Center for Semiconductor Components - CCS

http://www.ccs.unicamp.br

CHARACTERIZATION OF A 16 X 16 ACTIVE PIXEL IMAGE SENSOR

A.R. XIMENES*, J. W. SWART, M. J. DEEN

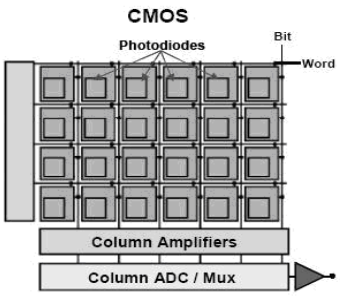
CCS, DSIF/FEEC, State University of Campinas (UNICAMP) P.O. BOX 6101, Campinas, SP, Brazil, 13083-970 - *ximenes@ccs.unicamp.br

Abstract

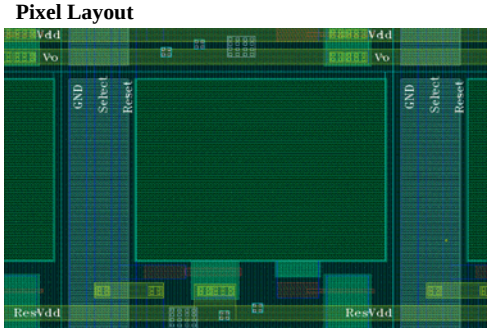
CMOS image sensors have become a strong competitor in the high sensitivity solid-state image sensor market, still dominated by charge-coupled device (CCD) sensor. Passive pixel MOS sensors have already presented for several low-cost applications. However, limitations in terms of signal-to-noise ratio, resolution, speed, versatility, etc, have been pushing the development of new types of MOS pixels. An appropriately designed active pixel MOS sensor might be a solution to overcome several of these limitations. Active Pixel Sensor (APS) arrays are under intense investigation as a possible substitute for CCD imagers. Power consumption, high integration and flexible pixel addressing are some of the advantages of CMOS APS arrays. Other differences between CCDs and CMOS image sensors arise from differences in their fabrication technologies. CCDs are fabricated in specialized technologies optimized for imaging and charge transfer. CMOS image sensors, on the other hand, are fabricated in mostly standard technologies and thus can be readily integrated with other analog and digital processing and control circuits. The possibility of integration in an entire system into one chip (System-on-a-chip) pushes its development and opens the possibility for new applications, as in very small and low-power systems. The parameters determination of this sensor like the maximum difference between the bright and dark that the sensor can work (Dynamic Range, typically around 70dB for human eye) the leakage current through the substrate when polarized in reverse bias (Dark Current) and the most important noise, associated with the difference of voltage at two neighbours pixels when illuminated by a collimated and uniform light source (Fixed-Pattern Noise – FPN).

Experimental

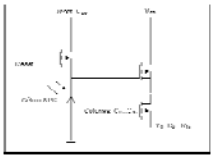
Readout Architecture:



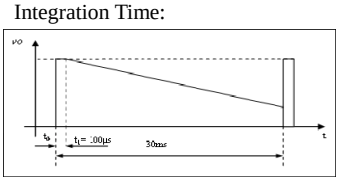
Pixel Layout



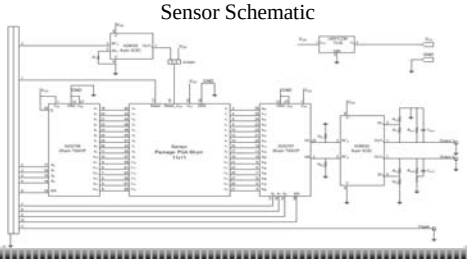
APS:



Integration Time:

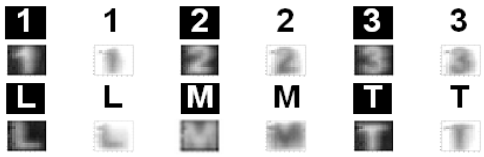


Sensor Schematic

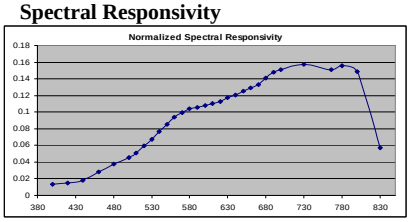


Results

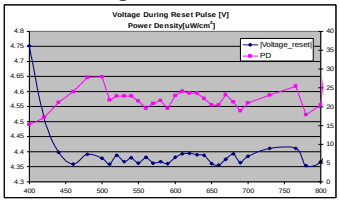
Image samples



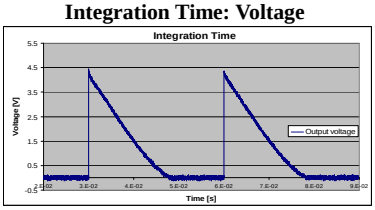
Spectral Responsivity



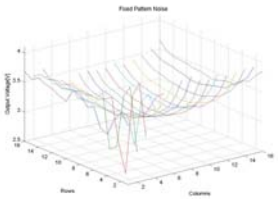
Reset Voltage Variation



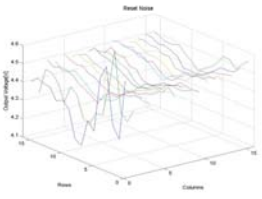
Integration Time: Voltage



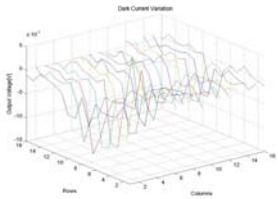
Fixed-Pattern Noise



Reset Noise



Dark Current Variation



Conclusions

This work have the main purpose the determination of different kinds of noise, as Fixed-Pattern Noise (FPN) and reset noise and parameters as Dark Current and spectral responsivity, as a standard characterization of image sensors. The idea of using the simple array of pixels is ideal to qualify the patterns of them, without any other standard circuits, as operational amplifier, multiplexers, etc. However, the extra necessary components to make the reading and addressing possible were added outside the sensor, but the match between the dual circuits is already and well known, due to the fact of these are commercial components. Although, some non-idealities may be present and the reading routine itself has a characteristic to minimize these mismatches, using double sampling during the integration time, once at the reset pulse (when the photodiodes are charged by a reverse bias connection) and another time around 20 ms of integration time. This time was chosen because it showed to be the best value for the light intensity applied. Different reading times and light intensities shall be performed in future works.

Acknowledgments

Author acknowledge the CCS/FEEC and McMaster University staff for helping in equipment preparation. This research was supported by CNPq.