(2017) No-Reference HSI Quality Assessment

Summary

The paper aims at assessing the quality of HS images without the need for pristine reference images. The authors do that by computing 5 statistical quality-sensitive features from the pristine and distorted HSIs and compare them to assess the HSI quality.

Distortions

- Gaussian noise with sd=0.05
- Gaussian noise with sd=0.20
- Blurring 3x3a average filtering
- Blurring 5x5 average filtering

Statistical Quality-sensitive features

Spectral features

1. **Local Spectra normalisation**
   The pristine HSI normalised spectra follows a Gaussian distribution while the distorted HSIs' normalised spectra deviates from this distribution distinctively.
   = Extract distribution features from the HSIs: shape and scale params

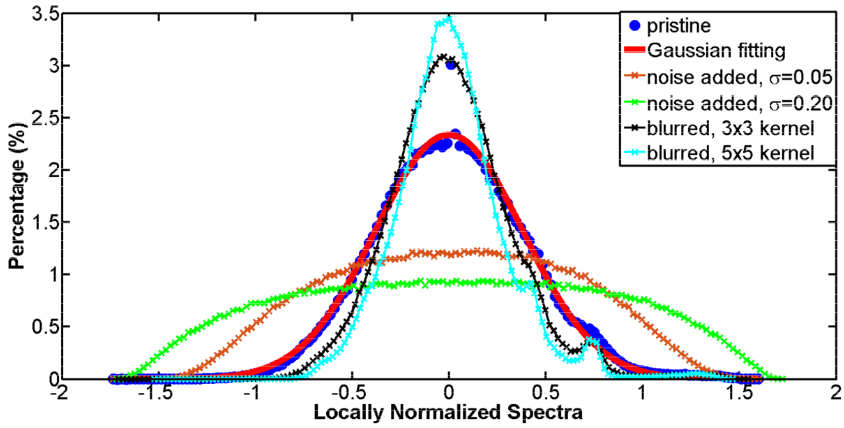
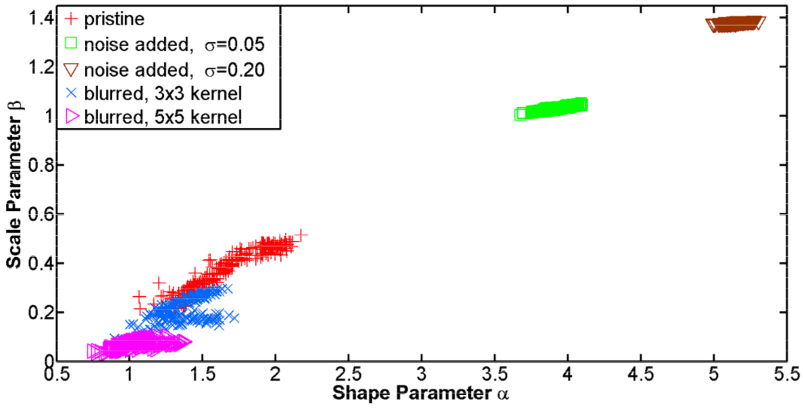


Figure 3. Histograms of locally normalized spectra of pristine hyperspectral image (HSI) and distorted HSIs.

To show that the extracted features are sensitive to the image quality



Spatial features

1. **Panchromatic images**

   HSIs usually have a large number of spectral bands. For time optimisation, we synthesise the HSI into panchromatic (gray-scale/reflect brightness of pixels) images. Which are useful for bringing forward the textural properties of an image:

   $$\boldsymbol{P} = w_r \boldsymbol{I}_r + w_g \boldsymbol{I}_g + w_b \boldsymbol{I}_b,$$

   I: is the spectral bands corresponding to red, green, blue ; w: is the weights assigned to each band

   The panchromatic image luminance is, then similarly, locally normalised.

