DESCRIBING TARGETS USING THE FULL-POLARIMETRIC SCATTERING SPECTRUM

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In radar polarimetry, having an invariant target characterization parameter is critical because it can identify a target under varying basis sets and orientation conditions. This target characterization technique can be classified into two categories: a) utilizing coherent scattering information and b) utilizing incoherent scattering information. Huynen [1] introduced a notable phenomenological concept of radar target characterization, where he employed six distinct target parameters to describe radar targets comprehensively.

To address the challenge of global variance, Cloude and Pottier proposed the eigendecomposition of the coherency matrix [2]. While α, a parameter derived from this method, can distinguish between certain canonical targets, it struggles to differentiate between all target types, such as dihedral and helical targets. To overcome this limitation, Corr and Rodrigues [3] devised an ingenious approach. They projected the scattering matrix onto a sphere and left- and right-handed helix bases, effectively eliminating ambiguity when distinguishing between dihedral and helical targets. Subsequently, Touzi [4] proposed an alternative scattering vector model by projecting the Kennaugh-Huynen scattering matrix con-diagonalization into the Pauli basis. This approach effectively addressed the limitations of the scattering-type parameter α.

Later, Dey et al. [5, 6] presented θ_{FP} as a new target characterization parameter in the linear H—V basis. Similar to α, this roll-invariant parameter offers good target characterization capabilities. However, it also fails to discriminate between a helix or dihedral scattering. Later, Dey et al. [7] analyze the complete spectrum of θ_{FP} by projecting the incoherent coherency matrix onto several scattering mechanism bases. This study categorized several landcover classes using the θ_{FP} spectrum.

We have shown the polarimetric spectrum over several scattering targets in this section. We conducted 1000 simulated random realizations of the normalized scattering configuration $\vec{\omega}_n$ to get the spectrum. The median value of θ_{FP}^p was then calculated as the average over 20 iterations. Additionally, we compared the average scattering-type parameter $\overline{\alpha}$ [2]. The expression used in this work is $\widehat{\alpha} = 45 - \overline{\alpha}$. As a result, $\widehat{\alpha}$ likewise varies from -45 to 45, much as θ_{FP}^p.

We employed C-band Full Polarimetric (FP) AIRSAR data over San Francisco (SF), USA. Following this, we have utilized the unsupervised clustering technique, i.e., K-means clustering to cluster the complete image into three different landcover targets; Urban (U), Waterbody (W) and Vegetation (V). Google Earth is used to create the ground truth data.

We have compared the accuracy score of θ_{FP}^p spectrum with $\theta_{\text{FP}}^{(1)}$, $\theta_{\text{FP}}^{(2)}$ and $\theta_{\text{FP}}^{(3)}$. These three scattering mechanisms are obtained from the elements of the three rank-1 coherency matrices following eigendecomposition. We observed an overall accuracy of around 51% for $\theta_{\text{FP}}^{(1)}$, $\theta_{\text{FP}}^{(2)}$ and $\theta_{\text{FP}}^{(3)}$ and, around 79% for θ_{FP}^p spectrum. A high confusion occurs between waterbody and vegetation and also between urban and vegetation for $\theta_{\text{FP}}^{(1)}$, $\theta_{\text{FP}}^{(2)}$ and $\theta_{\text{FP}}^{(3)}$ due to which low User's Accuracy (UA) and Producer's Accuracy (PA) is observed. It is observed that distinct clusters exist for waterbody, vegetation, and urban areas using the θ_{FP}^p spectrum. Therefore, according to the classification findings, the θ_{FP} spectrum outperforms the eigen-polarization states. With this method, many scattering targets can be distinguished from one another while only requiring one physical parameter, θ_{FP}, as opposed to multiple statistical and physical parameters, such as $\overline{\alpha}$ and entropy.

1. REFERENCES

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