

A Study on the Application of Passive Radar Technology to the Measurement of Ocean Surface Velocities by Ocean Radar Systems

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This paper discusses the application of passive radar technology to a marine radar system for measuring ocean surface currents.

While conventional radar measures the distance between the radar and the target, passive radar, which consists of an external transmitter and receiver, measures the time difference between the direct wave and the scattered wave by the target. Therefore, the distance resolution varies depending on the positional relationship between the target and the transmitter source and receiver. In particular, the closer to the line connecting the transmitter source and receiver, the worse the distance resolution becomes.

The Doppler velocity measured by the passive radar is the target moving velocity component in the direction intermediate to the target direction viewed from the transmission source and receiver, multiplied by a factor determined by the crossing angle between them. When the crossing angle is small (the transmitting and receiving target directions are close to the same direction), the coefficient is close to 1, but as the crossing angle increases (the transmitting and receiving target directions are close to opposite directions), the coefficient approaches 0. Therefore, the ability to measure velocity decreases the closer one gets to the line connecting the transmitter source and receiver.

When a passive radar is used as a marine radar, the strongest contribution to the signal to the receiver is considered to come from scattering by ocean waves that have the same angle of incidence and angle of reflection and where the difference in the propagation length of the scattered waves due to ocean waves shifted by one wavelength is equal to the radio wave length, satisfying the Bragg resonance condition. In this case, the closer to the line connecting the transmitter source and receiver, the longer the ocean wave wavelengths contributing to scattering become and the larger the phase velocity. On the other hand, the actual measured Doppler velocity is smaller in this region because the velocity measurement capability of the passive radar is degraded.

Thus, in ocean surface velocity measurement using a passive radar, the velocity measurement capability varies depending on the measurement region. In particular, in areas close to the line connecting the transmitter source and receiver, the resolution and velocity measurement capability deteriorate significantly, making effective measurement difficult.

Since one radar can only measure the velocity component in one direction, two or more radars are required to measure the ocean surface currents as a two-dimensional vector; when calculating the current vector from the two directional components, the accuracy of the current vector measurement is higher when the crossing angle of the directional components is close to 90 degrees.

For flow velocity vector measurements using passive radar, there are two possible systems: a system that uses an ordinary radar as a transmitting source combined with a passive radar using one receiver (bistatic radar) and a system that combines a transmitting source and two passive radars using two receivers (passive radar).

In the case of bistatic radar, the crossing angle of the two measured directional components cannot be increased, and the measurement area by the passive radar is limited to a region close to the line connecting the transmitter source and receiver, making it impossible to increase the flow velocity measurement capability and making it unsuitable for practical use.

When using two passive radars, the position of the transmission source can be freely selected because the

crossing angle of the two directional components to be measured is determined by the positional relationship between the two receivers. Therefore, it is possible to measure ocean surface currents with high accuracy by installing the two receivers so that the area to be measured is in the opposite direction of the transmission source.

Keywords: Ocean Surface Velocities, Passive Radar Technology, Ocean Surface Radar