Allied Vision

APPLICATION NOTE

Defect Pixel Correction on Alvium Cameras

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Scope

Alvium cameras are shipped with all pixel defects corrected. This document explains what pixel defects are and how the defect pixel correction (DPC) is calibrated on Alvium cameras based on the EMVA1288 definition of pixel defects.

EMVA1288

The European Machine Vision Association (EMVA) defines the EMVA1288 Standard for Characterization of Image Sensors and Cameras, including definitions for pixel defects. See www.emva.org.

Technical background

What are pixel defects?

Every sensor includes a number of defective pixels. A pixel defect has a response that deviates more than a specified value from the local background in a dark image, corrected gray image, or a saturated image. As application requirements differ, it is not possible to find a common denominator to exactly define when a pixel is defective and when it is not. As consequence, sensor manufacturers define defects in various ways.

Vision applications' requirements are typically much higher than the pixel defects allowed by sensor manufacturers. Therefore, Allied Vision's definition for pixel defects is stricter. The DPC improves sensor quality above the standard typically provided by the sensor manufacturer.

Pixel defects manifest due to defects in design of the semiconductor chip or manufacturing errors. They develop through the sensor's product life cycle. This aging is particularly caused by cosmic radiation, which is substantially increased during air transport, or by harsh operating conditions.

Pixel defects can typically be divided groups, such as:

Defect type	Value deviation from neighboring pixels	Dependencies
Stuck high pixels	Saturated or close to saturation	No influence of illumination
Stuck low pixels	0 or close to 0	No influence of illumination
Hot pixels	Much higher	• Defects become visible already in dark images. • Values increase with exposure time and temperature.
High or low pixels	Significantly deviating sensitivity	With illumination only

Table 1: Defect pixel characteristics

How do defects spread over individual cameras?

Figure 1 shows defect distribution for a camera model. This statistic is used to define the thresholds for detection.

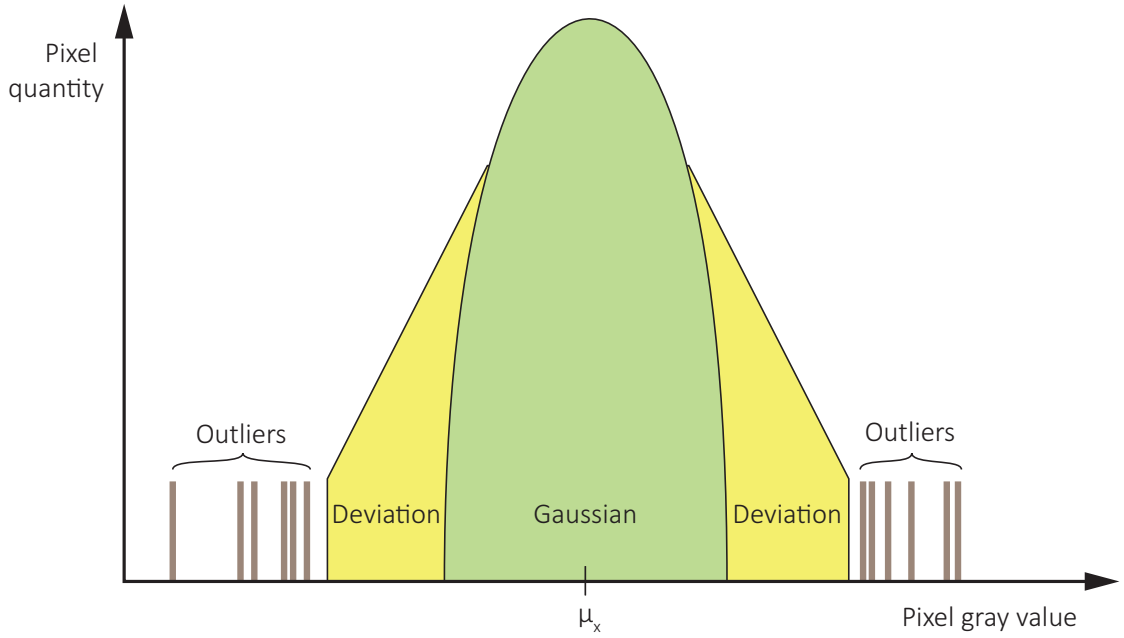

Figure 1: Schematic logarithmic histogram of a camera model

Gaussian: Shows a 1 to 1 image response for a sensor as calculated, using the Gaussian distribution for a homogeneous illuminated image, where μ_x represents the mean value.

Deviation: Deviation from the Gaussian distribution, which is typical for the sensor model. However, the quality is adequate for high-quality imaging, because deviations are minor.

Outliers: Values outside of **Gaussian** and **Deviation** are defined as defect pixels.

Pixel defects and warranty

For more information, please refer to the sensor data sheet or contact the sensor manufacturer. For sensor warranty information, see Allied Vision's Sensor Warranty Terms at www.alliedvision.com/en/support/warranty.

Examples for pixel defects

The following example show various pixel defects:

Figure 2: Example image showing various pixel defects

1. High pixel, significantly deviating in sensitivity
2. Stuck high pixel or hot pixel*
3. Stuck low pixel
4. Low pixel, significantly deviating in sensitivity
5. Cluster of stuck high pixels or hot pixels
6. Cluster of stuck dark pixels*

*Can be analyzed only from a sequence of differing images.

The same image after the DPC has been applied is shown below:

Figure 3: The same image after DPC correction has been applied

Decisive parameters for DPC calibration

The DPC on Alvium cameras strives to correct defects without damaging image details. The calibration parameters represent image acquisition in applications to create reproducible values in a stable test setup.

Temperature

Dark current accumulates over time. Because hot pixels have a higher brightness than the mean, they become visible in darkness. This is increased considerably by high temperature as well as by long exposure times. Therefore, pixel defects and associated detection threshold levels are usually defined for a specific exposure time and operating temperature. Temperature values are controlled for:

- Environment
- Camera: we ensure that the camera temperature is finally settled to the typical operating temperature during detection.

Image processing

Multiple images are averaged to eliminate temporal noise and processed to remove fixed pattern noise.

DPC metrics

For all calibration images, an exposure time of 100ms is used.

Thresholds define how much a pixel is allowed to deviate from its neighbors before it is tagged as defect. The threshold values were defined based on the histogram of the camera model, see Figure 1 on page 2. The following tables show the thresholds per model:

Threshold values on Alvium cameras

Model	Dark image detection	Bright image detection
Alvium xxxx C/U-040	10 count at 12-bit	3%
Alvium xxxx C/U-050	15 count at 10-bit	5%
Alvium 1xxxx C/U-120	30 count at 12-bit	6%
Alvium xxxx C/U-158	20 count at 12-bit	3%
Alvium 1500 C-210	30 count at 10-bit	6%
Alvium xxxx C/U-319	20 count at 12-bit	3%
Alvium xxxx C/U-500	130 count at 10-bit	6%
Alvium 1800 U-501m NIR	130 count at 10-bit	6%
Alvium xxxx C/U-507	20 count at 12-bit	3%
Alvium xxxx C/U-1236	20 count at 12-bit	3%

Table 2: Threshold values for the DPC on Alvium cameras

Alvium camera documentation

For documentation, such as user guides, see www.alliedvision.com/en/support/technical-documentation.

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