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Kernel-based methods for change detection in remote sensing optical images

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Kernel methods have proven their effectiveness in Remote Sensing image processing. The success of these approaches relies both on a well founded theoretical framework overcoming many practical issues limiting the effectiveness of standard linear methods. Kernel-based algorithms apply an implicit nonlinear mapping by projecting the pixels into a higher dimensional feature space where (possibly) simple and linear decision rules can be successfully applied. The resulting solution in the transformed space corresponds to a nonlinear solution in the original input space.
Recently, kernel methods have been successfully applied on multitemporal classification and change detection problems. The application of supervised methods such as Support Vector Machines (SVM) allows a full description of the ground cover transitions occurred at a pair of multitemporal remote sensing images. The efficiency of SVM in difficult problems, like low training set sizes and high dimensionality of the data, allows the user to include different sources of information in the multitemporal classification procedure, such as features extracted from image filtering or ancillary data such as digital elevation models. The accuracy of this family of approaches is particularly adapted when dealing with urban and environmental monitoring, where an accurate map of the classes of ground transitions is desired.
On the other hand, the intervention of the user is needed since these methods rely on the similarity estimated between training samples (labeled pixels after photo-interpretation or terrain campaigns) resulting in high costs (and computational time). Another way to deal with change detection is to apply the so-called unsupervised methods, that do not need any user intervention and the application is fully automatic. The application of such algorithms results often in a binary change detection map, showing only whether a change has occurred or not. These methods are particularly adapted when dealing with time constrained problems or where the user influence must be minimal. Classical applications of these algorithms are in post catastrophe assessment and natural hazards (landslide and flooding mapping).
Globally, the application of kernel-based methods results both in higher accuracies (than their linear counterparts) and in more precise decision boundaries given by the implicit nonlinearity of the kernels functions. Real case studies (in particular on VHR images) and a comprehensive review of the state-of-the art methods are presented, which validates the application of such algorithms in remote sensing image processing.

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