   The pristine HSI do follow a GGD and the distorted ones deviate

   = Extract distribution features from the HSIs: shape and scale params

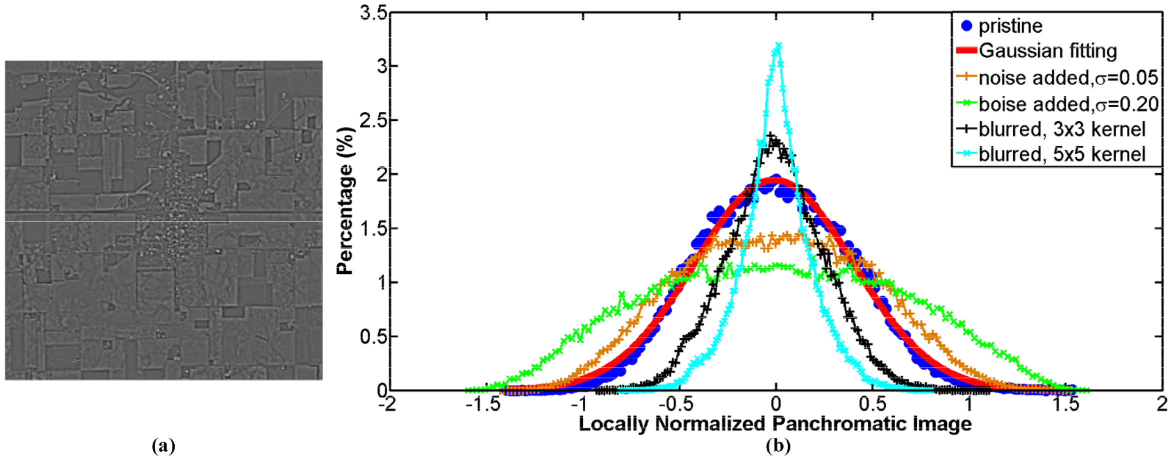


Figure 6. (**a**) The local normalization of pristine panchromatic image in Figure 5; and (**b**) histograms of locally normalized panchromatic images, under different kind of distortions.

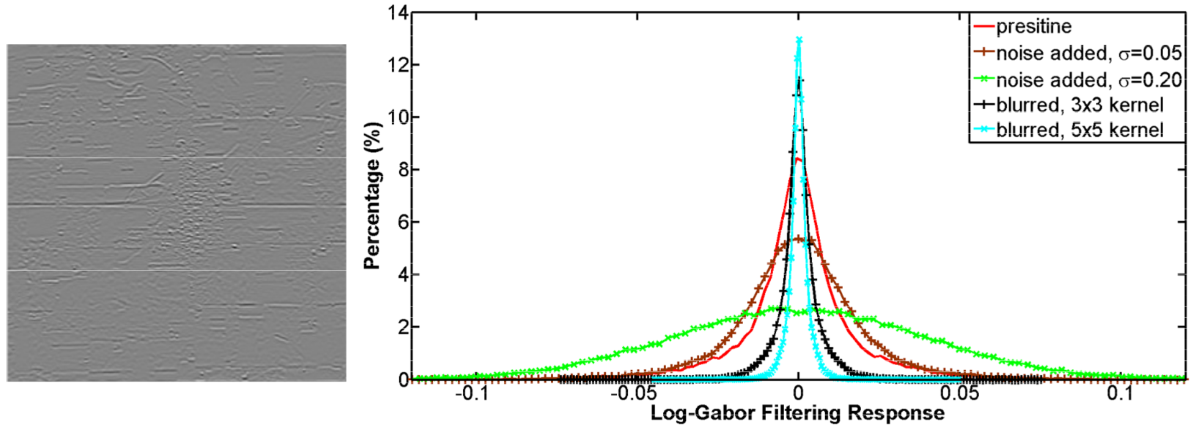
- **Log-Gabor filter on panchromatic image**

  To exploit the textural properties of the panchromatic image

  Again, different distortions lead to different deviated Gaussian distribution.

  (Same process)

= Extract distribution features from the HSIs: shape and scale params



(a) (b)

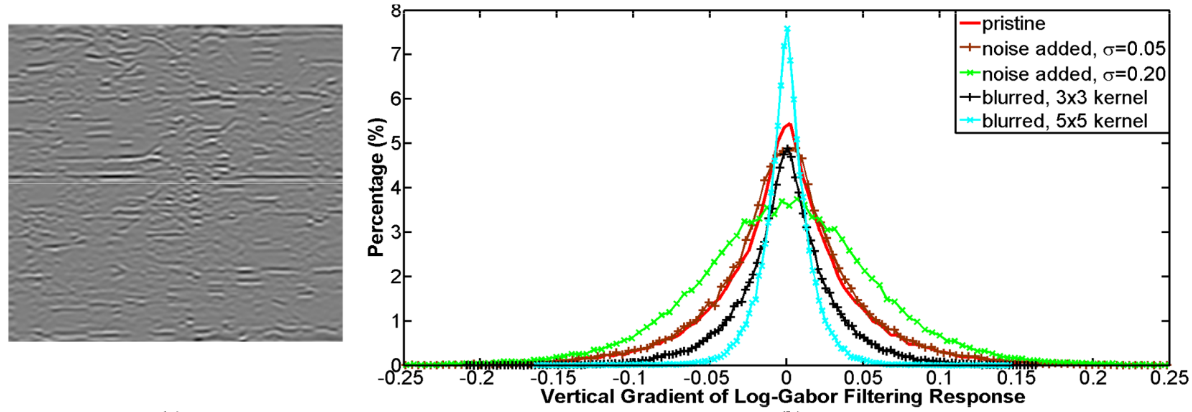
Figure 7. (**a**) Log-Gabor filtering response map $o_{1,3}$ of the pristine panchromatic image in Figure 5; and (**b**) histograms of Log-Gabor filtering response map $o_{1,3}$, under different kind of distortions.

