MULTITEMPORAL ANALYSIS OF MULTISENSOR DATA: INFORMATION THEORETICAL APPROACHES

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Satellite Multitemporal Observations and Satellite Image Time Series are a new type of data sets acquired with optical and Synthetic Aperture Radar (SAR) technologies. Presently, due to the large number of Earth Observation satellites, every location on Earth can be observed very often; however, the observations in practical situations are usually data takes by different sensors. As a result, new models and algorithms are needed to automatically perform the data analysis.

This paper presents two approaches for the analysis of multitemporal and multisensor data analysis. The first approach studies similarity measures derived from information measures and we assess their performance for multitemporal analysis. The temporal evolution of scene changes is measured as a variation in the common and disjoint information measures between the different sensor data models. The second approach proposes the use of specific density estimation methods to reduce approximation effects for the detection of the multisensor changes.

Usually, the problem of change detection can be decomposed into two steps [1]: the generation of a change map based on the comparison of two images using a similarity function, and a change classification performed either in an un-supervised or a supervised schema. In the former situation certain kinds of prior information about the scene, such as prior distribution assumptions, are necessary.

This paper will focus on an unsupervised approach for the generation of the indicator image in order to produce a binary change map. This approach is based on the comparison of local statistical similarity measures. In the literature, there are several kinds of similarity measures, among them mutual information based similarity measures that proved to be rather efficient. In addition, several similarity measures between multi-sensor images have been introduced in [2]. These measures are based on concepts such as statistical dependence or mutual information. The use of these measures allows for the design of image registration algorithms and automatic change detection techniques. Further, a new approach based on similarity measures is presented in [3]. The author employed a series of such measures for automatic change detection within optical and SAR images and compared the performance of each similarity measure. The final conclusion was that the CRA and the mutual information measures perform the best.

Taking advantage of the Mutual Information, a pixel-based approach comparing the localized Mutual Information shared by two pixels was proposed in [4]. When the two pixels share a lot of Mutual Information, their location is considered as being unchanged. Based on this idea, another new informational measure derived from the Mutual Information was introduced in [5]: the Mixed Information. This new information measure quantifies in a unique framework the shared and different information such that time separated pixels with different information are classified as having changed. The new method based on Mixed Information also proved to be invariant to nonlinear changes; thus, we further investigate its use for multisensor change detection.

Both methods in [3] and [4] are based on distribution estimation as histograms. In [1] it is suggested that the histogram method should be avoided due to its need of a high number of samples for estimation. As an alternative, a cumulant-based density estimation is used to derive the local distribution which is further used to compare the similarity between two images with the Kullback-Leibler divergence. In this case, the marginal distributions of each image are used. To overcome the shortcomings, this paper presents an alternative scheme which is an extension of the work in [4].

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