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A Video SAR Imaging Algorithm for Micro Millimeter-Wave Radar

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1.Abstract

- Millimeter-Wave, Micro Platform
- SAR， Two dimensional-dechirp, Chirp-Z
- High-resolution($0.15\text{m}\times0.15\text{m}$)
- Video-SAR, Overlapped Sub-aperture

2.ViSAR Imaging Model

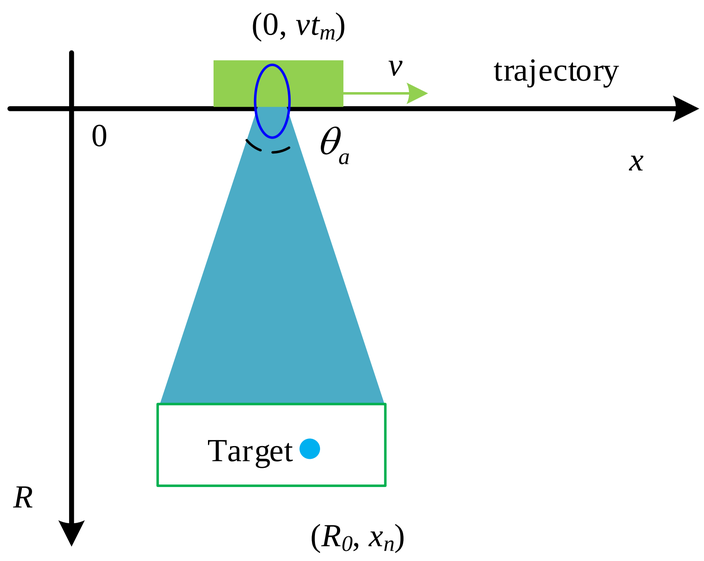


Fig.1. The ViSAR imaging Geometry

As the Fig.1 shows, during the coherent processing interval (CPI), the slant range model between the radar and the target is expressed as: $R(t_m)\approx R_0+\frac{(x_n-vt_m)^2}{2R_0}$

Assuming that radar transmits linear frequency modulation (LFM) signal and mixes its return with the de-chirp reference signal, the beat signal can be expressed as:

$$S_r(\hat{t},t_m)=\sigma_n\cdot rect\left[\frac{\hat{t}-\frac{2R_s}{C}}{T_p}\right]rect\left[\frac{x_n-vt_m}{T_m}\right]\exp\left(-j\frac{4\pi}{\lambda}(R(t_m)-R_s)\right)\cdot$$
$$\exp\left(-j\frac{4\pi\gamma}{C}(R(t_m)-R_s)(\hat{t}-2R_s/C)\right)$$

3.ViSAR Imaging Algorithm

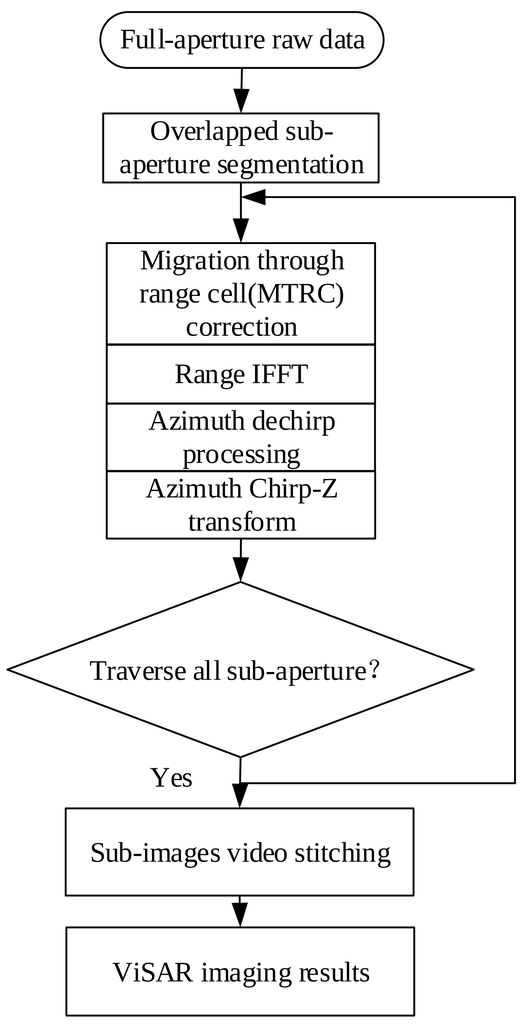
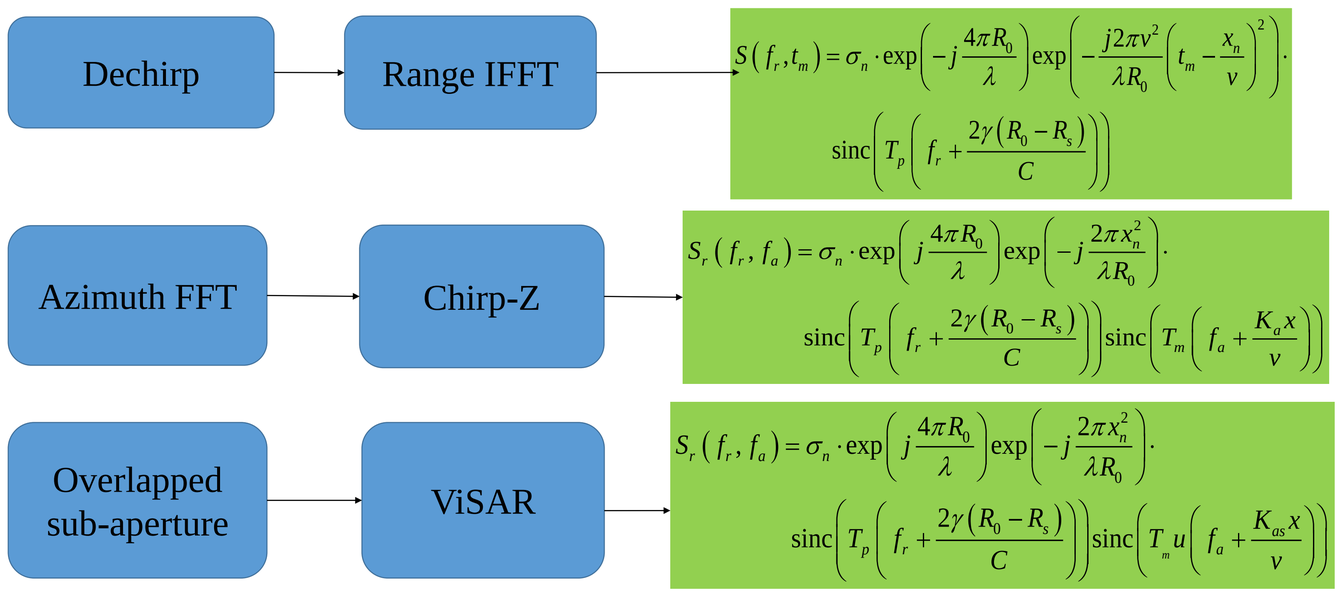


