A FULLY AUTOMATIC METHOD FOR ON-ORBIT SHARPNESS ASSESSMENT A CASE STUDY USING HYPERSPECTRAL SATELLITE IMAGES

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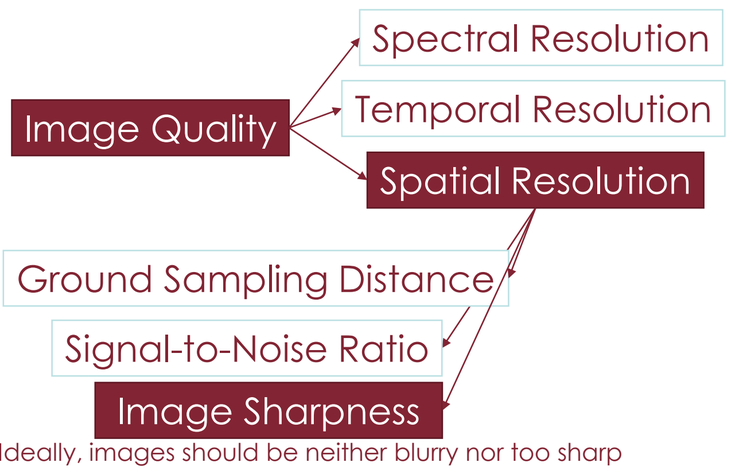
Abstract

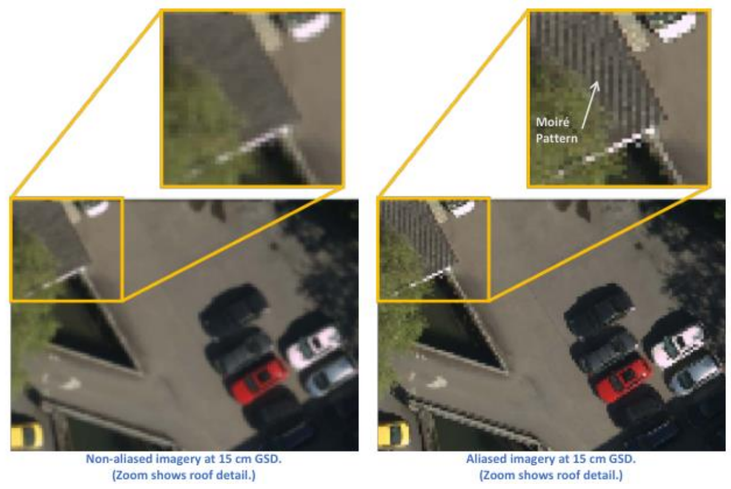
The recent surge in interest towards hyperspectral imagery has the potential to unlock a new range of applications for the scientific community. However, compared to traditional multi-spectral images, the workload required to process such high-dimensional data is dramatically increased, to the point that new and more flexible strategies must be developed in order to properly monitor the quality of this type of products. In the particular case of sharpness assessment, traditional procedures based on the edge method tend to be extremely time-consuming due to their reliance on visual analysis performed by human operators, and would make proper processing of all bands a daunting task to perform on a large scale. In this paper we propose a flexible and fully automatic approach to edge method-based sharpness assessment that can be applied independently from the number of spectral bands. We then present the results of the application of the methodology on the visible and near-infrared and shortwave infrared spectral cubes of a selection of PRISMA L2D images, which confirm the reliability of the methodology and suggest further improvements.

The Concept of Sharpness

- Sharpness can be defined as the quality of an image of being clear
- Image sharpness is a fundamental component of image quality



- Ideally, images should be neither blurry nor too sharp



Non-aliased imagery at 15 cm GSD. (Zoom shows roof detail.)

Aliased imagery at 15 cm GSD. (Zoom shows roof detail.)

