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TCR backscattering characterization for microwave remote sensing

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A Trihedral Corner Reflector (TCR) is formed by three mutually orthogonal metal plates of various shapes and is a very important scattering structure since it exhibits a high monostatic Radar Cross Section (RCS) over a wide angular range. Moreover it is a handy passive device with low manufacturing costs and robust geometric construction, the maintenance of its efficiency is not difficult and expensive, and it can be used in all weather conditions (i.e. fog, rain, smoke, and dusty environment). These characteristics make it suitable as reference target and radar enhancement device for satellite- and ground-based microwave remote sensing techniques. For instance, TCRs have been recently employed to improve the signal-to-noise ratio of the backscattered signal in the case of urban ground deformation monitoring [1] and dynamic survey of civil infrastructures without natural corners as the Musmeci bridge in Basilicata, Italy [2].

The region of interest for the calculation of TCR's monostatic RCS is here confined to the first quadrant containing the boresight direction. The backscattering term is presented in closed form by evaluating the far-field scattering integral involving the contributions related to the direct illumination and the internal bouncing mechanisms. The Geometrical Optics (GO) laws allow one to determine the field incident on each TCR plate and the patch (integration domain) illuminated by it, thus enabling the use of a Physical Optics (PO) approximation for the corresponding surface current densities to consider for integration on each patch. Accordingly, five contributions are associated to each TCR plate: one contribution is due to the direct illumination of the whole internal surface; two contributions originate by the impinging rays that are simply reflected by the other two internal surfaces; and two contributions are related to the impinging rays that undergo two internal reflections. It is useful to note that the six contributions due to the doubly reflected rays define the leading term in the angular region around the boresight direction.

The validity of the approach is well assessed by comparisons with experimental results, and its formulation is computer time inexpensive since in closed form. Moreover it is preferable to the model using near-field PO integrations for describing the interactions between the internal TCR's faces since this last requires the evaluation of multi-dimensional integrals, i.e. the expression of the final incident field contains a two-dimensional integral for each previous interaction.

[1] Y. Qin, D. Perissin, and L. Lei, "The Design and Experiments on Corner Reflectors for Urban Ground Deformation Monitoring in Hong Kong," Int. J. Antennas Propagat., vol. 2013, pp. 1-8.

[2] T. A. Stabile, A. Perrone, M. R. Gallipoli, R. Ditommaso, and F. C. Ponzo, "Dynamic Survey of the Musmeci Bridge by Joint Application of Ground-Based Microwave Radar Interferometry and Ambient Noise Standard Spectral Ratio Techniques," IEEE Geosci. Remote Sens. Lett., vol. 10, no. 4, pp. 870–874, 2013.