locations of the moving targets by CS method.

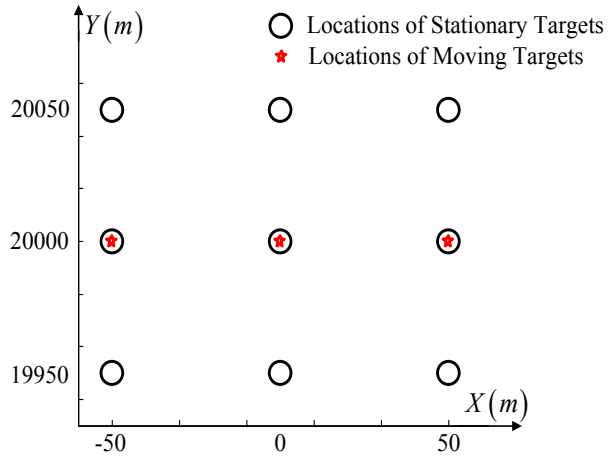
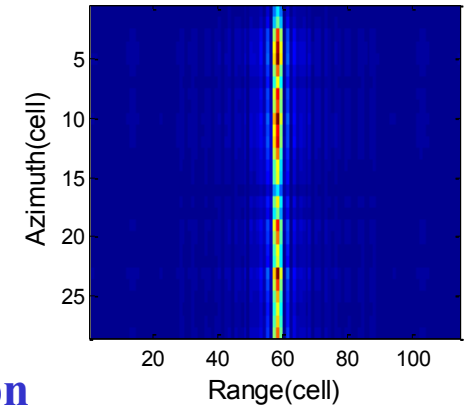
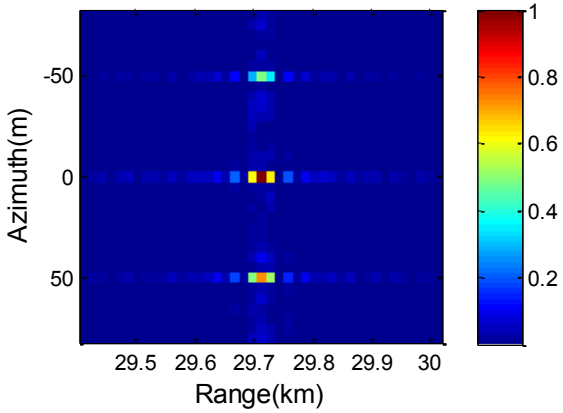


Fig.7 Relative locations of stationary targets and moving targets



signal after MTI



CS reconstruction result

Fig.8 Moving targets detection results

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4. Side-looking 3D Imaging Based on Airborne Three-Aperture MMW SAR

- **Because the essence of 3D imaging is imaging on the contour of targets, the targets only have few scatterers and is sparse in an azimuth-range resolution cell. Therefore, the CS theory can be introduced in 3D imaging. The side-looking 3D imaging result are presented based on real data of an airborne cross-track three-aperture MMW SAR developed by IECAS.**

