The antenna pattern calibration of a phased-array high-frequency radar system

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A linear phased-array HF radar system consisting of 16 Rx antenna elements operated at a central frequency of 26.39 MHz was installed on the Guanyin District's shoreline, Taoyuan City, Taiwan, in February 2022. This system monitors ocean surface parameters such as surface currents, waves, and winds, which are relevant to ocean surface dynamics in the Taiwan Strait. Typically, those parameters are estimated from the Doppler-Range spectrum, the level 1 product of the HF radar system, which is extracted using beamforming methods with the input of the Rx antenna pattern. However, due to the error of installing the received antenna cable, the practical antenna pattern would not exactly be like the original design, which could influence the output spectrum. Therefore, it is necessary to determine the actual pattern of the receiving antenna system.

Regarding radar pattern assessment, a field experiment was carried out. Accordingly, an additional transmitter was deployed on a boat and transmitted a continuously constant signal when the boat moved on an arc-shaped orbit with a fixed radius from the radar station, while the traditional radar transmitter was turned off. This study represents a calibration method for the receive antenna of a coastal HF radar system. Initially, the theoretical pattern is used to estimate emitter directions and compared to the target values for assessing the radar installation performance. Then, a matrix calibration method is applied to estimate the antenna phase and gain adjustment values. The estimation results will be further discussed. Finally, the antenna phase adjustment results will be added to correct the pattern of the Rx antenna array.

Keywords:phased-array HF wave radar system, the antenna pattern, the matrix calibration method