AIRSAR Wish List

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Abstract – AIRSAR has served as a test-bed for both imaging radar techniques and radar technologies for over a decade. In fact, the polarimetric, cross-track interferometric, and along-track interferometric radar techniques were all developed using AIRSAR. In this paper, we discuss the improvements and upgrades we would like to pursue if we had the necessary funding and workforce.

I. INTRODUCTION

The NASA/JPL airborne synthetic aperture radar (AIRSAR) system operates in the fully polarimetric mode at P-, L- and C-band simultaneously [1] or in the interferometric mode in both L- and C-band simultaneously. AIRSAR serves as a test-bed for both imaging radar techniques and radar technologies. Over the years, AIRSAR has been modified to collect data in a variety of along-track [2] and cross-track interferometric modes [3], to increase resolution, and to increase location and height accuracy. As a result, AIRSAR has become a very versatile and yet flexible system, allowing our investigators to collect data in a number of experimental modes. In addition, AIRSAR has been utilized to verify new data compression, calibration, and differential GPS techniques, new chirp generator technology, and new analog-to-digital converter (ADC) technology.

In general, we would like to make AIRSAR more modular, more reconfigurable, more capable, and more calibratable while reducing the mass, and power of the system. This would allow us to quickly reconfigure the system to check out different data collection concepts, possibly on different platforms, while pursuing the enabling technologies for future spaceborne SAR missions.

In this paper, we will describe three radar technologies that we would like to pursue that will reduce the complexity, mass, and cost while improving the flexibility and calibration of future SAR instruments. In addition, we will describe two imaging techniques that we would like to pursue. The repeat-pass interferometry mode will serve as a test-bed for future spaceborne SAR missions in disaster and hazard management. The polarimetric interferometry mode, on the other hand, will allow scientists to validate their algorithms on vegetation canopy height retrieval.

II. NEW RADAR TECHNOLOGIES

One of the key objectives of the radar testbed is to explore enabling technologies that will make future spaceborne SAR missions smaller, lighter, and cheaper. In this section, we will discuss the three technologies that we would like to pursue.

First, we would like to build an L-band digital receiver with selectable bandwidth that will reduce the size, mass, and cost while increasing the flexibility and reusability of the receiver subsystem. Instead of the traditional frequency down-conversion with mixers and frequency selection with band-pass filters, we would utilize the high speed analog-to-digital converters to perform direct RF sampling and digital signal processing techniques to perform the frequency selection.

Next, we would like to build a new calibrator with true delay lines that will enable us to calibrate the end-to-end system more accurately. With true delay lines, we should be able to derive the absolute path difference between two radar channels such as the top and bottom antenna channels for cross-track interferometry mode. This would simplify the calibration used in DEM generation and improve the accuracy of the DEM products.

Finally, we would like to build a 1-bit processor to generate interferograms in real-time that will improve the capabilities of future SAR missions in disaster and hazard management. This would allow us to detect changes in near real-time and be able to provide information to the disaster and hazard management agencies much more quickly.

III. NEW IMAGING TECHNIQUES

We would like to add two imaging modes to AIRSAR: the repeat pass interferometry mode and the simultaneous polarimetric interferometry mode. To collect data in repeat-pass interferometry mode requires the ability to repeat the flight path precisely to a fraction of the critical baseline. In L-band, the critical baseline is about 100 m and in P-band the critical baseline is about 300 m. In addition to flight path repeatability, the stability of the baseline is equally critical. This requires the airplane to stay within a narrow tube of 5 to 10 m. This can be achieved by allowing the usage of real-time differential GPS to assist in the navigation of the aircraft.

Also, the repeat-pass lines must be flown with nearly the same attitude as the reference data-take because the Doppler centroids have to agree to a fraction of a beamwidth to have coherence. This can be achieved with a steerable antenna to steer the antenna to, say, zero Doppler for both data-takes.

We have previously collected some data in simultaneous polarimetric interferometry (POLTOP) mode in C-band. However, the data quality was poor and the cross-polarized components were not calibratable due to poor SNR. We have three ideas that we would like to pursue in improving the SNR of the C-band radar in POLTOP mode. This includes the use of low-noise amplifiers and frequency down-conversion to L-band at the antenna back-end to reduce receive path loss, the elimination of the polarization switch to improve the transmit path loss, and the elimination of a couple of antenna transfer switches to improve the transmit/receive path loss.

IV. SUMMARY

In this paper, we outlined three radar technologies that we would like to pursue: the L-band digital receiver concept, a new calibrator with true delay-lines, and a real-time 1-bit SAR processor for interferogram generation. These technologies will pave the way for future SAR missions in reducing the complexity, mass, and cost while improving the flexibility, calibration, and capabilities of SAR instruments. We also described two imaging techniques that we would like to pursue: the repeat-pass interferometry mode and the simultaneous polarimetric interferometry mode. These new modes will allow scientists to validate their algorithms in disaster and hazard management applications and on vegetation canopy height retrieval respectively.

We are in the process of writing proposals in an effort to acquire the funding needed to implement the upgrades. We welcome any new ideas for the utilization of AIRSAR as a radar technology or imaging techniques test-bed and we also welcome financial and technical support in helping us realize our wish list.

REFERENCES

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