PROJECT PHARUS: TOWARDS A POLARIMETRIC C-BAND AIRBORNE SAR.

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A few years ago three institutes in The Netherlands developed a plan to design and build a polarimetric C-band aircraft SAR system of a novel design, called PHARUS (PHased Array Universal SAR), meant as a replacement for our current digital SLAR system. These institutes are the Physics and Electronics Laboratory TNO in The Hague, the National Aerospace Laboratory NLR in Amsterdam and the Microwave Laboratory of the Delft University of Technology. This work was done under contract of the National Remote Sensing Board. Currently the PHARUS project is being carried out by the above mentioned institutes, under program management of NIVR (Netherlands Agency for Aerospace Programs) in Delft.

The PHARUS project is divided into a definition phase and a realisation phase. The ultimate goal is the development of an airborne polarimetric SAR system in the C-band (same frequencyband as ERS-1), to be realised in the realisation phase (1991-1993). The dataprocessing for this system requires the development of software tools, that take geometric and radiometric corrections into account, as well as the calibration. This software development is also done in the realisation phase.

In the definition phase three preparatory studies are carried out and the detailed design of the PHARUS is made. These studies are essential for a proper design of the PHARUS. The system will have an active array antenna, reason why a preparatory study on antenna technology is included. Especially the problems of decoupling between the different polarisations and the integrated antenna design (including power and low noise amplifiers) will be studied. An antenna motion compensation study is necessary to build up the experience with corrections of aircraft or rather antenna movements. In the third preparatory study a SAR testbed will be realised in the aircraft that will also carry the PHARUS. The testbed is necessary to study general problems of aircraft SAR and to study the coherent integration processes which in the end determine the sensitivity of the system. Finally the testbed can be used to determine the antenna motions from the radarsignal (via autofocus techniques). The results will be compared with motion measurements taken from other sensors, like gyro's and accelerometers. This forms an important input for the final choice on a motion compensation system.

The PHARUS project is in its first year. This paper focuses on the results reached sofar with the design and realisation of the SAR testbed and the preparatory study on antenna motion compensation. In table 1 some key parameters of the SAR testbed are given. This is a very simple SAR system with a limited range. A single patch antenna is used for transmission and reception. This antenna is fixed to the aircraft. The beam can be steered in coarse steps of 3.5 ° to compensate for the average driftangle. The beamwidth of the antenna is wide enough to eliminate the influence of aircraft yaw. Each element of the array antenna is equipped with its own transistor power amplifier of 10 - 20 Watts.

-frequency	: 5.3 GHz (C-band)
-antenna	: 8-element patch antenna for transm. and rec. beamwidth 9.5 * 24 degr, VV pol. coarse step beamsteering (3.5 °)
-transmitted power	: 80 - 160 Watt peak by 8 transistors
-PRF	: 3500 Hz
-pulsewidth	: 32 ns (4.8 m) after compression 12.8 μs before compression
-digitisation	: 2048 samples I and Q, 8 bits @ 40 MHz
-range	: 6 - 13.7 km
-azimuth presumming	: 16 x
-aircraft	: Swaeringen Metro; used at an altitude of 6 km, and a speed of 100 m/s

Table 1: Properties of the SAR testbed PHARS.

The use of distributed power generation with transistors instead of central TWT (traveling wave tube) power generation will yield a much smaller than usual peak power in both the PHARS testbed and the final PHARUS system. The sensitivity of the system relies on the use of a high PRF (3500 Hz) and a large pulse compression ratio of 400. In the PHARUS system the peak power will be increased to approximately 2 kW.

The digital data that remains after the azimuth presumming with a factor of 16 will be recorded on a high density tape recording system. Apart from the azimuth presumming there is no on board processing for the testbed. By getting down as much data as possible, very flexible experiments are enabled with the system at the cost of long processing times.

The aircraft that is used in the project is a Swaeringen Metro II, a twin engine business plane, owned by NLR and in use as a laboratory aircraft. It will fly the PHARS and the PHARUS at an altitude of 6000 meter with a speed of approximately 100 m/s.

The study on antenna motion compensation includes the development of a simulator for raw SAR data. This computer model can be used to study the effects of aircraft motions on the raw SAR data and the SAR images. Real aircraft motion measurements can be used in the model to degenerate the data from an artificial testscene. These data can then be corrected again to a certain level of accuracy. Finally the image is formed from these corrected numbers and can be compared with the original. This model will play an important role in forthcoming motion compensation studies and experiments.

It is still to early to give detailed specifications for the PHARUS system. They will be fixed during the design phase. The plans are heading for a polarimetric SAR with user selectable values for resolution (3 - 10 meter), swath (near range, far range or wide swath with reduced resolution), polarisations. The frequency will most probably be the same as used for the PHARS: C-band (5.3 GHz).

The final system should be ready by 1994 if the plans can be carried out following the current time schedule.

European Association of Remote Sensing Laboratories

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