On-Orbit Sharpness Assessment

- Developed to monitor image sharpness over time and during sensor operation
- The family of **Edge Methods** is one of the most popular
- Uses edge-like targets to extract sharpness metrics from an image
- Usually **require human supervision**
- Targets **handpicked** by an expert

Unsuitable for large-scale analyses

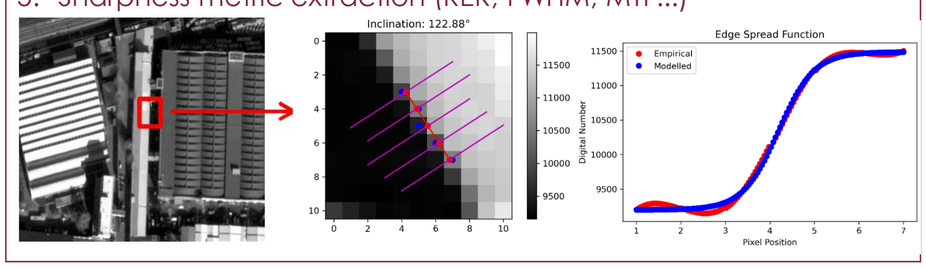
The Challenge Posed by Hyperspectral Imagery

- Surge in interest towards hyperspectral imagery in the past few years
- Very **high spectral dimensionality** of data
- Processing and monitoring product quality is very time-consuming and resource-intensive

Need for automated processing algorithms

The New Fully Automatic Method

1. Canny-based edge detection
2. Smart edge selection
3. Application of edge method on eligible edges
4. Calculation of ESF, LSF
5. Sharpness metric extraction (RER, FWHM, MTF...)



The PRISMA Case-Study

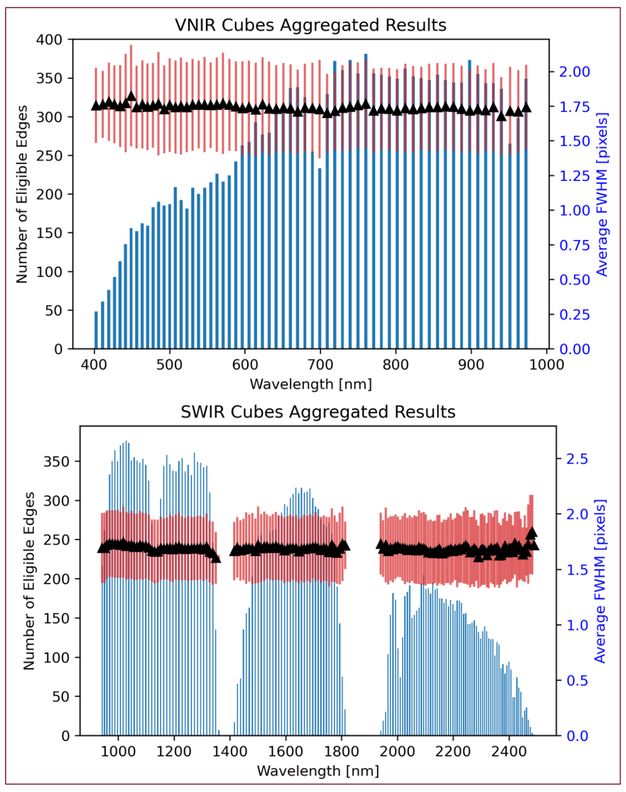
- Launched in 2019 by the Italian Space Agency
- 66 VNIR channels
- 173 SWIR channels
- 30x30 meter GSD
- Quasi-open data dissemination policy
- 6 images chosen around Italy for this analysis

Results

- Aggregated results for each channel of the spectral cube are plotted against the channel wavelength
- Black triangles: FWHM average
- Red error bars: FWHM standard deviation
- Blue bars: number of eligible edges

- Average cube FWHM ∈ (1.6-1.8)
- Standard deviation average ≈ 0.30
- Number of retrieved edges highest in NIR

The performance of the PRISMA images is balanced [2]



Conclusions

- Requires minimal hyper-parameter tuning
- Edges identified and processed **automatically**
- Suitable to **large-scale analyses**
- Enables continuous "in-line" monitoring
- Applicable to panchromatic, multispectral and hyperspectral imagery

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