

Pixel correction of cameras with ams CMV50000 sensors

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Description

This Application Note explains pixel correction of the CMV50000 image sensor and other special camera features.

Products

Baumer cameras: LXG-500x, LXC-500x

Content

1	General information	2
2	Sensor behavior	2
2.1	FPN pixel noise (Fixed-pattern noise)	2
2.2	RTS pixel noise (Random telegraph signal)	2
2.3	Salt-and-Pepper Noise	2
2.4	Dependencies	3
2.5	Root cause	4
2.6	Pixel correction	4
2.7	Basic principle	4
2.8	Correction example	5
2.9	Side effects	5
3	Alternative ways of pixel correction	6
4	Support	7
5	Legal information	7

1 General information

CMV50000 sensors provide a special feature for pixel behavior in dark light conditions meaning noise at pixel level – in the following referred to as pixel noise. Studies proved two noise components at pixel level. This Application Note gives explanations on both together with related pixel correction to improve image quality.

2 Sensor behavior

2.1 FPN pixel noise (Fixed-pattern noise)

CMV50000 provides a fix pattern and time-related noise component called FPN characterized by the pixel gray value along the x and y coordinates. The pixel gray value always differs from that of adjacent pixels in the acquired image sequence.

2.2 RTS pixel noise (Random telegraph signal)

Unlike FPN pixel noise, RTS pixel gray values show random behavior, i.e. time and gray value cannot be foreseen. The illustration below shows the behavior of 5 pixels with most severely differing gray values within the active sensor surface.

2.3 Salt-and-Pepper Noise

FPN pixel noise is also referred to as Salt-and-Pepper Noise named after the black and white pixel pattern. This definition merges with the definition of dead pixels which are dead (white or black) throughout the entire operating range of the camera.

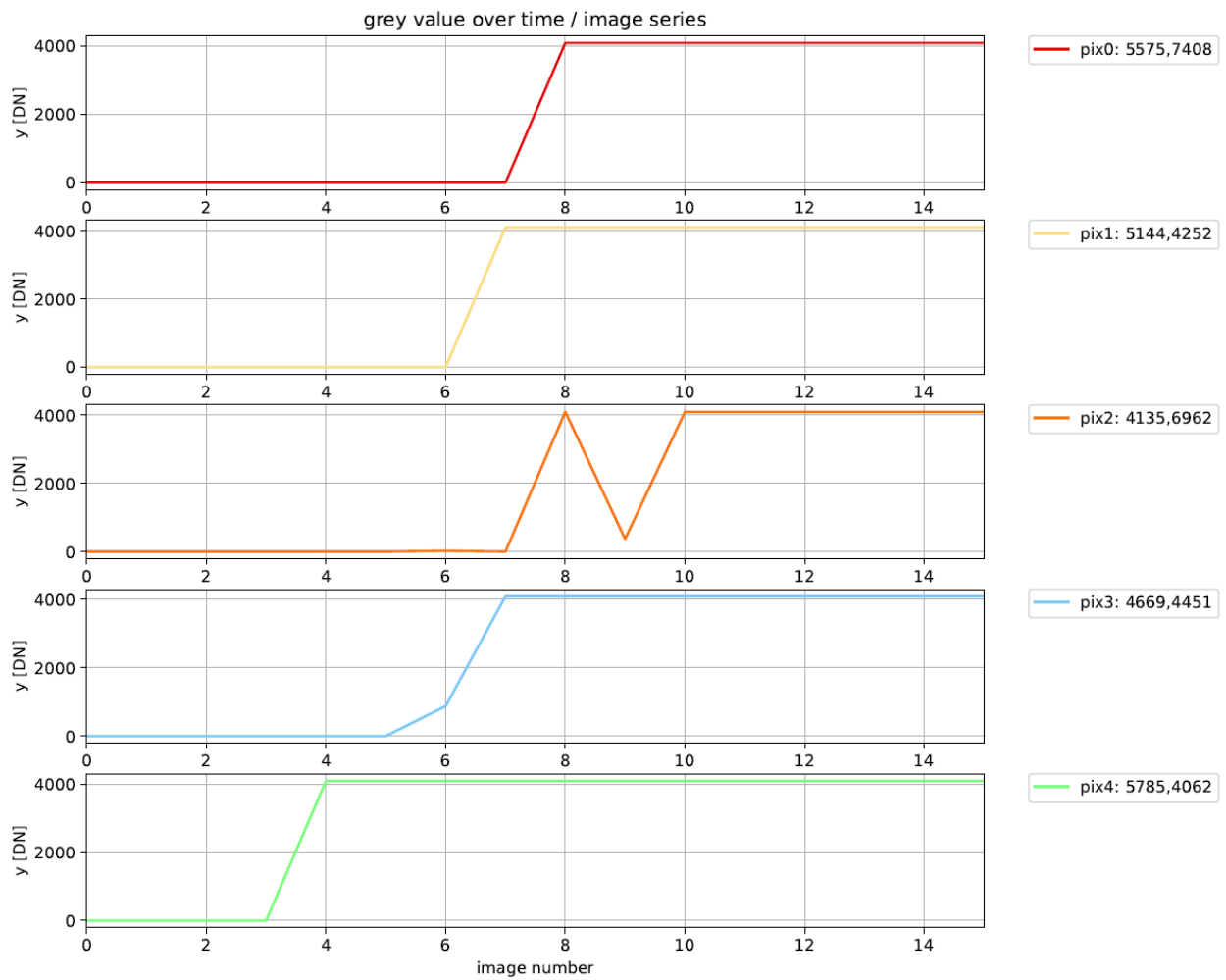
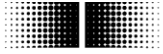


