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The Most Important Factors Influencing the Overall Quality of Optical Images

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PRISM

Copernicus Coordinated data Quality Control (CQC): Service Description

The **Copernicus Coordinated data Quality Control (CQC)** is the Copernicus Space Component Data Access system (CSCDA) component **in charge of monitoring the quality of datasets and products contributing to the Copernicus Space Component**

- **Datasets** are defined in response to the Data Warehouse (DWH) requirements.
- Datasets are **populated by Products** (that follows specific requirements)
- Products are **acquired by Copernicus Contributing Missions (CCMs)** and **issued by** the **Copernicus Contributing Missions Entities (CCMEs)**

From June 2019 the CQC service is run by SERCO Italia SpA, within the PRISM (Copernicus Contributing Missions access Support Functions and Platform) contract framework.

Source: https://spacedata.copernicus.eu/web/cscda/data-offer/quality-information - Accessed: 15/11/2019

CQC Service: Main Activities

The list of CQC main activities includes (but it is not limited to):

- The **assessment and monitoring of the overall datasets quality** against DWH requirements
- The **investigations of data quality anomalies**, in support to the CCMEs
- The **integration of new CCMs** into the CSCDA
- The proposition and coordination of **harmonisation initiatives**

Source: https://spacedata.copernicus.eu/web/cscda/data-offer/quality-information - Accessed: 15/11/2019

CQC Service: Harmonization Activities

- Having a visibility on a vast range of satellite missions and data (optical & SAR), the CQC Team has a **unique perspective on the different technical terms, definitions, metadata, file formats, processing levels, algorithms, cal/val procedures etc.** used by the CCMs.
- The comparison among products from different missions often highlights the **need for a strong, common effort of harmonisation**. For this reason, the CQC Team undertakes **harmonisation initiatives** dealing with different topics relevant to the abovementioned matters
- Within this framework, the **CQC Team is now investigating** the “evergreen” issues related to **the most important factors influencing the overall quality of optical images,** with particular emphasis on those at very high resolution (spatial resolution 2-4 m) covering the VISIBLE/NIR interval of the radiometric spectrum

✓ This is an **ongoing activity** in which we carried out the exercise shown in this presentation

Source: https://spacedata.copernicus.eu/web/cscda/data-offer/cqc-harmonisation-initiatives - Accessed: 15/11/2019

Exercise

Working Towards an Operational Approach for Defining a Statistically-based Sharpness Proxy: Proof of Concept

Objective

- Defining an **operational** method for **sharpness assessment** by means of **zonal statistics**
  - ✓ Operational means quick, reliable and applicable to different data sources
- The **objective** of the exercise **is** to **set up an experiment to validate the proposed approach** (**proof of concept**)
- The **objective** of the exercise **is not to compare the quality of the products** used as test case. For this reason, they will be treated anonymously.

Data Sources

1. **Product 1 (P1):**
   - Panchromatic band (0.45-0.9 μm)
   - Spatial Resolution: approx. 2 m
   - Acquisition date: 2017-08-02 18:14:44
   - Reference System: WGS 84
2. **Product 2 (P2):**
   - Panchromatic band (0.51-0.85 μm)
   - Spatial Resolution: approx. 5 m
   - Acquisition date: 2018-09-20 16:21:22
   - Reference System: WGS 84

Rationale

- **Sharper images** are theoretically characterised by an **higher contrast** (i.e., neat change of DN values) nearby edges, such as buildings in urban areas.
- **Blurred images** can be considered as affected by **noise** (intensity-dependent).
- Since the term “**noise**” is here referred to the image **non-homogeneities**, it can be **assessed on non-homogeneous areas** (Poli et al., 2014).

Therefore…

Source: POLI, D., REMONDINO, F., ANGIULI, E., & AGUGIARO, G. (2015). Radiometric and geometric evaluation of GeoEye-1, WorldView-2 and Pléiades-1A stereo images for 3D information extraction. *ISPRS Journal of Photogrammetry and Remote Sensing.* 100, 35-47.

