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Low-altitude Velocity Field Estimation in Doppler Radar

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Doppler weather radar radiates electromagnetic waves into the atmosphere. The waves are reflected by objects such as precipitation particles and buildings, away from the radar and scattered in many directions. Some of them return to the radar and the radar antennas receive the reflected waves. The object is moving under the influence of wind, so phases of received signals are shifted by the Doppler effect. The difference between phase of transmitted and received signal enables to measure velocity of wind around the object, which is Doppler velocity. Precipitation particles in the atmosphere are moving independently by the influence of turbulence, so Doppler velocity measured by multiple of the transmitted wave shows certain distribution. Such distribution is expressed as a function called Doppler spectrum whose independent variable is Doppler velocity and dependent variable is received power.

The most common method of calculating Doppler spectrum is Fast Fourier Transform (FFT) method, but there is a problem in FFT method. In Low-altitude observation influence of clutters such as mountains and buildings increases. In such circumstance spectral side-lobe level is high, and weather signal is buried and cannot be extracted by conventional filtering process. In this research, we proposed Minimum Mean Square Error(MMSE) method as a new method of calculating Doppler spectrum to solve the problem. We verified accuracy of the new method by simulation and presented results of applying this method to observational data. In the result, it was found that MMSE method solved the problem of FFT method and enabled to extract weather signal by reducing side-lobe. Therefore, MMSE method is effective as a spectral calculation method for Low-altitude observation.

Keywords: Doppler Radar, Minimum Mean Square Error, Doppler Spectrum