A Method Towards Cross-Sensor Hyperspectral Image Restoration with Known Spectral Response Functions

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Hyperspectral imaging (HSI) sensors continue to proliferate across airborne, spaceborne, and ground-based platforms, each with its own band count, centre wavelengths, and spectral response functions (SRFs). In practice, this unavoidable sensor fragmentation means that restoration models trained on one spectral layout often transfer poorly to another, while newly deployed sensors often lack the paired reference data needed to train a dedicated restoration model. At the same time, standard product metadata already records the spectral sampling of each band, typically the centre wavelength and bandwidth or an SRF. However, most deep restoration pipelines discard these fields and treat bands as anonymous channels indexed only by order.

This abstract outlines an ongoing research direction that reframes HSI restoration around the spectral measurement operator rather than a fixed band grid. The guiding premise is that hyperspectral observations are discrete samples of a continuous spectral field through sensor-specific SRFs. The restoration network should therefore model relationships between bands in physical wavelength space and condition its processing on known sampling metadata, rather than treating bands solely by their indices. Under this view, cross-sensor restoration becomes the problem of amortizing a feed-forward inverse over a family of known sampling operators, with the ambition of restoring data from unseen sensors whose spectral layouts remain inside the envelope of operators seen during training (known-SRF zero-shot cross-sensor restoration).

First, we formulate the problem so that spectral sampling shift is separated from other uncontrolled sensor factors. Second, we keep SRF information as an explicit input to restoration rather than an afterthought. Third, we centre evaluation on transfer across band layouts, including settings where the test sensor is withheld from training. The purpose of this abstract is to communicate the motivation and research agenda, and to invite discussion at WHISPERS on how sensor metadata should enter the next generation of hyperspectral restoration methods.