Kernel based orthogonalization for change detection in hyperspectral image data

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ABSTRACT

Kernel versions of principal component analysis (PCA) and minimum noise fraction (MNF) analysis are applied to change detection in hyperspectral image (HyMap) data. The kernel versions are based on so-called Q-mode analysis in which the data enter into the analysis via inner products in the Gram matrix only. In the kernel version the inner products are replaced by inner products between nonlinear mappings into higher dimensional feature space of the original data. Via kernel substitution also known as the kernel trick these inner products between the mappings are in turn replaced by a kernel function and all quantities needed in the analysis are expressed in terms of this kernel function. This means that we need not know the nonlinear mappings explicitly. Kernel PCA and MNF analyses handle nonlinearities by implicitly transforming data into high (even infinite) dimensional feature space via the kernel function and then performing a linear analysis in that space. An example shows the successful application of (kernel PCA and) kernel MNF analysis to change detection in HyMap data covering a small agricultural area near Lake Waging-Taching, Bavaria, in Southern Germany.

In the change detection analysis all 126 spectral bands of the HyMap are included. Changes on the ground are most likely due to harvest having taken place between the two acquisitions and solar effects (both solar elevation and azimuth have changed). Both types of kernel analysis emphasize change and unlike kernel PCA, kernel MNF analysis seems to focus on the most conspicuous changes and also it gives a strong discrimination between change and no-change regions. Ordinary linear PCA or MNF analyses do not give this beautiful discrimination between change and no-change regions.

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