Rationale

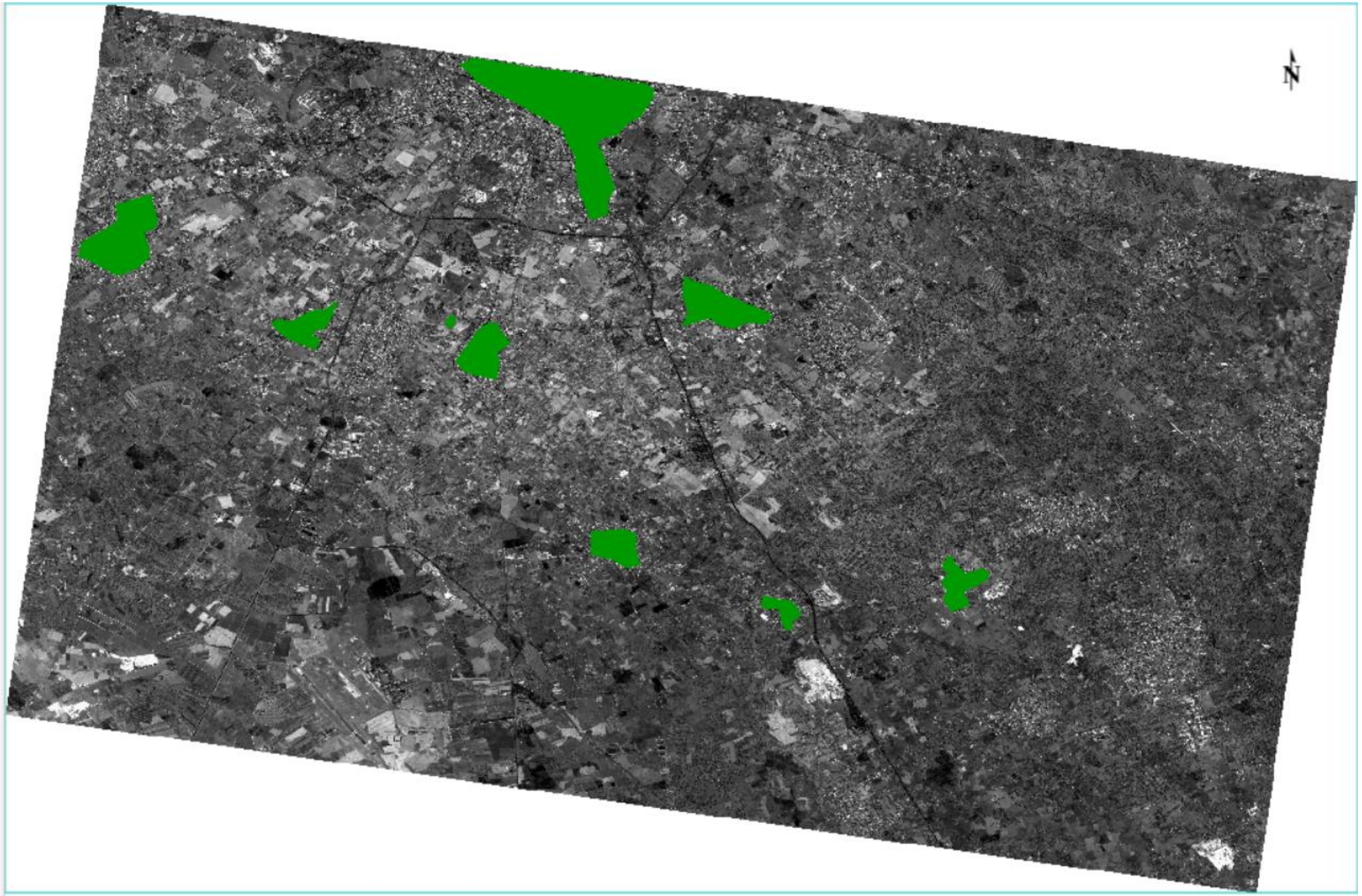
- If a **convolution filter with a small kernel (e.g., 3x3)** is applied to an image for computing the **standard deviation**, **higher values** can be found in areas characterised by features with higher contrasts **nearby edges** (e.g., urban areas).
- If the **standard deviation** is **normalised** by using a **mean convolution filter** (computed by using the same kernel dimensions), values computed in different images can be compared.
- Consequently, the **average value of the Sharpness Index (SI)**, **computed in non-homogeneous areas** (e.g., urban zones), can be used as **proxy of image sharpness**:

Sharpness Index (SI) = (image after StD filter/image after mean filter) * 100

- **The higher the SI, the higher the image quality in terms of sharpness**

Source: POLI, D., REMONDINO, F., ANGIULI, E., & AGUGIARO, G. (2015). Radiometric and geometric evaluation of GeoEye-1, WorldView-2 and Pléiades-1A stereo images for 3D information extraction. *ISPRS Journal of Photogrammetry and Remote Sensing.* 100, 35-47.

