SIZE-OF-SOURCE-EFFECT COMPENSATION

Size of Source Effect Basics

For infrared radiometric the size of the scene's object can have a severe influence on the temperature measurement's accuracy. Due to scattered or secondary radiation the observed signal and thus the calculated temperature increases with the object's optically imaged size. For an exact radiometric measurement, a compensation of this so called 'Size-of-Source-Effect' (SSE) is mandatory.

The general expression of the SSE based deviation is given by:

$$\sigma(d,D) \equiv \frac{S(d,T,T_{bkg}) - S(T_{bkg})}{S(D,T,T_{bkg}) - S(T_{bkg})}$$

With **d** the current optically imaged object's size, **D** the maximal optically imaged object's size (i.e. the maximal image size), **T** the measured, uncompensated object's temperature and $\mathbf{T_{bkg}}$ the current measured, uncompensated background temperature.

This expression can be translated to physical quantities given by the sensor:

$$\sigma(n,N) = \frac{(T_{obj} - T_{amb}) - (T_{bkg} - T_{amb})}{(T_{obj,ref} - T_{amb}) - (T_{bkg} - T_{amb})} = \frac{T_{obj} - T_{bkg}}{T_{obj,ref} - T_{bkg}}$$

With $\mathbf{T_{obj}}$ the current measured, uncompensated object's temperature optically imaged to pixels, $\mathbf{T_{bkg}}$ the background temperature given by the not-illuminated pixels, $\mathbf{T_{obj,ref}}$ the measured, uncompensated object's temperature of a fully illuminated scene of **N** pixels used as reference, $\mathbf{T_{amb}}$ the current ambient temperature of the sensor and **n** the current number of illuminated pixel.

The resulting compensated temperature is thus given by:

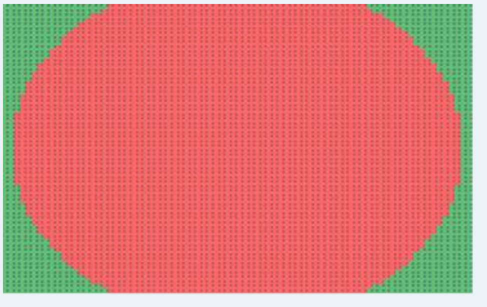
$$T_{obj,comp.} = \frac{T_{obj(n),uncomp.} - T_{bkg}}{\sigma(n,N)} + T_{bkg}$$

Using the above equation for compensating the impact of the SSE all **n** pixels detecting the scene's object have to be considered. In addition to the total of these pixels, the uncompensated temperatures of said object and the background have to be known.

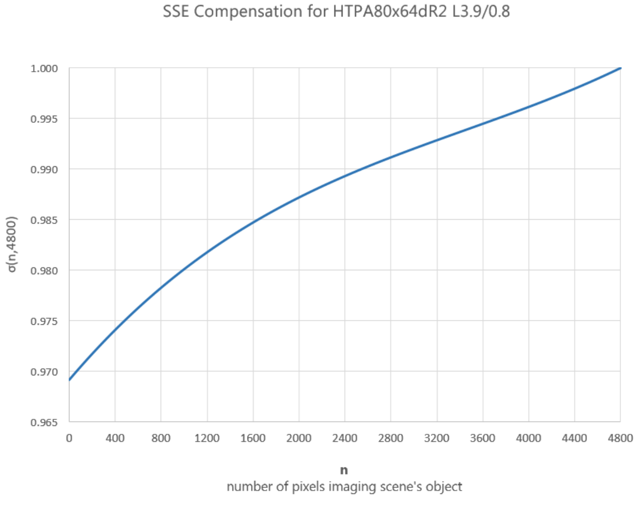
Sensor Specifics

Because of the optical source of the SSE, the compensation polynomial **σ(n,N)** has to be determined for each optical system individually.

For example: The radiometric radius for the HTPA80x64dR2 L3.9/0.8 sensor is given as 38.4 pixels (see datasheet), so the largest compensable object size in the thermal image has a size of **N = 4264 pixels**.



Red: Pixels within radiometric radius
Green: Pixels outside of radiometric radius



For the given example the determined compensation is describable as a 3rd order polynomial:

$$\sigma(n,4264) = 2.63 * 10^{-13} * n^3 - 2.72 * 10^{-9} * n^2 + 1.34 * 10^{-5} * n + 9.72 * 10^{-1}$$

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Pseudocode

Procedure Compensate SSE (pixelData, cp, thres, radiorad)

Inputs

- **pixelData** is the set of uncompensated pixeldata
- **cp** is the compensation polynomial
- **thres** is the threshold differentiating between background and object
- **radiorad** is the sensor's radiometric radius

Output

- **compPix** is the set of compensated pixeldata

Local

- **map** is the binary map for differentiating between back ground and object
- **avgTempObj** is the average temperature of all pixels imaging the scene's object
- **avgTempBkg** is the average temperature of all pixels imaging the scene's background
- **sumobj** is number of pixel illuminated from scene object
- **sumbkg** is number of pixel not illuminated from scene object

for each pixel do

```
if pixel outside of radiorad
then ignore
else if pixelData[pixel] < thres
then map[pixel] = 1  and  sumbkg ← sumbkg + 1
else if pixelData[pixel] > thres
then map[pixel] = 0  and  sumobj ← sumobj + 1
```

avgTempObj ← avg.(map[pixel] = 0)

avgTempBkg ← avg.(map[pixel] = 1)

for each pixel do

```
if pixel outside of radiorad
then ignore
else if map[pixel] = 1
then compPix[pixel] ← (pixelData - avgTempObj) / cp + avgTempObj
else if map[pixel] = 2
then compPix[pixel] ← (pixelData - avgTempBkg) / cp + avgTempBkg
```

return compPix

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