Modified Internal Gate (MIG) Technology – Technical Note

The consequence of the MIG sensor's NDCDS read-out property is that in low light when no reset is performed during a set of frames a final long integration image can be composed of the frame set just by subtracting the first frame from the last frame of the frame set even though there would be several frames in between these two frames. The overall read noise of this procedure is the read noise of a single read-out event multiplied by square root of two. By performing e.g. regression analyses on all frames belonging to the frame set one can actually reduce the overall read noise below the read noise of an individual read-out.

In order to reap the full benefit of the NDCDS read-out the MIG pixel should be equipped with pixel specific reset which can be easily realized by just incorporating one or more selection transistors into the MIG pixel. The benefit of the MIG pixel is that such selection transistors do not increase the pixel size since they can be implemented in the channel stop areas surrounding the actual photo-sensitive MIG transistors.

In case a MIG pixel is reset one or more times during a selected integration period the pixel value in the final frame as well as all values of the pixel before resets would be added together and from this sum the pixel value in the first frame of the integration period would be subtracted. This value would be then divided by the integration time in order to obtain the final pixel value representing intensity. In case the pixel would reach saturation at some point the pixel would be reset and the saturated pixel value would naturally not be included into the sum but instead the value before saturation. Besides the time between the frame wherein the pixel is saturated and the previous frame wherein the pixel was not saturated would be subtracted from the total pixel integration time.

In afore described manner frame rate down conversion can be performed for poorly lit subjects e.g. by subtracting frames at desired frame intervals at poorly lit image areas. For example, 100 Hz could be down converted to 10 Hz by taking into account every tenth frame or 25 Hz to 0.5 Hz by taking into account every 50th frame. Consequently, the frame rate can be afterwards down converted individually according to the speed of any subjects/objects in the image in a manner that maximizes the Signal to Noise Ratio (SNR) while image blur (i.e. motion distortion) is still kept below noticeable level. In other words, multiple optimized frame rates could be utilized for different frame areas in a single video stream.

In addition one can try to spot afterwards from a stored video stream a moment (or several moments) when the subject is stationary for a certain period of time in order to compose a motion distortion free maximum quality image from the subject. Due to the maximum frame rate the integration time can be matched more or less exactly to the time that the subject remains stationary which maximizes the signal. On the other hand, the noise is kept at minimum level since there is neither accumulation of read noise like in non-amplified sensors nor amplification noise like in amplified sensors. Similarly as in video mode different integration times could be utilized for different areas in a single still image.

To conclude, the MIG sensor technology revolutionizes the way cameras are used in low light since one does not need to preset the camera frame rate or integration time according to assumed subject movements in order to maximize the image quality. Instead one can use the camera at maximum frame rate and choose afterwards the desired integration time for still images or down convert the frame rate to a desired frequency without introducing any additional noise. This is unlike in any other image sensor technology.