IGARSS 10

ABSTRACT

"A New SAR Sensor Designed For Micro-Satellites"

by Prof. Dr. Hans Martin Braun

Space-borne Radar Remote Sensing is an important contribution to international environmental monitoring of environmental changes. Started in the 1970th with SEASAT, followed by ERS-1, JERS and SIR-A/B/C – X-SAR and others, the technology was strongly improved over the years and scientists used these sensors more and more for their world-wide investigations. Many Universities are using these data today and more and more even small countries are interested to have their own satellites systems.

University teams and industries in small countries were developing optical Earth Observation payloads during the last decade, however SAR satellite developments were too difficult for them up to now. The main reason is that when small teams are starting developing satellites, they need to start with small and not too difficult projects. This can be done with optical observation payloads because a small camera needs only a small satellite and it provides only a coarse resolution that is not difficult to handle. For a SAR sensor it is totally different. A small SAR (small antenna size) provides a high resolution needing a complex SAR-Processor for image generation. A coarse resolution SAR with a simple SAR-Processor, however, requires a long antenna that needs a big satellite to carry it being too difficult for newcomers in space.

This paper describes a new design of a SAR for a µSAT that overcomes this problem. The centre frequency and the SAR processing was optimized in a way to allow the realization of a simple but capable system that provides many interesting opportunities for researchers and allows to participate to the international environment monitoring activities.

One major point of that design is the decision of a centre frequency in S-Band that allows a certain penetration through vegetation being important for contributing to international activities in environment monitoring over the Brazilian Rainforest; a major activity in today's environmental research. This µSAR is operating with a relative small antenna in length and width matching therefore to the limited capabilities of the µSAT platform. The output power required is easily available and a new SAR processing concept allows a medium swath-width at an acceptable value of ground resolution.

The demand for designing a µSAR is to reach image parameters well suited for scientific investigations and environment monitoring of disasters (e.g. after flooding). The platform of a µSAT has typical dimensions of ≤1m in each axis, a maximum mass of 100kg and a DC-power of 200-300W overall.

In order to reach a swathwidth of 30km being a minimum for valuable scientific research and monitoring of disasters it is necessary to reduce the PRF from 6kHz, required by an antenna of about 3m from a Sampling Theorem point of view, to about 4kHz. In the spectrum of a 6kHz PRF the ambiguities from the neighbouring Doppler domains (PRF-Lines) are significantly down. After reducing the PRF to 4kHz azimuth ambiguities are arising strongly at both sides of the useful Doppler band. In order to overcome this problem, SAR raw data should be filtered and used only over a Doppler bandwidth around the center of each PRF line providing a resolution of 30m instead of the 1.5m, which would be originally feasible with a 3m antenna. This brings the azimuth ambiguity level down again. A 30m resolution is not demanding for attitude control of the µSAT and SAR Processing can be done without being jeopardized by the limited µSAT capabilities. The required bandwidth of 15 MHz is allowed by ITU regulations. Considering a satellite platform with an available DC-Power of 200W for the Radar, approximately 100W can be applied to the SAR power amplifier. With a typical Duty Cycle of 10% this would lead to about 1kW RF-Output Power of the SAR. With this output power a NESZ lower than the value for “mean grass” as defined by Ulaby can be reached and this image quality makes the µSAR a viable contributor to international environment monitoring programs. A patent for this technique is pending.

Biography:

Prof. Dr. Hans Martin Braun started his international carrier in 1976 at the company Dornier System in Germany. He soon became leading system engineer in the European satellite program ERS-1, where he was responsible for the performance of all Radar systems onboard the satellite, as there were SAR, Microwave Scatterometer, and Radar Altimeter. After that, he became chief designer of the German X-SAR cooperating with NASA-JPL’s SIR-C team. After many years in the spaceborne SAR technology, 1992, he founded his own company RST Radar Systemtechnik. Around 2000 he designed the SAR for the German Reconnaissance Satellite Constellation Program “SAR-Lupe” in cooperation with the German Satellite Manufacturer OHB-Systems. Today, he works on the next generation of the German Satellite SAR Constellation and is Professor on Radar Systems at the University of Stuttgart.

Bibliography/References:

[1] Fawwaz T. Ulaby, Richard K. Moore, Adrian K. Fung, Microwave Remote Sensing, vol. 3. Artech House Inc.

[2] Merrill I. Skolnik, Introduction to Radar Systems, Second Edition, McGRAW-HILL

[3] Leopold J. Cantafio, Space-Based Radar Handbook, Artech House Inc.