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Flooded-Area Mapping and Change Detection from Multitemporal COSMO-SkyMed Images

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Flooded-area and ground-change detection are relevant tasks when monitoring natural hazards due to storms and heavy rain. In this framework, remote-sensing synthetic aperture radar (SAR) data play a decisive role, thanks to their all-weather and day-and-night acquisition capabilities. This potential is further enforced by the current availability of very high-resolution data (VHR; up to 1 m) with short revisit time (up to 12 hours) granted by the recently completed Italian COSMO/SkyMed constellation, which represents a formidable tool with respect to rapid response after a flood.

In this paper, the problems of generating (fast-ready and detailed) flooded-area maps and change maps from multitemporal COSMO/SkyMed images are addressed by adopting an image-processing and pattern-recognition perspective. Multitemporal image-analysis methods are applied to pairs of COSMO/SkyMed images acquired on the same area at different times. This work is framed in the "OPERA – Civil protection from floods" pilot project, funded by the Italian Space Agency (ASI) in cooperation with the Italian Department for Civil Protection.

Focusing first on fast-ready mapping of flooded areas, the input images are combined into a false-color composite image for better enhancing flood water as compared to other land-cover classes. An appropriate pre-processing is required to combine the multitemporal images because they can be acquired with different sensor parameters. To this end a cross-calibration/normalization step is applied [1].

For detailed flooded-area maps, a multi-seed-growing segmentation approach is employed. It starts from a set of points in the pre-event image, corresponding to permanent water pixels. Seed-points can be manually selected by the user or automatically extracted by an appropriate algorithm. An anisotropic image-scanning mechanism is employed where the order of pixel analysis is dependent on the image content, so the growing sequence turns to be adaptive to the local and global image context [1].

The problem of detecting the ground changes occurred between two observation dates (typically before and after the flood) is addressed by a contextual unsupervised multiscale approach, based on Markov random fields (MRFs) [2], wavelet transforms, and generalized Gaussian distributions [3]. Wavelets are used to extract multiscale features from the input multitemporal data set [3]. An MRF model is introduced to fuse both the extracted multiscale information and the spatial context associated to the VHR multitemporal data set [1]. The statistics of the multiscale features in changed and unchanged areas are modeled by resorting to generalized Gaussian distributions and to parametric estimation techniques based on higher-order moments.

Experiments are presented on several COSMO-SkyMed multitemporal data sets, related to recent floods in Italy and Albania and to the tsunami occurred in 2011 in Japan.

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