CMOS Image sensors for machine vision in the era of artificial intelligence

Machine vision has always relied on global shutter image sensors with decent image quality and frame rate. Historically, only interline transfer CCD imagers were able to deliver the required image quality but since the last 15 years, global shutter CMOS imagers reached a similar quality with higher frame rate and lower power consumption, and entirely took over the market. This was a textbook example of disruptive innovation. A simpler technology reached the image quality that the market required and took over due to its cost, power, frame rate and form factor advantages. The enabler was correlated-double sampling with the global shutter pixels, which made read noise similar to global shutter CCDs. However, even after the shift to CMOS, quite different global shutter CMOS pixel architectures have been explored as pixels continued to shrink. Initially global shutter pixels used in-pixel voltage sampling for CDS. In smaller global shutter pixels, an in-pixel charge transfer to a storage region was used, and this technique was even combined with backside illumination. But now the combination of pixel level 3D interconnects, wafer stacking and dense capacitor storage allows to switch back to voltage sampling for pixel in the range of 2.2 µm.

In the first part of the talk, we will look back and identify the key enablers for global shutter pixel scaling and explain the rather large technological changes for different pixel size generations. Then the question is what can be done next for machine vision imagers. Are smaller global shutter pixels still needed? Should frame rate further increase? Or is it more useful to make our pixels more functional and more intelligent in the era of machine vision with artificial intelligence? Can pixel level optics bring extra functionality? Should the spectral range of wavelengths be extended? Should the pixel array be addressed in a smarter way? Or should we further investigate in-pixel circuit options to detect changes or local features inside or closer to the pixel matrix?

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