NASoftware Limited
Incorporating InfoSAR

Optimal Retrieval Algorithms for Polarimetric Images

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Polarimetric imagery is now becoming increasingly available; and as with other forms of SAR imagery, there are substantial gains to be made by using optimised retrieval algorithms.

A) Test Data

1. We illustrate this first using simulated data. Figure 1 shows a test pattern containing seven classes representing ground truth. We next simulate complex polarised images (HH, HV, VV) using typical polarisation properties for agricultural land.

The aim of the study is to classify this simulated data into the original seven classes using a variety of filter methods and polarisation measures.

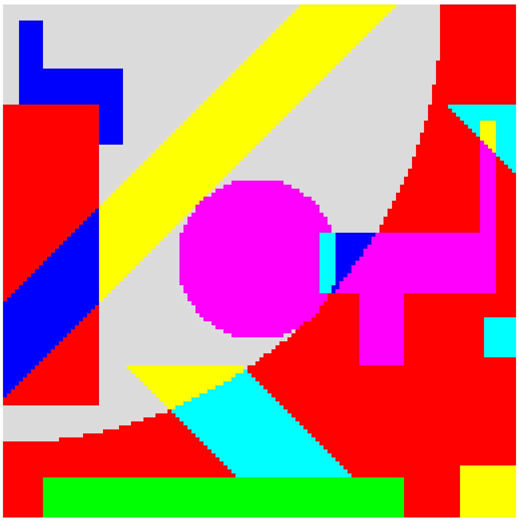
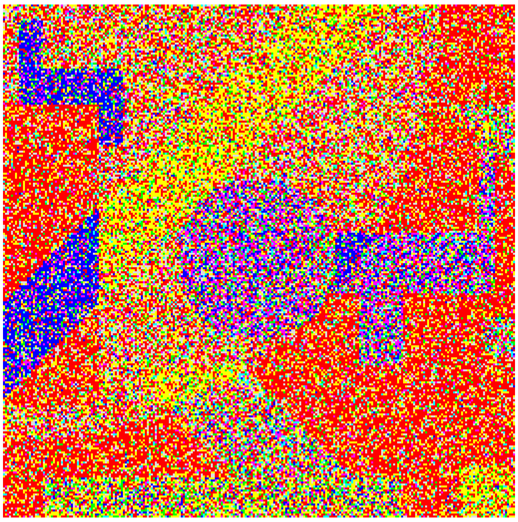
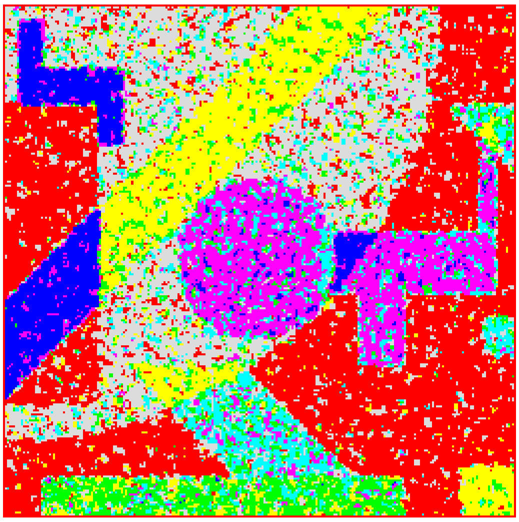


Fig. 1

Some results are shown below.

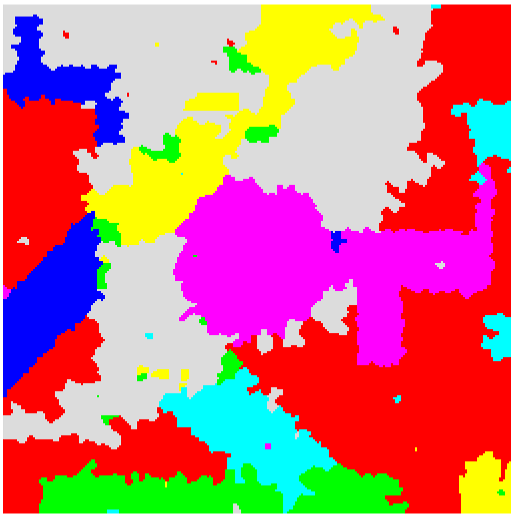


a) Initially we show the result of attempting to classify single pixels. The very broken pattern, caused by speckle noise, together with a low probability of correct classification (31.9%), indicate that some form of data averaging is essential.

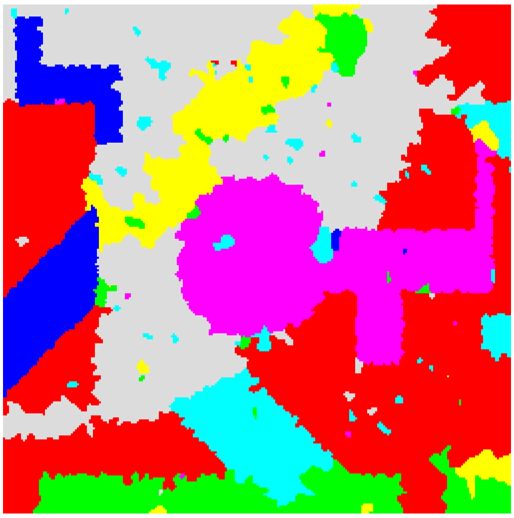


(b) Next we average the complex polarised data over a 3x3 window before classification. This clearly reduces the statistical error caused by speckle leading to the improved classification probability of 68.9%.

