Multi-Channel Radiometer Based on Bandwidth Synthetic to Improve the Sensitivity

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The microwave radiometer is a highly sensitive receiver capable of measuring low levels of microwave radiation. Limited by the interference or the performance of the pre-detection amplifiers, the bandwidth can not be enlarged infinitely to improve the sensitivity for a single channel radiometer. Some multi-channel radiometers are also reported. The scanning multichannel microwave radiometer (SMMR) is conceived in order to provide an instrument capable of obtaining global ocean circulation parameters (P. Gloersen and F. Barath, *IEEE J. Oceanic Eng.*, 2, 2, 172-178, 1977). International Sub Millimeter Airborne Radiometer (ISMAR) is a new passive remote-sensing radiometer which contains a number of heterodyne receivers (S. Fox et al., *MicroRad*, 2014). They are all composed of several single channels operating at different frequency, and every channel is independent of each other. So the bandwidth of these single channels can not be synthesized to improve the radiometer sensitivity. The front-end of polarimetric microwave radiometer is composed of ortho-mode transducer (OMT), multimode horn (MMH) and multichannel (A. J. Gasiewski and D. B. Kunkee, *IEEE Trans. Microw. Theory Tech.*, 41, 767-773, 1993). But the multichannel polarimetric microwave radiometer are designed for getting the polarization information of the target, it can not be used to synthesize a wide bandwidth to improve the radiometer sensitivity. The Synthetic Aperture Radiometer consists of a large number of single channel radiometers (C. S. Ruf et al., *IEEE Trans. Geosci. Remote Sens.*, 26, 5, 597-611, 1988). However, increasing the number of the radiometers is designed for improving the radiometer system's spatial resolution, which can not be used to improve the radiometer sensitivity.

A novel multi-channel bandwidth synthetic radiometer (MCBWSR) is presented based on the principle of bandwidth synthetic. An analysis of the MCBWSR sensitivity is deduced in terms of the conventional single channel radiometer sensitivity, and the sensitivity of the MCBWSR can be improved by $1/\sqrt{n}$ (n is the number of the single channel radiometer contained in the MCBWSR). Verification of this analysis is obtained by experimenting on a direct detection radiometer, a superheterodyne radiometer and a dual-channel bandwidth synthetic radiometer (DCBWSR) receiver and the sensitivities between three of them are compared. Numerical results indicate that the DCBWSR can improves the sensitivity by $1/\sqrt{2}$ of the single channel radiometer. Compared with the conventional radiometers, the MCBWSR can improve the radiometer sensitivity dramatically and the frequency band can also be used effectively. Meanwhile, it has the advantage of higher sensitivity and integration.