- **Directional gradient of log-gabor's response map**

  To further exploit the response features of the log-gabor filter, exploit the directional gradient of the response map: the vertical gradient.

  (Same process)

  = Extract distribution features from the HSIs: shape and scale params



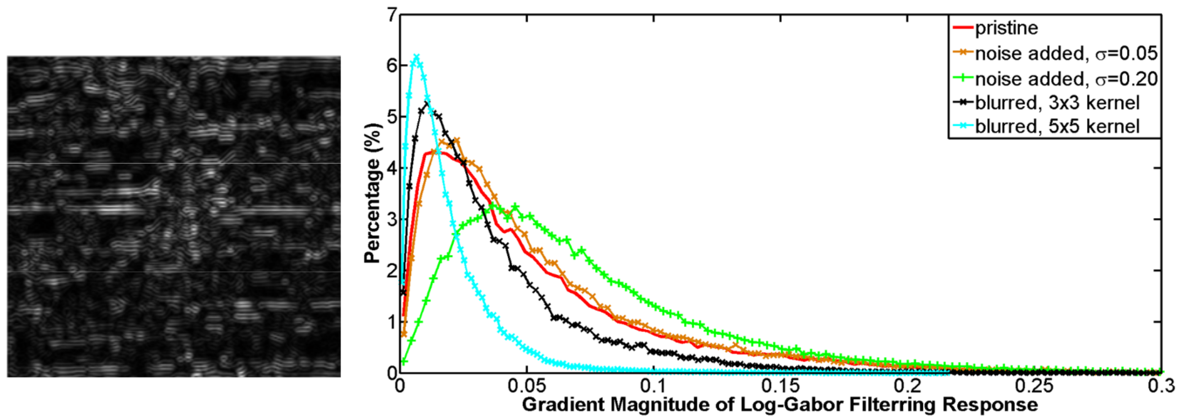
(a) (b)

Figure 8. (**a**) Vertical Gradient of Log-Gabor response map $o_{1,3}$ of the pristine panchromatic image in Figure 5; and (**b**) histograms of Log-Gabor filtering response map $o_{1,3}$, under different kind of distortions.

- **Gradient magnitude of the log-gabor response map**

  This time, the gradient magnitude follows a Weibull distribution and is deviated for distorted images as well

  = Extract distribution features from the HSIs: shape and scale params



(a) (b)

Figure 9. (**a**) Gradient magnitude of Log-Gabor response map $o_{1,3}$ of the pristine panchromatic image in Figure 5; and (**b**) histograms of gradient magnitude of $o_{1,3}$, under different kind of distortions.

Sensitivity to image quality

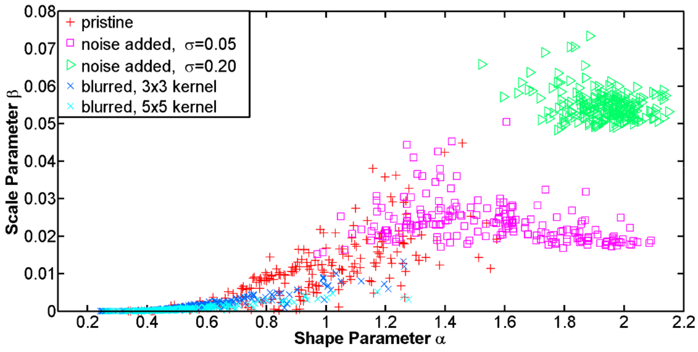


Figure 10. Visualization of spatial quality-sensitive features extracted from Log-Gabor response map $o_{1,3}$. Each point represents feature of a sub-image, each color represents a type of distortion.

Critique/Insights

- How come pristine images features are not clustered in most spatial quality-sensitive features graphs (fig10-12)?
- Play around with the panchromatic conversion
- In our version: keep water absorption bands ?
- have more types of distortions
- Do you have Critiques on the methodology itself?