CONFIGURATION, SYNCHRONIZATION AND IMAGING FOR A BISTATIC SAR EXPERIMENT UNDERGOING PREPARING

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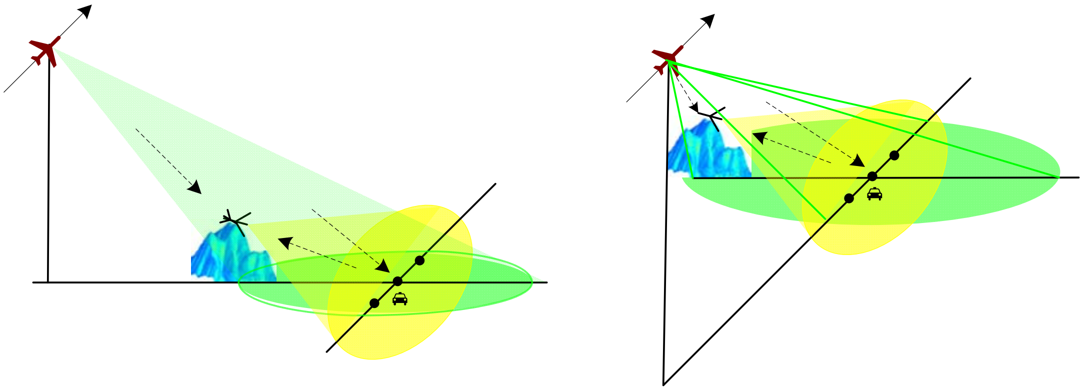
1. INTRODUCTION

Since bistatic SAR became a hotspot in recent years, many bistatic SAR experiments have been carried out in several countries. In China, many researches have been done both on synchronizations and imaging algorithms, but few experiments have been conducted yet. The IECAS has been working on bistatic SAR for several years, and is now preparing a bistatic SAR experiment to testify the related technologies. In this paper, we describe the configurations, synchronization methods and imaging algorithms for the experiment, and give some results gained from laboratory experiment. Besides, some other intentions of this experiment are also addressed.

2. CONFIGURATIONS

To make the first bistatic SAR experiment of IECAS feasible under present conditions, configurations with a stationary receiver are designed. The receiver is planned to be placed on a mountaintop which is nearly *800* m. The transmitter is mounted on an airplane which flies at a *8000* m height. The system works at X-band. The concepts of the configurations are illustrated in Fig.1. First, the transmitter works at a side-look mode. Both transmitter and receiver look from the same side of the scenario and make a bistatic angle about 23^o at the scene center. The transmitter receive echo signal itself, so a monostatic SAR image is available for this configuration. Secondly, the transmitter works at a forward-look mode. According to the result of the authors' former work[1], here the forward-look angle is chosen to be 30^o, which insures a good two-dimensional resolution ability. A relatively flat place is chosen to be the imaging scenario, which makes the imaging a little easier. Some calibration equipments like corner reflectors and sphere reflectors will be placed into the scenario to help the data processing. Some man made vehicles will also be included in the scenario, which are used to test the different characters in bistatic SAR images and monostatic image.



(a) side-look mode (b) Forward-look mode

Fig.1 Bistatic SAR configuration with a stationary receiver

3. SYNCHRONIZATIONS

To make the co-illustration time a little longer, the beam width of the receive antenna is quite big, which guarantees an azimuth width of 1 km. The transmitter can work both in strip or spotlight mode in the side-look case. A real time processor is mounted on the transmitter to generate the monostatic SAR image timely, which helps to provide the illustration information of the transmitter. The receiver will start to work before the mainlobe of the transmitter entering the scenario, so that it will not miss the co-illustration time.

The transmitter and receiver both use a stable oscillator whose nominated frequency is *10* MHz. The stability of the oscillator is $\sigma(\tau = 1s) = 10^{-11}$. According to the measurement in the laboratory, despite the linear phase error caused by a frequency deviation from the nominated frequency, the high order phase terms change over 200^o within *16* seconds. So a single synchronization link is established. The transmitter sends a synchronization pulse to the receiver *800* times per second. The synchronization pulse is a chirp whose bandwidth is *10* MHz and the carrier frequency is *3* GHz (different from the SAR carrier frequency to avoid interference). The SNR of the synchronization channel is better than *10* dB. The receiver has an adequate antenna to receive the synchronization pulse. It then samples the signal and does *12*-bit AD quantification. GPS and SINS are used to measure the trajectory of the transmitter for motion compensation. The phase error is then extracted from the synchronization signal, resampled to the SAR pulse repeat frequency and then used to compensate the phase error of the SAR raw signal before imaging.

This synchronization method has been tested by a laboratory experiment (see Fig.2 and Fig.3). The results show that after synchronization phase error compensation, the residual phase error within 16 seconds is between $\pm 3^o$. The imaging result of the corner reflectors also shows the quality improvement after synchronization phase compensation.

Fig.2 The synchronization unit of the receiver

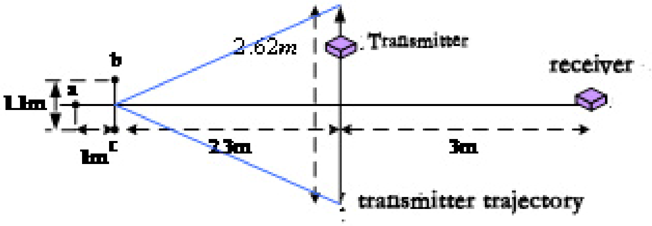


Fig.3 Bistatic SAR configuration of the laboratory experiment

4. IMAGING ALGORITHMS

The imaging algorithms for the side-look mode and the forward-look mode have been addressed in [2] and [1] respectively. Motion compensation and the synchronization phase error compensation is not included in these algorithms, but because of the stationary receiver, motion errors only caused by the moving airplane, so motion compensation is quite like the monostatic case. The synchronization phase error compensation includes the range alignment and the azimuth phase compensation. Once the phase error is obtained through the synchronization signal and interpolated to the SAR PRF, the range alignment can be done through resampling and the azimuth phase error can be directly compensated to the raw echo.

5. CONCLUSION

This paper describes a bistatic SAR experiment which is undergoing preparing. The bistatic configurations are shown and the reasons for choosing these configurations are given. The synchronization methods are addressed and some early laboratory experiment results are exhibited. Finally, the imaging algorithms for both configurations are discussed.

6. REFERENCES

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[2] X. Qiu, D. Hu, C. Ding, "An Improved NLCS Algorithm With Capability Analysis for One-Stationary BiSAR", IEEE Trans. Geosci. Remote Sens., vol.46, no. 8, pp.2224-2232.