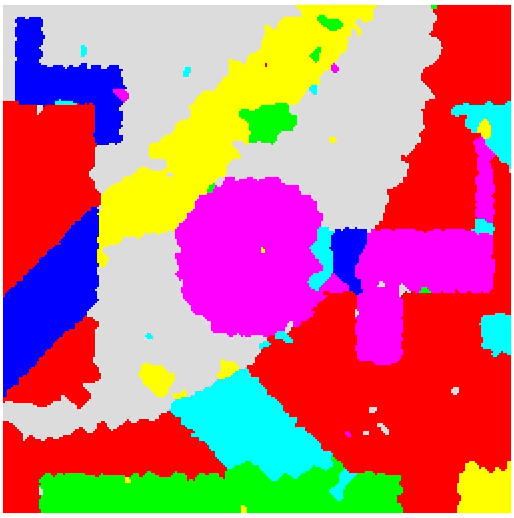
Next we investigate applying classification after an adaptive filter is applied to the data, in the form of segmentation. This offers the advantage of reducing speckle noise by averaging over homogeneous segments. A variety of polarisation measures can be used in segmentation.



(c) The span measure comprises the sum of the intensities in each polarisation. When this is evaluated over a 3x3 window and then segmented the correct classification probability rises to 85.1%



(d) Further improvement is observed when the determinant is evaluated over the 3x3 window and then segmented. The probability of correct classification rises to 89.2%.



(e) The probability of correct classification again rises, to 93.8%, when the three eigenvalues over the 3x3 window are jointly segmented.

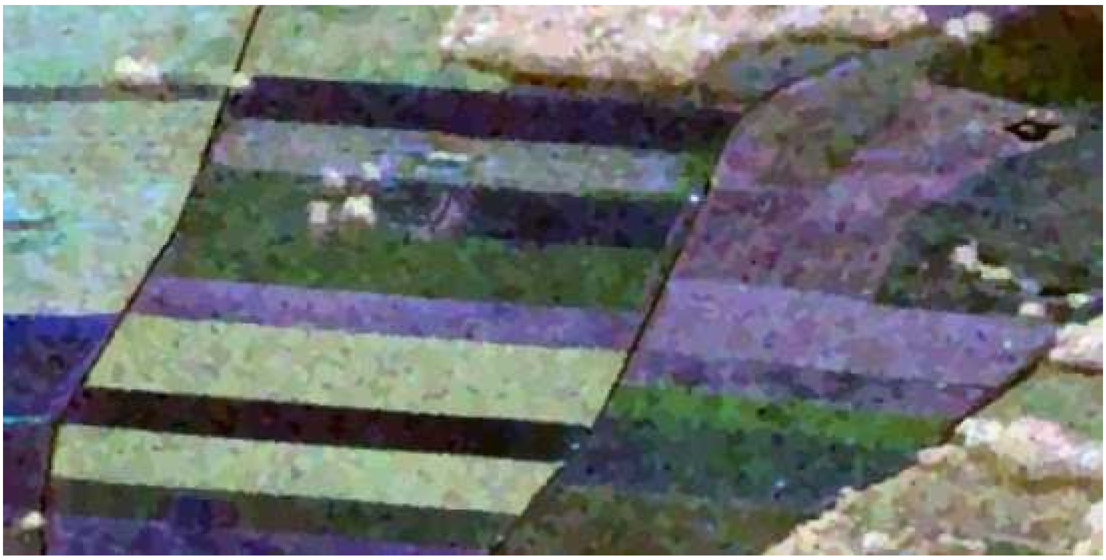
(f) Finally, full complex polarisation segmentation over individual pixels leads to a correct classification probability of 93.0%. This is slightly worse than the results for the 3x3 window since smaller segments are possible, with increased error. The test pattern does not contain small regions, which biases the performance towards methods that do not allow small segments.

B) ESAR Data

Figure 3 shows a false colour polarisation image from the DLR ESAR system where the components HH, HV and VV are applied to red, green and blue respectively. Supervised classification is not possible since there is no ground truth. However, we illustrate the comparative performance of different polarisation segmentation methods in the following images. Improvement in the definition of field boundaries indicates the increased sensitivity obtained with (c) joint eigenvalue segmentation or (d) full polarimetric segmentation, as noted earlier.

Fig. 3

(a) 3x3 span



(b) 3x3 determinant

(c) Eigenvalues over 3x3 window

(d) Optimised polarimetric algorithm

Reference:

P. Lombardo, C.J. Oliver, Optimum Polarimetric Segmentation for the Classification of Agricultural Areas, EUSAR 2002, Koeln, Germany, June 2002.