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PRISMA HYPERPANSHARPENING: A METHODOLOGY TO CREATE AN ENHANCED HYPERSPECTRAL DATACUBE

Abstract

To overcome the intrinsic trade-off between spatial and spectral resolutions of imaging sensors, multiple optical remote sensing systems, such as PRISMA (PRecursore IperSpettrale della Missione Applicativa) owned by ASI (Agenzia Spaziale Italiana), are equipped with two types of sensors: a panchromatic camera and a hyperspectral imager (HYC), acquiring numerous narrow and contiguous spectral bands. The PRISMA HYC module operates with a GSD of 30m and covers a wavelength range from 400nm to 2505nm with a spectral sampling interval of 12nm. Simultaneously, the Panchromatic Camera module acquires with a GSD of 5m. A novel training approach to produce an enhanced hyperspectral cube is here proposed, called Guided Full Resolution Framework. The framework includes two separate modules. The model, a lightweight Convolutional Neural Network, is first trained in a supervised manner, on synthetic data generated from AVIRIS-NG (ANG) flight. Each ANG flight is processed to generate a synthetic PRISMA hyperspectral cube by means of spectral and spatial resampling. Additionally, a synthetic panchromatic band is created: bands up to 700nm are weighted by specific gain factors and summed. The architecture of the model includes three distinct branches: the upper branch preserves spectral information of the hyperspectral cube, the lower branch extracts spatial details from the panchromatic image, the central branch upscales the hyperspectral cube. The same model is then trained in an unsupervised way, directly on PRISMA data, to improve the spectral reconstruction and to reduce distortions. In the unsupervised learning step, the loss is a combination of a spectral and a spatial loss, to make the model able to replace the learned features from the ANG sensor with the specific characteristics of PRISMA. Values of spatial and spectral distortions metrics calculated over different Italian sites prove the effectiveness of the methodology, ready to be applied in different fields of application, as improving products related to detection and classification tasks. An additional co-registration step will be implemented to enhance the alignment between the panchromatic band and the hyperspectral cube, thereby minimizing spectral distortion even more effectively.

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