PERFORMANCE OF PI-SAR2: X-BAND AIRBORNE POLARIMETRIC AND INTERFEROMETRIC SAR WITH SUB-METER SPATIAL RESOLUTION

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1. INTRODUCTION

The National Institute of Information and Communications Technology (NICT) has been developed the airborne polarimetric and interferometric synthetic aperture radar system, called Pi-SAR, in the X- and L-bands under the collaboration with the Japan Aerospace Exploration Agency (JAXA) for over 10 years[1]. The X-band SAR system of the Pi-SAR has spatial resolution of 1.5m in both of slant-range and azimuth. The spatial resolution is not enough precise to investigate the accessibility in the stricken area by the earthquake. In recent years, moreover, some X-band spaceborne SAR satellites were launched. The spatial resolutions of these spaceborne SARs are more precise than that of the Pi-SAR.

Under these situations, the new X-band airborne SAR system, called the Pi-SAR2, with sub-meter spatial resolution has been developed[2]. In this paper, the system and the performance of the Pi-SAR2 are reported with some data images.

2. PI-SAR2 SYSTEM

The Pi-SAR2 is the X-band airborne synthetic aperture radar (SAR). The maximum bandwidth is 500MHz. The corresponding slant-range resolution becomes 0.3m. The center frequency is 9.65GHz for the bandwidth of 150 and 300MHz, and 9.55GHz for the bandwidth of 500MHz. The transmit pulse is generated by the 12bit D/A converter with generating frequency of 1.6GHz, in the signal generating subsystem. This transmit signal is switched between the vertically and horizontally polarized transmit subsystems with the TWTA and the antenna. The peak power of the transmit signal is 8kW. The transmit subsystems are pressurized by the cabin pressure. The antenna beam widths in azimuth and elevation are about 3 and 35degrees, respectively.

The Pi-SAR2 has three receiving subsystems. Two receiving subsystems are connected to the vertically and horizontally polarized antennas in the main antenna unit for the polarimetric observation. Another receiving subsystem is connected to the vertically polarized antenna in the sub antenna unit for the interferometric observation.

The 8bit A/D converter with the sampling rate of 1.6GHz samples the received signals of each receiving subsystems. The sampled data are recorded to two digital data recorders. The recording rate is 200MB/sec/channel, and the total data rate becomes 600MB/sec. The capacity of the digital recorder is enough to more than 15-hour flight.

The Pi-SAR2 has some capacity for the future option. The 4th receiving subsystem is able to add to the original system. The sub antenna unit has the space for one more antenna. By using these capacities, the Pi-SAR2 is able to obtain the Pol-In-SAR function, the MTI function and so on.

The system control computer controls all subsystems. The computer displays various radar parameters and some navigation information. Operators are able to start/stop of the SAR observation with some navigation information.

The Pi-SAR is composed by two lacks. The signal generating, transmitting, and receiving subsystems are installed in one lack. Another lack includes the digital recorders, the control computer, and the power supply.

3. PI-SAR2 PLATFORM

The Pi-SAR2 is installed to the Gulfstream II airplane. The position and attitude of the platform is detected by the Applanix POSAV system with the GPS receiver. The post-processing of the measured position and attitude data with the ground recorded GPS data generates the orbit information for the synthetic aperture processing.

Both antenna units are installed under the wing. The main and sub antenna units are separated in the cross-track direction; the main and sub antennas are located in the left and right sides, respectively. The baseline length is about 2.5m that is wider than the X-band radar of the Pi-SAR system. The antenna beams of the Pi-SAR2 direct the left side. The antenna beam can be steered. The antenna beam steering in the elevation angle ranges from 40 to 60degrees from the nadir. The antenna beam steering in yaw ranges between ±9degrees. The antenna steering in yaw is not only to cancel the drift angle of the platform, but also to achieve the sliding spotlight function.

4. PI-SAR2 PERFORMANCE

The Pi-SAR2 is able to select the bandwidth as 150, 300, and 500MHz. The corresponding spatial resolutions in slant-range become 1, 0.5, and 0.3m, respectively. To achieve the same spatial resolution in azimuth, the control computer calculates the pulse repetitive frequency using the ground speed. The swath is about 10km for the bandwidth of 500MHz at the altitude of 8000m because of the recording rate. In the case of 150 and 300MHz, the antenna beam width limits the swath.

The minimum noise equivalent radar cross section is designed as -40dB for the 500MHz bandwidth at the altitude of 13000m. The value is still enough for the observation of ocean surface.

5. SUMARRY

The Pi-SAR2 has been under operation since September 2008. Some observation flight has done until now, and the performance of the Pi-SAR2 has been analyzed now. At the conference, some results of performance analysis will be displayed.

6. REFERENCES

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