ETSBD001 - Imaging with 3-D Aperture Synthesis Radiometers

Abstract

The spatial resolution is still a problem in passive microwave remote sensing, especially in low frequency. In recent years, the satellite formation flying has been proposed. Based on this technique, a large array is able to be synthesized in orbit to achieve higher spatial resolution. However, it is a big challenge for the control system to constrain all the satellites in a coplane in orbit. The 3-D array configuration is a good choice for a synthesized array based on satellite formation flying. In this paper, the complete formulation of visibility functions, including system imperfections, in a 3-D aperture synthesis radiometer (3-D ASR) is derived. The array factor of a 3-D ASR is defined. The reconstructed modified brightness temperature (BT) is a 3-D linear convolution of the modified BT and the array factor. Based on this relationship, the reconstruction method for a practical 3-D ASR is studied. The numerical results demonstrate that the reconstruction method is correct and stable. Finally, a discussion is given to analyze several existing methods that were proposed to reconstruct BT image for 3-D arrays in radio astronomy and earth observation. Compared with these existing methods, our imaging method is more suitable for earth observation based on the technique of satellites formation flying in low earth orbit. In addition, according to the derivations, some mature techniques that were developed for 2-D ASRs may be applied to 3-D ASRs.

Index Terms— 3-D aperture synthesis radiometers (3-D ASRs), array factor, image reconstruction, modified brightness temperature (BT), visibility functions.