### Histogram Statistics Characterization

#### Background

This algorithm serves as a general purpose algorithm occurring at different locations in the L1R processing flow. It supports characterization of all active detectors, including the inoperable ones, by computing statistics from single images or collects up to ~4.5 minutes long: minimum, maximum, mean, standard deviation, skewness, and kurtosis. In addition, the algorithm calculates for each detector the mean of squared pixel values and the adjacent detector correlations. For Earth scenes, the means and the standard deviations per SCA and per band are computed. To calculate these values, the input scene data need to be nominally spatially aligned. All results are stored in the database and used in other algorithms. For the OLI panchromatic band, all statistics are calculated and saved separately for odd and even frames. Processing of longer collects is described in Long Collect Statistics Characterization ADD.

#### Inputs

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Descriptions | Symbol | Units | Level | Source | Type |
| Scene data at any processing level, including blind detectors and video reference pixels (VRP) |  |  |  |  |  |
|  |  |  |  |  |  |
| Q |  | Nbands x NSCAs x Ndetectors x Nframes |  | Int or Float |  |
| Impulse Noise Locations |  |  | Nbands x NSCAs x Ndetectors x Nframes | LM | Int |
| Dropped Frame Locations |  |  | Nbands x NSCAs x Ndetectors x Nframes | LM | Int |
| Saturated Pixel Locations |  |  | Nbands x NSCAs x Ndetectors x Nframes | LM | Int |
| Detector offsets |  |  |  |  |  |

#### Outputs

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Descriptions** | **Symbol** | **Units** | **Level** | **Target** | **Type** |
| Detector Minimum response | *Qmin* | DN | Nbands x NSCAs x Ndetectors | Db | Float |
| Detector Maximum response | *Qmax* | DN | Nbands x NSCAs x Ndetectors | Db | Float |
| Detector Mean |  | DN | Nbands x NSCAs x Ndetectors | Db | Float |
| Detector Standard deviation | *σ* | DN | Nbands x NSCAs x Ndetectors | Db | Float |
| Detector Skewness | *γ1* |  | Nbands x NSCAs x Ndetectors | Db | Float |
| Detector Kurtosis | *γ2* |  | Nbands x NSCAs x Ndetectors | Db | Float |
| Number of valid frames for a detector | Nvalid\_pixels | Pixels | Nbands x NSCAs x Ndetectors | Db | Int |
| Detector Mean squared response |  | DN2 | Nbands x NSCAs x Ndetectors | Db | Float |
| Adjacent detector correlation | *ρ* |  | Nbands x NSCAs x Ndetectors | Db | Float |
| SCA Mean(for Earth scenes only) |  | DN | Nbands x NSCAs | Db | Float |
| SCA Standard deviation(for Earth scenes only) | *σSCA* | DN | Nbands x NSCAs | Db | Float |
| SCA average number of frames(for Earth scenes only) | *NSCA\_frames* |  | Nbands x NSCAs | Db | Float |
| Band Mean(for Earth scenes only) |  | DN | Nbands | Db | Float |
| Band Standard deviation(for Earth scenes only) | *σband* | DN | Nbands | Db | Float |
| Band average number of frames(for Earth scenes only) | *Nband\_frames* |  | Nbands  | Db | Float |
| Position in processing flow (RPS level) |  |  | 1 | Db | String |
| Linearization LUT version |  |  | 1 | Db | String |

**Note:** For the OLI panchromatic band, all output values need to be generated and saved separately for odd and even minor frames.

#### Options

Typically these data will be stored in the characterization database. For stand-alone processing, the individual detector statistics may be output to a summary report with a header containing start date and time of acquisition, end date and time of acquisition, processing date and time, calculated frame rate, filename and entity ID. A report generation should be selectable in work order.For each active detector, *d*, including inoperable detectors, blind detectors and VRPs, for all bands and SCAs, except for the OLI panchromatic band:

1. Obtain number of valid pixels, *Nvalid\_pixels (d)*, in image or collect. Pixels identified in the label mask as saturated, impulse noise affected, or parts of dropped frames, as well as filled pixels used to generate detector offsets and pixels corresponding to the Number of frames to be skipped at the top and bottom of the image, are considered invalid and need to be taken out of calculations. The symbol *l* is used to denote the list of valid pixels.
2. Find the minimum of valid pixel values, *l*:



1. Find the maximum of the valid pixel values, *l*:



1. Calculate mean as:



1. Calculate standard deviation as:



1. Calculate skewness as:



If *σ(d)* = 0, set *γ1* = 0.

1. Calculate kurtosis as:



If *σ(d)* = 0, set *γ2* = 99999.

1. Calculate correlation between each detector (image column) and the neighbor on its right side using only pixel pairs where adjacent pixels from both detectors are valid. This step needs to be performed for all detectors except the last one on each SCA.



where *Nvalid\_both* is the number of valid adjacent pixel pairs. A pixel pair is valid if both adjacent pixels in spatially aligned image, generated by two neighboring detectors, are valid.

1. Calculate mean squared response:



1. Save results to the database. Generate a report file, if that option selected in work order.

For each active detector, *d*, in the OLI panchromatic band:

 Repeat the steps 1 to 10, but separately for odd and even frames.

If the processed scene is an Earth scene, for each image band (OLI bands 1 to 9 and TIRS bands 10 and 11):

1. Calculate the SCA mean as:



1. Calculate the SCA standard deviation as:



1. Calculate the average number of frames for SCA as:



1. Calculate the band mean as:



1. Calculate the band standard deviation as:



1. Calculate the average number of frames for band as:



1. Save these scene summary statistics to the database