COMPARISON OF CENTRALISED AND DISTRIBUTED NOISE INJECTION CALIBRATION METHODS FOR SYNTHETIC APERTURE RADIOMETER

Kimmo Rautiainen, Juha Kainulainen, Martti Hallikainen

Helsinki University of Technology, Department of Radio Science and Engineering
P.O.BOX 3000, FI-02015 TKK, Finland
E-mail: kimmo.rautiainen@tkk.fi

1. ABSTRACT

The use of synthetic aperture technique in passive microwave remote sensing has been successfully demonstrated in recent years with airborne measurements [1] [2] and on-ground test measurements [3]. Aperture synthesis provides means of imaging the target with relatively good geometrical resolution without any mechanical scanning of the antenna structure. Instead of one large antenna a number of small ones are used, each connected to a dedicated radiometer receiver. The outputs of the receivers are connected to the correlator. Every two receivers form a baseline that samples the target at the spatial frequency specified by the physical distance between the two antennas. A two-dimensional image can be reconstructed form the correlated baseline visibilities [4].

The key issue to attain good quality scientific data relies on accurate instrument calibration. This paper concentrates on receiver phase and amplitude calibration, which is a major part of the whole instrument characterization. More specifically the coherent noise injection calibration method is discussed [5]. Main emphasis is placed on a comparison between the distributed and the centralised noise injection.

Eurepean Space Agency's (ESA) SMOS (Soil Moisture and Ocean Salinity) mission will be the first one to launch an aperepean synthesis radiometer in orbit. The payload is called MIRAS (Microwave Imaging Radiometer using Aperture Sythesis) [6]. The MIRAS instrument uses distributed noise injection for the receiver phase and amplitude calibration [7]. Helsinki University of Technology (TKK) has constructed an airborne two-dimensional L-band aperture synthesis radiometer HUT-2D. The HUT-2D calibration technique was designed to support the MIRAS instrument development. Like MIRAS, the HUT-2D receiver calibration relies on coherent noise injection. As an additional option, the operator can select whether to use distributed or centralised calibration. The nominal HUT-2D receiver calibration utilizes only the centralised noise source since it provides more accurate calibration results. For MIRAS the centralised calibration was omitted due to the massive need of coaxial cables. The HUT-2D distributed calibration system was included into its design in order to demonstrate in advance the distributed calibration technique chosen for the MIRAS. The demonstration was successful in the early phase of HUT-2D project.

The HUT-2D instrument has 36 receivers. One centralised calibration noise source provides coherent noise to all the receivers through noise division network. The distributed noise injection uses altogether 9 noise sources, each providing a calibration signal to 8 receivers. An overlap of four receivers is present, thus every receiver can be fed by two different noise sources. Using HUT-2D the experimental comparison of the two noise injection calibration methods is straightforward to conduct.

The final paper will present the results from the comparison. The results are also compared with the simulated ones based on the noise division network characterization measurements with vector network analyzer. The Figure 1 below presents the HUT-2D calibration subsystem in simplified form.

