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## Surface motion information retrieval from dense time series of spaceborne and terrestrial co-registered images

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With the progress of Machine vision and Image processing applications and the access to massive time series of images (terrestrial imagery, satellite imagery) allowing the computation of displacement fields, challenging tasks such as detection of surface motion became achievable. This calls for fast, flexible and automated procedures for modeling and information retrieval.

While supervised learning paradigms have been finding extended application within the field of remote sensing, the scarcity of reliable labeled data to be used within the training phase, sets a noticeable limitation for the generalization of these procedures in the shadow of huge spatial, spectral or temporal redundancy. Although this downside can to some extent be ameliorated by enriching training samples through active learning techniques, relying merely on supervised approaches, is a hindrance while analyzing large stacks of remote-sensing data. In addition, the process of information retrieval becomes more challenging when the data is not the direct acquisition of the scene but other derivatives (after applying different image processing steps) of it. Modeling of the motion maps and extracting high-level information from them and/or fusion of these maps with other available features of the domain (with the aim of increasing the accuracy of the underlying physical patterns) are good examples of such situation, calling to break-free from the supervised learning paradigm.

Dimensionality Reduction (DR) techniques are a family of mathematical models which work based on matrix factorization. The unsupervised DR techniques seek to provide a new representation of the data within a lower (thus more interpretable) sub-space. After finding this new representative space the original data is being projected onto this new-found subspace in order to 1) reduce the redundancy within data and 2) emphasize the most important factors within it. This will indirectly help clarifying the best (observation) sampling strategies for characterization and emphasis on the most significant detectable pattern within data.

Spatio-temporal clustering aims at improving the result of clustering by bringing in the spatial information within an image, including coherent regions or textures and fuse them to the information provided across the temporal(or spectral in case of hyperspectral imagery) dimension. One way to reach this goal is to come up with image pyramid of the scene using methods including Gaussian Pyramids and/or Discrete Wavelet Transform and then iteratively clustering the

scene beginning from the coarsest to the finest resolution of the pyramid, with the membership probabilities passed on to the next level in each iteration.

Applying the combination of the two mentioned techniques on the stacks of consecutive motion maps (produced by multi-temporal optical/SAR offset tracking) representing the surface behavior of different landslides, a more accurate classification of regions based on their landslide characteristics is expected to be achieved in a complete unsupervised manner. Extensive comparisons can then be made to evaluate the several existing clustering solutions in separation of specific known surface movements. Examples of application of these techniques to SAR derived offset-tracking glacier and landslide displacement fields, and optical terrestrial landslide displacement fields will be presented and discussed.