A novel imaging algorithm for frequency modulated continuous wave circular trace scanning synthetic aperture radar

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The frequency-modulated continuous-wave (FMCW) technique owns the advantage of light weight and low cost, which is easy to be applied in synthetic aperture radar (SAR) imaging. It is easy to apply the FMCW technique to the fast wide swath circular trace scanning SAR (CTSSAR) imaging mode. Unlike the traditional pulse mode straight line stripmap SAR imaging, FMCW-CTSSAR has a bigger pulse width and the distance between the antenna phase center and the target cannot be regarded as stationary during the one certain pulse, which is different from the conventional pulsed 'one step one stop' hypothesis. Additionally, the circular flight path introduces higher order range errors, if not compensated correctly, will damage the image quality. For current general imaging methods, the range-Doppler algorithm does not consider the high order resulted from curved trajectory. The wave-number domain imaging algorithm can deal with the problem perfectly, but it contains many interpolation operations, leading to a heavy loan of computation, which is difficult to apply to practical use. Hence, a proper imaging method needs to be designed.

In order to combining the two modes together to realize practical fast large scene observation, this paper first establishes the CTSSAR geometrical mode and provide the slant range expression under FMCW mode. The signal is received with Dechirp technique and the fast time variation during the electromagnetic wave propagation is also considered due to influence of the unique continuous wave. After that, the higher order phase errors and the residue quadratic phase error caused by continuous scanning frequency are also discussed. Consequently, a related matched filter is constructed to remove the errors and focus the final image. The whole process is completed by Fast Fourier Transform (FFT) and phase multiplication, excluding the interpolation operation, which successfully increase the computation efficiency. Some simulation results are shown at the end of the paper to prove the feasibility and effective of the proposed method.