Interaction Notes

Note 609

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Use of Crosspol to Suppress Early-Time Scattered Signal

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Abstract

This paper considers an alternate technique for suppressing early-time scattering signals by use of crosspol techniques, so as better to bring out late-time target resonances.

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1. Introduction

Recent papers [1, 2] have explored some techniques for suppressing early-time scattering from scatterers in the presence of targets of interest which one wishes to detect and identify. An example of such a scatterer is the human body in the presence of some weapon of interest.

The basic approach involves discriminating between angle-independent backscattering (backscattered field parallel/antiparallel to the incident field), and scattering characterized by target orientation, i.e., scattering natural modes linearly polarized based on target orientation instead of incident field. The foregoing papers [1, 2] accomplish this by differencing the returns from two orthogonal incident polarizations to approximately remove any aspect-independent scattering. This involves using delay lines and an inverter to obtain two returns, time-shifted from each other for subsequent analog differencing of the two returns. When one of the channel polarizations is aligned parallel to the target-natural-mode linear scattering, a maximum target return is obtained. The analog differencing is important so that the digital recording of the late-time target signal has more dynamic range (not diminished by the large early-time signal).

This paper discusses an alternate technique. This involves transmitting in a single linear polarization and receiving orthogonal to this polarization, i.e., looking at crosspol.

2. Use of Crosspol to Suppress Early-Time Scattered Signal

See [1 (Section 2)]. Here various cases of early-time scattering are considered which give a leading polarization-independent term. These include flat plates facing the radar as well as convex curved surfaces (as long as the materials are isotropic). We can use this property in which the scattered field is linearly polarized parallel/antiparallel to the incident field. Let us not receive this polarization; look at the crosspol.

As in Fig. 2.1, look at a linearly polarized target (such as a rod) in front of a flat (or even convex) surface. In this case, let us choose a horizontally (h) incident electric field. If the target is oriented at an angle ψ with respect to the h axis, the component of the electric field parallel to the target scattering at angle ψ has a component proportional to cos (ψ) in the receiving (v) channel, giving a transfer function proportional to

$$T = \cos(\psi)\sin(\psi) = \frac{1}{2}\sin(2\psi) \tag{2.1}$$

As we can see from this formula |T| is maximized with

$$\psi = [2n+1]\frac{\pi}{4} \quad \left(\text{or } [2n+1]45^\circ\right)$$
$$n = 1,2,3,4 \tag{2.2}$$
$$|T| = \frac{1}{2}$$

By rotating the radar antenna(s) with *h* transmitting and v receiving we can maximize the crosspol signal as in (2.2), while being insensitive to the large copol signal from the nearby scatterer.

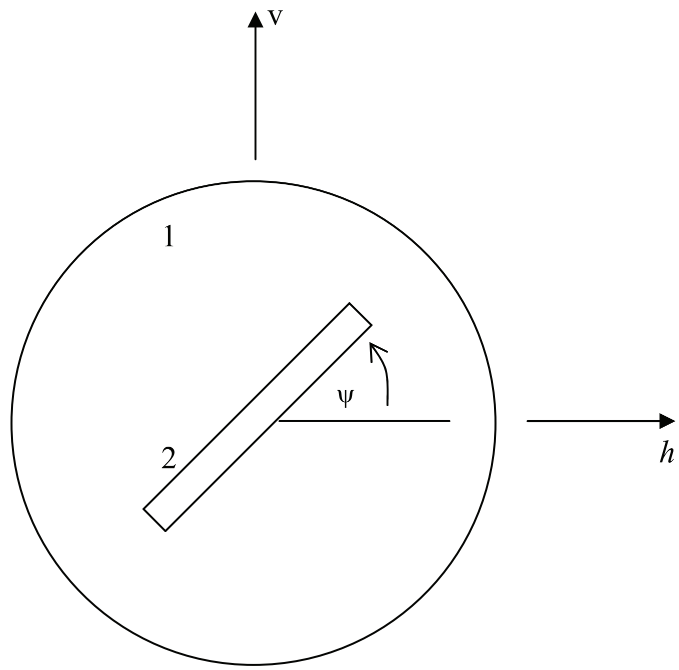
Here we see one disadvantage of the technique, namely the maximum |T| of 0.5. This is compared to the maximum for the 2-channel technique of 1.0. This is twice the scattering amplitude or four times the power (relative to the scattering from the nearby scatterer). On the other hand, the present technique is simpler, involving less equipment.

3. Concluding Remarks

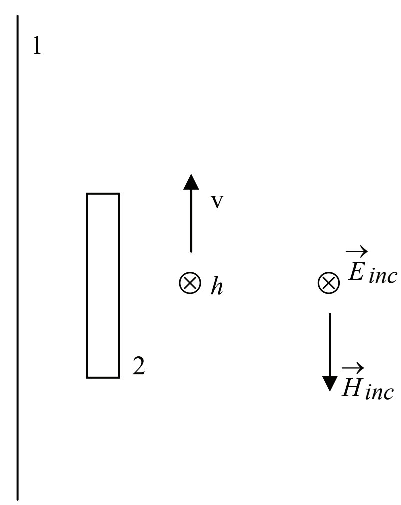
This alternate approach is simpler but perhaps less sensitive. In both cases, we need to consider the rotation of the radar polarization(s) about the propagation axis, so as to maximize the signal scattered from the target. One can envision mechanical (rotation) techniques as well as electronic techniques involving electronic combinations of *h* and v channels. A simpler technique involves two radars with the *h* channel polarization differing by 45° between the two radars, each radar operating independently so as to interrogate the target at different times. A similar technique also applies to the two-channel systems [1,2].

References

1. C. E. Baum, "Polarimetric suppression of Early-Time Scattering for Late-Time Target Identification", Interaction Note 599, December 2005.
2. C. E. Baum, "Various Linear Combinations of Polarimetric Channels for Suppression of Early-Time Scattering Signals", Interaction Note 600, December 2005.



A. Front



B. Side

Fig. 2.1 Linearly Polarized Target in Front of a Polarization-Independent Scatterer.