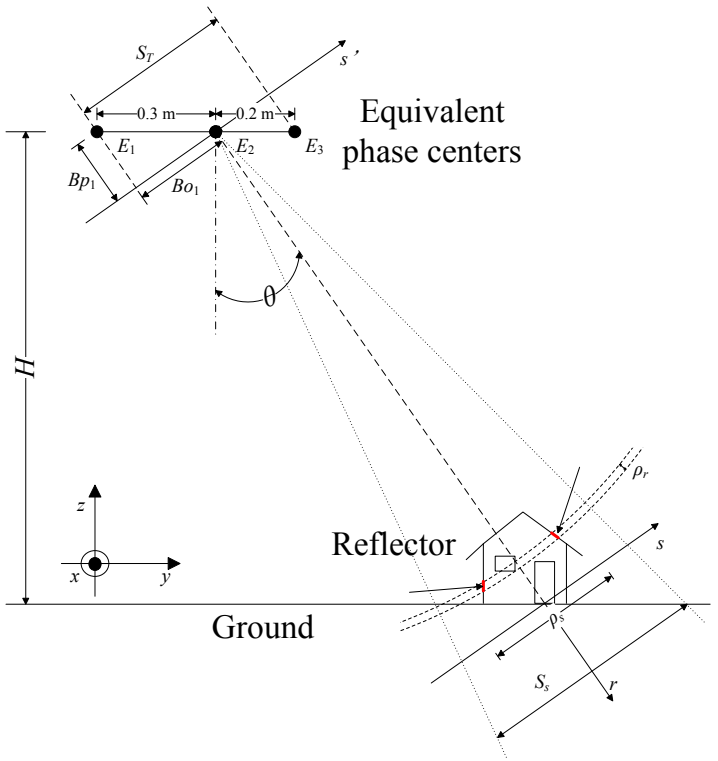
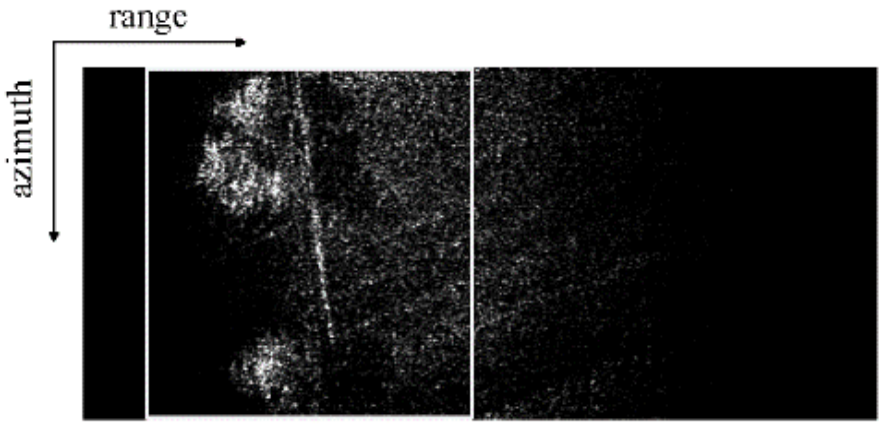


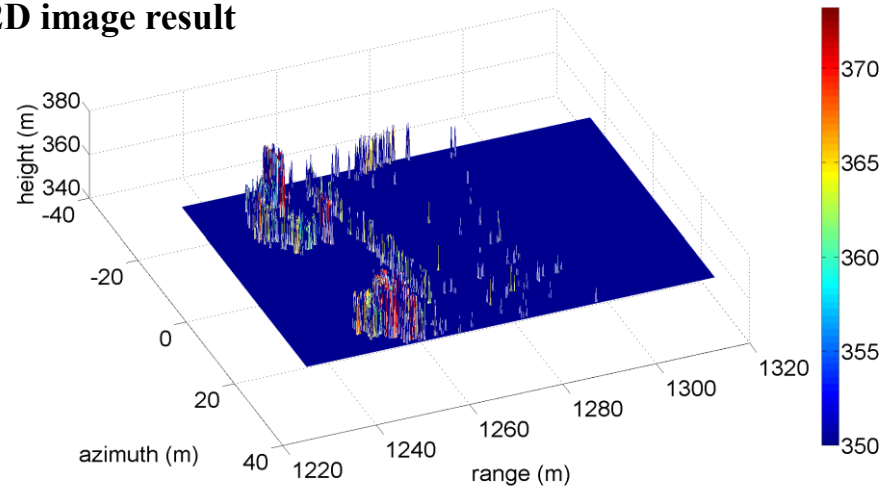
Fig.9 Side-looking 3D imaging model for airborne three-aperture MMW SAR

4. Side-looking 3D Imaging Based on Airborne Three-Aperture MMW SAR

Three aperture MMW SAR



2D image result



CS reconstruction result

Fig.10 2D image and 3D results based on CS for real data

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5. Side-looking 3D Imaging Based on Scene Sparse Spectrum

•Using the interferometry techniques to reconstruct the signal, the spectrum of the multi-antenna SAR images can become sparse 【Ref:IGARSS2013, SPARSITY ANALYSIS OF SAR SIGNAL AND THREE DIMENSIONAL IMAGING OF SPARSE ARRAY SAR】, CS method can be used for 3D imaging based on airborne cross-track sparse array side-looking SAR.