Fig. 1: Graph of 5 pixels with severe jumps in the gray value within a 16-image series acquired at 10 s exposure and 65 °C camera temperature.

2.4 Dependencies

The sensor's pixel noise shows dependencies to camera temperature and exposure time. In other words, rising temperature entails generation of considerably more pixels with gray values differing from adjacent ones. In terms of exposure time it is similar – the longer exposure the stronger FPN pixel noise.

The histograms below show pixel noise rising with increasing temperature and extended exposure. It is clearly seen that the amount of pixels outside normal distribution is significantly increasing. Conversely, to reduce pixel noise both temperature and exposure time should be as low as possible.

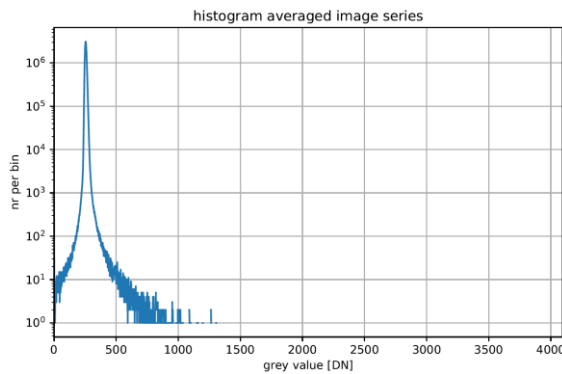
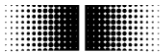


Fig. 2: Image histogram at dark acquired at 25 °C camera temperature and 75 ms exposure time

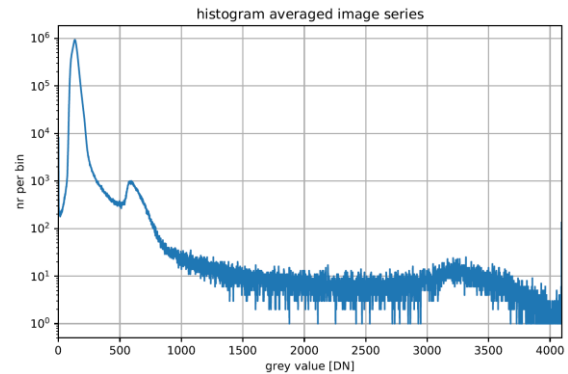


Fig. 3: Image histogram at dark acquired at 65 °C camera temperature and 10 s exposure time

2.5 Root cause

CMV50000 sensor manufacturer ams calls it leaks in the pixels' capacitive memory cells. If and when such capacitive leaks will occur cannot be foreseen. Therefore, it cannot be said either when the pixel will be completely black (minimum grey value) or white (maximum grey value). Furthermore, this effect seems to double every 10 °C rise in temperature from 30 °C onwards.

