TOMOGRAPHIC 3D RECONSTRUCTION FROM AIRBORNE CIRCULAR SAR

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1. INTRODUCTION

This paper analyzes the potential of Circular SAR to perform tomography of semi-transparent media. In [1] it was shown that both sub-wavelength resolution and 3-D confocal imaging were possible using circular apertures. Since then, several airborne experiments have been performed showing the potential of such geometries [2, 3, 4]. In this contribution, real data acquired at L-band by DLR's E-SAR sensor will be used to further analyze the high resolution and tomographic capabilities of circular SAR.

2. TOMOGRAPHIC IMAGING WITH CIRCULAR SAR

The theoretical resolution of circular SAR in the horizontal $x - y$ plane is $\lambda/4$, i.e. independent of the bandwidth of the transmitted signal. However, the resolution in the height direction does depend on the bandwidth. A Luneburg lens was deployed during a circular data take with the E-SAR system in order to evaluate the possibility that an airborne platform achieves the expected performance. This kind of lens keeps the radar cross section along the 360° of observation, becoming the ideal target to evaluate circular SAR configurations. The data were processed using a direct time-domain back-projection algorithm. Fig. 1 shows the resulting image after processing 135° aperture with a 20cm grid spacing, together with two zooms of the same image. Since the image was focused assuming a constant height, defocusing is produced whenever the reference height does not match that of the target. This effect can be observed in the zoomed images.

Residual motion errors (inaccuracies in the navigation data) were estimated using an autofocus approach applied over the Luneburg lens. Due to the low signal-to-clutter ratio of the range-compressed data of the Luneburg lens (its diameter is about

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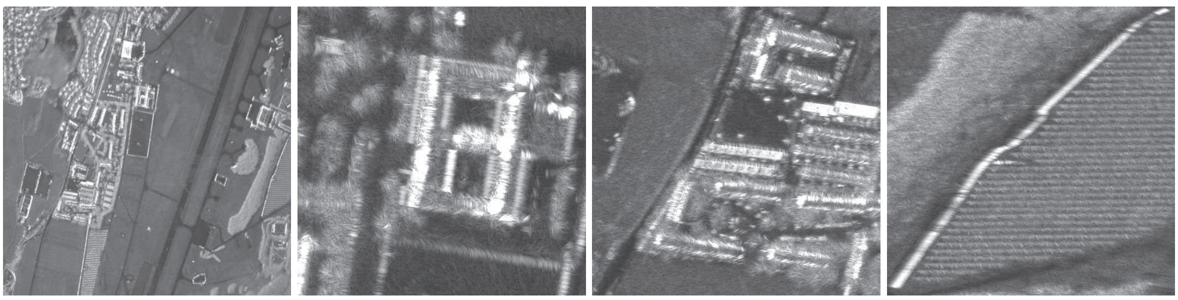
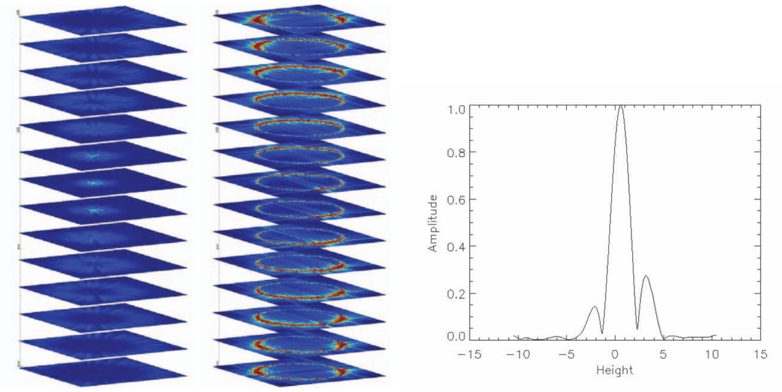


(a) (b) (c) (d)

Fig. 1. (a) High resolution image after processing 135° of the circular aperture. (b)(c)(d) Zooms over different areas of interest.



(a) (b) (c)

Fig. 2. (a) Tomogram and (b) 3-D spectrum of the Luneburg lens. (c) Height profile showing the location in height of the Luneburg lens with a resolution of 1.6m.

60cm, which is quite small for L-band), residual motion errors were estimated in the frequency domain using a novel autofocus approach.

After estimating and correcting residual motion errors, a tomogram over the lens was computed. Fig 2 shows the tomogram and the 3-D spectrum of the Luneburg lens. The height profile is also shown, where the obtained resolution corresponds to the theoretical one (about 1.6m in this case).

3. AFTERWORD

Circular SAR data acquired at L-band by DLR's E-SAR system has been processed and analyzed, showing promising results concerning 3-D volume structure information. The paper will include a detailed description of the methodology, as well as results with forests and man-made objects.

4. REFERENCES

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