Extraction of Optimum Classification Angle Using Arch-range Measured Data for Scale-model Targets

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Radar cross section (RCS) is a function of various parameters such as frequency, directions of incidence and scattering, and polarization. Depending on the transmitter and receiver positions, the RCS is classified as monostatic or bistatic. When the transmitter and the receiver positions are the identical (i.e., monostatic radar), the directions of incidence and scattering are identical, and the resulting RCS values are called monostatic RCS. However, when the transmitter and receiver positions are different (i.e., bistatic radar), the directions of incidence and scattering are different, and the resulting RCS values are called bistatic RCS. The concept of bistatic radar is not new; in fact, the earliest radars were of this type. In recent times, bistatic radars have again attracted interest because they can be used to detect stealth targets. Bistatic radar have a counter-stealth capability, since target shaping to reduce target monostatic RCS will in general not reduce the bistatic RCS.

RCS contains useful information for target recognition, such as scattering centers and natural resonance frequencies. The scattering centers on the target are related to the early-time response and natural resonance frequencies of the target are related to the late-time response. The early-time response occurs while the field passes across the target, whereas the late-time response occurs after the field completely passes across the target. The scattering centers and natural resonance frequencies are used as feature vectors for radar target recognition. We use time-frequency transforms to extract these feature vectors simultaneously.

In this paper, we measured the bistatic RCS of three different 1:32 scale-model targets at MSU (Michigan State University) arch-range measurement system while changing the receiver positions of 30°, 60°, 90°, and we extracted feature vectors using short time Fourier transform (STFT) and continuous wavelet transform (CWT), both of which are time-frequency analysis methods. The original dimension of STFT and CWT feature vectors is 100 x 100. In order to use these feature vectors as neural network input, we compressed the feature vector dimension as 8 x 8. Then, a multilayered perceptron (MLP) neural network was used as a classifier.

Using this process, the receiver position having the best classification performance was found by comparing the calculated classification probabilities. Consequently, we can decide where the transmitter and receiver should be located in the bistatic radar when the targets and feature extraction techniques are determined.