KOMPSAT-5 SPOTLIGHT SAR PROCESSING USING FSA WITH CALCULATION OF EFFECTIVE VELOCITY

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1. INTRODUCTION

Korea Aerospace Research Institute has built its own SAR image chain analysis system, called Kompsat-5 simulator for Kompsat-5 project. It simulates SAR observation with SAR hardware specifications, orbit and attitude information as we provide, so it generates raw data. The purpose of Kompsat-5 simulator is to see how errors of orbit and attitude affect final image quality. So, SAR image formation system called SIFS has been also built to focus the simulated raw data.

This paper is about SIFS, focusing Kompsat-5 simulated Spotlight raw data. Kompsat-5 operates step steering sliding spotlight mode to get images of resolution better than 1meter. It attains the data by dechirp on receive because of large range bandwidth and small range scene size for the mode. So, Frequency Scaling Algorithm is chosen for focusing the raw data as this algorithm handles dechirped data directly. We have found that the accuracy of effective velocity is critical in order to have a properly focused image for the Kompsat-5 high resolution system.

In this paper, first, we inspect criterions of effective velocity accuracy. Secondly, some aspects in calculation of effective velocity using geometry information will be mentioned.

2. EFFECTIVE VELOCITY

Effective velocity is also called SAR velocity. It is generally used in most SAR focusing algorithms such as CSA, FSA, RDA and so on. These algorithms are brought out based on simplified rectilinear observation geometry. So, the velocity is the antenna velocity seen on the rectilinear geometry, and it is calculated by fitting the real acquisition geometry information into the rectilinear model.

As the resolution gets finer, the accuracy of effective velocity is required to be high. So, in order to achieve an accurate effective velocity, even a small defect in the calculation needs to be handled carefully.

3. EFFECTIVE VELOCITY CRITERION

Effective velocity is very important parameter in range cell migration compensation and azimuth focusing as the velocity error is related to quadratic phase error as shown below.

$$QPE = \frac{4\pi V_r \cos^2 \theta_{r,c}}{\lambda R(\eta_c)} \Delta V_r \left(\frac{T_a}{2} \right)^2 \tag{1}$$

The velocity error also affects linear range cell migration compensation as shown below.

$$\Delta R_{lrcm} = \Delta V_r \sin \theta_{r,c} T_a \tag{2}$$

So, effective velocity accuracy criterions for RCMC and for azimuth compression can be found.

4. LIGHT SPEED EFFECT TO EFFECTIVE VELOCITY

Effective velocity is used to represent azimuth phase history of a point target, and azimuth phase is generated by change of slant range to the target. So, light speed needs to be counted in a realistic sense to increase the accuracy of the velocity. Slant range changes during light delay time. Effective velocity in the case when light delay time is discarded will be compared to that in the case when light delay time is counted.

5. SOME ASPECTS IN CALCULATION OF EFFECTIVE VELOCITY

Effective velocity is generally calculated by using geometry information. Closest approach and zero Doppler time need to be very precise in order to properly fit actual slant ranges to a simple model as below.

$$\{V_r(ta - ta_0)\}^2 + {r_0}^2 = r^2 \tag{3}$$

V_r is the effective velocity, ta is azimuth time when a slant range to a target is r, ta_0 is zero Doppler time and r_0 is the closest approach to the target. So, the effective velocity can be found by the equation above.

$$V_r = \sqrt{\frac{r^2 - {r_0}^2}{(ta - ta_0)^2}} \tag{4}$$

With N ta sample times, ta_1, ta_2, …, ta_N and r_1, r_2, …, r_N N velocity samples, V_{r1}, V_{r2} …, V_{rN} are calculated.

If all of the N velocity samples are very close to V_r then V_r is easily found. But there are two issues need to be considered.

First, if ta_0 is not correct then calculated N velocity samples are not correct. So, V_r cannot be found in this case.

Second, velocity samples calculated near zero Doppler time are mostly to be incorrect. It is because of that values of r and ta are having very small errors and these affect much to the result of the equation (4).

We have got some improvements in calculation of effective velocity as we avoid these two cases.

6. REFERENCES

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