Review of Le et al. JSTARS-2014-00192

General

This paper presents a new single parameter to describe polarimetric SAR imagery: the determinant of the scattering matrix. Citing Goodman's 1963 result, they show that the determinant is chi-squared distributed, with degrees of freedom related to the number of looks in the imagery. The authors do not show that this parameter is any better than others, such as span, except in the sense that its pdf is defined completely, not just asymptotically.   They also do not acknowledge that much of the useful information in a polarimetric image is in the relationship between the terms of the scattering matrix, and therefore the scalar parameters they discount contain information lost in the determinant. Other parameters they present, ratios of covariance determinant to theoretical values, or to other experimental values are ill-defined in how to put them to practical use. No comparisons with established procedures are made.

The paper is full of mathematical errors, typos and notational inconsistencies.

If it is to be published at all, much more effort needs to be put into demonstrating the utility of the new work, and showing how it compares to conventional classification discriminators.

Detail

P1, col1, para2: The authors state without citation that existing models are 'complex and unintuitive'. This statement needs validation, or it is just an opinion and should be noted as such. Since it forms the rationale for the entire paper, more justification is needed.

P2, c1, l36-52: text is a bit misleading, It says that 1) – 7) are statistical models, not parameters for which models have been proposed. p, q,r, s need to be defined.

P2,c1, l56-60: have been shown by whom? Citation required, or is this the authors' opinion?

P3, c1,l10-15: While it may be nice for mathematical purity to have an exact distribution instead of an asymptotic one, it should be demonstrated that the asymptotic assumption is invalid for POLSAR data. Ultimately, it needs to be shown that better separation of regions may be obtained using the proposed distribution than with existing methods.

P3, c1, l25: Incorrect nomenclature. Single pol transmit, dual pol receive is 'compact polarimetry'. Partially polarized signals contain both polarized and unpolarised power

P3, c2, eqns 16,17: Confusing notation or a typo? These are χ^2 distributions. Is the exponent missing in the equations so that the χ in the equations is really χ^2, with 2L-2i degrees of freedom, or did the exponent get dragged in to the dof, so that there are really only L-I degrees of freedom?

P3, c2, l43-48: This paragraph is a circular argument. SAR speckle noise is multiplicative, You use Goodman's results (eqn 16) to capture this, and eqn 19, as a direct result from 16 also does. It is not an implication. Note that eqns 18 and 19 break down for L<d, i.e. for single look imagery.

P3, C2, eqn 20: Why would the underlying covariance ever be known a priori? It is what we are trying to estimate.

P4, c1, eqn 21: For this equation to work, regions must be known to be homogeneous. Almost no natural regions are, i.e. their variance is caused by both natural variability and statistical variability. Anfinsen's work (your ref 16) shows this fact clearly. Consequently, this parameter, while formally satisfying, may be useless in practice.

P4, c1,eqn 23: is wrong. With numerator and denominator the same, it has fixed values of Rc=1,2,6 for d=1,2,3

P4, c1, l28-38: 1-D SAR is not 3-D SAR collapsed. Single pol is a single component of compact or full pol SAR

P4, c1, last eqn: You did not set d=1 here.

P4, c2, top eqn: Very confusing notation. Without clarification, I cannot figure out how the succeeding results are calculated.

P5, c1, l40: A Radarsat2 image of what?

P5, c1,l45: Multi-looked how? By boxcar averaging on a 3x3?

P5, c1, l48-60. Anfinsen's ENL technique (which one did you use? There are more than one in that paper.) is a good estimator of the heterogeneity of natural regions, but only under exceptional circumstances does it generate an L value in the sense required here. His ENL is, in general, non-integer. How did you deal with that? Why did you not use the formal L values from the imagery (1, 4 or 9)?

How did you determine that the regions you chose were truly homogeneous? How did you determine the theoretical determinant for the ratio test? Which other region was selected for the change test?

P6-7, sect VII. You used Anfinsen's ENL to compute the L value required to make the data appear homogeneous. It should result in an ENL image that is instructive. The ENL value should vary around the image, although the actual number of looks does not. Consequently, your noise images show no structure, because all the variance structure has been extracted in the ENL computation.