Example of **Urban** (non-homogeneous) test areas used for computing average SI values



Methodology: Part 1

Original P1 image

SI (3x3 Kernel)→ Average SI in urban areas

Simulation of lower level of blurring effect:
_Original P1 image + low pass filter Kernel 3x3

SI (3x3 Kernel)→ Average SI in urban areas

Simulation of higher level of blurring effect:
_Original P1 image + low pass filter Kernel 5x5

SI (3x3 Kernel)→ Average SI in urban areas

Results Part 1: Image Blurring

1023

100

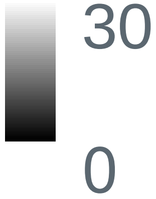
Original P1
Image

Original P1
Image + low pass filter
(Kernel 3x3)

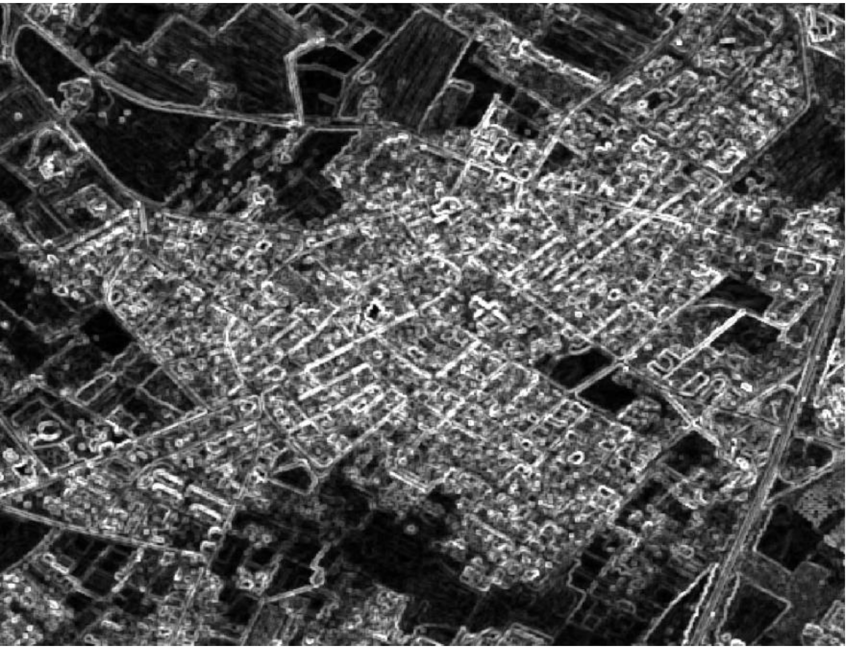
Original P1
Image + low pass filter
(Kernel 5x5)

Decreasing Sharpness

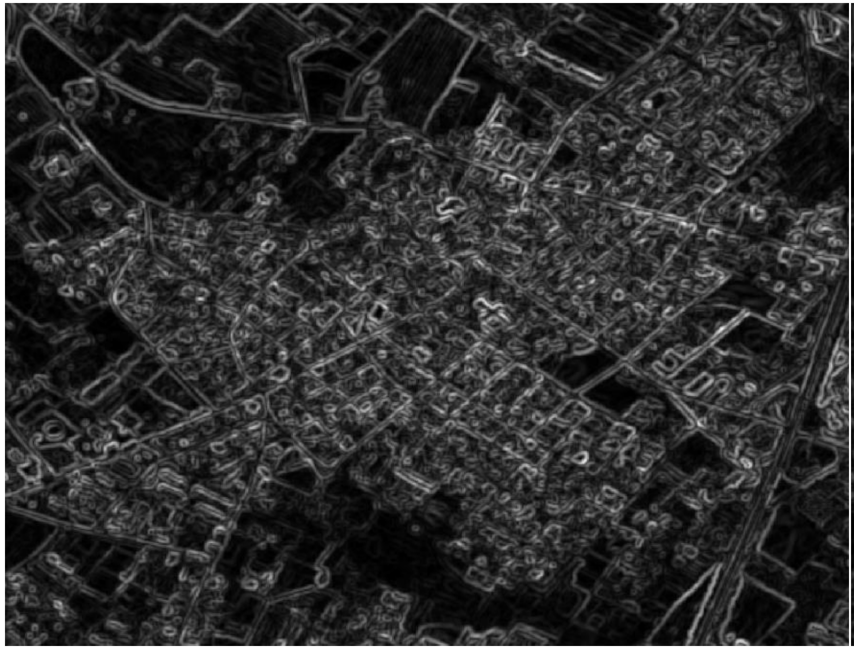
Results: Sharpness Index (SI)