Fig.2. The flowchart of the proposed algorithm



In the overlapped sub-apertures, the data is multiplexed, which shortens the time interval between the ViSAR frames. Thus the frame rate can be rewritten as:

$$F_f'=\frac{1}{(1-\beta)T_a'}=\frac{v\rho_a}{R_s\lambda(1-\beta)}$$

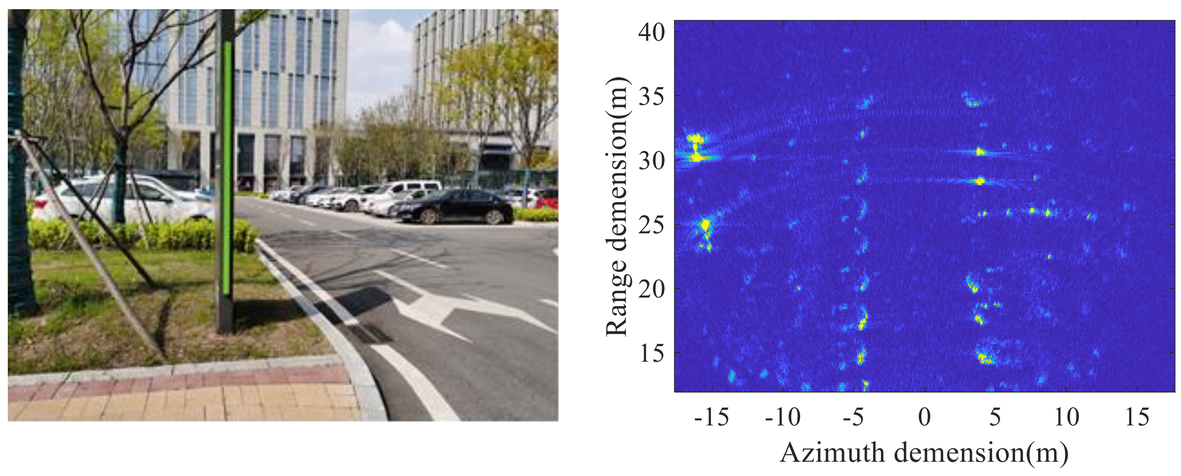
4.Experimental Analysis

Table.1. Radar System Parameters

Parameter	Value	Parameter	Value
v	5m/s	Carrier frequency	78.5GHz
PRF	5000Hz	ADC sampling rate	12MHz
Chirp rate	31.25MHz/us	Azimuth sampling numbers	1024
bandwidth	1000MHz	Center range	40m
Range sampling numbers	512	Azimuth resolution	0.15m

The Radar system Parameters is listed in the Tabel.1, which shows the expected two-dimensional resolution is $0.15\text{m}\times0.15\text{m}$.

The Radar illustrates the area of the parking lot. As the Fig.4 shows, it is easy to identify the head of the vehicles, a row of trees and the shutters among the vehicles on the right of the SAR image, which is the same as the distribution in the optical image of the observed scene. The raw data experiment validly proves the effectiveness of the proposed algorithm.



(a) (b)

Fig.4. The image of the observed scene (a) optical image (b) the SAR image

5.References

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