3 Pixel correction

In view of the large amount of pixels differing from adjacent ones on the active sensor surface, LUT-based correction which is similar to dead pixel correction is not feasible here. Studies showed a one-digit percentage of interfering pixels in relation to the camera's operating mode.

3.1 Basic principle

The large number of pixels and time-related behavior call for dynamic correction using 9×1 filters. Within the filter environment, the pixel's gray value is compared to adjacent ones using a threshold to decide if correction will be applied. Consequently, a high threshold implicates largely differing gray values and less pixel correction than using a low threshold.

3.2 Correction example

The illustrations below show pixel correction using a test image.

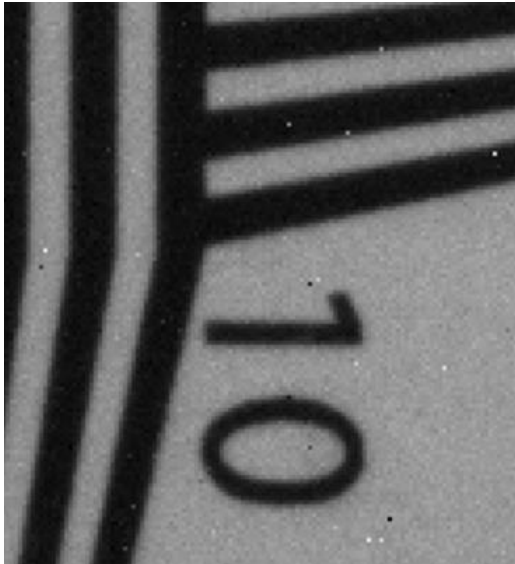


Fig 4: Pixel correction not active

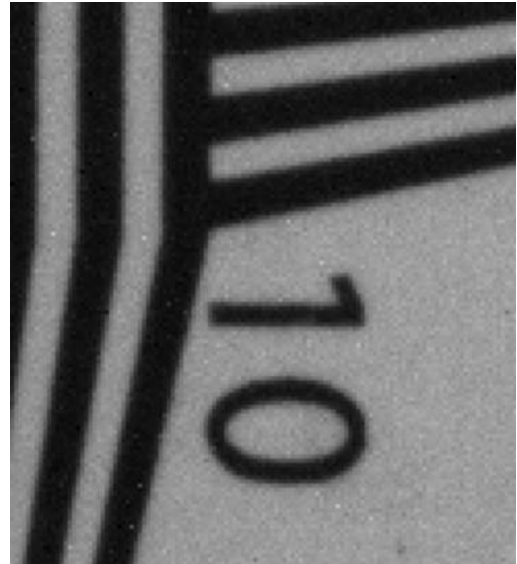
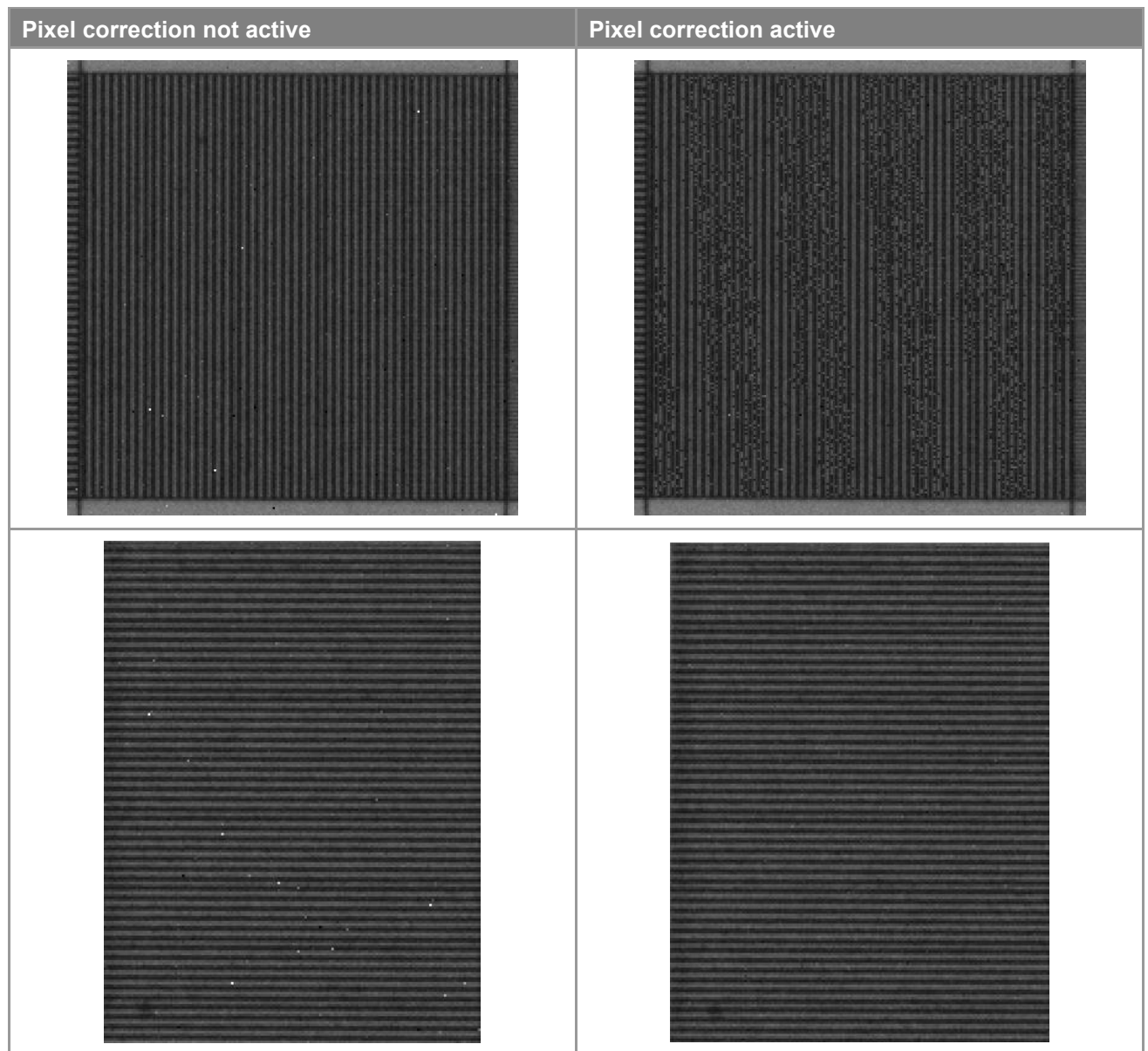
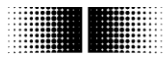


Fig. 5: Pixel correction active, threshold value 70

3.3 Side effects

The non-linear filter function has an effect on the EMVA 1288 measured results causing implausible values in this case. Filtering also interacts with the Modulation Transfer Function (MTF) of the camera system. Blurred edges impair resolution. Artifacts in line-by-line correction may impair delicate vertical structures. However, it depends on several variables such as structure size, pattern / repetition and the lens resolution capabilities (sharpness). The following illustrations show possibly incurred artifacts.



4 Alternative ways of pixel correction

Another option for FPN pixel noise correction is so-called Flat Field Correction throughout the entire image. However, RTS pixels cannot be addressed. Dynamic approaches with extended filter environment taking vertical structures into account are alternative solutions.

5 Support

Please contact our Technical & Application Support Center with any questions.

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6 Legal information

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