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An ensemble training scheme for machine-learning classification of Hyperion satellite imagery with independent hyperspectral libraries

Michael Friedel (1,2) and Massimo Buscema (2,3)

(1) Hydrogeology Department, GNS Science, Avalon, Upper Hutt, New Zealand (m.friedel@gns.cri.nz), (2) Mathematical and Statistical Sciences, Uniiversity of Colorado, Denver, CO, USA, (3) Semeion Institute, Rome, Italy

A training scheme is proposed for the real-time classification of soil and vegetation (landscape) components in EO-1 Hyperion hyperspectral images. First, an auto-contractive map is used to compute connectivity of reflectance values for spectral bands (N=200) from independent laboratory spectral library components. Second, a minimum spanning tree is used to identify optimal grouping of training components from connectivity values. Third, the reflectance values for optimal landscape component signatures are sorted. Fourth, empirical distribution functions (EDF) are computed for each landscape component. Fifth, the Monte-Carlo technique is used to generate realizations (N=30) for each landscape EDF. The correspondence of component realizations to original signatures validates the stochastic procedure. Presentation of the realizations to the self-organizing map (SOM) is done using three different map sizes: 14x10, 28x20, and 40 x 30. In each case, the SOM training proceeds first with a rough phase (20 iterations using a Gaussian neighborhood with an initial and final radius of 11 units and 3 units) and then fine phase (400 iterations using a Gaussian neighborhood with an initial and final radius of 3 units and 1 unit). The initial and final learning rates of 0.5 and 0.05 decay linearly down to 10–5, and the Gaussian neighborhood function decreases exponentially (decay rate of 10–3 iteration–1) providing reasonable convergence. Following training of the three networks, each corresponding SOM is used to independently classify the original spectral library signatures. In comparing the different SOM networks, the 28x20 map size is chosen for independent reproducibility and processing speed. The corresponding universal distance matrix reveals separation of the seven component classes for this map size thereby supporting it use as a Hyperion classifier.