SUPERRESOLUTION ENHANCEMENT FOR TEMPORAL HYPERSPECTRAL-ORIENTED DATA SETS

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Hyperspectral data that provide hundreds of contiguous bands with richer spectral information have shown promising results in various application domains. While spaceborne hyperspectral images are becoming increasingly available, the present spatial resolutions are limited to between 18-30m. For instance, HYPERION has over 200 bands between 0.4-2.5µm but at 30 meter spatial resolution. CHRIS/Proba and ASTER are two hyperspectral-oriented data sets. CHRIS provides multi-view of the same scene with 18 bands within the spectral range of 0.4-1µm and a spatial resolution of 18m at nadir. ASTER has 14 bands between 0.52-11.65µm with 15-, 30- and 90-m spatial resolution. Recent studies have shown spatial enhancement can be attained by superresolution (SR) image reconstruction method on multi-angle CHRIS images. In [1][2][3], multi-view CHRIS images are used as lower resolution input to various SR methods to increase the spatial resolution from 18m to 9m. The SR enhanced CHRIS images do not only generate more visual details, but also increase classification accuracies [3]. Building up on our previous experience, we further our understanding on the effect of SR methods on multi-temporal data which are acquired within a very short period of time.

In this study, we present the latest results of SR methods being applied on the multi-angle CHRIS images that have been acquired within a week. Location of the scene is Kalmthout, Belgium. One prerequisite of successful implementation of SR on multi-temporal multi-angle images is accurate co-registration. Our experience is that manual collection of ground control points for high angle image (in the case of CHRIS images, they are acquired at ±36° and ±55°) is extremely laborious and ineffective. The use of rigid transform such as projective transformation normally generates rather poor results. We will describe a two-tier procedure for automatic ground control point selection. This method is a hybrid approach using both feature-based and area-based (a.k.a. template matching) methods [4][5]. In the first step, control points are selected using scale invariant feature transform (SIFT) [6] and at the second step, selections are based on a Normalized Cross-Correlation [7]. The outliners within the collected control points will be screened by various criteria such as close spatial relationship. The final co-registration is performed using a non-rigid thin plate spline model [8].

The SR technique used for our experiment is Iterative Backprojection method [9]. The SR enhanced images using a single-date data set are compared to the SR enhanced images using multi-date data sets. An airborne hyperspectral AHS data set at 2.5m was made available for evaluation purposes. Three quantitative measures of image quality are used for the assessment: peak signal to noise ratio, structural similarity and edge stability. While visual interpretation shows that the use of temporal images might have unwanted noise which is a result of land cover changes that occurred during the period of two acquisitions, it is also found that feature contrasts are enhanced at various locations. All three quantitative measures indicate that the use of bi-temporal multi-view image sets for

SR is superior than using only a single-date data set. The inclusion of image at high angles (±55°) might bring degradation to the SR results due to their higher geometric distortions and should be handled with care or be discarded. The proposed automatic ground control point collection method performed very well in a scene which is comparatively flat. A set of 20 control points manually selected have been used for the assessment of the co-registration. On the average, the RMSE of co-registration is around 0.2 pixels. Theoretically, the automatic co-registration and SR method proposed in this paper can be applied on any other data sets. For instances, operational sensors such as HYPERION, ASTER, MISR, etc. The amount of information gained or the added values of SR would be application dependent. More investigation in applications such as land cover classification or spectral unmixing would shed light on the issue [2][10]. The implementation of SR, however, is still not straightforward, and parameter tuning can be very demanding because each acquired scene is different. More works are needed to automate or semi-automate this parameter setting process.

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