11.4 PRINCIPLE AND REAL-DATA APPLICATION RESULTS OF MMSE DOPPLER SPECTRAL PROCESSING

EIICHI YOSHIKAWA[1], NAOYA TAKIZAWA[2], HIROSHI KIKUCHI[2], TOMOAKI MEGA[2], TOMOO USHIO[2]

[1] Japan Aerospace Exploration Agency, Japan
[2] Tokyo Metropolitan University, Japan
yoshikawa.eiichi@jaxa.jp

Our previous research presented that excellent sidelobe reduction capability in phased array digital beam forming is realized by minimum mean square error (MMSE) approach (Yoshikawa et al., 2013) This work applied the MMSE approach to Doppler spectral processing that is governed by the same equation as phased array digital beam forming. The representative approach for adaptive spectral processing is the Capon method (Capon et al., 1969), and the MMSE approach can be understood as one of modified Capon methods. Most of adaptive spectral processing approaches including the Capon method need multiple independent sequences of an analysing signal. In contrast, a remarkable feature of the MMSE approach is that it works with just one sequence of an analysing signal. Since weather radars do not afford to obtain redundant sequences of a received signal for one direction, the MMSE approach is effective to the Doppler spectral processing in weather radars. The MMSE approach was applied to signals actually received by a very fast-scanning phased array weather radar which was developed by our research group. Compared with the normal FFT spectral processing that output ground-clutter contaminated Doppler spectrum, the MMSE approach reduced sidelobes of the ground clutter by 2030 dB, narrowed mainlobe width of the ground clutter to roughly its half size, and revealed precipitation signal buried by the ground-clutter sidelobes. It was, furthermore, shown that the narrowed and sidelobe-reduced ground-clutter signal can be easily removed by a typical Doppler spectral based ground clutter rejection method, and 3D precipitation profile with almost no ground clutter can be retrieved.

References

E. Yoshikawa, T. Ushio, Z. Kawasaki, S. Yoshida, T. Morimoto, F. Mizutani, M. wada, "MMSE Beam Forming on Fast-Scanning Phased Array Weather Radar″, IEEE Trans. Geosci. Remote Sens., vol. 51, no. 5, pp. 30773088, May, 2013.

J. Capon, "High-resolution frequency-wavenumber spectrum analysis″, Proc. IEEE, vol. 57, no. 8, pp. 1408-1418, Aug. 1969.