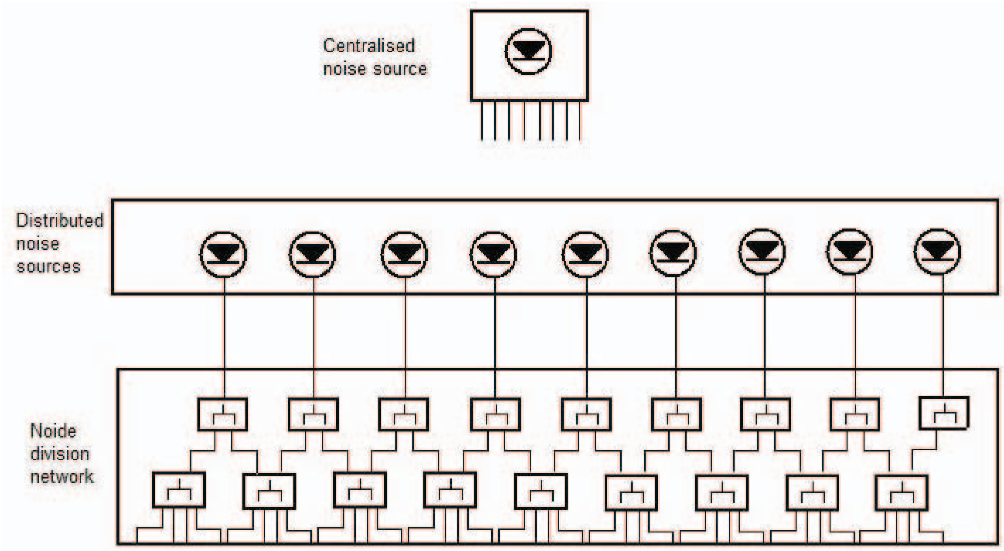

Figure 1. HUT-2D simplified calibration subsystem block diagram. The overlap of four receivers is realized in noise division network with power dividers. The switching block that provides necessary isolation between the noise source inputs and neighboring power divider blocks is left out from the Figure. Centralised noise source has 8 outputs. The outputs are connected to the noise division network bypassing the distributed noise sources.

2. REFERENCES

[1] K. Rautiainen, J. Kainulainen, T. Auer, J. Pihlflyckt, J. Kettunen, M. Hallikainen, "Helsinki University of Technology L-band Airborne Synthetic Aperture Radiometer, " *IEEE Trans. Geoscience Remote Sensing*, Vol. 46, No. 3, pp. 717-726, Mar 2008.

[2] M. Martín-Neira, I. Cabeza, C. Pérez, M. A. Palacios, M. A. Guijarro, S. Ribó, I. Corbella, S. Blanch, F. Torres, N. Duffo, V. González, S. Beraza, A. Camps, M. Vall-llossera, S. Tauriainen, J. Pihlflyckt, J. P. González, F. Martin-Porqueras, "AMIRAS—An Airborne MIRAS Demonstrator," *IEEE Trans. Geoscience Remote Sensing*, Vol. 46, No. 3, pp. 705-716, Mar 2008.

[3] A. B. Tanner, W. J. Wilson, B. H. Lambrigsten, S. J. Dinardo, S. T. Brown, P. P. Kangaslahti, T. C. Gaier, C. S. Ruf, S. M. Gross, B. H. Lim, S. B. Musko, S. A. Rogacki, J. R. Piepmeier, "Initial Results of the Geostationary Synthetic Thinned Array Radiometer (GeoSTAR) Demonstrator Instrument," *IEEE Trans. Geoscience Remote Sensing*, Vol. 45, No. 7, pp 1947-1957, July 2007.

[4] I. Corbella, N. Duffo, M. Vall-Ilossera,A. Camps, F. Torres, "The Visibility Function in Interferometric Aperture Synthesis Radiometry," *IEEE Trans. Geoscience and Remote Sensing*, vol. 42, no. 8, pp. 1677-1682, August 2004.

[5] F. Torres, A. Camps, J. Bará, I. Corbella, R. Ferrero, "On-Board Phase and Modulus Calibration of Large Aperture Synthesis Radiometers: Study Applied to MIRAS," *IEEE Trans. Geoscience Remote Sensing*, vol. 34, no. 4, pp. 1000-1009, July 1996.

[6] K. D. McMullan, M. A. Brown, M. Martín-Neira, W. Rits, S. Ekholm, J. Marti, J. Lemanczyk, "SMOS: The Payload, "*IEEE Trans. Geoscience Remote Sensing*, Vol. 46, No. 3, pp. 594-605, Mar 2008.

[7] I. Corbella, F. Torres, A. Camps, A. Colliander, M. Martín-Neira, S. Ribó, K. Rautiainen, N. Duffo, M. Vall-Ilossera, "MIRAS End-to-End Calibration: Application to SMOS L1 Processor," *IEEE Trans. Geoscience Remote Sensing*, vol. 43, No. 5, pp. 1126-1134, May 2004.