

Adaptive Parametric Estimation and Classification of Remotely Sensed Imagery Using a Pyramid Structure

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Abstract

The earth resources observation satellites acquire imagery at high spatial and temporal resolution, thereby providing a huge number of data points to be analyzed. The analysis of large areas over a long time span is necessary in many applications. Therefore, a reduction in the number of operations performed on each high resolution image is required, particularly if real time results are desired or if the computing resources are limited. Often it is desired to segment and classify the regions of an image. The operations required by many segmentation algorithms are extremely memory and computationally intensive.

If the objects or regions of interest are relatively large compared to the pixel size, then the probability of groups of contiguous pixels being in the same class is much greater than the probability being in different classes. For large homogeneous interior regions, it may not necessary to classify all the individual pixels to identify the class label of that regions. For boundary regions between two or more classes, however, more pixels are needed to identify the exact boundary. By identifying homogeneous interior regions without searching all the pixels, the number of operations and computational cost can be reduced. One means of efficiently implementing this idea involves a multilevel approach which can be applied naturally through what is called a pyramid structure. Each pyramid level represents a resolution level of the image. At each level, the interior and boundary regions are identified. The boundary regions are emphasized by ignoring the interior regions which were already identified at a previously analyzed level. This approach has all the advantages of region based segmentation, including incorporation with neighborhood information, reduction of noise and reduction of processing requirements.

The concept of unsupervised region based image segmentation has been employed. It does not however depend on the traditional local merging and splitting of regions with a similarity test of region statistics. Rather global parameters of each class are estimated and updated with representative values of the regions using the mixture distribution technique, the image is then classified through a pyramid structure. This approach has several advantages; (1) reduction of computational cost, (2) no ordering problems in region merging associated with global estimation and labeling, (3) increased in efficiency by starting from very homogeneous regions and adapting the variability or change of each class along the boundary regions through the multilevel structure, (4) easy adaption to the substantial changes in characteristics of class with time and between study areas, (5) reduction of sensitivity of noise. Note that the algorithm has been implemented and tested using multispectral simulation and satellite data.