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A study on suppression of aircraft clutter using range-Doppler walk correction in Ocean Radar

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Conventionally, ocean areas have been observed using ultrasonic wave gauges and GPS wave height measuring system for disaster countermeasures associated with changes of the natural environment. Observations of ocean areas using ultrasonic wave gauges and GPS wave height measuring system are point measurements. Therefore, it is difficult to obtain spatial information on the ocean areas. Ocean radar is used in research for tsunami forecasting, ocean surface current velocities and other oceanographic observations, because it can obtain a spatial information of the ocean area. Ocean radar can obtain information on surface currents and ocean waves through first and second order scattering, which can be observed using the Bragg scattering resonance mechanism. If an aircraft intrudes into the radar coverage area during oceanographic observations, it is observed as aircraft clutter, which degrades the SINR of the first and second order scattering. Compared to change in the velocity of surface currents and ocean waves, change in the velocity of aircraft are larger and therefore observed as signals with different properties. Specifically, on the range-Doppler map, aircraft signals have a property of spreading in the Doppler direction compared to surface currents and ocean waves [1]. Aircraft clutter is observed as spread signal in the Doppler direction and is therefore difficult to suppress using signal processing of suppress specific Doppler frequencies. Applying range Doppler walk correction to adjust aircraft velocity and acceleration suppresses the spread of the aircraft clutter and superimposes the signal on the specific range Doppler cells. As a result, it is easier to suppress aircraft clutter and improve the SINR of surface currents and ocean waves.

Fig1(a) shows the location of the ocean radar used in this research, and Fig1(b) and Fig1(c) show the transmitting and receiving antennas of the radar. The ocean radar is installed on the roof of Niigata University. It is about 1 km from the sea. The transmit antenna is a 45◦ tilted 3-element Yagi-Uda array. The received 4-element array is vertical and horizontal 2-element Yagi-Uda array. Then, the receiver has 8 channels and can simultaneously acquire observation data for 4 vertically polarized and 4 horizontally polarized waves. In this paper, we confirm the suppression effect of aircraft clutter by applying the range-Doppler walk correction to data obtained by the oceanic radar. As a result, it was confirmed that surface current and ocean wave signals can be observed significantly by suppressing the aircraft clutter.

(a)Installation Position (b) Transmitting Antenna (c) Receiving Antenna

Fig 1. Ocean Radar

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References

[1] A. Dzvonkovskaya, et al., “Fast-moving target observation using high-frequency surface wave radar,” 2014 International Radar Conference, 2014.