### Relative Gain Characterization (Histogram Method)

#### Background

This function calculates the relative gain of a detector for a given band and SCA from the lifetime scene histogram statistics. There are four different algorithms to calculate the relative gain: classical average mean, classical average standard deviation, SMA-1, and SMA-2.

The relative gains obtained from any method can be applied to the image to correct the striping due to differences in detector response. Some combination of methods may also be used to generate a single set of relative gains.

#### Inputs

|  |  |  |
| --- | --- | --- |
| **Descriptions** | **Level** | **Type** |
| Histogram Statistics  |  |  |
|  Detector Mean,  | Nband, Nsca, Ndet | Float |
|  Detector Standard Deviation, *σdet* | Nband, Nsca, Ndet | Float |
|  Adjacent Detector Correlation, *ρ* | Nband, Nsca, Ndet | Float |
|  Number of Valid Frames, *#frames* | Nband, Nsca, Ndet | Int |
| Threshold values |  |  |
|  Minimum Mean | Nband, Nsca | Int or Float |
|  Maximum Mean | Nband, Nsca | Int or Float |
|  Minimum Standard Deviation | Nband, Nsca | Int or Float |
|  Maximum Standard Deviation | Nband, Nsca | Int or Float |
|  Minimum Number of Frames | Nband | Int |
|  Maximum Number of Frames | Nband | Int |
|  |  |  |

#### Outputs

|  |  |  |
| --- | --- | --- |
| **Descriptions** | **Level** | **Type** |
| Relative Gain |  |  |
|  Ratio of Means |  |  |
|  Classical Average | Nband, Nsca, Ndet | Float |
|  Ratio of Standard Deviation |  |  |
|  Classical Average | Nband, Nsca, Ndet | Float |
|  SMA 1 | Nband, Nsca, Ndet | Float |
|  SMA 2 | Nband, Nsca, Ndet | Float |

#### Procedure

1. Read in the processing parameters.
2. Read in an SCA.
3. Determine if each scene in the data interval is valid.
	1. A scene must have data for all SCAs.
	2. Each SCA mean, , for a scene must be within the minimum and maximum mean thresholds.
	3. Each SCA standard deviation, *σSCA,* for a scene must be within the minimum and maximum standard deviation thresholds.
	4. The number of frames in a scene must fit within the number of frames thresholds.

If a scene does not meet each of these conditions it is invalid and its data will not be used.

1. For every scene in the interval, weight each detector mean, , standard deviation, *σdet*, sum of squares, *SumQ2*, and adjacent detector correlation, *ρ* with the number of valid frames, *#frames*.

 

 

1. Calculate global weighted detector statistics by summing each weighted factor in the interval, and dividing that sum by the total number of frames.









where 1 and 2 are the first scenes in the interval and *m* is the last.

1. Once the global detector statistics are calculated, the relative gain can be calculated using the different methods.

	1. The SCA average mean method is calculated by taking the ratio between the global detector means and the SCA average mean. The SCA average mean is the mean of all the global detector means in the SCA.



* 1. For the SCA average standard deviation method, the gains are calculated by taking the ratio between the global detector standard deviations and the SCA average standard deviation. The SCA average standard deviation is the mean of all the global detector standard deviations in the SCA.



* 1. The SMA 1 method gains are calculated by solving a matrix equation that contains the *SumQ2* and ρ products.
		1. First the global *SumQ2* and ρ products should be put into a matrix as shown below. Besides the last row, the matrix only has nonzero entries along two diagonals.



where *m* is the number of detectors.

* + 1. A reciprocal relative gain matrix is multiplied with this matrix, and their product is set equal to a zero matrix. The last entry in the zero matrix is set to the number of detectors to ensure that the mean of the relative gain estimations will be equal to one.



where *r* is the relative gain.

* + 1. Once these matrices are set up, any matrix solution method can be used to solve the equation.
		2. The element-by-element reciprocal of the relative gains vector will have to be taken to get the relative gains.
	1. The SMA 2 method is similar to the SMA 1 method.
		1. The global *SumQ2* and ρ products should be put into the matrix a little differently as shown below. This (tri-diagonal) matrix has values along three diagonals, except for the first and last rows, which only have two entries.



* + 1. A reciprocal relative gain vector is multiplied with this matrix, and their product is set equal to a zero matrix. The zero matrix here is not actually zero but the smallest possible positive non zero number the computer can use.



* + 1. Once these matrices are set up, any matrix solution method can be used to solve the equation.
		2. The element-by-element reciprocal of the relative gains vector will have to be taken to get the relative gains.
		3. After the relative gains have been found, they will have to be normalized to one.
1. Repeat Steps 2-6 for all SCAs and Bands.