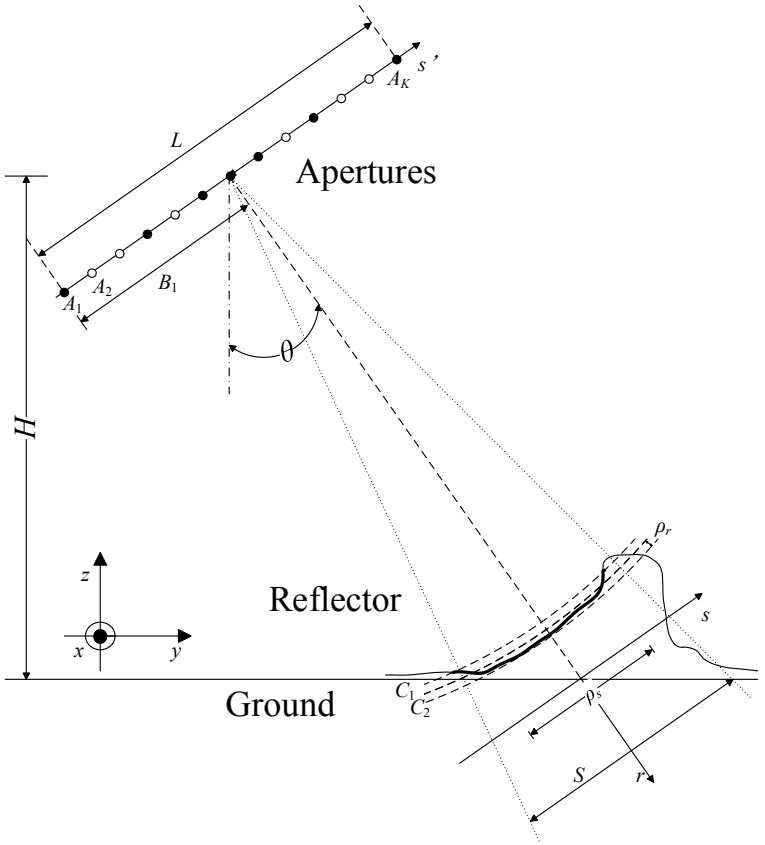
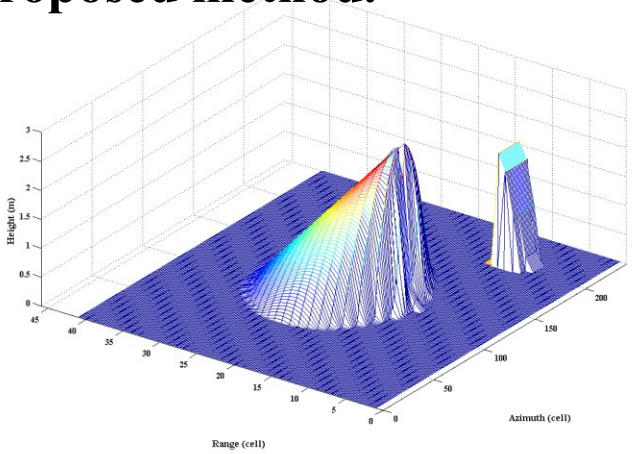


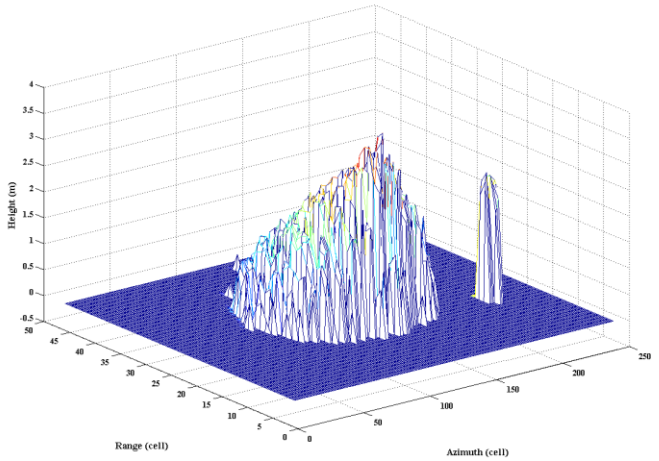
Fig.11 Side-looking 3D imaging model for airborne cross-track sparse array SAR

5. Side-looking 3D Imaging Based on Scene Sparse Spectrum

- The cross-track sparse array is [1001011101001], possessing 13 EPC positions by 7 EPC. It is the half sampling array nearly.
- 3 subarrays [111] is used to get 3D reference image for the 3D signal interferometry reconstruction.
- Compared with the lower-frequency-pass filter processing【IGARSS2013】, The higher resolution is obtained by the CS method. The simulation result have validated the feasibility of the proposed method.



simulated scene



CS result with half sampling

Fig.12 3D results based on signal reconstruction and CS

Thank you!