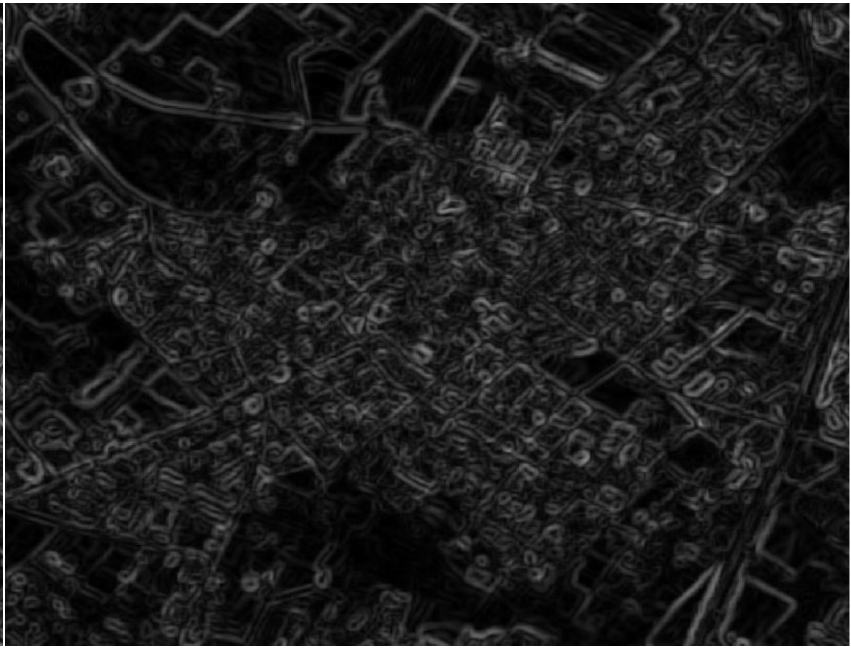
SI (Kernel 3x3) of Original P1 Image



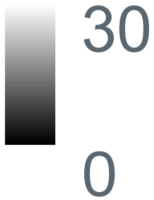
SI (Kernel 3x3) of Original P1 Image + low pass filter (Kernel 3x3)



SI (Kernel 3x3) of Original P1 Image + low pass filter (Kernel 5x5)



Results: Sharpness Index (SI)



SI (Kernel 3x3) of Original P1 Image

SI (Kernel 3x3) of Original P1 Image + low pass filter (Kernel 3x3)

SI (Kernel 3x3) of Original P1 Image + low pass filter (Kernel 5x5)

Average SI ≈ 16

Average SI ≈ 8

Average SI ≈ 5

Decreasing Sharpness

Methodology: Part 2

A) P1 and P2 data pre-processing:

- **Project P1 and P2 to the same reference system (UTM 34N) with the same pixel spacing (5 m) (Resampling Algorithm: Bilinear interpolation)**

B) Comparing zonal statistics

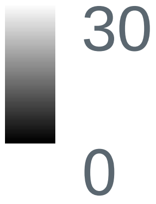
- ✓ SI (3x3 Kernel)→ Average SI over urban Areas

Results Part 2: P1 VS P2

Original P1 Image Resampled to 5 m

Original P2 image Resampled to 5 m

Results Part 2: P1 VS P2



SI (Kernel 3x3) Original P1 Image
Resampled to 5 m

SI (Kernel 3x3) Original P2 image
Resampled to 5 m

Results Part 2: P1 VS P2

30

0

SI (Kernel 3x3) Original P1 Image
Resampled to 5 m

Average SI = 16

SI (Kernel 3x3) Original P2 image
Resampled to 5 m

Average SI = 8

Conclusions

- A **proof of concept** related to an operational method for **sharpness assessment**, based on **zonal statistics**, was presented
- The performances of the **sharpness index** (SI) were tested with a 2-phases experiment:
  - ❖ Part 1) Synthetic experiment with P1 data
  - ❖ Part 2) Comparison between P1 and P2 data
- **In both cases, the different level of sharpness perceived by observing the data were detected by the SI.**

✓ **<u>This confirms the rationale that drove the experiment.</u>**

Follow Up

- The presented **approach** is still **under development (experimental phase)** therefore **results** are **preliminary**
- The **way forward** is towards a **image-based method** that allows **to quantitively compare the sharpness of scenes** observed and imaged by **different sensors**.
- **Future activities** will account for having a **better understanding of the impact of the different image characteristics** (e.g. spatial resolution, radiometric resolution, acquisition geometry etc.) **when comparing SI data between different data sources.**

THANK **YOU**
FOR YOUR ATTENTION

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