Overview

In this paper, the authors pitched several scalar random variables (such as **R, L, D,** and **C**, **p.11-12**) that were intended to act as the statistical models representative of polarimetric SAR (POLSAR) covariance matrices. The majority of this paper was spent to derive the statistics of these proposed random variables. The whole idea throughout this paper is to introduce them as the better, representative statistical models that will form the foundation for a variety of POLSAR applications. However, the scope of this work is actually much narrower. It was indeed summarized in the first sentence of the abstract: "several novel scalar statistical models to present the determinant of … covariance matrices". Basically it is the distribution of the determinant of sample covariance matrices that is involved, which is a random variable and was studied previously by Goodman in [14]. I don't think those can be taken as (new) statistical models of POLSAR covariance matrices. My other concern is that, having all the statistics defined, the paper stops short to demonstrate how they are going to be used. Nevertheless, as the authors have correctly stated, many of the dissimilarity measures involve the determinant. I think the authors can instead focus on the benefit of using those statistics to quantify the classification performance. So I encourage the authors redo this paper. A major revision is also needed to strength the validation part and streamline the development – having too many trivial equations makes people easily lost in grasping the main ideas.

Comments

Title and Introduction – The title is overstating and the introduction describes some twisted concepts. What was developed is actually a measure, which is defined over an assumed statistical model – in this case complex Wishart. As a measure, of course it is scalar, but being scalar is not important. The way those "statistical models" were presented has nothing to do with being "representative". The "statistical models" over the variables from II.A.1) – II.A.7) were not developed to address the challenge "that is there now exists not one but many observable quantities". Remember in addition to complex Wishart there are many more statistical models for POLSAR data. Using Wishart leads to the determinant statistics shown in this paper. If one quantity say cross-pol intensity is of the interest, for example to derive biomass, one can proceed to derive the statistics over cross-pol intensity.

Eq.(3) is misleading – it is not a distance between two classes Cx and Cy. It is a relative distance from a sample Cx to several classes.

Equations and Derivation – The majority of the derivation is to develop the log-statistics of chi-squared distribution. However, this has been widely referred in the literature, for example the log-moments of gamma distribution. Also, a much elegant method, MoLC, has been developed based on Mellin transformation (Nicolas and Anfinsen, http://eo.uit.no/publications/JMN-TRANS-10.pdf). Also see Anfinsen and Eltoft (TGRS 2011) for more references.

III.C "Consistent Measures of Distance" – How is this "consistent" defined?

V. "Validating the Proposed Models" – Visual comparison of the histograms is not sufficient to vigorously validate statistical models. For example, Fig.1 can simply point to a failed description. Consider using hypothesis test.

VI. "Discussion" – Fig.8 doesn't show anything that is a particular strength of the developed statistics. Other advertised directions are unfounded. Need further support – and this section should be the main focus.

"Complemented with target decomposition techniques" (**p.25**) – It is a comparison of apple and oranges. Target decomposition is a completely different thing.